Sanjay Bhasin

Lean Management Beyond Manufacturing

A Holistic Approach

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Preface

The significant problems we face cannot be solved by the same level of thinking which caused them

Albert Einstein

A Brief Summary of the Rationale for This Book

The decision to carry out this project has been triggered from various sources; in general, there are six very diverse yet interconnected reasons.

In the first instance, I have been requested on numerous occasions to undertake this. Often clients have indicated that when they follow the numerous Lean manuals and "how to" guides, they still encounter practical and everyday issues which are not clearly identified within the literature. Whilst the term "Lean" was conceived in excess of thirty years ago by Krafcik (1988), there still remain erroneous illustrations of the concept Lean as a perception. Despite the advancement made as regards the ingredients professed as vital for Lean to be successful within an organisation, undertakings to deliver a translucent comprehension of the philosophy have been and continue to be relatively mystifying. There currently blatantly exist procedural and philosophical cavities in the prevailing literature which attempts to clearly exemplify the indisputable and decisive requirements which any organisation attempting to adopt Lean and its ideology should both consider and integrate within their own Lean journeys.

Secondly and regrettably, I still find efforts to align the Lean initiative to the prevailing culture of organisations rare. In my experience, the majority of Lean initiatives which fail to achieve their intended objectives can be contributed to this factor coupled with the change management principles adopted by the respective organisations. Lean always needs to be envisaged as an everlasting expedition. Inherently within this voyage, efforts need to be made to alter the prevalent culture

of the organisation in question which is often either overlooked or measly efforts made to accommodate this. The organisation then seems flabbergasted that its Lean efforts have not materialised into a successful implementation.

Thirdly, I still encounter too many Lean efforts focusing upon the immediate organisation or particular functions within that organisation, namely manufacturing. Lean should always be viewed as a holistic ideology which also requires a need to embrace suppliers rather than viewing them as adversaries. The full benefits of Lean can never be realised unless the continuous improvement principles are applied throughout the organisation's value chain. Within this book, there is awareness that increasing product obsolescence, tighter launch deadlines and shrinking profit margins are forcing organisations to look for many ways to reduce the cost and time involved in manufacturing. Once we add the pressures of sustainability demands and a struggling global economy, a Lean supply chain becomes imperative to success. The book proceeds to indicate the notion of outsourcing, which is typically and erroneously employed to save costs. Very few companies are in a position to produce everything in-house, and the financial investment to do so would be unfeasible.

Fourthly, Lean is and constantly should be observed as integrating a commercial perspective; this has been clearly represented by Toyota who is devoted towards discovering improved methods of creating cars; with this in mind, performance management should be clearly integrated within any efforts to integrate Lean. A comprehensive investigation will be demonstrated in order to decipher whether organisations embracing the Lean principles as part of their overall strategic option managed to secure a competitive advantage. The intention is to decipher the potential benefits an organisation experiences by analysing the impact that the organisation's Lean journey has on its financial and operational efficiency levels. This is considered to assist in establishing an ideal promotional opportunity of any Lean initiative. I am often perplexed when Lean champions state to me that their organisation is seeking the return on investment from their Lean initiative; yet in the first instance, no efforts had been made to integrate effective performance parameters. A balanced portfolio of metrics is often necessary. Lean does not easily correlate itself to the traditional accounting systems; it is for this reason that organisations need to embrace systems which can suitably measure the impact Lean is making within their own organisations. Undeniably, Lean does involve a substantial investment which subsequently reaps exponentially a greater degree of savings. It is for this reason that it is important to gauge reliably the impact of Lean; this information is vital for policy makers within the organisations to make evidence-based decisions. A modified balanced scorecard will be discussed and recommended which embraces strategic, operational and indices focused towards the future prospects of an organisation.

Fifthly, the implementation of any major initiative requires bespoke and dedicated interjections required at particular junctures of the initiative; consequently, a considerable effort will be made to exemplify the phases of a Lean journey which often organisations, whilst espousing to the continuous improvement ideology, pay scant attention to. It is considered vital to plan out the Lean journey and then be

able to categorise the stage of Lean an organisation exhibits in its overall implementation journey. This presents a prospect to guide an organisation of precise prerequisites it needs to gratify if the company is serious regards embracing Lean as an ideology. I have witnessed numerous Lean audits which can often be placed at two extremes of a continuum; they are too vague and consequently not supporting many organisations' Lean journey; alternatively, they are too prescriptive with little flexibility. In the latter's case, the organisations struggle to apply the audit effectively. In this case, I have devised a comprehensive audit which organisations can suitably adapt to gauge their progress.

Lastly, if one seriously proposes the above objectives, it is important to promote the view of Lean as an overarching ideology. An exhaustive review is needed focusing upon the fundamental ingredients of modern-day thinking such as culture, the strategic inferences of Lean, implementation problems, obstacles to Lean, and performance measurement. This includes an evaluation as to whether Lean is indeed a panacea to all manufacturing problems. Lean should not be viewed as another process or initiative; instead, it requires a total radical transformation of existing practices and interconnections. Neither should its principles be viewed as gospel since they constantly need challenging in order to move things forward. However, this needs to be undertaken systematically through evidence-based decision-making and not in isolation without considering the impact upon other areas both within the organisation and across the value chain. This can only be undertaken, in my view, when Lean is adopted and executed by the organisation as an overarching ideology.

Reference

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Secondly, it is my late mother, Rampiyari Bhasin, who unfortunately passed away during the compilation of this book. It will always be the values she espoused of integrity, diligence, and endurance which besides being a considerable comfort to me in the last few months will constantly continue to inspire me for the rest of my life.

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Chapter 1
Introduction

Abstract Increased awareness of Lean has resulted in a plethora of "how-do-Lean" literature and a conundrum of Lean definitions, with little emphasis beyond this transactional process and outcome focus. This chapter will begin to explore how the Lean concept has shifted from a technical production system focus to an all-encompassing organisational philosophy. A valued definition coupled with a brief outline of the scope of this book will be provided. A Lean organisation understands customer value and focuses its key processes to continuously increase it. The ultimate goal was to provide perfect value to the customer through a perfect value creation process that has zero waste. To accomplish this, Lean thinking changes the focus of management from optimising separate technologies, assets, and vertical departments to optimising the flow of products and services through entire value streams that flow horizontally across technologies, assets, and departments to customers. Eliminating waste along entire value streams, instead of at isolated points, creates processes that need less human effort, less space, less capital, and less time to make products and services at far less costs and with much fewer defects, compared with traditional business systems. Companies are able to respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times. Likewise, information management becomes much simpler and more accurate.

A Reliable Definition of Lean

It was essentially during a span of four decades whereby in the early stages all the Lean doctrines and procedures were familiar to only very specific manufacturers, academics, and quality proponents. Lean has evolved over the previous forty years, and it is important to recognise a consequent view with regard to its ideology. This has led to various definitions of Lean. It was the Toyota Production System which developed the approaches, practices, and instruments of Lean. This began to change in the 1980s; the phrase "Lean" is attributed to John Krafcik in 1988 who was an

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undergraduate at the MIT, working under the guidance of Jim Womack. The research team were investigating the international automobile industry whereby they identified certain exclusive behaviours at the Toyota organisation. It was during their focus upon the examination of the performance levels whereby they discovered that Toyota excelled at many of the performance indices, whereby Krafcik stated 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 (p. 43).

According to Liker (1998, p. 8), "*Leanness is a process, a journey, not an end state*"; Wilson (2010) suggested that "*the Lean solution is a large paradigm shift*" (p. 16). Doolen and Hacker (2005) pointed towards the concept that Lean is a multifaceted concept.

There also exist definitions which concentrate on the point of production (Shah and Ward 2007); some look at its philosophy to eradicate waste (Cross 2012) or the creation of a balanced flow (Campell 2006). Beitinger (2012) focused upon how Lean through eradicating waste will facilitate Leanness, enabled the company to become "*subsequently more flexible and more responsive by reducing waste*" (Wilson 2010, p. 9). In reference to this book, the views of Prof. Liker's (1998) are also considered whereby he proposed that Lean is "*a philosophy that when implemented reduces the time from customer order to delivery by eliminating sources of waste in the production flow*" (p. 481); this view whilst holding a significant intensity of relevance is not thought to fully encapsulate the contemporary thinking behind Lean. The relevant principles of Lean are now also increasingly being applied to the service sector; consequently, an investigation undertaken by NIST (2003) has complete prominence in reference to the pursuing investigation; it suggested that Lean is "*a systematic approach to identify and eliminate waste through continuous improvement; flowing the product at the pull of the customer in pursuit of perfection*" (p. 1).

Brief History of Lean

In an effort to provide a brief historical account, the notion of Lean is often stated to have started with Benjamin Franklin who in 1733 began publishing "*Poor Richard's Almanack*"; at that stage, they were written on an annual basis and included weather reports, recipes alongside homilies, i.e. "*a penny saved is two pence clear; A pin a day is a groat a-year*" (Smalley 2006, p. 3). Henry Ford adopted the "Lean" concept within his business initiatives (Ligus 2007). Equally, Frank Gilbreth constantly stressed the notion of waste. F.W. Taylor pioneered what is presently referred to as standardisation and best practice deployment in the

"*Principles of Scientific Management*" (1911). Shigeo (1989) regarded as the prominent advocate of single minute exchange of die (SMED) and mistake proofing singles out F.W. Taylor as his role model.

Subsequently, Henry Ford assisted to provide a spotlight on waste whilst developing mass assembly. The concept of "*Design for manufacture*" (DFM) is attributed to Ford and mentioned within "*My life and work*" (1922). Sakichi Toyoda, within his textile company operating looms recognised the wastage as production, was interrupted once a thread snapped; the concept of Jidoka is attributed to him, whilst Kiichiro Toyoda, the creator of Toyota, acknowledged the importance of preventing poor quality occurring in the first instance through particular attention being attributable to the various processes and their alignment. It was, subsequently, Ohno (1988) who then developed the core concepts further and increased their use; this was evidently applied to manufacturing in the 1950s; this developed to vehicle assembly within the 1960s and pursued within the broader supply chain in the 1970s. The "supplier manuals" within the 1970s made the concept of Lean more obvious to the many organisations external to Toyota.

The actual concept of "Lean" was created by Krafcik (1988); this was undertaken as a researcher working for the "International Motor Vehicle Program" (IMVP) as part of the Massachusetts Institute of Technology. The level of Lean awareness within the Western world is attributable to Womack et al. (1990). "*Lean Enterprise*" as an idea was instigated by Womack et al. (1990) in an effort to illustrate the expansion of the Lean principles outside the host organisation. The advancement of Lean concentrated upon quality in the earlier years of 1990s towards quality, cost, and delivery in the late 1990s; this has been extended to "*customer value*" from 2000 onwards. The expression "*Lean Provision*" (Womack and Jones 2005, p. 8) represents the phases in order to be able to supply the desired value to the customer. The contemporary research implies that this could involve extending the principle to a number of organisations.

Wincel and Kull (2013) suggested that within the existing economic environment of ever escalating universal competition, organisations are driven to improve flexibility, sharpen market responsiveness, improve output, and simultaneously reduce their overall costs. Lean manufacturing is one of the keys but not only means by which this is being pursued. The fundamental principle of Lean utilises continuous improvement to concentrate upon the eradication of waste or non-value-added procedures existing within the organisation (Womack and Jones 2005). Lean as a concept should form part of a company-wide strategy with its objective to increase the market share enjoyed by the organisation, whilst simultaneously endeavouring to decrease its operating cost base (Wilson 2010).

Lean as a system enables organisations to decrease their costs by eradicating waste; it enables the organisation to improve its quality levels and levels of customer fulfilment. Samuel (2010) advocated that an organisation embracing a Lean production system expects complete support from its various functions such as administration, HRM, and finance. The supporting functions have to undergo a transformation since the processes have to become better synchronised and linked with the ultimate goal of attempting to reduce levels of waste in the organisation.

Liker (2004), Hines et al. (2008), Camp (2013), Singh et al. (2010), Samuel (2010), and Marksbury (2012) suggested that the wastes which Lean endeavours to concentrate upon are as follows and usually associated with Lean management:

(i) **Overproduction**
Overproduction occurs when your company produces more than your customer requires. You could be producing items for which there are no orders or producing more than is required at the correct time. This is the worst waste as it has a knock-on effect in multiplying all the other wastes. Overproduction increases defects, impacts on inventory costs, process chains, and waiting alongside unnecessary motion and transportation.

(ii) **Inventory**
Inventory is the quantity of parts required to manufacture a product, or finished good and products held in stock. When not in use or not being utilised in production, they take up valuable space/volume. They may become obsolete whilst in stock and detract raw materials and parts from use elsewhere. Competitive companies make sure that their paper or IT systems control their inventory so that money is not wasted on unwanted or unnecessary materials, parts, or finished goods.

(iii) **Defects**
Defects result in scrap and reworking/reprocessing as a result of products being found to be defective and have to be reworked or disposed of, both a costly process. Defects are caused by poor or inferior manufacturing processes as a result of either human error or equipment breakdown or both. Reworking takes additional time and therefore increases the cost of the finished product. Scrapping or disposal incurs additional costs and unnecessary use of resources that impacts an organisation's bottom line performance.

(iv) **Waiting**
Every task in a manufacturing process is dependent on the processes that take place upstream and downstream. If operators, equipment, information, or materials delay the production process for any reason, time is wasted and your cost of production will increase further impacting, cumulatively, on your profitability.

(v) **Transportation**
The unnecessary movement of information, items, materials, parts, and finished goods from place to another wastes time, resources, and money. Unnecessary transportation is usually paired with unnecessary motion, damage to, and even loss of product. Even the paper or IT systems (if any) to track the movement can be adversely affected.

(vi) **Motion**
Unnecessary motion relates to staff, and in particular operators, moving around the workspace wasting time and effort. All unnecessary motion can be caused by poor standard procedures and practices, poor process design, or poor work area layout.

(vii) **Over-processing**
Over-processing involves the taking of any unnecessary steps during the manufacturing process. It can also mean producing parts or products of a higher quality than is required. This may be due to malfunctioning equipment, errors in reworking, ineffective processes, poor communication, and not benchmarking against the customers' requirements, including internal customers further down the process.
Another one which has been adopted in much of the recent literature; i.e. Wincel and Kull (2013).

(viii) **Incorrect use of staff and their abilities**
Not properly utilising the skills and abilities of staff, and even not engaging with them loses your organisation time, non-use of skills and ideas, missed improvement opportunities, and learning opportunities by simply not listening to your staff. Your staff need to be integral to the complete production process, whether that be manufacturing or administration. From the "shop floor", they can generate ideas which can eliminate the other seven wastes. Such engagement will help to improve your processes and staff development continuously.

An easy way I learned at a seminar to remember the wastes, they spell TIM WOODS

T—Transport—moving people, products, and information;
I—Inventory—storing parts, pieces, documentation ahead of requirements;
M—Motion—bending, turning, reaching, lifting;
W—Waiting—for parts, information, instructions, equipment;
O—Overproduction—making more than is IMMEDIATELY required;
O—Over-processing—tighter tolerances or higher grade materials than are necessary;
D—Defects—rework, scrap, incorrect documentation;
S—Skills—under-utilising capabilities, delegating tasks with inadequate training.

Numerous acronyms for these eight wastes have been proposed as aids to memory, but the one that seems to have caught on best is DOWNTIME. It is simple, straightforward, and appropriate. Here is what each of the letters stands for:

Defects
Overproduction
Waiting
Non-utilised/underutilised talent
Transportation
Inventory
Motion
Excess Processing

Principles of Lean

Atkinson (2010) proposed that the central theme for Lean is to exploit customer value through reducing the wastes that are generated within an organisation. In essence, Lean attempts to generate more value for its customers, whilst utilising less resources. The Lean ideology develops from an attempt to widen the organisations' remit by attempting to persistently improve the customer value (Clarke 2011). In order to achieve this, the organisation has to alter its focus from vertical transformations to a situation whereby the products of the complete value streams flow horizontally across the various functions towards the customer. The literature, Bicheno and Holweg (2009), Camp (2013), Womack and Jones (2005), and Marksbury (2012), is abundant, suggesting that there exist five essential principals to Lean, namely:

(i) Identify the customers and specify the value; clearly define value for a product in view of the customers' perspective; targeted attempts to waste reduction can occur,
(ii) Proceed to categorise and map the value stream which essentially comprises of all the collective activities used to deliver the end product,
(iii) Improve the flow by eradicating the waste which assists to reduce the lead time of delivery,
(iv) Be responsive to the customers' demand schedules, and
(v) Continuously pursue perfection.

One considers that the a prominent and overall challenge faced by Lean organisations is to develop a culture which assists to both generate and maintain a long-term obligation from senior management towards the entire workforce.

Scope Covered by the Book

It is imperative to clearly clarify at this stage of construction that, whilst the principles, procedures, ideology, and theory of Lean is being increasingly applied within the service sector, its roots remain firmly within the manufacturing sector and it is this area that this book's focus will concentrate upon. It is considered that a very broad discussion on Lean would loose focus and any attempts to make generalisations as the impact of Lean on performance requires particular direction. Likewise, often the cultures of a service and manufacturing organisation are too diverse which would have impacted upon the recommendations and conclusions made.

Nonetheless, the principles of Lean outlined within this book are transferable to other sectors. The intention is to enable organisations viewing Lean as a strategic deployment to fully comprehend and recognise the possible pitfalls, whilst concurrently improving the potential implementation rates. Undeniably, both in my

experience and extensively collaborated through other empirical research, as will be reflected upon within the book, the predominant factor for most Lean initiatives failing to achieve their intended outcomes centres upon both the prevailing organisational cultures and the change management systems utilised. Consequently, there will be a considerable focus within the book clarifying aspects which organisations need to be attentive about in their endeavours to both implement and sustain their respective Lean initiatives.

Likewise, during my investigations of Lean implementations in the past, company executives and Lean champions have often reflected upon the sustainability aspect of their Lean programmes. The conversations seem to centre upon the true impact of the initial successes which were not maintained. As a Lean practitioner, this opens up an extensive debate about sustainability which, whilst acknowledging the impact of culture, also needs to examine the need to consider the implementation remit and scope of Lean. For Lean to be effective at a strategic level, it needs to be embedded within the entire organisation and then progressively extended to the entire value chain. Otherwise, the benefits from Lean will never be fully realised. Frustratingly, the company executives and Lean champions will often depict excuses about Lean and its ideology rather than undertaking their own root cause analysis. With this in mind, a sophisticated Lean audit has been devised which can prove fundamental for companies to assess the juncture of Lean that they have reached as an organisation on their journey. It encompasses indices under various categories in order to identify particular areas the organisation needs to concentrate upon. The added benefit of this audit is that it helps to identify possible lines of action open to the organisation in order to either consolidate its Lean initiative or to try and embed Lean to a greater degree.

Lean initiatives still have a chequered record of success which is clearly evident in Britain. Consequently, there is a dedicated section which assists to elucidate the possible pitfalls that companies should be mindful of in their quest to successfully implement Lean. The predominant barriers will be ascertained and substantiated by the research undertaken for this book. Furthermore, as a result of ones experience of Lean initiatives within many organisations over the last twenty years, possible counteractive measures will be explored. It is important that an organisation embarking upon its Lean quest is fully conversant with the problems and complications that can accompany a company's decision to adopt and implement the Lean principles.

Whilst a wide-ranging discussion on Lean as a strategic option needs closer scrutiny whereby its principles and ideology will be analysed in depth; it is necessary to try and determine whether those organisations adopting Lean, as part of their strategy, proceed to perform better than would have been the case otherwise. This needs a detailed investigation since often companies profess to be embracing Lean, though upon a closer investigation, it becomes apparent that only some components of Lean are instilled. It is then also often evident that the company is devoid of commitment necessary to fully embed Lean into its overall entity.

In order to clarify that Lean resulted in a sustained improvement in the business's performance, the analysis will consider the performance measurement

doctrine in order to gauge whether this actually happens in practice. In order to make this judgement, it is vital that the analysis proceeds further than a review of an organisation's financial statements. Although the balanced scorecard methodology (Kaplan and Norton's 1992, 1993, 2001, 2005) will be utilised, it was important to extend this principle for reasons which will become clear during the investigation. A tailored adaptation of the balance scorecard was used which was based upon the idea forwarded by Maltz et al. (2003). This will be used as part of the methodology and data capture in order to determine the impact of Lean on the organisation in question. In order to make a valid judgment, it was necessary to examine indices which explored an organisation's performance from a multifaceted perspective, namely:

- Financial,
- Operational,
- HRM,
- Procedural, and
- Sustainability, looking at the future prospects of the organisation.

A subsidiary development of the book will focus upon the Lean journey; the literature review proceeds to clarify the inputs required should an organisation be deemed to be on classed as fully embracing Lean. It was felt that an additional gauge is necessary in order to try and determine whether an organisation was fully committed to Lean ensuring that this judgment could be reliably made; alternatively, the investigation would have lacked rigour since a standardised approach would not be possible. Figure 1.1 illustrates the objective of the book in a pictorial format.

The book proceeds to empirically validate the data captured in order to provide the reader with evidence-based decisions with regard to aspects covered within the overall discussion. Sophisticated statistical investigations will be undertaken in an effort to test the assertions advocated through literature reviews and the authors own extensive involvement with Lean initiatives within the UK. Furthermore, there will be an attempt made to investigate whether there is a distinction between the Lean journeys of organisations within three sectors. In order to facilitate triangulation,

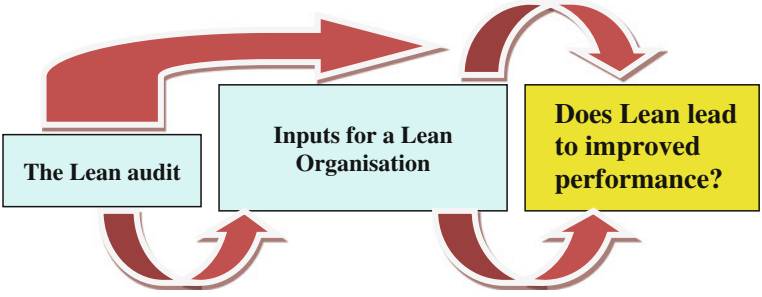

Fig. 1.1 The objectives

small, medium, and large organisations will be investigated within several sectors, namely:

(i) Electronics,
(ii) Automotive components, and
(iii) Generic small components.

Summary

In any investigation of this magnitude, it is important to try and clarify the possible consequences if Lean is not promoted and implemented appropriately. Similarly, Lean cannot and should never be viewed as a panacea to every manufacturing problem. In this context, the prevailing considerations will need to be evaluated with view towards providing companies with a balanced view of both Lean's potential and possible limitations. Finally, the author is absolutely convinced with regard to the need to portray a message that any organisation serious in regard to its Lean commitment needs to both adopt and view it as an overarching ideology. Consequently, it is imperative that the Lean concept should be regarded more as a philosophy or condition than as a process. In that respect, "*Leanness is a relative measure*." Ohno's principles clearly assisted to reflect how the Toyota Production System was much more than a production system since he promoted it as a complete management system. In this situation, Lean needs to be regarded as an ideology or philosophy since there is a requirement for its commitment from all the various levels within the organisation. Lean transcends far beyond the engineering and management disciplines since at its core, it always tries to emphasise the concept of value and the eradication of waste in a continuous method based on common sense. To be successful, the organisations need to separate the Lean philosophy from the techniques and tools used to support the philosophy. Lean is essentially an arrangement of techniques embraced from a structure that has descended from a philosophy. Consequently, Lean must always be observed as a philosophy with the tools such as Six Sigma acting as enablers.

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Chapter 2
Clarification of the Lean Concept

Abstract This chapter explores the concept of Lean in detail and will attempt to tackle many of the existing misconceptions regards Lean. Lean is a complex ideology that requires considerable effort if implemented appropriately. The procedural aspects will be discussed at length, outlining the importance of implementing the Lean principles in a systematic fashion. Furthermore, there exists empirical evidence that suggests that most Lean initiatives fail. The literature and evidence available is analysed to explain possible causes. HR, culture, and change management are often cited as prominent reasons for Lean not being successfully implemented. This aspect will be further scrutinised. Furthermore, as this investigation hopes to consider whether Lean aids competitiveness of organisations, a thorough evaluation will be undertaken to judge whether existing empirical research verifies or refutes this assertion.

Understanding the Concept of Lean

As intimated earlier, it was the Toyota Production System (TPS) that developed the relevant approaches, Lean practices, and instruments. The phrase "Lean" is attributed to John Krafcik who in 1988, as an undergraduate at the MIT, worked under the guidance of Jim Womack stated 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 43). An exploration undertaken by NIST (2003) has complete prominence in reference to this pursuing investigation; it suggested that Lean is "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).

Liker and Franz (2011) suggest that there are still only two per cent of Lean programme implementations that reach their expected results. The rationale for this is that there is often little understanding of organisational factors that enable successful

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implementations and continuation. There are many obstacles that a Lean journey encounters (Henderson and Larco 2003). Ransom in his investigation (2008) states that "*there are really only 5 % who practice the art skilfully in a world class master practitioner kind of way*" (p. 4). Liker's earlier work (2004) reviewed that "*50 % of the auto suppliers are talking Lean, 2 % are actually doing it*" (p. 2). Likewise, the "*Manufacturer*" (2002) authenticated this whereby it suggested that whilst one hundred Lean companies were questioned regards their proximity towards becoming a total Lean organisation; only 3 % suggested that they were beyond "doubt" Lean; however, 22 % implied that they were only approaching this state.

Toyota's philosophies were moulded by the personalities, ethics, and capabilities of its creators in the Toyoda family. The Lean principles are firmly founded on shrewdness and scientific methods (Bicheno and Holweg 2009). Koenigsaecker (2005) proposes that Lean success as a strategy necessitates imagination, reflection, and trialling. Taiichi Ohno, Shigeo Shingo, Sakichi, and Kiichiro Toyoda reflected this doctrine. The prevailing assertion within a substantial amount of the literature states that the main objective for Lean "*is to eliminate waste*" (Lewis 2008). In practice, the chief driver for Lean is the need to construct a thriving and resilient company (Singh et al. 2010). Unfortunately, there still persist misconceptions regards Lean; this is in spite of hundreds of books and proportionately more papers and articles coupled with supplementary resources devoted towards Lean.

Radziwill (2013) suggests that Lean is principally and notably a system, in essence an assimilated sequence of portions with a noticeably defined objective. Lean expects total dedication and should be extended further than just the engineering and management disciplines whilst stressing the concept of value in its endeavour to eliminate waste in a sustainable manner. Similarly, it is important that the companies distinguish the Lean ideology from the techniques and tools such as Six Sigma utilised to maintain the ideology. Whilst proponents of Lean such as Toyota inform us of the Lean instruments, organisations need to discover their own methods of improving these instruments (Liker 2004). The Toyota way fundamentally outlines the doctrine of the Toyota culture, allowing the TPS to operate successfully. Regrettably, many organisations consider the TPS has a collection of tools aiding better effectiveness. Instead, they should view Lean as a complete system which persuades its employees to constantly advance the processes they utilise (Singh et al. 2010). Consequently, often countermeasures were instigated and these have become a necessity for engineers and others in their manufacturing processes (Womack and Jones 2005).

The TPS should be viewed as facilitating a complete management ideology focused upon overall customer fulfilment. Equally, Montgomery (2010) suggests that it promotes a setting of teamwork and enhancement simultaneously advancing quality in the process. Organisations hoping to demonstrate that Lean aids performance levels for their own company are required to implement a more wide-ranging approach to performance management (Neely et al. 2005). Dimancescu et al. (1997) made an initial breakthrough to measure the impact Lean makes on an organisation though the analysis was somewhat restricted. The reimbursement an organisation accrues from Lean is not always obvious and not captured

appropriately through traditional accounting methods. Further work from Bond (1999) and Wade (1997) coupled with the comprehensive addition to the field of performance management by Kaplan and Norton (1992, 1993, 2001, 2005) proceeded to provide a more comprehensive system to gauge the performance of an organisation.

Nonetheless, the study by Maltz et al. (2003) will be analysed as they were able to extend the principles of the balance scorecard further by looking at sustainability of an organisation's performance levels. Lean needs to be viewed as an overarching strategy or a prominent strategy as has been advocated (Atkinson 2010). Fullerton and Wempe (2009) suggest that too often, there still exists a profound prejudice towards viewing Lean as a manufacturing concept rather than viewing it as a company-wide notion. The Lean success requires total devotion from all tiers of an organisation (Hines et al. 2008; Jones 2009). There is a consensus amongst academics (Cocolicchio 2008; Haskin 2010; Koenigsaecker 2005) that the main objective of Lean is to secure organisational profitability resulting from superior performance levels.

Lean Development

A truly Lean organisation such as Toyota communicates that Lean is more than a compilation of tools and that its ideology focuses upon a need to reduce three categories of waste (Koenigsaecker 2005), namely Muda (non-value adding work), Muri (overburden), and Mura (unevenness). Liker (2004) suggests Lean is both challenging and needs to be innovative. Whilst an organisation could learn from benchmarking exercises, it needs to recognise that the Lean journey for any one organisation is a unique experience and needs to be handled as such (McVay et al. 2013). Ohno (1988) reflects that the TPS was more than a simple production system since it was developed into a wide-ranging management system. Bicheno and Holweg (2009) suggest that to reap the full benefits of Lean, it needs to be extended to the complete value chain. It needs to be recognised that organisations operate uniquely with each one displaying idiosyncratic struggles and limitations (Cross 2012). It is vital that the company in question adopts all the Lean principles that will help it find its own solutions (Mcvay et al. 2013; Cocolicchio 2008). A company on the Lean journey is required to appreciate where it is heading (future position) and its present position (Johnston 2009).

It is fair to say that over the last quarter of a century, the term "Lean" has spread to almost every sector. In the early days of implementation, the manufacturing companies visiting Japan to see what Toyota was doing had a number of false starts or lessons learned (depending on whether your glass is half empty or half full!). Early implementations focussed on empowered teams and continuous improvement (kaizen) or attempts to replicate a pre-defined box of tools such as 5S, Single Minute Exchange of Dies (SMED), SPC, and kanban. Likewise, for many, Lean became synonymous with kaizen events—which were actually kaikaku—radically

reconfiguring individual operations. For some, this led to them developing their version of Toyota's famed Production System (TPS) including their own schematic "house" or "temple" of Lean along with departments of continuous improvement specialists.

Procedural Requirements for Lean

A fundamental prerequisite is the need to ensure that the suitable tools are put into practice within the right circumstances and contained in a manner that proceeds to support the organisation's value chain (Bicheno and Holweg 2009). A kanban system, for instance, when operational in an environment of fluctuating demand would be regarded as waste (Womack and Jones 2005). Research (Angelis et al. 2011; Black 2007; Conner 2009; Dalal 2010; Henderson and Larco 2003; Laureani and Antony 2012; Wheatley 2005) implies that any organisation hoping to implement Lean has to guarantee that it does not utilise a few exceptional tools, and that instead, it is vital that the company uses and applies the majority, if not all, of the following:

- Cellular structures since it is imperative that the requirements to produce a product(s) are grouped closely for efficiency (Lee 2008)
- Kanban methodology needs to be fully embraced (Smalley 2009)
- Kaizen which focuses upon the constant quest of advances in quality, cost, delivery, and design
- This also requires the need to detect problems with feedback loops ensuring modifications are implemented (Campell 2006)
- Single-piece flow systems to be adopted need to be geared towards adding value (Bartels 2005)
- This needs to be combined with process mapping indicating the product and information flows (Jones 2009).

Furthermore, an organisation needs to actively work towards supplier development (Bicheno and Holweg 2009); likewise, this needs to be combined with supplier base reduction which aids scheduling and planning; equally, the relationship with suppliers needs to be one of collaboration and not an antagonistic one (Hines et al. 2008); SMED attempts to reduce hold-ups in changeover times on machines (Bicheno and Holweg 2009); kaikaku attempts to support the incremental changes required as opposed to kaizen, when appropriate (Sim and Rodgers 2009); 5S and common visual organisation are needed to reduce untidiness and disorganisation (Womack and Jones 2005); and total productive maintenance (TPM) is required focusing upon dependability, reliability, and capability of equipment through maintenance as forwarded by Ohno (1988). Imperatively, an organisation should never lose focus upon the concept of value and the wastes should always be considered, namely over production, waiting, transportation, inappropriate processing, inventory, unnecessary motions, and defects; proponents have recently added an eighth waste, underutilised people.

Predicted Benefits of Lean

There exists an accumulation of literature and empirical evidence suggesting the benefits of Lean. Subsequently, primary empirical research has been undertaken as part of this investigation. However, the intention of this chapter is to provide an indication of the more thorough and robust considered research that has been undertaken. Bicheno and Holweg (2009) advocate that the effective companies assimilate methodical variations to align the demands of the customer, strategy, and stakeholders within the business. Lean has to extend behind manufacturing to be successful (Womack and Jones 2005; Stump and Badurdeen 2012). Inherently Lean endeavours to fulfil customer requirements through timely delivery, reducing variability and consequently the overall cycle time at an enhanced quality level (Waurzyniak 2009; Wilson 2010; Halliday 2005). Empirical evidence (Hines et al. 2008; Laureani and Antony 2012; Marksbury 2012) suggests that the more competent companies abridge and level the flow from raw material input to the final product; whilst managing to reduce waste, followed by a certainty of what they are doing. Likewise, the strictly world-class companies, i.e., Toyota, exhibit several distinctive management behaviours; the prominent one being quoted is the ability to link the respective organisation's strategy to action (Jones 2009).

Empirical Evidence on the Benefits of Lean

"*The Lean Strategies Benchmark report*" (Bartels 2005) discovered when an organization realistically adopts Lean across the entire organization, that it is three times more likely to be regarded as industry best-in-class. The NIST report (2003) discovered Lean can result in operational improvements such as cycle time being condensed by 90 %. Likewise administrative benefits including a reduction in order processing time are also possible as suggested by the McKinsey & Company's Production System Design Centre (PSDC 2002); They proceeded to suggest that 60 % of the better performing companies had adopted Lean effectively.

The EEF final investigation (2001) conducted in companies that had adopted four or more of the key Lean tools reaped greater benefits from their Lean journeys. Shah and Ward (2007) discovered a positive association of Lean with operational performance. Koenigsaecker (2005) summarises an investigation undertaken by the Association of Manufacturing Excellence (AME) whereby the quoted benefits included a saving of 95 % in lead time. The Manufacturing Foundation findings (2004) stated that 62 % of their sample reaped benefits from Lean. Ransom (2008) quotes that Lean awards companies a competitive edge, namely a revenue expansion of 10–12 %, and an income development rate of 12–15 %.

Rationale for the Low Numbers of Successful Lean Initiatives

Similarly, Lean initiatives suffer from a low record of successful programmes; once again, the subsequent section highlights the existing evidence. Nonetheless, an attempt is made to subsequently provide the reader with a more detailed input regards how the record of successful Lean initiatives could be improved. A considerable literature exists which dictates the reasons for the low numbers of successful implementation; Table 2.1 summarises the empirical evidence of the possible hindrances towards Lean and the mindset change required from proponents should they hope to combat the existing trend of experiencing low numbers of successful initiatives; this proceeds to recognise the contribution made from the main literature sources.

Table 2.1 Main hindrances to successful implementations

Literature explanations for the low numbers of successful implementations	
Rationale forwarded	Literature sources
Improve the internal communications systems; required to aid empowerment and to adopt the principles of Lean	• Angelis et al. (2011) • Camp (2013) • Eisenhardt and Martin (2010) • Hines et al. (2008)
Need to observe Lean more than a manufacturing improvement strategy and allow its remit to surpass outside manufacturing	• Koenigsaecker (2005) • Liker (2004) • Shook (2010) • Spear (2004)
Effectively manage the sub-cultures; no company has a homogeneous culture and it is important to retain focus upon the Lean mission and vision	• Stefanie et al. (2012) • Wincel and Kull (2013) • Angelis et al. (2011)
Recognise that every Lean journey is distinctive; there does not exist a stable formula to achieve Lean success; and the respective companies commence with a dissimilar arrangement of constituents (or influences and restrictions)	• Sim and Rodgers (2009) • Johnston (2009) • Laureani and Antony (2012) • Bartels (2005) • Campell (2006)
Customised accounting procedures need to be adopted; both standard costing or activity-based systems are unable to accommodate the complexities of Lean. Preferably, value stream/product-based costing taking into consideration product development whilst vending alongside production and supplier costs is required; in this way, the personnel involved within the value stream are able to detect if they are influencing a greater degree towards value instead of costs	• Neely et al. (2005 • McVay et al. (2013) • Schonberger (2008) • Singh et al. (2010) • Tangen (2005) • Saurin et al. (2011) • Baggaley (2006)
Promoting the Lean paybacks; there is a sketchy record of organisations treating Lean as an business initiative	• Gremyr and Fouguet (2012) • Cocolicchio (2008) • Doolen and Hacker (2005)

(continued)

Table 2.1 (continued)

Literature explanations for the low numbers of successful implementations	
Rationale forwarded	Literature sources
Lean has to considered as a long-term venture and one whereby the benefits may not be obvious within the first year	• Wheatley (2005) • Cross (2012) • Fullerton and Wempe (2009)
Companies are required to adopt appropriate compatible IT systems; there exists a need to link the operational level to effective enterprise software proceeding to extend it to the customers' value chain	• Cross (2012) • Marksbury (2012) • Montgomery (2010) • Williams and Duray (2012)
Adapt the organisational structures; a definite requirement exists to shape in line with the "*value streams*" concentrating upon the customer and product groupings	• Radziwill (2013) • Mehta and Shah (2005) • Montgomery (2010) • Jones (2009)
A need to sustain the Lean momentum; it is essential that the company intermittently elucidates objectives for individual value streams whilst deducing the accomplishment disparity between the customers' requirements and the actual provision	• Wilson (2010) • Motley (2005) • Pullin (2005) • Ransom (2008) • Camp (2013)

HRM Implications for Lean

Relevance of an Organisation's Culture

The entire concept of Lean cultures has a dedicated section subsequently, and this notion should be awarded total prominence. Most Lean journeys suffer as a result of prevailing cultures, and this section provides an indicative clue to the surrounding issues. Liker and Franz (2011) suggest that Lean should be viewed as a journey and at the onset, it is essential to decipher the current state; the current stated ideals and behaviours have to be contrasted with the Lean principles and behaviours. The part played by managers is the essential component of supporting progress (Celani and Singh 2011). Employees cannot just be viewed as a significant resource to the company; instead, they need to be viewed as the organisation (Skabelund 2012). Fundamental factor to most Lean initiatives failing can be attributable to an organisation's culture and change (Mann 2005; Hines et al. 2008; Montgomery 2010). A company's culture encapsulates the conventions, principles, norms, and noticeable artefacts of its employees and their behaviours (Wincel and Kull 2013). Daft (2001) captures the concept as he suggests a company'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*" (p. 322). Managing around the culture is a distinct possibility; however, this may not result in sustained success (Marksbury 2012; Angelis et al. 2011; Zokaei et al. 2013). In order to induce organisational change, there is a need to initially change behaviour (Laureani and Antony 2012; Montgomery 2010; Stefanie et al. 2012). Efforts to replicate a

formula that has proven effective in one organisation under different restrictions has proven to be irresponsible (Camp 2013; Skabelund 2012).

It is vital that the Lean organisation develops a more conducive culture, whilst managing around the culture is a distinct possibility as there exist several ways to achieve the desired goals (Angelis et al. 2011). However, this may not result in sustained success (Marksbury 2012). A popular view (Montgomery 2010; Shook 2010) suggests that it is futile to bring about organisational change by attacking attitudes and values. In order to induce organisational change, there is a need to initially change behaviour (Laureani and Antony 2012). Zokaei et al. (2013) suggests that companies hoping to secure Lean success need to relinquish the conventional disciplinary and personnel administration and instead look to adopt strategic human resource management (Montgomery 2010; Stefanie et al. 2012). Knowledgeable leadership encourages the motivation and enthusiasm of employees. The research shows that this will facilitate fresh resolutions, a quicker acceptance of innovative ideas with the intention to fulfil customer needs (Johnston 2009; Wincel and Kull 2013). Lean proponents suggest that a company's organisational strengths and faults are often varied to those discovered in another organisation; consequently, an intention to replicate a formula which has proven effective in one organisation under different restrictions would be irresponsible (Camp 2013). The association between Lean and HRM is obvious (Skabelund 2012). It is essential that HRM needs to absorb techniques in order to apply the Lean principles and especially the Plan, Do, Check, Act (PDCA cycle) to all of its undertakings (Wilson 2010).

Considerations for an Appropriate Change Strategy

Alongside culture, the literature focuses upon an appropriate change strategy in order to achieve a successful Lean implementation (Wilson 2010). The recommendations forwarded concentrate on the key requirements for success: to create and then communicate a vision and an overarching comprehensive plan that all the employees can both comprehend and share with (Ohno 1988), and to develop an awareness of determination to succeed in a concentrated fashion and to try and cascade this principle to the entire organisation (Liker and Franz 2011). It is also suggested that there has to be an internal sensei whose responsibility centres on the Lean initiative whilst cascading its principles in order to encourage empowerment and self-ownership (Shook 2010). To accomplish Lean, it is vital than the organisation views training as an asset (Stephanie et al. 2010). Likewise, the training needs to be directed towards resolving issues within a specific area (Camp 2013). Value stream mapping, for instance, is an imperative aspect for Lean to flourish, though it is frequently snubbed because it can seem dreary and theoretical (Wilson 2010). Similarly, whilst formal training continues to contribute a crucial role, the developmental aspect needs to be embedded within the culture of the organisation (Mann 2005). Managers should be required to provide team members with persistent feedback and coaching (Wincel and Kull 2013).

From a performance gauge perspective, it is vital to utilise an appropriate Lean performance management system (Camp 2013); this will be clarified at length within the course of this investigation. It is vital that an organisation on the Lean journey views the Lean initiative as an investment with greater returns to be reaped subsequently, as expenditure is required for aspects such as reorganisation and training (Henderson and Larco 2003). It is also crucial that a conducive culture is instigated as discussed earlier; this needs to link the remuneration systems with performance management and the reorganisation necessary (Wincel and Kull 2013). In this context, there exists a need to guarantee strictness and entrench the modifications in formal policies, procedures, processes, work standards, job specifications, and competence classifications (Marksbury 2012). In many recent Lean initiatives, the process of piloting the Lean principles and procedures before cascading them to the remaining parts of an organisation have yielded positive results (Sim and Rodgers 2009). The importance of commemorating and broadcasting the triumphs has operated effectively in many recent initiatives (Mann 2005).

Potential Issues Associated with Lean

Similarly, in a dedicated section later in the book, the author analyses potential issues with Lean if executed incorrectly. This chapter again provides a sense of the existing thinking.

It is important to evaluate some of the literature that is critical towards Lean. Cooney (2002) argues that in certain circumstances, alternative manufacturing strategies may prove more beneficial and essentially that the market characteristics prevalent in a sector may dictate the choice of the production strategy selected. Critics have suggested that some aspects of Lean such as mixed model scheduling or heijunka attempt to squeeze or limit the demand supply (Kincaid 2004). Consequently, agile production focusing upon customer demand variability can provide other options. The nature of long-term contracts found within Japanese organisations is not often the norm (Mehta and Shah 2005). In situations whereby companies are expected to make low amounts of dissimilar and fluctuating product lines, whereby it then becomes extremely difficult to attain a stable flow of product centred on the standard times (Kincaid 2004).

Stump and Badurdeen (2012) mention the concept of the decoupling point that has appeared within literature and essentially that stock could be held in a modular form and only pursued to completion once the exact customer specifications are known. In this case, an organisation could utilise the Lean principles up to decoupling point and pursue agile for the remaining stages. In essence, an increase in the organisation's products or a change in the volumes ensures that the decoupling point shifts upstream permitting the value chain to become more agile (Stump and Badurdeen 2012). Sceptics of Lean have also focused upon the association of Lean upon personal stress (Sawhney and Chason 2005). Gill (2003) intimated that Lean can pose greater stress levels that are manifested by employee attrition and

absenteeism as a result of accidents. He suggested that Lean can prove challenging for managers.

Lean and Performance Measurement

Baggaley (2006) suggests that any organisation needs to recognise the prominent performance measures that can assist to influence higher results in particular areas. The literature suggests that by overseeing and enhancing the processes, coupled with customer and employee relations, which the commercial perspective should progress as a result (Haskin 2010; Malone and Sinnett 2005; Maskell and Baggaley 2004). Current research has shown that numerous standard businesses concentrate on the performance measures linking the internal processes without a strong association to the customer needs in their particular targeted markets (Singh et al. 2010; Wan and Frank 2008). Likewise, whilst benchmarking systems can harvest encouraging results, if particular care is not taken, the organisation could be heading in a false direction through its focus on the identical processes and practices of the prevailing sector, without awarding appropriate importance on the customer (Malone and Sinnett 2005). A disparity in both time and quantity exists in all processes within a supply chain; this is a major issue that Lean has to address; consequently, an appraisal of Lean would need to ensure that this is considered (Baggaley 2006).

Neely et al. (2005) insist that performance indices need to be selected which allow an organisation to assess whether improvement is occurring against objectives and check points (milestones). Too often, companies select generic indices with very slight thought of their significance. The test for any company, which is serious about ensuring that Lean improves its competitiveness, is to select measures for the proper level of the company (Tangen 2005). Wan and Frank (2008) propose that too often, the true gains secured as a result of Lean are difficult to quantify. It is also important to try and ensure not only that the indices selected proceed to reflect the product portfolio and their respective life cycles, but also that they gauge important parameters for the organisation both internally and externally (Shah and Ward 2007).

The literature suggests that there has been a huge augmentation in the scope of global competition which now concentrates upon the service levels, degree of flexibility, customisation, and extent of innovation (Womack and Jones 2005; Shah and Ward 2007; Shetty et al. 2010; Singh et al. 2010). Montgomery (2010) proposes that an organisation cannot be outstanding at all of its competitive priorities concurrently, i.e., cost, quality, delivery, flexibility, and service. Terry Hill's "order qualifiers" and "order winners" principle needs to be considered alongside its links with the decoupling point which proceeds to offer a better indication when choosing the performance factors (Neely et al. 2005). Furthermore, the conventional accounting systems tended to focus upon apportioning overheads largely centred upon direct labour (Neely et al. 2005; Tangen 2005). The systems and structures of

manufacturing have altered to such an extent that this does not provide an accurate assessment; in modern times, direct labour forms a very tiny proportion of the cost of goods sold.

The empirical research draws attention to the conventional metrics that have been utilised and proven to be unsuitable for modern progressive organisations hoping to compete on a global scale. By way of summary, the limitations are mentioned within the literature regards the standard metrics, namely the conventional indices are often historical which makes it harder to make correlations (Lawson et al. 2003); many of the standard financial accounting instruments are not appropriate for the types of strategic decisions organisations presently; cost alone cannot always be the prominent factor (Kaplan and Norton 2005); and that they present modest amounts of information on the actual source of particular issues that the organisation may be truly facing (Malone and Sinnett 2005). Often, the association between both the financial and non-financial measures is delicate and not obvious which specific indices need to address (Tangen 2005). A greater emphasis is needed towards the intangible assets that are often neglected in many performance measurement systems (Lawson et al. 2003; Shah and Ward 2007). For Lean, the concept of value adding needs considerable emphasis which is often neglected in many systems (Bicheno and Holweg 2009; Womack and Jones 2005).

Empirical evidence (Baggaley 2006; Haskin 2010; Shah and Ward 2007) reflects that effective metrics do facilitate an efficient execution of strategy; conversely inadequate or bias gauges can actually be detrimental to an organisation (Neely et al. 2005). At a strategic level propose Shah and Ward (2007) that it is vital:

- that the measures selected strengthen an organisation's strategy,
- are conducive to the prevailing culture, and are
- constant with the established existing acknowledgment and reward systems.

Montgomery (2010) suggests that a high degree of consideration is required to ensure that the performance measures selected enable an organisation to progress, for instance, different products on varied stages of a product life cycle may need differing measures.

In the case of organisation-wide measures, a high technology business, for instance, at the start may need to focus upon reliability, speed, and efficiency in order to secure credibility and brand awareness. At the growth phase, the prominent gauge may then become market share. On the other hand, within mature industries, price, operational costs, and capacity utilisation may play a more prominent role. Likewise, in the case of an ageing industry, the respective cash flow indices may begin to take on a greater significance (Schonberger 2008). Tangen (2005) suggests that there exist three categories of performance indices:

- the basic measures concentrate upon the traditional measures such as finance,
- the intermediate levels focus on a more balanced perception, and the
- uppermost level, analyses the connecting interaction across the entity.

Table 2.2 summarises this process aptly by describing which measures apply at differing stages:

Table 2.2 Performance gauges

Varied indices and their appropriate standard		
Categories	Criteria of measures for this class	Operational considerations
Strategic level	Look at the associations between the indices	Ensure all sections are covered and utilise IT to support this process
Transitional	Widen the scope by analysing internal and external stakeholders; start considering the mid-term and long term	The information to be cascaded to the respective personnel in order to aid decision-making
Basic level	Largely very internal concentration	The strategic objectives need to be covered at the basic level

By way of example, reducing defects may be an internal objective, although in proposing this, the organisation might be perceived pessimistically by the market with the end result being a worsening of its share price. The non-financial measures such as product and service quality, client fulfilment, and originality are now more evident. By definition, the financial indices focus upon the past, whereas long-term sustainability of an organisation relies upon customer service (Tangen 2005); the types of factors include:

- quality,
- dependability,
- speed,
- cycle time,
- employee competencies, and
- efficiency.

The literature does indicate the problems associated with decoding how the qualitative targets lead to measurable indices. Neely (1999) proposes that the "Stockholm School of Economics" determined an affirmative association on how customer satisfaction impacted upon an organisation's financial viability. The findings suggested that a yearly point increase in customer satisfaction proceeded to impact to the degree of $7.48 million over five years for an archetypal company within Sweden.

An analysis of KPIs can be laborious, and it is important that organisations work efficiently with the data capture and subsequent analysis. The literature (Kaplan and Norton 2005; Neely et al. 2005) does suggest that companies need to utilise IT with superior eagerness in reference to performance measurement. An IT-balanced scorecard assists to spotlight on the connecting associations and linkages whilst assisting the managers to enhance value. The literature reflects upon acronyms CPM, BPM, or EPM (Corporate, Business and Enterprise performance management) with the obvious advantages of focusing upon areas for concentration at an earlier stage.

Tangen (2005) has suggested a possible method of assessing the indices that a company uses. Table 2.3 proceeds to build upon the initial concept that allows an organisation to effectively analyse the indices utilised. This process is effective in identifying those gauges that may no longer serve a useful purpose.

Table 2.3 Assessing indices

Factors used to appraise the indices utilised			
Essential criteria	The appropriate standards expected	Level of success Score 1–10	Time lag to make a change (days)
Fundamental requirements	– Precise data and information – Assists to secure aims – Accurate dimension – Outcomes are understood		
Association to the performance	– Monetary concentration – Non-monetary – Associations are analysed		
Relation to the stakeholders	– Internal focus – External perspectives – Are all or some stakeholders considered?		
Decision-making levels considered	– Strategic concentration – Applied to all levels – Whether only basic levels are considered		
The possible time frames involved	– Intermediate targets – Lengthy emphasis		
The level of analysis required	– Obtainable information – Concentration on particular aspects – IT considered further		

Summary

Whilst the concept of Lean has been largely associated with manufacturing and production processes, its principles embrace the entire business. Lean needs to be viewed as a voyage necessitating a strong start and one that never concludes. Essentially, Lean is a commercial ideology. The literature suggests that Lean does support effectiveness by refining the general performance levels of a company. Any organisation hoping to implement Lean needs to review it as an emerging concept and vigorous since it is developing continuously. Despite some of the criticism, it is feasible to assimilate other tactics without confronting the essential intentions of Lean; ideal examples would be overall equipment effectiveness (OEE) along with overall supply chain effectiveness (OSCE). The literature dictates that a significant confusion exists regards Lean only focusing upon manufacturing. The ideology and concept of Lean is largely successful when pertained to a complete organisation. The Lean ideology is unrestricted and enables the acceptance of other instruments and methods such as TQM and Six Sigma. The strategic components of Lean are multifaceted, though the empirical evidence to date suggests that when managed

well and executed as a total ideology, the organisation will reap major financial benefits. Lean has strategic significance; it makes good business sense. Nonetheless, Lean cannot be implemented in a haphazard fashion as all the relevant components within the value chain have to be managed including the logistics, accounting, HRM, and suppliers whilst developing a conducive culture for Lean to flourish.

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Chapter 3
Lean Cultures

Abstract Organisational culture impacts performance because it affects individual behaviours. It is a key determinant in whether an idea or process is accepted or rejected. Both empirically and in the author's own experience fundamental to almost every collapse of Lean initiative is the primary concern of corporate culture and change management (Mann in Creating a lean culture. Productivity Press, New York 2005). Some have suggested that Lean can work better under some cultures (Kull and Wacker in J Oper Manage 28:223–239, 2010). Culture and cultural change is considered by many to be the most important element successfully implementing and sustaining Lean processes. Inevitably, there do exist dependable cultural requirements which could be stated as being regarded indispensable for Lean to flourish; this should not come as a surprise to anyone since it was outlined by Ohno (Toyota production system—beyond large-scale production. Productivity Press, New York 1988). Lean expects a communal agreement and eagerness for the relevant systems and processes that lead towards the achievement of a Lean enterprise (Nelson and Winter in J Econ Perspect 16:23–46, 2002). Organisational culture can be regarded as the persona of an organisation (Mann in Creating a lean culture. Productivity Press, New York 2005); it encompasses the assumptions, values, norms, and tangible artefacts of an organisation's employees and their relevant behaviours. Numerous conjectural, epistemological, and procedural approaches to culture have proceeded to reveal its complexity. Research (Ransom in Wall street view of lean transformation, 2008) indicates that up to 40 % of the change projects tend to fail; similarly, of the 59 % that thrive, only 20 % go on to meet the initial objectives outlined by the senior management teams. Nine out of the top ten barriers to change are regarded to be people related, and these seem to concentrate upon aspects such as poor communications and employee resistance (Ransom in Wall street view of lean transformation, 2008). Often Lean practitioners indicate that 80 % of becoming a total Lean enterprise is culture-related (Ransom in Wall street view of lean transformation, 2008). The Aberdeen Group (Enhancing lean practices: Lean adoption in the industrial machinery and components industry, 2006) in their comprehensive study cited numerous barriers preventing the

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formation of a major group of obstacles towards the adoption of Lean; the prominent one, 70 %, was that a significant cultural change was needed; ironically, the third highest, 39 %, surprisingly was still a lack of senior management support.

Culture Investigation

Culture is cumulative, evolving over time as people share experiences, adapt to similar conditions, and deal with their physical and social environments. Any Lean initiative entails its participants to review the job environment and satisfaction, motivation, demand leadership responsibility, and need to develop new behavioural patterns, and insists on the Lean tools and methods. Undeniably, the working environment defines how employees will react during the Lean implementation. As way of a summary, the intention of this book in trying to decipher the relevance of culture to the success of Lean, the research needed to try and investigate how the respective organisations managed to:

- Endeavour to make decisions at the lowest level which could be gauged by the number of organisational levels;
- Propose an unambiguous precision of vision which is required; this should also assist to indicate how the organisation's status should reflect once the transformation is completed;
- Make sure that there is a strategy of change embracing the communication systems and how its goals will be accomplished;
- Allocate responsibilities within the pilot programme to begin with and ultimately within the entire organisation so that it is also apparent who is leading the programme;
- Build up supplier relationships based on mutual faith and dedication; this could be assessed by features such as:
  - Relationship years that have existed with a supplier,
  - A percentage of procurement £s procured under long-term supplier agreements,
- Cultivate a learning environment for which indices, such as training hours/employee, can assist to provide an estimated barometer;
- Scientifically and constantly concentrate on the customer; this could be indicated through the percentage of projects the customer was involved with;
- Sponsor Lean leadership at every level; once again, this could be gauged by the quantity of Lean metrics at every level;
- Preserve the examination of existing processes through, for example, quantity of recurring issues and the customer assistance to suppliers;
- Make a meticulous attempt to exploit constancy in an altering environment whereby efforts are genuinely made to:

  - Timetable changes,
  - Program restructures, and
  - Procurement quantity alterations.

- Calculate the portion of an organisation's employees operating under Lean,
- Scrutinise the quantity of an organisation's departments engage in Lean,
- Advocate Lean as a long-term commitment.

The General Perception of Organisational Culture

For over 25 years, researchers have employed several definitions of culture, containing a shared belief system within the organisation (Sathe 1983); extensively collective core values (Peters and Waterman 1982); combined understandings (Barley 1983); and the arrangement of basic assumptions of an organisation (Schein 1985). In total, these definitions have advanced around collective values and a considerable amount of the literature has concentrated on culture imitating the organisation's founder and top managers (Peters 1987). Earlier work, prior to 1987 suggests Lewis (2002), deliberates on a clarification of culture; Bryman (1984), Sathe (1983), Barley (1983), and Schein (1985) are illustrations of authors who took a functional approach. The later period focussed on the properties of culture on organisational performance (Brown 1995; Lewis 2002). Fitzgerald (1988) acknowledged shared beliefs and mutual practices within companies. However, the definition of organisational culture depicted by Daft (2001) inclines to entirely summarise the concept, namely 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 (p. 322).

The Toyota method is overtly "*taught to new members*" (Liker 2004, p. 299), and the principles have a gravity which transcends beyond the intensity of rudimentary assumptions to distinguish waste. Initially, academics have used it as a metaphor although many have instigated to utilise culture as a variable rather than a "*root metaphor*" (Wilson 1997, p. 88); something an "*organisation had*" versus something "*it was*" (Wilson 1997, p. 89). The fundamental literature proceeds to divide culture into four types before proceeding to examine the balanced culture:

- Adaptability/entrepreneurial culture (also referred to *Developmental*) branded by a strategic concentration on the external environment through flexibility and amend and meet customer needs. Flexibility and creativity are the primary organisational goals used to cope with uncertainty and ambiguity. There is less centralisation, since the firm requires everyone to be trained, developed and empowered. It does foster Lean since managers are responsible for both development and for performances. Firms work closely with their suppliers under long-term arrangements;

- Rational culture (*Market*) which focuses upon the external and not internal environment. Rational cultures have the core values of competitiveness and productivity, focusing on the bottom line and profitability. The external environment drives activities within the company towards winning, creating leaders centred primarily on achievement. Customer satisfaction and loyalty reflect the rational cultures which support Lean too;
- The Group culture (*clan*) emphasises upon envelopment and involvement of members to meet varying external demands (Saffold 1988). These are often identified by minimum levels of management, consensus, information sharing, high morale, participation, and job security. This is effective in organisations requiring high morale and participation levels;
- The bureaucratic culture (*Hierarchical*) reinforces a systematic methodology to its daily activities (Lewis 2002). In spite of endeavours to standardise organisation cultures, sub-unit cultures are expected to endure and cultivate somewhat eccentric cultures. One current example is McDonalds Corporation. There is intense specialisation and little discretion. Japanese Lean organisations have a culture of written and unwritten rules and employees are socialised into the way things are done in the firm;
- The Balanced culture; evidently different organisational cultures affect the various aspects of the Lean process. This is aptly reflected by Liker and Franz (2011):

> Toyota has a passion for excellence, an obsession with satisfying customers, striving for perfection, driven by core values, highly self-critical leaders who are humble and leave their egos at home, a desire to build something that will endure forever and complete faith that investing in people is the only way to succeed. (p. 3)

The values of one particular prevailing culture can be balanced with others for true organisational effectiveness. Taking the same logic to its extreme, it could be concluded that imbalances when discovered in one area, the managers need to focus on the weaker areas. The proposition being that an organisation with a balanced culture will have the most effective lean processes, when compared with firms that are concentrated on a culture depicted by one of the above. There are multiple ways to examine culture; one believes that this method outlined can assist to capture the entire spectrum of organisational culture possibilities to facilitate measurement. As Peter Drucker had intimated, if you cannot measure it, you cannot manage it; one could add …or sustain it!

Undeniably, it needs to be recognised that culture advances over time (Kotter and Heskett 1992) as a consequence of the changing group members, variations in the company's market environment and common alterations. Nonetheless, variations in the fundamental principles and customs defining behaviour may not change, and in fact, what organisations may observe is purely behavioural obedience (Denison 1990; Wilson 2001). Cultural sway does not seem conceivable in the systematic methods approved by promoters such as Peters and Waterman (1982) and Deal and Kennedy (1982). Trompenaars and Turner (2004) outline that the instruments often proposed are generally most repugnant, intimidating and manipulative. Schein (1991) upholds that a culture will not change unless it is conveyed to the surface and challenged.

A frequent criticism that can be directed to many organisations is the lack of attention paid to the human element. Human skills such as communication, problem solving, teamwork, and leadership are imperative for strategic success. The evidence has accurately deducted that, in due course, thriving organisations do not rely upon technology, patents, or the prevailing strategic position for competitive benefit. Instead, they need to utilise their personnel to create this competitive advantage. It will be reflected in the subsequent analysis that many organisations are only discovering, by chance, that the only method in which an effective strategy can be implemented is through its own people.

The Magnitude of Culture for Lean

There exist different aspects of organisational culture that affect Lean processes. The support for the implementation of Lean processes throughout a firm is a precondition. The job environment and satisfaction, often regarded as the dominant determinants of company culture, are closely related to the common mindset of employees; this is directly associated with their viewpoints, referred to as paradigms. The paradigms dictate the manner in which we think and act, and we cannot expect that a solid conviction will alter overnight, especially if the frame conditions are kept the same. It is important to try and understand how employees ponder in regard to the history and how leaders make their decisions. This assists the policy makers to determine how to create a motivating environment for the Lean journey. In this perspective, Schein (1991) highlighted that any new values promoted within an organisation will only be integrated at a stage once they have been tested and confirmed; the intention is optimistic, for them to be accepted as the norm and equally being received to a level of being regarded as unconscious assumptions. As mentioned within the literature, there is a consensus which agrees that whichever strategy, irrespective of its benefits, will not be acknowledged or followed if it sits external to the boundaries of that organisation's culture. The approach in which the required change is instigated, embraced, and confronted will always be distinguished by the organisation's culture. On the whole, the evidence indicates that overlooking an organisation's culture incorporates two foremost risks; namely, omitting the chance to exploit it as a positive influence on competitiveness and accordingly permits this to become an unconstructive influence since it will proceed to hinder change. Nonetheless, taking no notice of the prevailing culture is certainly not advocated if the company in question intends to secure a competitive advantage within the market place. Likewise, efforts to cope by circumventing the existing culture can act as a genuine opportunity given that there are habitually numerous ways to achieve the desired goals (Nelson and Winter 2002). However, it needs to be reiterated that this course of action will certainly not result in achieving a persistent and sustained success.

Altering the culture to suit the desired strategic disparity is a drawn-out procedure especially in circumstances where the organisation's culture is solid as the

author well discovered in the times that his old organisation Royal Doulton Plc embarked upon Lean. A prevalent opinion proceeds to suggest that it is pointless to try and attempt efforts to introduce organisational change by attacking attitudes and values. The technique to introduce organisational change is the need to alter behaviour in the first instance. Behavioural change proceeds to encourage the desired changes both in attitudes and values (Cocolicchio 2008). Altering the strategy to permit its alignment to culture results in a situation whereby an acceptance of an alternative output is happening to that one which was anticipated. A level of compromise between actually attempting to alter the culture and changing the strategy is often very likely to be tolerable (Hatch 1997; Mann 2005). Critically, an attempt to accomplish a constructive culture similar to that one well documented at Toyota certainly takes a considerable time and effort to realise. Empirical research stemming back over 20 years by Kotter and Heskett (1992) which investigated eleven large organisations such as *General Electric* and *Xerox* proceeded to conclude that efforts to achieve cultural change can take between 4 and 6 years in a small organisation.

Everlasting organisational change generally will only be possible in the first instance by altering people's attitudes and values which is time-consuming and difficult. In order to achieve a triumphant Lean implementation, the prevailing empirical evidence declares that the employees' natural struggle to change adversely impacts possible efforts to transform the existing culture, unless the company blatantly recognises the employees concerns. Acceptance of the Lean thinking can only exist when an organisation inaugurates a listening and learning culture; in this situation, the process design is produced by those who deliver the product or service, and not by a business analyst situated within an ivory tower who has little of no direct knowledge about the product or service. Daft (2001) does provide a warning whereby in a successful organisation occasionally culture can become established and the organisation in question may be unsuccessful in adapting. As Lean proponents, we have a duty to persuade against rigidity and stability. In the past, cynics such as Bryman (1984) and Smircich (1983) have doubted whether any organisational change is controllable and assert that in fact enhanced entrepreneurship, the implementation of a market orientation, and teamwork principles are actually superficial indicators of culture; view shared by Hatch (1997).

A successful implementation needs to modify the way work is done throughout an organisation's systems, operations, and procedures which are inherently linked to the organisation's culture. Brown (1995) provides a synopsis on the methods by which an organisation's culture could sway strategy formulation; this is largely as a result of its sway on checking behaviour, careful perception, and interpretation, effect of values, a consequence of assumptions, and the power of various sub-cultures. Trompenaars and Turner (2004) reiterate that intense, suitable, adaptable cultures which value all stakeholders and leadership whilst demonstrating a strong sense of mission may be associated with elevated performance levels over continuous periods of time. The parable that Lean is more focused towards the Japanese culture is a total myth. Documental evidence quotes the example of

Nissan who encountered significant problems regarding its quality, defects, growing costs, and delivery struggles. There was a requirement for them to be rescued from the verge of bankruptcy by Renault. Similarly, the documental evidence also states that the Toyota's Georgetown Plant (USA) has proven itself to be one of the most resourceful plants in the world; this is also the case with their NUMMI plant in California bearing in mind that NUMMI is a union plant composed of previous General Motors workforce.

Culture Should Reflect the Lean Journey

Present-day research discloses certain anomalies. Deducing a company's profile of its existing culture would permit organisations to prudently bring the rudiments of the culture into alignment and advance towards an idyllic situation. Similarly, a cultural appraisal can permit organisations to analyse the disparity between their existing and desired cultures, respectively. An evident and unambiguous message from the Manufacturing Foundation's study (2004) was that one dimension does not suit in every application of Lean; likewise, that practices and diagnostic apparatuses need to be adaptable enough to suit an organisation in a variety of programmes.

In one's experience, a constant implementation plan would possibly produce variable results in different countries; the overarching plan needs to be changed to the ethnological culture specific to the region. Whilst it has been proposed in the past that the prevailing culture can be influenced to safeguard competitive advantage, the overwhelming evidence does suggest that in situations whereby an proposal's implementation clashes with culture, the implementation will be fought in one of two ways:

(i) Either the scheme will be disallowed or
(ii) It will be changed so that it complements the existing culture.

Nonetheless, one is required to fully recognise that many of the previous studies, which point towards this issue, tend to rely upon interviewees' insights of cultural change, and these are primarily verified through variations in user behaviour rather than unequivocally computing variations in assumptions, beliefs, and values of the affected users. This area is fraught with danger, however, since there are occasions whereby it is practical to suppose that behavioural variations designate cultural changes since the former is acknowledged to be the observed indicator of a cultural change plan.

Undeniably, both the evidence from literature and one's own experience do propose that generating alterations in organisational culture is challenging. This was evident in the earlier days and is the prevailing situation presently; Smith and Peterson (1988) suggested that there are examples of case studies available of organisations: "*within which major changes in culture have been successfully accomplished ... but these are rare*" (p. 121). Lean philosophy founded on the

Toyota way comprises of a far greater and more prevalent cultural revolution than what most organisations still wish to both recognise and adept their existing systems. An intrinsic difficulty within the UK is that Lean initiatives have generally reflected a dawdling cultural alteration; yet, the organisations are placed under considerable pressures to deliver benefits within the initial year of a Lean initiative and its implementation. Intelligent endeavours to amend culture by managers may reap greater benefits though as was clearly documented by Womack and Jones (2005) that the Lean implementers need to agree that if a suitable and operative culture exists, it would be appropriate to take steps to upkeep or strengthen it. Consequently, if the culture is unsuitable, then it is vital to be able to determine what needs to be transformed and to advance and execute strategies for change.

Without doubt, I have encountered Lean facilitators who have effectively used the work of Spears and Bowen (1999) as this can be used as a template that maintains that the TPS can be abridged in four basic rules. The first contains the matter of standardised work methods that are essential to Lean; certainly those cultures recognising the importance of Heijunka (levelling out the workload), product volume mix, the pressures on people, equipment, and suppliers are absolutely crucial. This empowers waste easier to be noticed. The second rule incorporates the subject of supply chain management. Toyota, for instance, created the "Supplier Consulting Group" heartening that its suppliers can alter to its JIT procurement ideology and process. Toyota guarantees that all its major suppliers become part of the Toyota's supplier association who are also encouraged to impart best practices, evidence, and apprehensions. Rule three emphasises upon the factory layout and workplace design which is generally regarded indispensable for Lean. Rule four integrates the continuous pursuit for perfection by encouraging a culture which is prepared to expose problems. In Lean, the expectancy is that everyone has two major responsibilities. The primary one is to run the business on an everyday basis. The second, however, is to advance the business or contribute towards this incessantly.

Favourable Cultural Features for Lean

The prevailing literature suggests that a company secures a sustainable competitive advantage by adopting value adding strategies that proceed to distinguish it from its competitors whilst making it complex for the competitors to copy this strategy (Shook 2010). The significant impact Human Resource Management and culture proceeds to make towards an organisation's strategy is evident since the prevailing literature suggests nine of the top ten barriers to change are people related. Similarly, it should be recognised that organisations are often making sweeping statements regards people being their greatest asset, though upon a closer inspection, one often finds that the company pays lip service to this statement.

Undeniably, the contemporary thinking specifies that there is a definite association between culture and organisational performance. In fact, the evidence proceeds to state that consumers are engrossed, not just to the products but to the complete communication environment around their purchases. In a similar context, the idea of supporting an organisation whose values and panaches they respect is considered by consumers. Morgan (1997) asserts that a constructive culture stimulates learning and continuous improvement as information flows spontaneously. Other subsidiary benefits do exist including reducing labour turnover and attracting top employees as evidenced by books such as "*The Top 100 Best Companies to work for in America*." In addition, cultural factors do definitely act as sturdiest persuaders for employee retention. This aspect has been reinforced recently and can be empirically traced back. Sadri and Lees (2001) reveal the example of Hewlett Packard whereby in the late 1990s, their Great Lakes division conveyed an attrition rate of 20 %; over 50 % of the employees considered "*excessive pressure*" at work as a main factor. After a plan lasting 2 years, the company, despite reducing its working hours, augmented its production and productivity. The warning which was communicated by Lewis (2002) is still relevant and apt whereby he urged 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 (p. 286).

Prosperous Lean enterprises represent an open culture which was initially popularised by Schein (1985) whereby employees can contribute out of a sense of commitment and solidarity. Relationships are characterised by empathy and support. In such cultures, organisations place a high priority on communal support, partnership, creativity, and productive relationships.

In a similar context, it is vital that so-called Lean experts need to distinguish the difference between organisational climate and culture. In essence, it is important to always acknowledge that culture refers to the deep construction of an organisation, which is entrenched in the values, beliefs, and assumptions of the respective employees. Whereas the climate is awareness and is very illustrative since it scrutinises the features of the environment that are consciously perceived as apparent by the organisational members. Much of one's recent work has reinforced the evident link between lean and competence-based management. The proposition is that organisations can enhance productivity and generate a maintainable organisation by developing a culture of competencies that span the business activities. The issue which organisations and Lean proponents need to consider, nonetheless, is that any particular attention on the tangible outcomes alone can force organisations to ignore or fail to pay sufficient attention to the intangible aspects of culture and in particular reminding some companies that their composition is made of one vital asset, namely people.

The empirical evidence does dictate that from a corporate viewpoint that culture can help elucidate why some organisations are more effective than others. In fact, this stems back to Kotter and Heskett (1992) which is still very relevant as they assist to summarise the findings into four categories, namely that:

(i) Culture can have a primary impact on an organisation's long-term economic performance;
(ii) That the evidence suggests that it will continue to have a significant role in the future;
(iii) Negative cultures can certainly develop even when employees are seen to be rational and intelligent;
(iv) Whilst difficult to change, corporate cultures can be made more performance enhancing.

This had been reiterated as early as the 1990s by Furnham and Gunter (1993) who stated 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 (p. 240).

However, once again, the recent Lean history has demonstrated that situations arise whereby cultures that are viewed positive in one set of conditions or historical period of time may certainly prove to be dysfunctional in a separate set of circumstances. The cynics could recommend that, in fact, it could be asserted that there does not exist any such thing as an ideal culture, only an appropriate culture. Culture and efforts to align it to a more conducive state appears frequently in any discussion where HR practices are seen to contribute to a competitive advantage (Shook 2010; Dalal 2010; Angelis et al. 2011). Management structures need to facilitate the appealing, motivating, and bonding culture which acts as a prerequisite to both charm and retain gifted employees (Stefanie et al. 2012). Integral to this aspect is that if an organisation considers that its recruitment and retention is solely based upon the reimbursement package, the employee attracted by this will almost certainly disappear for an improved set of conditions (Mann 2005). Similarly, Celani and Singh (2011) propose that the prospective employees' optimistic perceptions about an organisation will greatly persuade their aspiration to pursue employment with that organisation. Dan-Shang and Chi-Lih (2008) recommend that in accordance with the contingency theory and the behavioural perspectives, efficient connections between the organisation's strategy and its HRM practices may improve the company's performance. Wilson (2001) and Dalal (2010) agree that any strategy, in spite of its credibility and value, will not be acknowledged and accepted if it is remote to the limits of an organisation's culture.

The Significant Cultural Considerations

A Lean culture for an organisation serious on progressing focuses upon the need to sustain change through appropriate management, empowerment, and communication. In summary, a Lean culture can be explained as containing the following fundamentals:

- the need to make decisions at the lowest possible level;
- a shared vision to be in place and pursued by the employees;
- a participative leadership style to be followed with total collaboration;
- there needs to exist a continuous pursuit for perfection;
- teamwork to be actively promoted through overall involvement and personnel who are entirely dedicated and participating;
- extensive and widespread communication systems reflecting what an organisation's overall goals and performance expectations are;
- the work being undertaken needs to provide personal and professional gratification for the employees;
- to secure and maintain highly capable workers authorising them to become part of a management team;
- authorised workers;
- common gains; and
- scarce or no boundaries permitted to develop between the functions.

Bearing in mind that even in 2004 that the extensive Manufacturing Foundation study of 153 companies in the UK had reiterated the prominent implementation premises which were evidently depicted in the successful Lean implementations; these included that

- The Lean focus is sensibly selected; the boundaries are carefully elected and well defined;
- Practised guides are necessary to train the trainers; similarly that the internal or external sensei with pertinent knowledge are employed;
- The programmes need to deliver some quick gains; however, the forewarning needs to indicate that the Lean principles are obligatory and would not be maintainable without investment in the future;
- Where possible the staff to secure externally accredited training qualifications, there were numerous examples cited and the initial impetus was achieved from Cardiff University's LERC which promoted consistent and universal standards;
- All the outcomes are captured; their research exposed that the reported paybacks of 5:1 or 10:1 were not just spin. Inopportunely, many organisations as is the case presently utilise operational measures alone to quantify the success of their Lean programmes. It was also indicated at that stage that more organisations need to measure the impact of Lean on financial measures such as the return on sales, return on Capital employed, and liquidity. Their study also discovered how 86 % of their clients specified that they continued to spend their own money on Lean once the funding from other sources had ceased;
- Overall, the values of networks were promoted; these assist to share the general learning. Linkages have now been recognised to become one of the most shared sources of "non-threatening" evidence and awareness on Lean.

Establishing a trademark for employees can also enhance organisational success (Celani and Singh 2011; Clarke 2011); this situation can occur since it has the potential to curtail certain costs such as those related to recruitment and retention.

The labour market is evolving and potential employees are prepared to consider a lower salary whilst seeking employment with an organisation that possesses a constructive reputation (Skabelund 2012). Likewise, the strong brand has a positive impact upon existing employees too. According to Stefanie et al. (2012), numerous employment attributes have to be in place in an effort to establish an employer brand, namely "*functional, economical and psychological benefits*" (p. 269). Stefanie et al. (2012) utilise the concept of "*Employee Life Cycle*" (ELC) whereby phases are used to clarify how brand loyalty can contribute to an organisations efficiency levels:

- Pre-employment; the challenge being to market the company's values and norms,
- Introduction; it is imperative that the indicators received by a new member do not contradict those received in the pre-employment stage. Mentoring is specifically mentioned as a way to facilitate higher productivity of newcomers who gain familiarity of the organisation within a small lead time,
- Growth; the employees speed up their performance through training whilst progressing to develop both professionally and on a personal level,
- Maturity; organisations need to retain the employer of choice by using the sustainable HRM practices which have already been outlined,
- Decline; the signs which the organisation needs to continuously communicate are that it values the employment relationship,
- Post-employment; there has to be a recognition that past employees can impact the organisation's reputation.

The "Halo" Effect

Rosenzweig (2009) unmasked the misapprehensions that are frequently established in the corporate world. These misconceptions often affect both the business press and academic research proposing to reveal the secrets of success or the path to excellence. The most prevalent delusion is the "Halo Effect" (p. 14) signifying that when an organisation's company's sales and profits are high, the conclusion often made is that:

(i) It has an excellent strategy;
(ii) Has a visionary spearhead;
(iii) It has very accomplished employees; and
(iv) An enthused corporate culture.

However, in circumstances when the performance of the organisation begins to weaken, the deduction can be made

(i) That the overarching strategy was inappropriate;
(ii) The spearhead became arrogant;

(iii) The employees started to become complacent; and
(iv) That the culture was stagnant.

In actual fact, very little would have changed, as the company performance develops a "Halo effect" which shapes the way we observe strategy, leadership, people, and culture. Rosenzweig's work does proceed to enlighten a concept which has been around in Lean recent history, namely when researchers and Lean practitioners use the phrase "*strong cultures*". In my experience, strong cultures do not necessarily lead to organisational effectiveness. Undeniably, strong cultures do proceed to raise fundamental ethical questions about the managerial ideology. Many recent initiatives have indicated that ideally it may be more fitting to scrutinise the level of conformity amongst members on specific value issues; this has been consequently reinforced by Rosenzweig (2009). Whilst much of the research informs us that Toyota is the best learning organisation, it views standardisation and modernisation as two sides of the same coin, managing to combine them in a manner that makes possible enhanced continuity. The modern dynamic and progressive organisations comprehend that the answer to organisational learning is the need to support the objectives of its employees towards the common goals.

Rosenzweig (2009) proposes within his book that frequently business writers are inclined to grasp on the behaviour of companies that happened to announce fine results without really bearing in mind their cause and effect. A significant disclosure from his research is that the influence of company performance on employee satisfaction is more influential than is true of the reverse. He is also critical of the "best of" registers suggesting that individuals assembling these lists make the significant blunder of only probing the traits of exceptional performers. In reality, the halo effect is only one amongst the business delusions that Rosenzweig (2009) outlines in this book. The remaining ones which he expounds upon are the delusions of:

- Single explanations;
- Lasting success; and
- Absolute Performance.

The "delusion of single explanation" (p. 80) is about the search for the one '*explain everything*' response to enlighten a particular result or a phenomenon. He recommends that it is a human trait to seek neat stories with simple causes and effects. Likewise, it is a reflection of a significant amount of our procedures whilst undertaking analysis. This research has revealed issues with the 'makes sense' concept, whereby in practice, this actually may make no sense at all. "*Delusion of lasting success*" (p. 101) is derisive of many of the more popular management texts alongside their authors who proceed to promise to provide a procedure to guarantee lasting success, when we only pursue this formula for it. He is also scornful of three of the most popular management books:

(i) 'In Search of Excellence by Tom Peters and Bob Waterman;
(ii) The two best sellers by Jim Collins '*Good to Great*'; and
(iii) '*Built to Last*'.

Rosenzweig (2009) makes mention of "Absolute performance" (p. 110) whereby this refers to the need to surpass ones competitors; a business may proclaim declining profits and market share in spite of improving key performance indicators since its competitors achieved better results.

Fit an Appropriate Change Strategy to Lean

The literature is consistent in recommending that companies must start considering individuals with specific knowledge, talent, and proficiency as a scarce resource (Dan-Shang and Chi-Lih 2008; Stefanie et al. 2012; Eisenhardt and Martin 2010; Celani and Singh 2011). Consequently, the HR experts within modern organisations need to become the main players in creating, developing, and delivering that organisation's strategy (Liker and Hoseus 2010; Clarke 2011). The issue being that many HR professionals continue to adopt old practices whereby employees are viewed as raw materials to be acquired and then modified through training (Eisenhardt and Martin 2010). We need to accept certain realities if change:

- 3–5 % of people will willingly adopt the change and be very strong advocates;
- 90 % will be open to change and are looking for leadership;
- 3–5 % will directly oppose the change.

In a similar context, there are several rules of change that the author has witnessed from his experience of being involved in kaizen events:

(i) People do what they perceive is in their best interest, thinking as judiciously as circumstances allow them to;
(ii) People are not inherently opposed to change; most will in fact embrace the initiatives provided the change has positive meaning for them;
(iii) People thrive under creative challenge but will wilt under the negative stress;
(iv) That people are generally different; no single elegant solution will address the entire breadth of these differences;
(v) People often believe what they see; the actions speak louder than words and a history of previous deception impacts the present suspicion;
(vi) The manner in which to manage effective long-term change is to initially visualise what you need to accomplish, and then inhabit this vision until it comes true;
(vii) That in earnest, change is an act of imagination; until the imagination is engaged, no important change can occur.

The trend amongst most organisations, whilst openly declaring that people are their most important assets, unfortunately, many have failed to fully infuse the human resource systems, practices, or cultures that will begin to confront the prevailing view of demonstrating bias towards their respective financial assets (Mosley 2007; Dalal 2010; Liker and Franz 2011; Montgomery 2010). The recruiting process, for instance, should be transformed into a strategic undertaking

with a persistent pledge to both find and attract the most competent individuals at every level and from every supply source (Luthans 1998; Mosley 2007; Angelis et al. 2011).

It is important that the change strategy advocates several practices necessary for HRM whereby the aim is to facilitate a competitive advantage, namely:

(i) "Information sharing" was proven to be the case for organisations performing well; essentially, employees need to be kept informed regards how they will be impacted;
(ii) Evaluate performance both at an organisational and individual basis; this helps to identify, i.e., potential training needs;
(iii) Promote and develop internally; there were benefits realised which were attached to reducing turnover and increasing productivity;
(iv) Modern reward systems; rather than concentrating upon lump sum salaries, employee reimbursement should be based, to an extent, upon performance.

This aspect was well summarised by Croll and Yoskovitz (2013) who suggested that people are the major strategic source; strategy needs to be built upon a human resource foundation; "*today's managers are trying to implement third-generation strategies through second—generation organisations with first-generation management*" (p. 35). They suggest that existing rigid chains of command need to be replaced by networks; that the officious systems need to be removed in favour of more adaptable processes. Furthermore that management styles instead of being autocratic styles need to adopt empowerment and coaching.

The conventional role of the HR/Personnel sections has traditionally been very functional. In these cases, the progress Lean is able to make is restricted. A greater strategic approach to HRM is now required (Clarke 2011). Research has supported the value-added contributions of HRM and cultural adaptation practices. Once again, traditionally, there have been forwarded various approaches as to how HRM can assist an organisation to achieve competitive advantage. The role of HRM is that it should actively be promoting the adoption of an appropriate culture. The three methods by which an organisation can maintain competitive advantage through its HRM policy are as follows:

(i) HRM and capacity to change; organisations need to be accomplished at adjusting and innovation, otherwise risking failure is a distinct possibility;
(ii) Strategy implementation; organisations should constantly consider and create new strategies to match both their internal and external customer needs;
(iii) Strategic unity; this fundamentally measures the fit between an organisations' internal and external stakeholders sharing a core set of principles and assumptions about the organisation. This has been reinforced by Celani and Singh (2011), Laabs (2009), and Skabelund (2012) who advocate that the person–organisation fit can assist to clarify the impact of sustainable HRM within the employer brand. The insinuation is that potential employees endeavour to match their personal characteristics and values with those of the organisation and its culture in order to try and achieve equivalence.

Bearing in mind, that the literature suggests culture and change have been important factors which have contributed to every Lean failure (Hines et al. 2008; Lee 2008; Womack and Jones 2005; Koenigsaecker 2005). All organisations should be required to find their own ways of implementing Lean. It is fallacy if a Lean promoter suggests that there is only one universal way that Lean should be applied. The accomplishment of Lean is determined by the readiness of the workforce to work together. Triumphant Lean implementations have established the requirement for definite nucleus characteristics. Leadership and management must always be an integral component and be fundamental members of the total team. The leadership team has the whole responsibility for the construction of this culture.

An unswerving vision is a precise prerequisite to succeed as a Lean enterprise. Repeatedly, this provides a roadmap to success through the usage of the business plan. Ideally, before any organisation takes the original stride of any journey, it is imperative to recognise where you want to go (the objective) and how you intend to get there (the plan). Accordingly, it is necessary to cascade the top-level strategies into the section, department and ultimately to the individual responsibilities, developmental plans, quantifiable goals, and timeliness. Instead of concentrating on the actual Lean techniques, it is imperative to ensure that the culture is apt in the first place; undeniably, unless, the organisation manages to anchor these new behaviours into its culture, the transition is destined to not succeed.

There is certainly a need to create a sense of urgency since this reinforces the Lean competitive philosophy of speed to market. In a similar context, Lean systems are much more forcefully mutually dependent, and when struggles take place, the processes necessitate greater consideration to guarantee steadiness. A fundamental obligation for this alteration is the requirement to construct short-term results in order to secure reliability. Similarly, there is present a requirement to acknowledge that ultimately the finest people to bring any cultural change are in fact the internal employees. Many exponents of Lean, as has proven to be the case in many successful Lean initiatives, recommend the need to secure the services of a change agent who is capable of understanding the whole system. Many Lean expeditions are destined for disappointment since there is no acknowledgement that the services of a "sensei" are needed. In the author's experience, if the sensei has performed his/her job, they should ultimately work themselves out of a job. The firm's employees will change if they witness the benefits. Evidence proceeds to recommend that it is favoured to be isolated and to work on a precise project, rather than commit to a global or strategic plunge without ensuring command. In a similar context, it is suggested to be able to agree the period of a project prior to its inauguration as research determines that change can be tolerated over short periods. Similarly, and aligned to this facet are other constituents of Lean, standardisation and visual controls, by way of example, are required in order to assist the business in its endeavours to concentrate on the process itself. In many instances, and within large projects, it may be obligatory to dissect large-scale and long-term projects into very manageable and incremental goals. Nonetheless, it is imperative that and very critical to assemble a strong enough team to direct this process.

Indisputably, fear and anxiety should be eradicated in order to be able to accomplish the compulsory belief. Empowerment does lead to higher performance. It does occur frequently that the people are concerned regards their immediate environment; the level of interest starts to decrease the more distant the theme of the information becomes. Empowerment of employees is an additional imperative prerequisite. The level of employee engagement is not widely used in many organisations, and ultimately, the evidence suggests that the success levels start to be impacted too. In the author's experience, it is often discovered that the employees should be encouraged and systems established enabling this; when this ensues thoroughly and the employees permitted to make a real contribution, this assists to set the organisation apart from the competition; however, it is fundamental that the work is required to be inspiring and rewarding as well as offering a prospect to further advance the skills to perform fully. This notion is not new neither; as early as 2002, the "Manufacturer" stated that 18 % of the variations in productivity and 19 % in profitability are accounted for by people management practices. The initial proponents of Lean such as Ohno (1988) clarified that Lean is not just a set of tools and techniques but at its heart are the people. It is the person whose awareness, aptitude, and yearning to improve that assists to navigate organisations to new levels of continuous improvement.

Nonetheless, despite many organisations commencing their Lean journeys who assert that Lean is proving an effective ideology, deplorably, most of the organisations felt that the workers did not possess the appropriate skills and knowledge to push Lean further. Unfortunately, as the empirical findings will reveal later that most of the organisations were not depicting adequate Lean training programmes. The evidence suggests that work-related habits are just as problematic to change as are the personal habits. Psychologists use the term "extinguish" (Mann, p. 16) when speaking about altering habits. Extinguish infers a procedure taking place progressively rather than an occurrence producing a speedily transformed situation. Upon much closer scrutiny, it could be suggested that the Toyota Production System is about harnessing its principles. It ensues to validate how a resilient and stable culture can be initiated whereby the company interpretations are widely pooled and pursued constantly over an era of many years. When a business demonstrates to be serious-minded in reference to its Lean journey, it is obligatory to institutionalise the improvement and sustainability. Lean enterprises hoping to succeed in their quest cannot afford negative sub-cultures. Dissimilar cultures exist in many organisations; the culture of an outward-looking marketing department may be substantially different from that of an internally focussed manufacturing function. Nonetheless, the overall aims and objectives need to be similar.

Research also focuses upon the individual feedback and coaching rather than relying upon training alone (Croll and Yoskovitz 2013; Eisenhardt and Martin 2010). Whilst formal training continues to contribute a crucial role, the developmental aspect needs to be embedded within the culture of the organisation (Mann 2005; Dan-Shang and Chi-Lih 2008). Managers should be required to provide team members with persistent feedback and coaching. Linked to this aspect is the concept of information sharing (Dalal 2010). Any organisation needs to be aggressively seeking links,

influences, and to entrench pockets of individual-based awareness and capability (Mann 2005). Otherwise, the organisation in question runs the risk of not using the full capability of its intellectual capital (Croll and Yoskovitz 2013). There has been a general recognition amongst forward thinking organisations that have managed to make progress regards their business process re-engineering; that often a barrier towards tangible progress for many of them was the failure to accept the premise that managing the information resource is often equally as important as is true of the other resources (Montgomery 2010). However, the issue in many cases which continues to exist focuses upon the requirement that it should be a senior HR executive who should be creating the social networks which are imperative in order to capture and transfer the knowledge suitably (Mosley 2007; Angelis et al. 2011).

In the author's experience, the Lean practitioners need to be able to deal with the catalogue of excuses that they will encounter; the archetypal ones stumbled upon recently are depicted below alongside an appropriate and valid explanation what the excuse was often indicating:

- "We are too busy right now" = *I am overwhelmed as it is; equally I can't see how this fits;*
- "This does not apply to us—we are different" = *I cannot think outside of what I already know;*
- "We are too big/small" = *I don't want to take a risk on something that I do not understand or do not trust;*
- "It would not work here" = *Although others do it, it would take too much time and effort to deal with the real issues;*
- "Let us wait until the time is right" = *Since the time will never be right, I will never have to think differently.*

Equally, the Lean facilitator needs to be aware of the negatives which will often be expressed and be astute enough to convert this into a positive response:

- "We are going to lose our jobs"—*You have got a chance to earn your future;*
- "The change is an excuse to get rid of people"—*We want to become more effective in the long run;*
- "We are better off the way we are"—*The competition is improving; they will pass us by if we do nothing;*
- "This place is bad and will stay that way"—*Tell us how to make it better, or you might be happier someplace else;*
- "This is just another stupid idea"—*If it is stupid, can you make it better. Your wisdom is hereby solicited.*

A very important component in order to successfully execute Lean is a need for the business to analyse its compensation system guaranteeing that it connects directly to the annual business plan. A balanced compensation plan which concentrates upon the measures of:

- continuous improvement;
- operational efficiency;

- teamwork; and
- short-term results.

will promote the culture where the Lean initiatives can persist, prosper, and produce remarkable results. Individual pay structures pay for the job, and unfortunately fail to differentiate skills or influence satisfactorily. The group and organisational-based pay plans do promote collaboration amongst workers, more than is the case with individual plans. The prevailing research suggests that the best results are often achieved when the following are practiced on a consistent basis:

- the workers concentrate on specific goals,
- the objectives are attainable as perceived by the workers,
- unbiased measurement is installed and visible.

There is ample evidence which proceeds to recommend the opinion that a positive culture incorporates several key essentials; this has proven to be evident in much of one's recent experiences within organisations, albeit organisations representing manufacturing or tertiary sectors:

(i) Namely, a transparent corporate vision supported by the corporate values;
(ii) That employees are highly valued at all levels and there;
(iii) Occurs widespread collaboration between departments;
(iv) That the culture is adjustable; and
(v) Finally, the culture is maintained in some way perhaps through noticeable symbols, slogans, stories, or ceremonies that focus upon the corporate values.

In summary, it could be suggested that when any business is resolute regards its commitment to Lean that the following could help to establish the best practices in managing the intricate process of Lean change. Of particular significance is its association with its endeavour towards accomplishing the desired culture in order for Lean to flourish. Undoubtedly, otherwise, the full benefits Lean has to offer are never realised.

(i) A very detailed vision and mission are essential; these need to be linked to the lean activities. The vision and mission needs to be communicated, discussed, and explained using all possible channels; metaphors can be very powerful since they add a dimension to the overall explanation that had not existed,
(ii) Create an awareness of perseverance regards initiatives with tangible milestones; these need to be clearly communicated to the whole organisation,
(iii) Coupled with the above, cultivate a detailed Lean implementation plan; this should also be used to assess the progress of the initiative and form the basis of the communication systems. The consistent use of the lean tools and methods is vital in order to achieve the Lean vision. The integrated use of Lean tools is necessary for transparency, visualisation, standardisation, focus, and engagement. The thought patterns can be formed more easily by repeated

experiences; in order to achieve the desired experience, the use of Lean tools and methods is required. The use of the following Lean tools can commence to change the thought arrangements in line with the organisation's coaching procedures, namely

- Visualisation,
- 5s,
- Value streaming,
- Using the A3 method (this is an ideal method for constructing and formalising how problems can be solved as results are based upon the Deming cycle of plan, do, check, act),

(iv) Expand and correspond a visualisation and master plan that everyone can relate to; strong visual messages may seem trivial, but the latest behavioural science studies demonstrate how changing routines affect the production of neurotransmitters within the brain necessary for neuron connections via synapses. In essence, anything which impacts the production of neurotransmitters has the potential to change how we think, as the connections are formulating,

(v) Create a strong "Lean steering Committee" "Continuous Improvement Department" or similar body in order to supervise the Lean initiative. Often, this may require industrial engineering, an incentive, and suggestion scheme coupled with ownership of the performance system,

(vi) Assign a programme Director or similar position whose sole responsibility is to implement Lean; evidence suggests that these things do not happen by chance,

(vii) Scrutinise the organisation's partiality for change; change can create stress. Leaders need to be attentive of the negative stress reactions such as threats, resignation, or illness. It is necessary to work with those creating a development plan to lower the dissension by establishing attainable milestones, prioritisation, and positive feedback systems,

(viii) Instruct and prepare managers, staff, and workers,

(ix) Develop and implement Lean performance indices; these need to be stretching and achievable; it is vital that the progress is apparent and communicated,

(x) Support the involvement of all parties to secure authorship, ownership, and buy-in; all the behavioural research and relevant Lean exploration advocates this; if the intention is to achieve cultural change which is based upon different behaviours and thought patterns, then a clear strategy must be pursued. Meaningful work assists to encourage participation and self-development. We need to manage employees and the more a mental process is used, the stronger it becomes; consequently,

- the more we think about a given idea, the more it shapes our environment,
- the more it shapes our environment, the more actions are aligned,

- the more actions aligned, the more they become habit,
- habits form behavioural patterns, and
- behavioural patterns form culture,

(xi) Make available sufficient resources to accomplish the vision; once again, the evidence suggests that Lean does not occur fortuitously but requires dedicated commitment,

(xii) Bring into line the various components; this includes aspects such as culture, performance reward systems, pay systems, performance measurement systems, and workforce organisation with the Lean vision,

(xiii) Authorise action and assist to eradicate barriers which deter Lean from progressing; the best way to harmonise expectations is the efficient communication and participation; these two elements are strongly interdependent,

(xiv) Develop a pilot and make it a success; this is a debate that often transpires; the important factor is that Lean should be viewed as being successful which promotes further adherence,

(xv) It is imperative that the organisation celebrates and publicises the success,

(xvi) Extend the pilots until all is accomplished; if this structure is utilised, it is important to try and approach the process in a systematic and meticulous way,

(xvii) To make sure, thoroughness is existent; it is fundamental to entrench the changes in formal polices, procedures, processes, work standards, job descriptions, and skill classifications.

Conclusions

The empirical evidence evidently substantiates that Culture can facilitate a competitive advantage for organisations especially when aligned to the organisation's competitive strategy. An efficient change strategy methodically coordinates all the HRM measures and their application in a manner that positively impacts upon employee attitudes and behaviour, aiding the business to secure a competitive advantage. Organisations need to eradicate the traditional disciplinary and personnel administration and steer towards a strategic human resource management. 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. Literature draws an association with Lean, whereby efforts have been made to implement many of the HR components discussed; the established literature suggests that fundamentally every Lean failure can be contributed to corporate culture and change management (Mann 2005; Shook 2010; Liker and Franz 2011). Consequently, this reiterates the importance of developing a conducive culture for an initiative to flourish.

It could be stated that it is not in fact capital that restrains growth for most organisations, but poor culture. Evidently, sustainable culture has yet to be methodically incorporated into organisations. Most organisations have considerable work should they hope to secure greater levels of profitability and a superior degree of competitiveness. The research continues to provide further insights; an area receiving considerable attention presently focuses upon the concept on the correlation between strategic fit and a firms HRM efficiency and labour yield. Employees form the prominent barrier between a company's organisational strategy and its business results. The employees will choose or not to adapt their behaviour which has a major implication in implementing any strategy. However, organisations need to appreciate that ensuring a strategy that works from end to end with its people by concentrating the assets and realigning the company's systems, whilst may seem expensive and time intense; ultimately will reap substantive costs savings and make a difference to the performance of the organisation. From the analysis, it is possible to extract empirical evidence; the underlying theme has been provided:

(i) The best performing organisations have an advanced pledge towards people management systems;
(ii) Organisations with flexible job designs but no systematic coaching or training, had lower productivity and stock performance;
(iii) Companies need to implement all the practices of a high-commitment system if they hope to secure the respective performance advantages.

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Chapter 4
Lean Process Requirements

Abstract Lean encompasses complex interrelated set of processes; a successful implementation of Lean is directly related to supply chain management. There is a growing need for the strategic and operational alignment between the different links of the supply chain. In the current market place, partner companies within a supply chain are facing increased global competition, wide demand fluctuations, and the challenges to maintain adequate supply lines capacity. Within a supply chain, Lean strategies can be implemented in the area of product design, process planning, and organisational control. Similarly, having spent considerable time looking at the importance of culture to Lean, we need to analyses the core technical inputs should Lean hope to reap its full benefits. However, this chapter also examines the contemporary debate which has been somewhat sketchy and an effort will be made to clarify the association of Lean with outsourcing, IT, Six Sigma, and agility whilst specifying the necessary tools should an organisation hope to successfully implement Lean. Finally, an attempt is made to provide an outline 25 of the essential tools and followed by another list of 52 tools is provided—with fear of some repetition. The list is not intended to be exhaustive, but once again in one's own experience it has become evident that these components need to be evident for Lean to thrive. The core concept that every organisation should recognise is that a collection of appropriate and timely tools will be required for Lean to thrive. Equally, the type and application of the tools should and will depend on the stage of the Lean journey that the organisation has managed to reach.

The Technical Components for Lean to Flourish

Often contributors have erroneously recommended that the application of Lean and the Lean tools is synonymous. Nonetheless, the tools must always be implemented in a structured manner and at an appropriate time whilst taking into consideration their overall interactions. A straightforward requirement suggests that the appropriate tools are implemented in the right circumstances within the setting of the

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organisation's value chain. Lean is an end-to-end value stream that ultimately needs to provide an organisation with improved competitiveness. In which case, an exceptional cell supplying into a tangle of poorly controlled inventory would result in waste. In a similar fashion, 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. Frequently, within Lean implementations, the fundamental concern remains that Lean efforts begin with a tactical approach rather than an overall strategic one. Constantly, 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.

Lean and Supply Chain Management

For Lean to flourish, it is vital that strategic and operational alignment between the different links of the supply chain happens. There are basic steps an organisation needs to take to account in order to develop a supply chain, as it does not materialise fortuitously. A Lean supply chain is a dynamic ecosystem comprising of:

- processes,
- products, and
- companies.

All these three components need to work together smoothly in order to deliver products and services and add value to the entire network as they meet customer demands in a cost-effective manner. This alignment aims that the chain remains competitive and adds value to consumers and stakeholders. We need to look at supply chain management as the integration of key processes from the end-user to those who provide products, services, and information in order to enable the creation of value for customers and stakeholders. The need for collaboration between members of the supply chain, both upstream and downstream, exceeds functions of integrating the flow of information and materials. Currently, it is necessary that the operations along the supply chain are performed at the lowest cost: with a level of quality aligned to consumer expectations and with the ability to change when necessary. This needs to be fast, whilst having a level of reliability to meet the demands of the consumer. Very few services are provided by one function alone, which means that it is vital that waste removal has to be pursued throughout the whole "value stream"—the entire set of activities across all the entities involved in jointly delivering the product or service are required.

What does a Lean design for a supply chain mean? A Lean supply chain design requires that supply chains minimise the cost of operations at all levels. Lean requires that the supply chain uses the least amount of resources to efficiently complete its job. The primary resources in a supply chain are inventory, warehouses, trucks, people, and working capital. A Lean supply chain will be designed to have minimal inventories in the system, minimal amount of warehousing space

required to store these inventories, and optimised shipments to reduce the cost of moving inventory. A Lean supply chain will also be designed to establish long-term, stable supply contracts with the lowest negotiated cost, but typically without any substantial ability to change ordered quantities, delivery destinations, and required need dates after the order has been placed. Lean design will most likely not engage secondary suppliers, because a second tier of suppliers is expensive to maintain. All of these factors will reduce the costs of the supply chain operations, making it extremely cost-efficient, but will also constrain the supply chain's ability to adapt to any changes in demand, supply, or other resources, due to the built-in rigidity of the design. And therein, lies the rub, low inventories make the supply chain vulnerable to not being able to fulfil orders if the demand such as suddenly materialised spikes or any changes in demand that were not foreseen. Inability to change orders with the suppliers also constrains the supply chain's ability to react to any changes in demand and may saddle the supply chain with unwanted inventory. Having no secondary suppliers also limits the ability of the supply chain to the reacting of spikes in demand and/or exposes it to supply failures from the primary suppliers. The focus on being Lean prevents this supply chain from building redundancy by design, which reduces the supply chain's ability to manage variability.

On the other hand, the only reason for supply chains to exist is to manage variability! So a Lean focus on the supply chain design actually goes against the very basic nature of the supply chains. However, if the Lean focus is seen simply as the most efficient way to execute business operations (which includes a fair amount of agility to respond to natural volatility in demand), then it can be used to design effective supply chains. Likewise, if *Lean* is a supply chain strategy that is good in certain conditions, I would like to know when is *Lean* not good. When should a firm spend more money than is absolutely required to organise its operations? Also, most firms have a large assortment of material to be managed: raw materials, WIP, finished goods, and retail assortments almost always consist of a mixed bag of products when it comes to their demand profile. Whilst some products may have a stable demand profile, others will be more volatile to manage. This means that the enterprise supply chain that must be designed to cater all these types of products must be Lean (to best manage the products with a stable demand) and agile (to manage others with volatile demand) simultaneously. After all, you could not run a business with a Lean supply chain with the lowest cost, but that cannot respond to any changes in demand or supply. Since all demand and supply have inherent variability, such a rigidly designed supply chain will quickly build up unwanted and obsolete inventories as it is incapable of reacting to changes in demand and supply. Of course, too much emphasis on creating agility may be expensive and may also not provide the best design as we shall see when we discuss agile as a supply chain strategy.

Finally, the cost focus serves much better a generic business strategy as suggested by Michael Porter because a cost focus can be used effectively to drive any corporate function, such as accounting, human resources, merchandising, production planning, engineering, and so on. There is nothing specific about the cost focus

that would make it work any extra magic for a supply chain than what it can do for any other corporate function, and hence its inability to drive supply chain strategy. To summarise:

- Supply chains must manage variability and an exclusive focus on Lean prevents supply chains to be designed effectively for managing natural variability and hence from doing their most important job
- As most firms have several products to manage and these products have widely varying demand and lead-time patterns, the enterprise supply chain must be designed to work for all these products without undue focus on a single characteristic
- There is nothing special about the cost focus that helps driving supply chain strategy any more than it can do for any other corporate function. To that extent, it remains an effective business strategy, but not a supply chain strategy.

New relationships are required to be formulated in order to eliminate waste and to effectively manage the value stream as a whole. Instead of managing the workload through successive departments, processes need to flow through all the value-adding steps without interruption, using the toolbox of Lean techniques to successively remove the obstacles to flow with the intention to meet the demand from the end customer. Removing the wasted time and effort represents the biggest opportunity for performance improvement and enabling a greater focus upon creating value. Lean places greater emphasis on wasteful activity, and in line with this, Toyota identified seven deadly wastes related to activity rather than design and implementation: transportation issues, inventory control issues, unnecessary movement of persons or equipment, time management, overproducing concerns, over-processing, and errors. Significant costs may be attached to each of these types of waste, as more and more layers of waste become visible and the process continues every action needs to add value for the end customer. In this way, Lean thinking represents a path of sustained performance improvement—and not a one off programme.

Research undertaken by "Accenture" and Stanford University (2014) and summarised within (www.valuechaingroup.com) reveals that companies with a successful supply chain strategy exposed a strong correlation with financial success. Developing a Lean supply chain assists companies to leverage their own Lean processes far beyond what they could do alone. The best-in-class organisations are applying the Lean principles across the supply chain. Rather than attacking the symptoms, firms need to analyse the causes and drivers of waste and non-value-added activities and processes. A over emphasis within one area can sub-optimise another part of the supply chain; an example could be working to reduce inventory alone without identifying its root causes can increase inventory somewhere else in the supply chain ecosystem including within your own organisation.

The wastes that are part of Lean thinking are well documented, namely anything that does not add value to the customer or that a customer would not be will to pay for. Much of the supply chain waste and costs are attributable to business practices

and processes at both the customers and suppliers. An example being that a customer firm's frequent schedule changes may unintentionally cause a sequence of events that increase waste in the supply chain. Frequent schedule and order changes particularly less than lead time changes may compel a supplier to carry excess inventory, cause shortages, and increase lead times as the supplier struggles to cope. Schedule and order changes can increase overall cycle times at both customer and supplier, with the customer order earlier because of increased purchased-part lead times, whilst continually making changes mid-cycle and keeping just-in-case inventory of its own. This situation can facilitate into shortages, expediting and increasing longer lead times. Supplier quality problems can create other cost drivers ranging from

- rework,
- shortages, and
- expediting both at customers and suppliers, as well as
- warranty returns,
- customer complaints,
- increased volume at call centres, and
- loss of market share (Fig. 4.1).

Whilst many of the hidden cost drivers within the supply chain are relatively easy to uncover, many of the problems begin and end with the customer/supplier

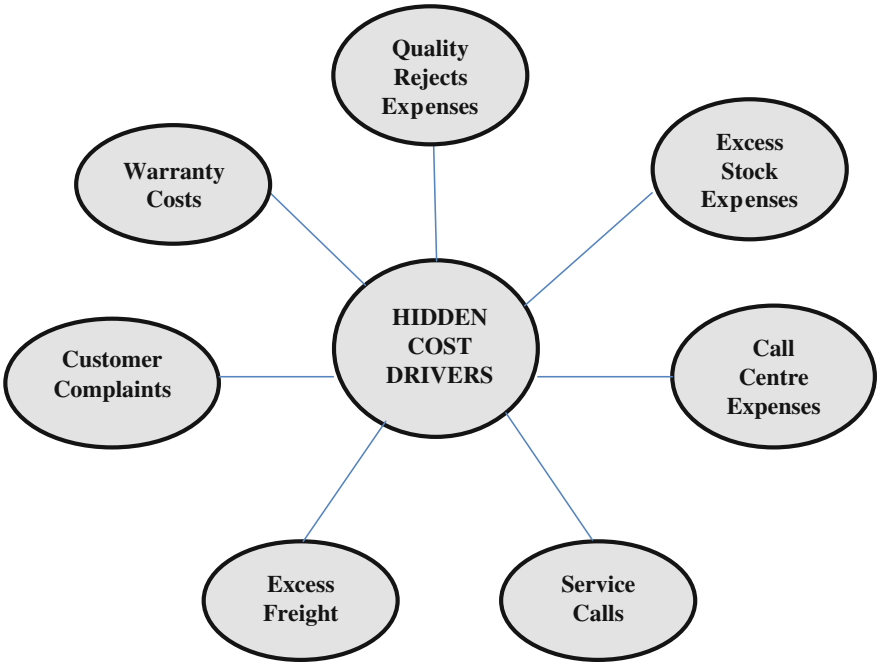

Fig. 4.1 Supplier quality problems

relationship. Consequently, developing good business relationships with key and critical suppliers can help in areas that are weak, for instance, by:

- developing common and simple communications,
- developing a common understanding of each other's needs,
- sharing business strategies in order to develop in the same direction,
- understanding and overcome differences in quality systems and IT systems, and
- mutual involvement in innovation and product design.

In order to eliminate the hidden cost drivers, each firm needs to apply Lean thinking both to its own organisation and work with suppliers to adopt Lean too. As Lean thinking contends organisations, its services must think strategically beyond its own boundaries. Because value streams flow across several departments and functions within an organisation, it needs to be organised around its key value streams. This includes enhancing the value delivered by internal service and back office operations, finance, human resources, legal and compliance, customer service, information technology, marketing, and facilities management, amongst others. For Lean systems to succeed, it is imperative that supply chain management is fully considered. Toyota, for instance, 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. It is essential to be able 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 as discovered in many recent Lean initiatives. 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 aids to shrink lead times and improve customer service.

Lean has to be expanded into the supply chain otherwise the benefits remain both restricted and localised. The need for just-in-time delivery, minimising inventories, and the dependence upon the high-quality products and services has to inevitably embrace suppliers into the improvement efforts. The evidence from many successful Lean initiatives dictates that for a Lean programme to succeed, it is vital to bring together different sections that historically erected barriers between them. The literature proceeds to dictate that the Lean philosophy relies on three goals:

- flow,
- harmony (pace set by customers), and
- synchronisation (pull flow)

and that this needs to exist in all sectors.

As far back as 2003, Emiliani (2003) documents how the Wiremold Company achieved financial and non-financial rewards by applying Lean principles and practices throughout the value stream. Bicheno and Holweg (2009) reflects on how

supply chains have altered and mentions the "*partnership philosophy*"; how both parties could benefit from this arrangement. Conventionally, organisations in Britain, especially those with traditional structures and outlook, 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. Consequently, supply chain coordination should be encouraged, that is

- working to common quality standards,
- sharing transport, and
- employment of intercompany communication methods such as EDI.

Furthermore, supply chain development should be supported as inefficiencies within the supply chain are examined. Usually, lead time is split between in-house processes and supplier processes, which crucially means that we should involve suppliers too. The closer the order signal is to the actual use, the less volatility is passed upstream and smaller the buffer stock required securing availability. The author remains flabbergasted, regards the frequency by which he often discovers that often many organisations fail to grasp the simple logic behind this philosophy.

Those who doubt Lean have often made accusations 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. 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. 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.

Sharing information on demand with suppliers enables companies to establish their production or purchasing programme, whilst also calculating automatic inventory restocking for the customer. This gives customers a better balance between excess inventory and missed sales, whilst reducing supplier uncertainty and giving the supplier greater flexibility. Furthermore, when information is shared regards demand and inventory, the time between the order being placed and the delivery being made is reduced. Mayano-Fuentes and Diaz (2012) proved in their study that greater the level of interaction between cooperation and information integration with customers, the greater the intensity of Lean adoption. This should be a trigger for managers to recognise that collaboration with customers creates an environment that favours Lean; this cooperation should be substantiated by

information integration with customers, whilst simultaneously making advances in Lean with view towards maintaining customer cooperation and integration.

In short, to move forward in Lean adoption, companies have to establish relationships with suppliers and customers based on confidence and a high level of motivation to learn, and allow knowledge to be shared freely. A Lean strategy should embrace the forging of relationships with the main supply chain partners. The supply chain should endeavour to identify the costs of operations and reduce them continuously for improvements to the final consumer; all members of the supply must continually improve processes to increase value to the consumer. Besides the integration of operational processes upstream and downstream supply chain, there is a need to operate with a smaller number of suppliers, thus creating greater collaboration for the Lean practices being applied not only by the focal company, but also by their suppliers. The evidence proves that for a successful Lean supply chain management system, this is dependent on the following ingredients:

(i) Develop the organisational flexibility;
(ii) Develop and maintain a strong relationship with suppliers;
(iii) Try and achieve a full coordination within the supply chain;
(iv) Increase the quality of information to reduce the uncertainty and inventory levels; the transfer of production related information from the customer to supplier means that the latter's operations can be better adapted to the customer needs. Suppliers can put in place policies to contend the variability in demand and balance production and demand and so reduce inventories along the chain;
(v) Outsource the activities that are not distinct competencies;
(vi) Implement on-demand production system, reduce inventory, and reduce costs;
(vii) Reduce the number suppliers and develop efficient suppliers;
(viii) There needs to be a transparency of costs; the cost structures should be transparent between firms in the chain;
(ix) There has to exist a constant assessment of the relationship with customers and suppliers, namely measure the efficiency of the relationship between the two perspectives of the supply chain;
(x) Eliminate the blaming of another link; one should not blame the vendor but to apply quality tools and apply them together to solve problems;
(xi) For global operations, the suppliers need to be close to their consumers in the various locations;
(xii) Resourcing to be evident; new providers are hired only when possibilities with existing suppliers are exhausted;
(xiii) The development of new technologies must be aligned and integrated with the needs of the consumers; and
(xiv) Early involvement of suppliers is necessary in the development of new projects.

In order to reach both control and evolution of the practices of Lean supply chain management, it is necessary to measure the performance generated by the deployment

of joint practices. Once again the empirical evidence suggests that the performance measures must extend beyond the control of internal activities, measuring the results in the supply chain. Seven dimensions could be used:

- demand management,
- value specification,
- standardisation of processes and products,
- efficiencies within the value chain,
- key indicators of the process,
- alliances, and
- cultural change in the supply chain.

Supply chain restructuring becomes an important prerequisite with an increasing availability of outsourcing. In essence, it goes beyond improvements in business routines and involves strategic policy shifts to implement:

- group purchasing,
- reverse e-auction, and
- time-based logistics, different supply chains relationships, and employee deployment.

It is important that the supply chain is viewed from a systems perspective, in addition to focussing on the internal issues of any one firm alone. It is important to commence collaboratively in order to create a high-level extended enterprise value stream map, including your own organisation and the key stakeholders. Often it is discovered that the least visible interactions and relationships between firms are the least visible and least addressed yet have the greatest potential for harbouring the hidden cost drivers. Equally, it is important to take the baseline performance measures in order that we can demonstrate the rate of return on investment as the progress is made. The following graphic illustrates some simple steps to get started on this journey.

Lean Extended to Outsourcing

Since, Lean sustainability requires all the component parts that suppliers provide, external network configurations that involve suppliers and customers are critical for sustainability.

The philosophy should extend to an organisation's decision on outsourcing. It is estimated that about 70 % 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. Whilst key capabilities are sourced out to external firms the company does not lose its internal capability (Fig. 4.2).

All the key suppliers are part of Toyota's supplier association. Toyota aims to create bonds amongst individuals and partners. The myriad of Toyota plants in many countries pursue the Toyota system. The work instructions are generated and

Fig. 4.2 Lean extended to outsourcing

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.

A basic outsourcing model consists of the outsourcer, outsourcee, transportation system, and communication system. The communication system is responsible for providing an information exchange link between the outsourcer and the outsourcee.

- If executed correctly, outsourcing can save time, foster creativity, improve quality, and make a company more flexible.
- A successful business partnership requires planning, communication, added value, and growth.
- Many companies tend to overlook such "soft" savings in many supply chain initiatives.
- Dictating a process without fully understanding its implications will only lengthen and exacerbate the supply chain.
- Expect depth and not necessarily breadth from outsourcing partners.

Increasing product obsolescence, tighter launch deadlines, and shrinking profit margins are forcing organisations' to look for many ways to reduce the cost and time involved in manufacturing. Add the pressures of sustainability demands and a struggling global economy, and a Lean supply chain becomes imperative to success. Most companies incorporate some level of outsourcing, which is typically employed to save costs. Very few companies are in a position to produce everything in-house, and the financial investment to do so would be unfeasible. But outsourcing can provide much more than mere cost savings. If executed correctly, it can also save time, foster creativity, improve quality, and make a company more flexible. In short, outsourcing has the potential to make a company leaner.

Today's consumers constantly expect more:

- innovation,
- creativity,
- service, and
- value.

In the same way, brand owners should expect more from their outsourcing suppliers. A successful business partnership requires planning, communication, added value, and growth. A contract manufacturing relationship should be no different. Outsourcing is not simply a means to improve the bottom line and meet demands. It can be a vehicle to improve both the brand and the contract manufacturer. By learning from each other and adapting the supply chain accordingly, both companies can become leaner, more responsive, and ultimately, more profitable. In any industry where quality issues can derail a launch or permanently damage a brand, a supplier that can deliver zero defects within shorter time frames is a definite asset. Some outsourcing partnerships even include full inspection and documentation, so final product arrives at the supplier with all quality checks in place, ready to integrate into the manufacturing process. Another time-saving benefit of outsourcing is the inclusion of experts in the manufacturing process. After the initial research, one of the most difficult and time-intensive tasks in product development is taking a product from trial to mass production. Unique skills and knowledge are required to make such a transition a success. The most innovative outsourcing companies provide value-added services to further save time.

Potential Pitfalls of Outsourcing

Along with all the potential for savings, outsourcing also presents challenges and pitfalls. A leaner supply chain can only be achieved when both parties are intentionally driving for the same goal. Exchanging performance feedback and creative ideas to improve processes is necessary for both companies to grow and improve. Experts also insist that becoming Lean through outsourcing requires constant communication and realistic expectations.

Constant improvement of focused goals is the best way for a company to create an ongoing culture of Lean manufacturing, and the effects always trickle down. Micromanaging is an important trap to avoid. Whilst collaboration is essential, dictating a process without fully understanding its implications will only lengthen and exacerbate the supply chain. If an outsourcing company has been qualified, trust it to understand the best way to meet your requirements. In so many cases, a marketing company feels it understands manufacturing better than the manufacturer. This is a huge mistake. Allow the experts to work for you and you will get great results. Be wary of any company claiming it can do everything, and do not insist that outsourcing companies perform tasks for which they are unsuited. The ideal supply chain is one in which every participant understands its contribution and focuses on doing its specific part to the best of its ability.

When it works, nothing can make a company more efficient and successful. Outsourcing is a long-standing tradition in many industries. Like many long-standing traditions, it includes many dated ideas and concepts. If businesses must become Lean to compete in the current marketplace, it stands to reason that business relationships must also become Lean in order to survive and thrive. The world

is changing. Business is changing. Luckily, outsourcing is also changing and providing opportunities for companies to improve more than just the bottom line. With the right outsourcing partnerships, companies can improve their products and themselves;

- **Developing the Scope of Work**—Planning and creating clear expectations are the key to successful outsourcing. Milestones are critical during the supplier planning/approval phase, launch phase, and during production. Developing the initial contract is the most important step in the outsourcing process, although it is not the only critical step.
- **Values and Culture**—Subcontractors may not necessarily share your values, or they may not have a culture that is conducive to continuous improvement. Your supplier evaluation should include a review of the subcontractor's philosophy, employee moral, housekeeping, teamwork, and its commitment to continuous improvement. Underutilised human potential is essential to a successful outsourced project. This is often overlooked, and it encompasses the greatest opportunity for achieving production cost, quality, and delivery objectives.
- **Managing the Scope of Work**—Buyers who have their own set of requirements/needs may negotiate your production contract. Whilst the production, sales and quality teams may all have different expectations or needs from that of the buyer, this is a recipe for a very difficult customer/supplier relationship. This is the time to focus on common goals to ensure that all the needs of the affected teams are met. An experienced programme manager will ensure the scope of work is clear to all parties, from the negotiation stage to completion. A competent programme manager will also ensure the scope of work is met whilst educating customers and suppliers to the documented agreement. You should get what you agreed to pay for! Defining that in the beginning and managing those expectations is crucial to a successful outsourced product. A RACI (responsibility, accountability, consultation, and information) matrix is an effective tool for clarifying and ultimately managing the scope of work. RACI defines who is responsible for which deliverables such as planning, set-up, reporting, delivery, and transportation.
- **Supply Chain Management**—The scope of work needs to define responsibilities for not only your supplier, but also for your supplier's responsibility to manage their supply base. For example, you do not want an ingredient substituted for in your finished tablet, not be told and not have it identified on the product's label. Substitutions are not uncommon, and many times occur somewhere in the supply chain.
- **Lean Manufacturing Principles**—Specific expectations should be spelled out in the scope of work for continuous improvement, in adherence to the Lean manufacturing principles.
- **Assessing Lean Capabilities**—The easiest and most telling place to start assessing a supplier's Lean capabilities is in housekeeping. This area is critical to eliminating waste and to the overall quality of your manufactured tablet! The supplier's work areas, warehouse, and office should be organised, labelled, and

in showroom condition. The supplier should ensure that only those things required for the work area are present there. Everything in the area should be labelled, have a home, a purpose, and always be accessible to the operator.

Your outsourcing system should evaluate the supplier's level of empowerment, participative decision-making, gain sharing, and continuous improvement initiatives. You should determine whether the supplier has a formal programme to solicit employee ideas. Employees can identify waste in an operation better than any other source. They will tell you if asked, and if they feel it is their best interest to do so. Suppliers should involve their employees and everyone should feel a sense of ownership for housekeeping and organisation. If the supplier does not have effective leadership, teamwork, and high morale, you should find another supplier. Everyone has to be on board. Your outsourcing system should provide an evaluation of your supplier's leadership effectiveness. Quality and Lean are synonymous. To ensure system compliance, process audits should be a very important part of your system. If your supplier does not have documented systems and process audits, it does not have a repeatable process, and it is not manufacturing to specifications.

Key performance metrics and goal setting needs accommodating. Suppliers should track and post key performance metrics, so everyone knows how they are performing and what their goals should be. Ensure that each area of your business is driven by specific goals that drive continuous improvement, and that each goal ties into the company's long-term goals, and that your organisation agrees with those goals. Ensure that your supplier focuses on first-time quality throughput for your tableting. Having to reprocess your product can affect tableting flow ability, change particle morphology, and affect compaction behaviour. The cost of improving your supplier's process should be the supplier's responsibility, along with the costs associated with receiving defective material. You are expected to deliver quality products; your suppliers should have the same expectation. Remember, inspection does not assure quality; only a process that is in control will produce consistent quality. Your supplier telling its employees to work harder or to offer more suggestions may create a short-term improvement (the Hawthorne Effect). However, identifying the systemic inefficiencies within an organisation will provide sustainable improvement and will help create the culture necessary to keep you competitive. Developing a culture where all employees have the skills needed to identify waste, take ownership for quality, solve problems, and the motivation to care about the long-term success of the company, are essential in today's global market. You need to be able to evaluate your suppliers' culture as it relates to Lean and continuous improvement.

Evaluating processes for the elimination of waste through continuous improvement in your supplier's production processes, material, work-in-progress, scrap, administration, quoting, systems, administrative policies, and rules is an effective way for you to ensure that you are receiving value. That will reduce the pressures on your bottom line. Outsourcing production can be very successful, but you cannot assume that any supplier will perform to your expectations, unless you

have controls in place to ensure accountability. You will require a constant flow of information, a frequent presence, frequent milestone reviews, rewards and penalties, and a very clear initial document that clarifies all your requirements. Outsourcing production can expand your production capabilities and help you grow, but you cannot outsource the responsibility for delivery and quality.

When a company outsources its services to some off shore providers, a customer might have to pay more than what he/she would have paid if on shore resource were used. Offshore outsourcing can have many more hidden costs. They can take costly and long process to choose a vendor. It may take four to twelve month or longer timeframes to finish the work handover to the offshore vendor. Costs related to severance packages due to layoffs of regional employees who cannot be reallocated globally. Finally, there can be costs associated with turnover, and extra costs related to adjusting to the cultural differences for instance language. In Lean manufacturing and just-in-time inventory, purchasing goods and services is really important, and hence, manufacturers keep low stock levels. Their job is to control the stock levels of sourced goods. Problem arises when raw materials do not arrive on time and it disrupts the supply chain. Also, if a company relies on just one source for a critical part for their product, and that source fails to deliver, the supply chain is again disrupted. Risk diversification plays an important role here. A company can try to diversify the risk from suppliers, thus eliminating the vulnerability arising from failure of one source. Adapting supply chain innovation strategies such as outsourcing, just-in-time inventory, and Lean manufacturing can prove successful in saving costs if all the risks are well managed. All the costs with these methods should be accounted for and then a final call should be made regards whether "Outsourcing a good option for us?"

Chen et al. (2010) suggest that Japanese car producers design and provide detailed drawings of only 30 % of the parts in their cars, the rest are distributed to its first-tier suppliers, who usually have expertise in process engineering and plant operations. By focusing upon product design and final assembly whilst aggressively outsourcing parts, Lean companies are able to steadily decrease unit costs; however, as most projects are outsourced as a "turnkey" project to suppliers, the Lean producers are barely involved in manufacturing of most, and often key, components of their products. As a result, the organisation's own ability to design, debug, and improve manufacturing systems or even large segments of their products could decrease. Toyota in Japan attempts to maintain long-term relationships with its suppliers and assists them to improve manufacturing by loaning/switching its engineers through the supplier companies. This approach promotes communication and knowledge sharing between producers and suppliers to a greater extent. Likewise, another trade-off to distributed design occurs when the parts are mostly outsourced as the innovations from internal product research and development at a company may flow out to competitors too quickly; often before the company has been able to fully benefit from it fully. Since most suppliers provide parts to multiple customers, to reduce cost, suppliers are likely to provide parts that are similar, if not the same, to each customer.

Lean and IT

The Lean ideology is often reported to be opposed towards the embracing of IT. Lean proponents, by definition, are technical sceptics (Womack and Jones 2005). It is ironic that on the surface, 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. The Lean community, it needs to be stressed, is not and should never be against IT but equally must not be obliged to sprint towards automated solutions; through experience, this tends to institutionalise large amounts of waste. It is vitally 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". Attitudes towards IT by Lean proponents are changing. 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. In practice, the real issue has often been on how the IT solution is used, not the IT solution itself. 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.

Process simulation regularly plays an important enabling role in Lean programme delivery. Basic Lean tools, including value stream mapping, are fine for analysing simple, linear processes with relatively consistent demand patterns. Static approaches are less appropriate for analysing processes which incorporate volatile demand dynamics, product mix complexity, or the shared use of specialist resources (machines or labour). Where such time dependencies are important, a process simulation model can more accurately describe and visually explain the dynamics of the process, its performance, and resource requirements and show what the main drivers for end-to-end process performance are.

Fundamentally, Lean aims to ensure that resources are matched to demand, and process simulation is a tool that frequently used to do precisely this, whether it is for a call centre, a factory, or a police custody suite. The objective of most process simulation tools is to enable decisions on how best to match available resources with customer demand. Process simulation can be very effective in establishing "current state" understanding and in considering various "future state" options. In each new environment that Lean has entered—such as the service environment (including banking and insurance), health care, construction, public sector, or retail, we have seen examples of implementations that have followed a similar path. However, what we now know is that applying Lean is situational as it depends upon the circumstances we are operating in and the business problem(s). The agile

movement was already prevalent in the IT sector, and some folks were trying to adopt Lean methods inside this approach. However, what really interested me were three further strands that have emerged. Firstly, the Lean Start-up movement was very much in evidence drawing on the prevailing evidence whereby in many ways this gets to the heart of what Lean is all about, solving problems for customers. Secondly, the work is that Toyota is doing to translate Lean principles and use the Toyota Way in IT. Thirdly, work is happening whereby companies are embedding Lean principles into project management using visual management and PDCA. This last area is applicable beyond the IT arena.

Future state process visualisation using value stream mapping is very limited, and this can be more powerfully and visually enabled using process simulation. Usually, the key question in testing future state process designs is "*how well will the new process design work*?" This is where process simulation can add real value as it allows all stakeholders to evaluate the impact of making a wide variety of "what if" change scenarios quickly and without the cost and risk of implementation or pilot implementation.

Another area where simulation can contribute strongly within a Lean initiative is when organisations are trying to unlock new process design thinking from legacy resources. Such employees can more readily engage with a very visual process simulation model and this helps unblock improvement ideas. The very creation of a process simulation model forces teams to ask the right process and performance questions. Often, these are questions that are being asked for the first time. Once built, a process simulation model can then be used to help stress-test the viability of solutions suggested by kaizen style improvement teams in a risk free environment. This encourages more radical redesign thinking and helps management identify implementation priorities. As an integral part of a Lean activity, companies spend a lot of time designing new process layouts, producing CAD drawings, and producing process maps en route. The cost of such activities can easily run into six figures, yet none of these outputs will actually determine whether the new process will work or not! This is the job of process simulation which can test the capability of the new design and provide essential implementation confidence to management that they have selected the right solution.

Lean cannot afford not to embrace technology; it may permit a much more complex or advanced manufacturing process to occur. The development of new bar coding capabilities, new RFID technologies, and mobile devices brings new tools to the toolbox for potential use. Toyota offers a common-sense approach that has defined the company from the start. In its advanced North American facilities, this approach has culminated in a harmonious combination of robotics, e-kanbans and automated business processes all working in harmony with the TPS. As technology is edging further into the production cycle and takes on more critical tasks, the line between technology and Lean is becoming blurred. In essence, we should implement technology when it is appropriate to do so to aid in the use of the Toyota Production System. One of the obvious but often overlooked tools is information from an electronic floor system. A floor information system can help manufacturers move forward with Lean concepts of identifying problems, following the flow of

parts, and measuring changeover times. With information systems, factory floor processes and part flow, sometimes referred to as a "current state map", are visibly tracked through production. The process flow is visible and available all day to all employees. Improvement becomes a continuous, ongoing goal for both management and floor workers. To truly contribute to Lean manufacturing, floor information systems should provide the following:

- Accessibility: all floor employees have access to the system and are empowered to identify problem situations.
- A JIT approach: a just-in-time production approach is dynamic and reactive to customer and floor demands.
- Tracking: changeover times can be tracked to specific assets and employees.
- Process improvement: opportunities for process improvement are identified and recorded.
- Communication: floor personnel have access to communications such as e-mail when appropriate.
- Data: operators can access data through electronic, paperless display of electronic image and video documents.
- Quality checks: quality checks are captured electronically in real time so that employees can be alerted to non-conformance conditions.

As much as Lean initiatives have developed through processes and organisational structure, Lean-enabling technology has also evolved. In recent years, manufacturers have become more sophisticated with their Lean-enabling technology implementation, moving beyond electronic kanban (using an electronic signal to notify plant employees when other departments need materials). For instance, they are integrating modelling and simulation into their applications and using value stream mapping to document the production process and value-added activities. Recent evidence suggests that these measures, along with supermarket sizing ("inventory levels planned based on uncertainty of demand and attainments") and order management integration ("visibility into manufacturing constraints when order promising"), are amongst the "Lean automation" tools being used by manufacturing firms today. Moreover, 63 % of top-performing manufacturers (top 20 %) have enabled Lean manufacturing practices through demand planning and forecasting systems. Best-in-class manufacturers are using such solutions to determine forward-looking inventory targets by customer, location, and so forth, for production planning and scheduling. The best-in-class manufacturers cited manufacturing execution systems (MES) and advanced planning and scheduling (APS) as rounding out the top three Lean-enabling technologies, all of which are more likely to be used in tandem with the Lean tools discussed above. The MES allow manufacturers to more efficiently track and trace production across the organisation, optimise production schedules that have real constraints, and improve quality from both a process and finished product perspective. APS results in the creation of production plans at different levels of granularity (from monthly to near real time) using a variety of approaches, such as theory of constraints and takt time scheduling. A critical caveat for manufacturers who decide to leverage technology in a

Lean environment is that it should be reliable and thoroughly tested to serve the organisation's processes and people, according to the Toyota Way; that is, the technology should be pulled by manufacturing rather than pushed to manufacturing.

Lean and Six Sigma

Six Sigma is a process improvement methodology that has been proved to make step function improvement in any business environment. Six Sigma is driven by quality. It uses facts and data focused on customer value. It is not a one-time project to fix a problem. It is not a "Flash in the Pan" or a "Flavour of the month" programme that will go away. Six Sigma is a structured way to approach your business issues. If Six Sigma is embraced and implemented into your organisation's culture, you can achieve about a 20 % margin improvement, 15 % capacity improvement, and/or a 20 % capital reduction. Six Sigma defines customer value as a product or service that is received by a customer at the right:

- location,
- cost,
- time, and
- delivers.

All of these as defined by the customer, not you. Many times we see customer value as the "functions" part only—that the product worked or the service did what is was supposed to do. But we forget that customer value includes the delivery process that is made up of the other three items above—location, cost, and point in time.

The History of Six Sigma

In the 1980s, engineers at Motorola Corporation developed Six Sigma as a business improvement methodology. They discovered the mathematically derived point where the cost of eliminating an error/defect is greater than the cost of living with (and repairing) the defect. That is, there is an acceptable point of imperfection—and any quality improvement made beyond that point is more expensive than the expected cost savings of fixing the imperfection. Motorola explained that Six Sigma (which represents 3.4 defects per million) is the optimum level to balance quality and cost. This discovery forced Motorola to assess quality levels by measuring defects in millions rather than thousands, which had been the traditional method. This change enabled a vast improvement in the ability to assess and improve quality levels. Six sigma enabled Motorola to cost-efficiently perform defect-free more than 90 % of the time, resulting in significant savings.

Lean and Six Sigma have both been popular brands of performance improvement initiatives in the last decade. Both of those programmes can coexist independently. Organisations wishing to knit both programmes together have done so using the "**Lean Sigma**" term. It may be useful to clarify that this is absolutely fine as these approaches can be deployed to achieve complementary objectives. Six Sigma, originally developed by Motorola in the 1980s, is effectively a quality management approach which is aimed at defect and process control. Its name indicates its strong statistical origin, relating to a very low level of acceptable defects per million opportunities and therefore a high-quality standard, whereas Lean focuses more heavily on the velocity of the end-to-end process and the cost of non-value-added activities involved in that process. Both will claim to be strongly driven by customer value through the process.

Whilst Lean and Six Sigma differ, they are also complementary. The methods that are deployed within Six Sigma can be used comfortably within a Lean improvement initiative. Usually, Six Sigma will deploy a "define, measure, analyse, improve, and control" (DMAIC)-driven loop and this is analogous to the other "plan–do–evaluate" and "map–do" cycles defined within parallel improvement approaches. A Six Sigma programme will depend on the collection, cleansing, and analysis of significant amounts of statistical data. This can involve a lot of work and organisations with limited capable resources can struggle with this. Six Sigma will often require training many employees in new, sometimes quite complex, statistical analysis methods, with successful delegates being presented with different coloured "belts" to signify capability in the style of martial artists. The appropriateness of this approach to the culture of the business must be considered and a clear cost justification produced before implementation. Both approaches can therefore be implemented separately to achieve parallel objectives, or as mutually complementary components within an integrated programme. They both help companies respond to increasingly demanding customer needs through a model of operational excellence that creates delivery agility.

This change enabled a vast improvement in the ability to assess and improve quality levels. Six Sigma enabled Motorola to cost-efficiently perform defect-free more than 90 % of the time, resulting in significant savings. Its objective is to find and eliminate causes of defects or mistakes in processes by focusing on outputs. The empirical evidence states that even a Sigma level of 6 though gives:

- 500 surgical operations failed per week,
- 1000 letters lost per hour, and
- every day 15,000 cheques charged to a wrong account.

Lean is often erroneously portrayed as being in competition with other innovative ideas. Recently, this centres on the debate involving Lean and Six Sigma. Womack and Jones (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. 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. Nonetheless, it should be recognised that Toyota makes heavy use of poka-yoke and heijunka in conjunction with line stops and andon boards to expose problems quickly. In recent years, the author has discovered that when the two ideologies are combined, the outcome is speed. 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.

By definition, any Lean Sigma programme is eclectic in style. Perhaps such programmes should really be termed "**Lean–Sigma–TPM–TQM–JIT programmes**", because complementary building blocks from all such philosophies can be found deeply embedded within such programmes. Obviously, the author feels that it does not really matter which banner is flown, as long as essential levels of understanding and commitment are secured from the outset. Six Sigma is a process improvement methodology that has been proved to make step function improvement in any business environment. Six Sigma is driven by quality. It uses facts and data focused on customer value. As mentioned, it is not a one-time project to fix a problem. It is not a "Flash in the Pan" or a "Flavour of the month" programme that will go away. Six Sigma is a structured way to approach your business issues. If Six Sigma is embraced and implemented into your organisation's culture, the evidence proceeds to show that the organisation will indeed achieve about a 20 % margin improvement, 15 % capacity improvement, and/or a 20 % capital reduction. As Six Sigma defines customer value as a product or service that is received by a customer at the right:

- location,
- cost, and
- time.

and delivers all of these as defined by the customer, not you.

The concept and principles of Six Sigma are very transparent and unmistakable making them clearly recognisable, namely:

- understand the critical-to-quality (CTQ) requirements of our customers and stakeholders,
- understand our processes ensuring they reflect these CTQs,
- manage by fact,
- measurement and management by fact enables more effective decision-making,
- by understanding variation, we also know when to take action and when not to,
- involve and equip the people in the process, and
- undertake improvement activity in a systematic way.

Whilst the concept of Six Sigma began in the manufacturing arena decades ago, the idea that organisations can improve quality levels and work "defect-free" is currently being used by public sector organisation of all types and sizes. Naturally, as Six Sigma permeates into today's complex, sophisticated government landscape, the methodology is "tweaked" to satisfy unique needs of individual public bodies.

But no matter how it is deployed, there is an overall framework that drives Six Sigma towards improving government performance. Common Six Sigma traits include:

- a process of improving quality by gathering data, understanding and controlling variation, and improving predictability of the organisation's business processes,
- a formalised DMAIC process that is the blueprint for Six Sigma improvements (The DMAIC process will be described in greater detail later in this paper);
- a strong emphasis on value. Six Sigma projects focus on high return areas where the greatest benefits can be gained; and
- internal cultural change, beginning with support from leaders and champions.

By defining, measuring, and analysing a business's processes, Six Sigma is able to improve the effectiveness of its operations as well as to design services of a quality that is likely to suit the needs of potential customers. More importantly, not addressing the quality issues can in time result in less efficient processes. Six Sigma uses facts and data to understand, reduce, and control variation in your business processes and variation that you now may be compensating for and which costs you money. This is not about analysing reports which you may receive on a weekly or monthly basis. Go and see what is happening out in the workplace and collect real data on how things are done. One local authority chief executive would listen to contact centre recordings to understand what was actually taking place. It is the difference between what you think is happening and what is really happening. There is variation everywhere. To reduce it or eliminate it, you first have to understand it. Understanding and addressing variation helps you predict outcomes that you had to compensate for before and outcomes that impact your customer needs. In Six Sigma, these facts and data on the variation are collected and analysed to come up with conclusions, which lead to better decisions.

Used properly, Lean and Six Sigma can help organisations to maintain high standards of services, despite the cuts. The call has been to do "more with less"—in other words, to be more efficient. But care must be taken to ensure that the focus is not solely on taking the money out; it needs to be reiterated that this to a degree is the easy bit. There are, in fact, two ways in which to increase value:

- one, by reducing waste and thus the cost of a product or service and
- the other, by increasing value-adding activities.

The challenge for most organisations is to reduce spend whilst retaining or even improving service delivery. The call therefore is "*better with less*". Whilst the concept of Six Sigma began in the manufacturing arena decades ago, the idea that organisations can improve quality levels and work "defect-free" is currently being used by public sector organisation of all types and sizes. Naturally, as Six Sigma permeates into today's complex, sophisticated landscape, the methodology is "tweaked" to satisfy unique needs of individual organisations. However, no matter how it is deployed, there is an overall framework that drives Six Sigma towards improving overall organisational performance as intimated earlier. By defining, measuring, and analysing a business's processes, Six Sigma is able to improve the

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Lean Sigma—Bringing Them Together

Operating by itself, Lean focuses on using the minimum amount of resources (people, materials, and capital) to produce solutions and deliver them on time to customers. Certain proponents have suggested that Lean implementation can involve extremely thorough data collection and analysis that take years before any change occurs. This approach often yields desired results, but that this takes too long to get there. Meanwhile, Six Sigma, operating independently, aims to improve quality by enhancing knowledge generating processes. In many cases, this leads to slow, deliberate, change-intolerant practices. To combat these challenges, organisations have found that by merging the Lean methodology with the Six Sigma methodology, a synergy is achieved that provides results much greater than if each of the approaches was implemented individually.

When Lean is added to Six Sigma, slow processes are challenged and replaced with more streamlined workflows. Additionally, the data gathered during Lean implementation help identify the highest impact Six Sigma opportunities. When Six Sigma is added to Lean, a much-needed structure is provided that makes it easier to consistently and predictably achieve optimum flow. The two methodologies work so well together, that a new, integrated, Lean Sigma approach, with its own unique characteristics, has been defined and incorporated by several leading organisations. Lean Sigma therefore is the application of Lean techniques to increase speed and reduce waste, whilst employing Six Sigma processes to improve quality and focus on the voice of the customer. Lean Sigma means doing things right the first time, only doing the things that generate value, and doing it all quickly and efficiently. When meshed together as Lean Sigma, each of these ideals serves to increase delivery speed whilst decreasing variation in performance. As a result, Lean Sigma allows managers to effectively address issues of speed, quality, and cost.

The Lean Sigma-Based DMAIC Approach

With this methodology, a team defines a problem and works through to implementing a solution linked to its underlying causes, establishing practices to ensure the solution sticks.

- Define
  The define phase of the DMAIC process is often skipped or short-changed, but is vital to the overall success of any Lean Sigma project. This is the phase where the current state, problem statement, and desired future state are determined and documented via the Project Charter.
- Measure
  The measure phase is where the business gathers quantitative and qualitative data to get a clear view of the current state. This serves as a baseline to evaluate potential solutions and typically involves interviews with process owners, process mapping of the key business processes, and gathering data relating to current performance (time, volume, frequency, impact, etc.). Information that gives a clear view of the current state is found in numerous locations—and all of it is valuable and should be captured.
- Analyse
  In the analyse phase, the business studies the information gathered in the measure phase, pinpoints bottlenecks, and identifies improvement opportunities where non-value-added tasks can be removed. A business case is conducted, which takes into account not only hard costs but also intangible benefits that can be gained, such as productivity and satisfaction, to determine whether the improvement is cost-effective and worthwhile.
- Improve
  The improve phase is when recommended solutions are implemented. A project plan is developed and put into action, beginning with a pilot programme and culminating in full-scale deployment. Where appropriate, new technology is used and integrated.
- Control
  Lean Sigma's goal is growth, not just reducing costs. Its aim is effectiveness, not just efficiency. In this way, a Lean Sigma approach drives organisations not just to do things better but to do better things.

In the past, companies used Lean Sigma primarily for operational improvement—refining existing processes to reduce costs, improve performance, and provide better customer value. However, dramatic upheavals in the competitive marketplace are prompting business change on a more significant scale. Organisations must innovate, not just improve. Despite its heritage, Lean Sigma is well suited for this step change in target and scope. Because of its core tenets—analysis based on facts and direct customer input. Lean Sigma is equipped to facilitate a much broader transformation, helping an organisation rethink its entire business and create a more innovative climate.

One of the reasons it has only been recently applied is that, unlike manufacturing, it is very hard to see a physical product in services and follow it through its key processing from raw material to finished product. In the service world, the service product is hidden within many interconnected departments. This is why it can take weeks to complete a simple service because of invisible hand-offs, bottlenecks and non-ownership of the process as it crosses interdepartment boundaries all with their own measurements for performance.

Many managers lack statistical knowledge and the ability to apply statistics to problem-solving. If you look at management development programmes, how many devote time within their programmes to practical and applied statistical methods. So the challenge is to motivate the managers to understand and apply statistical methods. It is a fundamental framework for managers to use these techniques for problem-solving in organisations. There is a real gap. One of the problems is short-term thinking by senior managers. We need to change the mindset which thinks just for short-term results and which lacks a clear vision or strategic direction. We need to move away from creating fire-fighting managers who only tackle problems that arise on a daily basis without determining the root cause, so the problems come back again and again. There is a big need for a change in culture. We need brave leaders setting direction and looking at how we transform businesses.

Lean Sigma brings powerful methods for quickly combating recessionary pressures, and its application in the service sector and office environment unlocks significant opportunities to reduce costs, remove waste, and improve the overall customer experience. It provides a compelling option for consideration, not least because it helps organisations across the public and private sector to achieve cost reductions without sacrificing service quality. Improvement activity must be tailored to circumstances if benefits are to be sustained and in reality, different approaches are often brought together to deliver the right result. "Lean Sigma" recognises that the improvement strengths of Lean can be harnessed with the financial benefits and analytical discipline of Six Sigma to create benefits on a far greater scale. It is a systematic method to improve an organisation's capability to meet customer demands and identifies ways to deliver improved customer service at lower cost—in other words: "**achieving much better with less**". By putting Lean Sigma principles into practice, it is considered that organisations can offer high-performing services that typically achieve:

- a clear focus on the issues that matter most to customers and other stakeholders,
- an understanding of customer demand and how this can vary,
- greater responsiveness and flexibility to meet customer needs,
- more effective service delivery, at reduced cost,
- whole systems' improvement through more capable end-to-end processes,
- sustainable changes in culture, improved communication, and morale
- higher levels of customer satisfaction, and
- improved productivity and efficiency.

Lean Sigma's goal is growth, not just reducing costs. Its aim is effectiveness, not just efficiency. In this way, a Lean Sigma approach drives organisations not just to

do things better but to do better things. In the past, companies used Lean Sigma primarily for operational improvement, namely refining existing processes to reduce costs, improve performance, and provide better customer value. Nonetheless, dramatic upheavals in the competitive marketplace are prompting business change on a more significant scale. Organisations must innovate, not just improve. Despite its heritage, Lean Sigma is well suited for this step change in target and scope. Because of its core tenets, the analysis based on facts and direct customer input; Lean Sigma is equipped to facilitate a much broader transformation, helping an organisation rethink its entire business and create a more innovative climate.

Business Benefits from Lean Six Sigma

The organisations that have successfully embraced Lean Six Sigma have experienced numerous benefits; these once again range and are determined by the extent of implementation and commitment displayed by the management team:

- Effective management decisions due are based upon heavy reliance on data and facts instead of gut feelings and hunches. This means that costs associated with fire-fighting and misdirected problem-solving efforts with no structured or disciplined methodology are often significantly reduced.
- Increased understanding of customer needs and expectations, especially the critical-to-quality (CTQ) service performance characteristics which will have the greatest impact on customer satisfaction and loyalty.
- More efficient and reliable processes;
- Improved knowledge across the organisation on various tools and techniques for problem-solving, leading to greater job satisfaction for employees;
- Reduced number of non-value-added operations through systematic elimination, leading to faster delivery of service, faster lead time, faster cycle time to process critical performance characteristics to customers and stakeholders;
- Reduced variability in process performance, service capability, reliability, delivery, and performance, leading to more predictable and consistent level of quality and service performance; and
- Transformation of organisational culture from being reactive to proactive thinking/mindset.

Lean methodology concentrates on creating more value with less work. The Six Sigma system strives to identify and eliminate errors/defects. Consequently, Lean Sigma provides a method to accelerate a company's decision-making processes, whilst both reducing inefficiencies as well as increasing quality. Both Lean and Six Sigma have the same goal of continuous improvement, but it is reached by asking different questions. In reality, a pragmatic approach needs to be taken, picking the best bits of each approach to use for the problem that needs to be solved. Lean Sigma is the way the organisations can follow the more progressive organisations to steadily improve the services they deliver without any additional resources. Given

this change in mindset, and the similarity of much of the work being done, there is no intrinsic reason why productivity growth should be any different in the public sector than in the private sector.

Indeed, many proponents recently have identified that the opportunities are probably greater in the public sector over the next few years. Lean Sigma does not require expert statisticians. It does not mean that you need highly qualified Lean Sigma experts; ultimately, it is a case of what is most convenient for your organisation. It is not a cure all for every nook and cranny of an organisation. There may be a need for some expertise—be it statisticians or other experts. But for the relatively straightforward projects that most organisations are looking at, what is needed is for everyone in the organisation to understand Lean Sigma. You should not see Lean Sigma as the purview of experts, but as a philosophy which embraces the organisation.

Lean Sigma and Agile Manufacturing

Whilst Lean advocates and traditionalists need to embrace Six Sigma, it is necessary to view agile manufacturing from a similar perspective. Every process has the potential for error, and the principle behind this is to look at all the ways in which things can go wrong, especially in the eyes of the customer, and try and eliminate the defects. Take for example the business of a planning application to a local authority. The process begins with your first call to the planning department. Various things can go wrong, namely you can be placed in a queue and have an unacceptably long wait, you can be passed between departments, or when you receive the document, you notice that your details have been recorded incorrectly or that you are being charged a higher amount than you were quoted in the phone call. Six Sigma also looks at "excessive variation in processes"—for example, the same X-ray on the same machine with the same operator may take 15 min one day and 21 min the next. Why? How can we reduce this variation?

Leagile—a hybrid strategy of Lean and Agile manufacturing

The term "***agile manufacturing***" refers specifically to the operational aspects of a manufacturing company which accordingly, try to translate into the ability to produce customised products at mass production prices and with short lead times. Agile manufacturing is a new idiom that is used to represent the ability of a producer of goods and services to survive and flourish in the face of continuous change. These changes can occur in markets, technologies, business relationships, and all other facets of the business enterprise. Agile manufacturing can be defined as the capability of surviving and prospering in a competitive environment of continuous and random change by reacting quickly and effectively to changing markets, driven by customer-designed products and services. The relation between agility and flexibility is extensively discussed in the literature. It has been proposed that the origins of agility lie in flexible manufacturing systems. Consequently, these

firms need a number of distinguishing attributes to promptly deal with the changes inside their environment. Such attributes include four main elements:

- responsiveness,
- competency,
- flexibility/adaptability, and
- quickness/speed.

The base for agility is the amalgamation of information technologies, staff, business process organisation, innovation, and facilities into main competitive attributes. The main points of the definition of various authors may be summarised as follows:

- high-quality and highly customised products,
- products and services with high information and value-adding content,
- recruitment of core competencies,
- responsiveness to social and environmental issues,
- combination of diverse technologies,
- response to change and ambiguity demand, and
- intra-enterprise and interenterprise integration.

Agile manufacturing aims to meet the changing market requirements by suitable alliances based on core competencies, by organising to manage change and uncertainty, and by leveraging people and information. Agile manufacturing does not represent a series of techniques much as it represents an elementary change in management philosophy. It is not about small-scale improvements, but and completely different way of doing business with a primary emphasis on flexibility and quick response to the changing markets and customer needs. The competitive nature of the organisation's market is undeniably regarded to depict instability; research (Wang and Feng 2011; Krishnamurthy and Yauch 2007; Wang and Feng 2011) reflects that in these types of circumstances, a dependence upon Lean systems alone may be restrictive and that existence necessitates the embracing of agile methods. It is essential that manufacturing is able to adapt to changes, and improve the technical support ensuring that it remains at a high level whilst reducing the time to market with shorter production runs since it operates in a bespoke market. It is considered that independently that neither of these strategies would provide a competitive advantage. The ideology of Lean attempts to eradicate waste from the processes whilst endeavouring to provide equilibrium and optimise the work flow in order to secure effectiveness.

A properly implemented Lean system would ensure:

(i) Waste is located and removed within production which reduces costs and improves capacity;
(ii) Assists to instigate a culture of continuous improvement;
(iii) Looks for an opportunity to develop quality levels; and
(iv) Lessens risks through testing and responses at each stage.

Agile manufacturing, on the other hand, offers other advantages, namely:

(i) possible solutions in order to get products to the market quicker whilst shrinking development cycles;
(ii) projects not performing well are isolated quickly which reduces the risk of further waste; and
(iii) priority alterations can be accommodated at a lower cost.

Organisations need to manage this process of instilling the hybrid strategy; research reveals that leagile can operate very well, even on the same site when assisted by a restricted rotation of staff. The empirical evidence advocated amongst others and Wang and Feng (2011) suggest three possibilities through which the concept could be adopted by the organisation:

(i) Pareto curve approach: it could be forwarded that the top 20 % of the products by volume are prone to be more certain and would then provide an opportunity to operate the Lean doctrine. Equally the slow moving 80 % which are potentially less predictable and could utilise the agility principles.
(ii) Decoupling point: the principle behind this is that stock can be held in a modular form but proceed to completion or construction once the precise customer specifications are known. Consequently, organisations should use the Lean methodology up to decoupling point and agile for the remaining process.
(iii) "Information" decoupling is operated on the similar lines except centres upon information which has not been twisted by stock management procedures such as reorder processes.

Leagility would prove beneficial for organisations as Lean and agile can accompany each other; the decoupling point could be used effectively by the organisations since the supply chain implications would have to be managed effectively. Any increase to the organisation's product or a change in the volumes would enable the decoupling point to shift upstream which would consequently make the supply chain more agile. The culture at the respective organisations needs to accommodate outsourcing more of its non-core company processes. The research provides ample examples of third party logistics (3PL) organisations, for instance, which provide a practical service on purchasing, logistics, and the routine components of product design and repair as reflected by Wang and Feng (2011). Leagile principles support this since they can be viewed as a method to create additional high value functions for the respective company.

Whilst agile manufacturing plays prominence to flexibility, it does provide a possibility for the organisation to be more effective and reduce the lead time in influencing change which will promote the organisation as opposed to its competitors. The Lean approach will permit the organisation to offer products to its customers at a high quality and lower prices; this will be possible as the costs should decrease as less stock will be necessary and more efficient processing made possible. Agile will allow the organisation to join potential markets whilst being more competitive with bespoke customers. Similarly, organisations need to

consider hybrid processes which are integral to leagile organisations; there is a necessity to ensure that there is in existence a high degree of association between the organisations' requirements and the process characteristics.

Yusuf and Adeleye (2002) were able to demonstrate that a broader array of competitive competences and performance levels of agile organisations correlated considerably and positively; however, similarly, such associations were only able to witness in these cases a constricted variety of capabilities and performance levels within the Lean organisations. Consequently, the evidence suggests that challenging concurrently on numerous competitive capabilities augment performance levels in a greater depth than would be the case when competing upon factors such as cost and quality alone. Likewise, leagile organisations embrace the formation of virtual organisations; this should be encouraged since it provides any organisation with an opportunity to deal with unforeseen variations in a more agile fashion. The possibilities for the organisation are as follows:

(i) Expand its flexible knowledge supply chain which will enable higher production runs permitting greater economies of scale;
(ii) Establish international alliances with other companies in order to broaden its product line or to fill its existing portfolio gaps;
(iii) Facilitate an integration of numerous distinct business entities through the advantages offered by sophisticated information technology; and
(iv) This offers the organisation considerable market strength; the virtual organisations merge their respective proficiencies with other partners in order to accommodate a particular mission that no individual organisation would be able to cope with.

Leagile philosophy assists to inform the company regards make or buy decisions. The prevailing situation dictates a harsh decision for any organisation. Crude oil prices and transportation outlays have escalated; this then emphasises the significance of inventory production and static facility charges. The internal direction offers many advantages, namely:

- composite market,
- the technological aptitude of the company,
- a greater degree of control over their own competitive environment,
- opportunities to explore economies of scale, and
- a greater ability to segregate the products.

However, the trade-off needs to be fully contemplated; benefits of outsourcing include the following:

- permitting the release of resources,
- decreasing the overall operating costs,
- improving the overall capability levels, and
- permitting the organisation to concentrate upon its fundamental responsibilities.

Leagile Implementation Factors for Consider

In adopting the hybrid system, any respective organisation needs to utilise a company-wide and holistic approach. A summary is provided whereby the literature and research proposes certain aspects necessary to exist for leagility to be successful, namely:

(i) Assuring that the decision-making process happens at the lowest possible level; a conducive culture and a common vision amongst the workforce has to exist.
(ii) Communication, resolving issues, teamwork, and leadership are vital for a leagile strategy.
(iii) The company would need to drive out the outmoded punitive and personnel administration and move towards a strategic human resource management.
(iv) Evidence suggests knowledgeable leadership stimulates the motivation and appetite of the staff; this subsequently will enable new resolutions, quicker embracing of new ideas which will proceed to assist to enhance the organisation's competitiveness.
(v) The organisation would need to ensure that a collaborative approach is present in order to exist.
(vi) Complete teamwork with delegated authority to be actively promoted which will support both motivation and efficiency through empowerment and appropriate delegation.
(vii) It is recommended that the communication channels should be clear regards the overall goals and performance expectation.
(viii) The organisation needs to explicitly feel that its personnel are a prominent strategic source; the actual strategy will require strong human resource foundation; the evidence suggests that existing inflexible manacles of command found in other organisations will necessitate a requirement to be exchanged for networks; the bureaucratic systems need to be detached in favour of more adaptable processes.
(ix) Equally, the management styles instead of being tyrannical would need to facilitate empowerment and coaching.
(x) The flexibility of the work would need to continuously provide professional fulfilment to the staff.
(xi) The organisation would need to fully eradicate or greatly reduce the borders between the various functions.

The implementation of leagility requires a situation of a complete business philosophy which should integrate both the "socio-technical systems", namely recognising that all work organisations conglomerate a technical, i.e. technology, and a social system, i.e. people and organisational structures. The prevailing structures are required to guarantee that the personnel are invigorated to pursue creatively within their daily routine and operational tasks. Leagile 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 various functions. Clearly, the change to Leagile needs a significant determination and change. The empirical evidence implies that instigating Leagile can be tremendously complicated. In most cases, within the implementations, there are obvious omissions which are related to the organisational development components; this affords the apparatus to hold things together. This includes the change management procedures that need to be associated with the prevailing culture, a performance payment arrangement, pay systems, and a performance measurement system coupled with the workforce organisation.

Sustainability of a Leagile System

The respective organisations need to recognise that markets are dynamic in nature with must be constantly revised and alterations made if a strategy is to stay in line with the market. Ideally, it needs to become more market driving rather than market driven. In this case, often the competition is reduced whilst forming barriers for competitors. Organisational structures would need to supplement a leagile strategy. The company would need to pay particular attention to its organisational structure; there would need to be a greater move towards separating the company into specific units which would necessitate certain modifications in order to gratify the objectives. Decentralisation would need to be actively encouraged with a less bureaucratic style of leadership which is imperative in order to deal with the uncertainty. This is not equally necessary for a Lean organisation and certainly not to the same extent but is needed for a leagile strategy.

It is also proposed that leagility should be applied to the complete value chain. Similarly, leagility is required to be extended into the entire supply chain. The research proposes that for it to succeed that it is necessary to combine the various sections that may have conventionally initiated obstacles between them (Marodin and Saurin 2014). The organisation in question would need to continuously strive towards retaining its agile philosophy. The evidence dictates that companies that depict a Lean approach tend to try and minimise the change whether from an internal or external perspective. However, agile organisations tend to prosper at the constant changing conditions. The organisation needs to continue looking at decentralisation; the decision-making needs to be delegated to lower levels which is conducive to a leagile organisation. This will assist to ensure that the company retains its flexibility. Likewise, in order to preserve its market position, the organisation needs to adopt a holistic approach.

Equally, the empirical research suggests that any organisation wishing to sustain and improve its competitiveness in the future needs to embrace the following:

(i) The use of environmentally conducive processes and products; fortunately, there needs to be a promotion of this happening; this needs to be undertaken appropriately and making the suitable investments in order to achieve this; however, an aspect that it needs to strengthen its use of information.

(ii) The organisation needs to examine the possibility to utilise information in a variety of ways to secure competitive advantage. There is a definite need to embrace the emerging technology; the organisation should consider innovative ways to link the shop floor to its enterprise software and then to its customers' value chain.

The organisation hoping to implement leagile would be required to continuously examine its infrastructure. Leagile organisations necessitate a considerable degree of cross-functional collaboration. The human resource aspects of analysing prevailing management structures need to continuously occurring; this includes the need to look at roles and responsibilities. Equally, Stump and Badurdeen (2012) suggest the need to look at remuneration systems which should be based upon skills and performance whilst endeavouring to strive towards a flatter management structure. The organisation would need to continuously strive to illuminate urgencies for every value stream and proceed to recognise the performance disparity between what its customer requirements are and what is the value stream it is delivering.

The competitive nature of the organisation's market is undeniably regarded to depict instability; the organisations that are attempting to implement leagile systems tend to demonstrate that in these types of circumstances, a dependence upon Lean systems is inadequate, and that existence necessitates the embracing of agile methods. In this regard, this aspect any organisation would need to implement manufacturing systems which are

- able to adapt to changes,
- improve the technical support ensuring that it remains at a high level whilst
- reducing the time to market with shorter production runs since it operates in a bespoke market.

It is considered that independently that neither of these strategies would provide a competitive advantage for an organisation. The ideology of Lean attempts to eradicate waste from the processes whilst endeavouring to provide equilibrium and optimise the work flow in order to secure effectiveness. A properly implemented Lean system would ensure:

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(i) Pareto curve approach: it could be forwarded that the top 20 % of the products by volume are prone to be more certain and would then provide an opportunity to operate the Lean doctrine. Equally the slow moving 80 % which are potentially less predictable and could utilise the agility principles,
(ii) Decoupling point: the principle behind this is that stock can be held in a modular form but proceed to completion or construction once the precise customer specifications are known. Consequently, the organisation in question could use the Lean methodology up to decoupling point and agile for the remaining process,
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Whilst agile manufacturing plays prominence to flexibility, it does provide a possibility for the organisation to be more effective and reduce the lead time in influencing change which will promote the organisation as opposed to its competitors (Krishnamurthy and Yauch 2007). The Lean approach will permit an organisation to offer products to its customers at a high quality and at a lower price; this will be possible as the costs should decrease as less stock will be necessary and more efficient processing made possible. Agile will allow the organisation to join potential markets whilst being more competitive with bespoke customers. Similarly, the organisation needs to consider hybrid processes which are integral to leagile organisations; there is a necessity to ensure that there exists a high degree of association between the organisations' requirements and the process characteristics.

As early as 2002, Yusuf et al. were able to demonstrate that a broader array of competitive competences and performance levels of agile organisations correlated considerably and positively; however, similarly, such associations were only

witnessed in the case of a constricted variety of capabilities and performance levels within the Lean organisations. Consequently, the evidence suggests that challenging concurrently on numerous competitive capabilities would augment performance levels to a greater depth than would be the case when competing upon factors such as cost and quality alone. Likewise, leagile organisations embrace the formation of virtual organisations; this should be encouraged since it provides an organisation with an opportunity to deal with unforeseen variations in a more agile fashion. The possibilities for the organisation are as follows:

(i) expand its flexible knowledge supply chain which will enable higher production runs,
(ii) permitting greater economies of scale,
(iii) establish international alliances with other companies in order to broaden its product,
(iv) line or to fill its existing portfolio gaps,
(v) facilitate an integration of numerous distinct business entities through the advantages offered by sophisticated information technology, and
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However, the trade-off needs to be fully contemplated; benefits of outsourcing include the following:

- permitting the release of resources,
- decreasing the overall operating costs,
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An organisation hoping to implement leagility *w*ill be required to continuously examine its infrastructure; leagile organisations necessitate a considerable degree of cross-functional collaboration. The human resource aspects of analysing prevailing management structures need to continuously occurring; this includes the need to look at roles and responsibilities. Equally, the organisations that have implemented leagility suggest the need to look at remuneration systems which should be based

upon skills and performance whilst endeavouring to strive towards a flatter management structure. The organisation would need to continuously strive to illuminate urgencies for every value stream and proceed to recognise the performance disparity between what the customer requires and that the value stream it is delivering.

Lean and Strategy Formulation

Isolated and inappropriate use of the Lean tools is often inaccurately promoted the Lean way forward by too many Lean proponents and organisations. Kaizen, for instance, 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" (p. 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. 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. 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*" (p. 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. 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.

Similarly, many Lean journeys start with a major training commitment. This is often observed as a preferred strategy for consultants since there is less pressure to deliver any result other than a trained audience. 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. 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. The author has discovered the situation in many organisations that utilised it effectively; they proceeded to half 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. Progressive organisations, in the past, such as BMW Engines and Vauxhall, have utilised CMMS

either as a stand-alone system or as 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.

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. 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. Rethinking the value side is as important since this leads to the seeking of new opportunities. The literature has sometimes made reference to "*mechanical*" Lean which in essence is a reference to the implementation of tools in a piecemeal fashion; "*Managerial*" Lean, on the other hand, is its implementation in an integrated manner. "*Innovative*" Lean takes it beyond the shop floor and the organisation to create a new opportunity, new value, and new customers.

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 and stage of Lean implementation. Equally, by making reference to a value stream, an organisation is only examining one product, one family at a time. 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. 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 trying to both capturing and contextualising this into Lean, it should be remembered that strategy precedes process and process precedes structure; this could be translated in terms of define value first; then, we should proceed to define a process that provides the desired value. This will then assist to create an organisation able to operate the process effectively.

The majority of organisations fail to achieve Lean since there exists confusion between the Lean goals and the intended results which it is expected to accomplish. Many organisations struggle on the commencement of their journey which is critical to the success of Lean. 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. Ironically, many consultants proceed to recommend a tactical approach which is misleading. This is because Lean has progressed from operational improvements and many cannot visualise Lean as a strategy.

Lean needs to be constantly treated as a system comprising of more than the sum of its components. The Toyota Production System grew through both revolution and evolution. The revolution rejected the concepts of mass production and the evolution developed the details and the tools in a constantly methodical manner. It is erroneous to suggest that Lean is little more than scientific management, since it predominantly focuses on people and leadership. Similarly, Lean becomes inflexible when it transforms into a programme that is managed. At its core, Lean is little more than a problem-solving methodology that everyone can use on a daily basis. If Lean is successful, then you will have fewer managers because people will solve problems as they arise on the shop floor. Similarly, when Lean becomes a programme, egos get involved with implementation projects and strategy.

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. The inclination for many Lean organisations at the start of their journey can be grouped into several categories; they are often very concerned about:

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

All of the above approaches in isolation have inherent weaknesses. Many organisations have started their journey with workplace reorganisation. Undoubtedly, marginal increases in productivity are achieved, though despite being difficult to measure, the improvements may be isolated. Kanbans 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 for many modern enterprises. Consequently, kanbans are used to move small, controlled batches of material in a "pull" environment. Nevertheless, as has been witnessed by the author in many recent organisations, kanbans without other harmonised improvements such as reducing equipment changeover times can cause poor equipment utilisation and worsen late shipments. 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.

Lean is an entire business philosophy; it essentially needs to ensure that the whole business is analysed its entirety, including how orders are processed, the way materials are purchased, and the way manufacturing is done. In essence, it is necessary to subscribe to the total approach and stress the need to combine the "socio-technical systems", whereby the work organisations combine a technical, i.e. technology, and a social system, i.e. people and organisational structures. Historically if we were to examine the TPS, it could safely be concluded that it is an interlocking set of three underlying elements: the philosophical underpinnings, the managerial culture, and the technical tools. This was neatly summarised by George Koenigsaecker early, 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).

It is often necessary to adapt the principles of Lean in order that it can both cope and tackle local circumstances. There are numerous issues being encountered in efforts to apply the TPS principles to other companies without appropriate adjustments. Whilst the principles of Lea have been around for over three decades, the literature is still 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 consistently. Companies need to safeguard a philosophy whereby people are permitted to look creatively at what they do on a daily basis and do it better; this principle was initially proposed by Ohno (1988) and has been subsequently 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. Undeniably, there has to be a recognition that the pioneering work within the automobile industry is misleading as conditions differ in other industries and any correlations may be spurious.

An area which Lean proponents need to actively promote and are often misleading is the need to clarify that there is no "cookbook" to explain each step of the Lean process and exactly how to apply the tools. Often it is discovered that quality improvements are only possible if companies implement comprehensive change management programmes addressing both the organisational and technological aspects of quality management. An aspect often not advocated sufficiently centres upon a need to suggest that Lean should be applied to the entire value chain. Lean ranges from an organisation's product development to its distributional logistics as depicted in Fig. 4.3.

It is often evident when new in a client organisation that the senior policy leads do not grasp the real concept of Lean and its associated impact; it is imperative that Lean is not viewed as a *direction and instead it should be viewed as a state to be reached after a certain time*. Without doubt, all the determinants of Lean might not point in the right direction all the time; many organisations encounter *instances where they can receive and send mixed signals.* However, Lean requires a need to explain that the TPS necessitates to be adapted to prevailing circumstances for successful Lean implementations. Those organisations that manage to both view and apply Lean as a comprehensive management system, rather than a group of tools, tend to perform better and achieve their Lean implementation more smoothly.

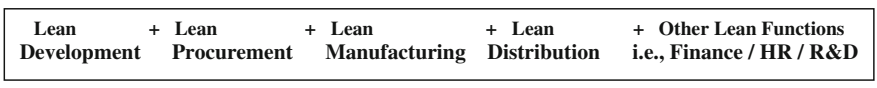

Fig. 4.3 Scope for Lean

Lean is successful where organisations see it as a never-ending process. An organisation always strives to be Lean, but will often never quite achieve it. Essentially, there is always a gap between where the organisation is and where its ideal state is. 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. The entire way of thinking must become embedded in every person of the organisation. It is insisted that it is a total system; however, if it is referred to as a value stream, by definition, the organisation will proceed to analyse one product, one family at a time. Whilst this strategy may be sufficient to an extent, it will be necessary to analyse further aspects in order to understand the system. A policy to continue examining one product from raw material to finished goods is only a partial investigation. 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. If the intention is to secure the full benefits, this unsettling can seem painful but is a prerequisite since it is crucial that the business is reorganised 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.

The work and research undertaken by the author over the previous twenty years indicated that organisations are required to ensure that instead of merely embracing one or two solitary tools that it is obligatory for companies to operate most, if not all, of the following components of Lean. Sheridan (2000) had proposed 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. Securing the full benefits of Lean requires a need to concentrate on the whole value chain. It has become evident that for the Toyota Production System to work effectively, it needs to be adopted in its entirety, not piecemeal. Undeniably, Lean is an arrangement and should be utilised as such. Each component builds on the previous one, anchoring the systems as a whole. In this case, a system of sprinkling Lean tools which are not properly used will undoubtedly confuse the workforce.

In order to reap the full benefits and classed as a truly Lean enterprise, Lean has to be expanded into the supply chain. In addition to the need for just-in-time delivery, minimising inventories, and the dependence upon the high-quality products and services, there is a prerequisite to embrace suppliers into the improvement efforts. Progressive organisations are recognising that if they are to succeed at Lean, it is necessary to bring together different sections that historically erected barriers between them. Much of the contemporary empirical evidence corroborates that the Lean philosophy relies on three goals:

(i) flow,
(ii) harmony (pace set by customers), and
(iii) synchronisation (pull flow).

and that this needs to exist in all sectors. Even over ten years ago, 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, the prevailing scenario was that 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. Consequently, supply chain coordination should be encouraged, i.e. working to common quality standards, sharing transport and the employment of intercompany communication methods such as EDI. Furthermore, supply chain development should be supported as inefficiencies within the supply chain are examined sooner and to a greater extent. Often in practice, it is usually discovered that lead time is split between in-house processes and supplier processes, which crucially means that we should involve suppliers too. The closer the order signal is to the actual use, the less volatility is passed upstream and smaller the buffer stock required securing availability. For Lean success, any organisation cannot leave this decision to chance (Womack and Jones 2005). In its early stages, it needs to be treated as a strategy until it becomes an ideology embraced by the entire value chain (Bicheno and Holweg 2009).

Lean should never be viewed as a business improvement tool; it is a philosophy which needs to be driven from the top team down if it is to generate required levels of understanding and belief. The prevailing evidence does proceed to suggest that appropriate strategic management proceeds to both facilitate and encourage better performance. Nonetheless, it should be recognised that the relationship is in fact quite complex, heavily influenced by factors such as the nature of change, environmental turbulence, and industry structures. The literature does offer a pragmatic deduction, insisting that businesses which perform formal strategic planning have a higher probability of success than those which do not. The truly great companies are those that have been able to sustain long-term ROI and growth rates for 10 years or more. Frustratingly, it is still often the case, what is termed as "strategic" is often no more than ordinary one-year to five-year capital operational budgeting in many organisations. 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. In a similar perspective, improving operational effectiveness, whilst needed for management, should not be deemed as strategy. 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.

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. These companies are able to conceptualise the impact on processes, stakeholders, and the business objectives. If these are not fully understood, the impacts will be discovered late and the proposed or implemented changes suffer. All organisations need to identify all of its process owners and participants in the value stream. 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. 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. 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.

Unfortunately, Lean is being considered as a cost-reduction strategy and not as a market supremacy one by the majority of the organisations. 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.

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. Table 4.1 provides a useful approach on how this should be viewed. 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,
- very little attention is paid to the recognition of a starting point; this is coupled with
- little or no assessment being undertaken to assess the impact on the overall organisation, and
- 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.

Table 4.1 Approaches to Lean

Customer value	Business value
Reduction of a cost per unit	Assists the aggressive sales strategies
Decreased cost per product customisation	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

Lean Tools

Lean provides a methodology for eliminating waste and improving organisations. This methodology developed over the last five decades and has yielded a wide array of tools and techniques. An attempt is initially made below to outline 25 of the essential tools; the list is not intended to be exhaustive, but once again in one's own experience, it has become evident that these components need to be evident for Lean to thrive. Subsequently, another list of 52 tools is provided—with fear of some repetition. The core concept which every organisation should recognise is that a collection of appropriate and timely tools will be required for Lean to thrive. Equally, the type and application of the tools should and will depend on the stage of the Lean journey that the organisation has managed to reach. The following is a collection of 25 essential Lean tools. Each tool is distilled into a simple description of what it is and how it helps.

Lean tool	What is it?	How does it help?
5S	Organise the work area: • Sort (eliminate that which is not needed) • Set in order (organise remaining items) • Shine (clean and inspect work area) • Standardise (write standards for above) • Sustain (regularly apply the standards)	Eliminates waste that results from a poorly organised work area (e.g. wasting time looking for a tool)
Andon	Visual feedback system for the plant floor that indicates production status, alerts when assistance is needed, and empowers operators to stop the production process	Acts as a real-time communication tool for the plant floor that brings immediate attention to problems as they occur—so they can be instantly addressed
Bottleneck analysis	Identify which part of the manufacturing process limits the overall throughput and improve the performance of that part of the process	Improves throughput by strengthening the weakest link in the manufacturing process
Continuous flow	Manufacturing where work in process smoothly flows through production with minimal (or no) buffers between steps of the manufacturing process	Eliminates many forms of waste (e.g. inventory, waiting time, and transport)
Gemba (the real place)	A philosophy that reminds us to get out of our offices and spend time on the plant floor—the place where real action occurs	Promotes a deep and thorough understanding of real-world manufacturing issues—by first-hand observation and by talking with plant floor employees

(continued)

Lean tool	What is it?	How does it help?
Heijunka (level scheduling)	A form of production scheduling that purposely manufactures in much smaller batches by sequencing (mixing) product variants within the same process	Reduces lead times (since each product or variant is manufactured more frequently) and inventory (since batches are smaller)
Hoshin Kanri (policy deployment)	Align the goals of the company (strategy), with the plans of middle management (tactics) and the work performed on the plant floor (action)	Ensures that progress towards strategic goals is consistent and thorough—eliminating the waste that comes from poor communication and inconsistent direction
Jidoka (autonomation)	Design equipment to partially automate the manufacturing process (partial automation is typically much less expensive than full automation) and to automatically stop when defects are detected	After Jidoka, workers can frequently monitor multiple stations (reducing labour costs) and many quality issues can be detected immediately (improving quality)
Just-in-time (JIT)	Pull parts through production based on customer demand instead of pushing parts through production based on projected demand. Relies on many Lean tools, such as continuous flow, heijunka, kanban, standardised work and takt time	Highly effective in reducing inventory levels. Improves cash flow and reduces space requirements
Kaizen (continuous improvement)	A strategy where employees work together proactively to achieve regular, incremental improvements in the manufacturing process	Combines the collective talents of a company to create an engine for continually eliminating waste from manufacturing processes
Kanban (pull system)	A method of regulating the flow of goods both within the factory and with outside suppliers and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed	Eliminates waste from inventory and overproduction. Can eliminate the need for physical inventories (instead relying on signal cards to indicate when more goods need to be ordered)
KPI (key performance indicator)	Metrics designed to track and encourage progress towards critical goals of the organisation. Strongly promoted KPIs can be extremely powerful drivers of behaviour—so it is important to carefully select KPIs that will drive desired behaviour	The best manufacturing KPIs: • Are aligned with top-level strategic goals (thus helping to achieve those goals) • Are effective at exposing and quantifying waste (OEE is a good example) • Are readily influenced by plant floor employees (so they can drive results)
Muda (waste)	Anything in the manufacturing process that does not add value from the customer's perspective	Eliminating muda (waste) is the primary focus of Lean manufacturing

(continued)

Lean tool	What is it?	How does it help?
Overall equipment effectiveness (OEE)	Framework for measuring productivity loss for a given manufacturing process. Three categories of loss are tracked: • Availability (e.g. down time) • Performance (e.g. slow cycles) • Quality (e.g. rejects)	Provides a benchmark/baseline and a means to track progress in eliminating waste from a manufacturing process. 100 % OEE means perfect production (manufacturing only good parts, as fast as possible, with no down time)
PDCA (plan, do, check, act)	An iterative methodology for implementing improvements: • Plan (establish plan and expected results) • Do (implement plan) • Check (verify expected results achieved) • Act (review and assess; do it again)	Applies a scientific approach to making improvements: • Plan (develop a hypothesis) • Do (run experiment) • Check (evaluate results) • Act (refine your experiment; try again)
Poka-yoke (error proofing)	Design error detection and prevention into production processes with the goal of achieving zero defects	It is difficult (and expensive) to find all defects through inspection, and correcting defects typically gets significantly more expensive at each stage of production
Root cause analysis	A problem-solving methodology that focuses on resolving the underlying problem instead of applying quick fixes that only treat immediate symptoms of the problem. A common approach is to ask why five times—each time moving a step closer to discovering the true underlying problem	Helps to ensure that a problem is truly eliminated by applying corrective action to the "root cause" of the problem
Single minute exchange of die (SMED)	Reduce set-up (changeover) time to less than 10 min. Techniques include: • Convert set-up steps to be external (performed whilst the process is running) • Simplify internal set-up (e.g. replace bolts with knobs and levers) • Eliminate non-essential operations • Create standardised work instructions	Enables manufacturing in smaller lots, reduces inventory and improves customer responsiveness
Six big losses	Six categories of productivity loss that are almost universally experienced in manufacturing: • Breakdowns • Set-up/adjustments • Small stops • Reduced speed • Start-up rejects • Production rejects	Provides a framework for attacking the most common causes of waste in manufacturing

(continued)

Lean tool	What is it?	How does it help?
SMART goals	Goals that are specific, measurable, attainable, relevant, and time specific	Helps to ensure that goals are effective
Standardised work	Documented procedures for manufacturing that capture best practices (including the time to complete each task). Must be "living" documentation that is easy to change	Eliminates waste by consistently applying best practices. Forms a baseline for future improvement activities
Takt time	The pace of production (e.g. manufacturing one piece every 34 s) that aligns production with customer demand. Calculated as planned production time/customer demand	Provides a simple, consistent, and intuitive method of pacing production. Is easily extended to provide an efficiency goal for the plant floor (actual pieces/target pieces)
Total productive maintenance (TPM)	A holistic approach to maintenance that focuses on proactive and preventative maintenance to maximise the operational time of equipment. TPM blurs the distinction between maintenance and production by placing a strong emphasis on empowering operators to help maintain their equipment	Creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. In the right environment, this can be very effective in improving productivity (increasing up time, reducing cycle times, and eliminating defects)
Value stream mapping	A tool used to visually map the flow of production. Shows the current and future state of processes in a way that highlights opportunities for improvement	Exposes waste in the current processes and provides a roadmap for improvement through the future state
Visual factory	Visual indicators, displays, and controls used throughout manufacturing plants to improve communication of information	Makes the state and condition of manufacturing processes easily accessible and very clear—to everyone

Similarly, 52 Lean tools have been identified below which once again are not intended to provide the reader with a complete list; the same selection criteria should be used as indicated earlier.

1. Bin system: A 2-bin system is an inventory replenishment system. It can be considered a specialised form of a Kanban. In a 2-bin system, inventory is carried in two bins. As the first bin, the "working bin", is emptied, a replenishment quantity is ordered from the supplying work centre. During the replenishment period, material is used from the second bin which typically contains enough to satisfy demand during the lead time plus some safety stock. In this way, there is always a bin of parts available at the work centre to be processed, and inventory is capped at two bins of parts.

2. 5 Why's: The 5 Why's process is used to uncover the root cause of a problem or defect. This technique relies on asking why something occurred, and then asking why this cause occurred. The process is repeated until the root cause if found.
3. 5S: 5S is a system for cleaning, organising, and maintaining a work area to maximise efficiency and consistency. 5S is often one of the first major initiatives of companies who implement Lean.
4. A3 report: An A3 report is a presentation of a problem on a single sheet of paper, including all the background information on the problem, root causes, potential solutions, and action plans. The name comes from the A3 paper size, typically 11″ × 17″. By presenting everything on one sheet of paper, the A3 report can be a very useful root cause analysis tool. Many Lean practitioners believe that when you confine your problem-solving to one page of paper, your thinking becomes more focused and structured.
5. ABC inventory: An ABC inventory system categorises inventory items in three levels—A, B, and C. The A items are extremely important, and typically high volume or high value items. B items are moderately important. C items are a low priority and typically low volume items. The system is used to define inventory stock levels, reorder points, and cycle counting frequencies for items.
6. Benchmarking: Lean benchmarking is the process of using a successful organisation as a reference for identifying ways for another organisation to improve. It can be conducted as a comparison with the best practices at other organisations, or it can provide a tool for comparing practices within an organisation over time to prevent backsliding of performance.
7. Bottleneck analysis: Bottleneck analysis studies a process to identify the step in the process where the capacity available is less than the capacity required. That process is known as the constraint. The next step is to identify ways of removing the constraint.
8. Cause and effect (fishbone) diagram: A cause and effect diagram displays graphically the factors and underlying causes of a defect or problem. The factors are drawn on lines radiating out from a central line. The completed diagram resembles a fish skeleton hence the nickname.
9. Cellular manufacturing: Cellular manufacturing organises processes into flexible cells comprised of sequential steps. This organisation allows for a number of processes to be completed on a part in quick succession with limited movement between steps.
10. Check sheet: A check sheet is a written document listing critical elements to be checked on a regular basis. Check sheets can be used to maintain almost any Lean practice, or they can be used when implementing Lean practices.
11. Cross-training: Cross-training is a primary technique used to build flexibility in a workforce by training workers to perform some or all the other operational steps required within the work centre. Flexibility is a critical element of a Lean operation.

12. Current state map: The current state map is a process map showing the existing processes exactly as they currently exist. This tool is used to identify opportunities for improvement, and to measure the improvements after changes have been made.
13. Dynamic scheduling: Dynamic scheduling adds flexibility to a scheduling system by creating update procedures to refine and change a schedule as new information on supply and demand factors is obtained.
14. Empowerment: Empowerment is a critical element of developing a Lean culture. It pushes decision-making to the lowest possible level and encourages employees at all levels to take action to solve customer problems and improve the organisation.
15. Enterprise resource planning (ERP): ERP systems are large-scale computer systems enable information flow throughout an organisation, and with other organisations. An ERP system provides the processes for planning monitoring and reporting on all supply chain, manufacturing and sales activities.
16. External set-ups: External set-ups is a technique for identifying and performing time-consuming machine set-up steps that can be conducted without machine stoppage. This allows those set-up activities to be conducted whilst the machine is still running with another set of tooling installed. External set-ups are one of the techniques used to achieve Single Minute Exchange of Dies (SMED).
17. Failure modes and effects analysis (FMEA): FMEA is a process for analysing potential failures within a system and the effects these failures will have. This technique is used to identify defects before a process is designed, or to diagnose complex defect processes.
18. Flexible manufacturing system: A flexible manufacturing system is comprised of a group of numerically controlled machine tools and is interconnected by a central control system. In a Lean manufacturing environment, this allows rapid changeovers, small batch sizes, and reduced lead times.
19. Flow chart: A flow chart is a technique for visually representing a process in order to better understand the process and to identify opportunities for improvement.
20. Future state map: A future state map is a process map showing the design of a process after improvements are implemented. It represents the goal for the how the process will work.
21. Heijunka: A production smoothing technique utilised by the Toyota Production System so that load levelling is accomplished by volume or mix of products. This method is used in conjunction with set-up reduction so that smaller quantities of items can be produced without costly changeover costs or lost capacity.
22. ISO-9000/1: The ISO standards provide a measurement, documentation, and tracking framework that compliments Lean. The focus of ISO on defining processes and holding processes to standards is useful for identifying opportunities for improvement and in maintaining Lean practices after implementation.

23. JIT/inventory reduction: Just-in-time inventory, and inventory reduction in general, is a core component of Lean. In the Lean system, inventory is viewed as waste. JIT strives to minimise inventory so that materials arrive where they are needed at the time they are needed. Materials do not arrive ahead of schedule and are not forced to sit in long queues.
24. Jikoda: Jikoda is the Japanese term for stopping the production line when a problem or defect occurs. In Henry Ford's time the American factory worker could be fired for stopping a production line. But Taiichi Ohno and Sakichi Toyoda considered this human form of automation to be fundamental to the Toyota Production System's success.
25. Kaizen events: Kaizen events are focused activities where a team attempts to identify and implement a significant improvement in a process. The events are limited in scope and intended to create significant change and improvement quickly.
26. Kanban/small batch sizes: Kanban systems use cards or bins for inventory replenishment. When a supply of material is used up, the card is delivered to a work station so that the materials can be replenished. Kanban systems are pull systems, with inventory movements only initiated when a downstream process requires material from an upstream process.
27. Lean supermarket: A Lean supermarket is an inventory organisation and storage system designed to centralise components when continuous flow is not possible. The supermarket regulates inventory levels and replenishment. Whenever one-piece flow cannot be accomplished, a Lean supermarket is often employed as a way of managing buffer inventory and allowing employees to have easy access to the parts they need.
28. Level loading: Level loading is a production scheduling technique where production is smoothed out over short time horizons to distribute work evenly, thereby creating a consistent and achievable production plan.
29. Mass customisation: Mass customisation is an approach fostering flexibility. With mass customisation, every product is considered custom, and processes are designed to rapidly switch between products. In such a system, a process would have lot sizes approaching single items, and set-ups between products would be virtually eliminated. This system would allow for a very large variety of products, and the addition of new products with minimal changes to the production processes.
30. Metrics-based process mapping: Metrics-based process mapping is a tactical level tool, usually used to "drill down" from a value stream map to allow improvement teams to capture and analyse data regarding elimination of waste and process improvements.
31. Milk run: A milk run is a delivery route that has been planned and optimised to minimise travel time. It can be used by delivery companies to schedule deliveries, or within a facility to plan material handling traffic.
32. Mind maps: Mind maps are a visual tool used to organise and present inter-related ideas. This tool is similar to cause and effect diagrams and other

mapping tools. Mind maps offer great flexibility and can present complex systems in a very easy to understand format.

33. One-piece flow: One-piece flow is a scheduling technique where the batch size is set to one. The processes are designed with sufficient flexibility that a set-up can occur between every item without slowing production.
34. One-touch exchange of dies: One-touch exchange of dies a technique allowing a machine die to be exchanged in a single step. To accomplish this, a die or tooling is often loaded into a machine in one rapid step. One-touch exchange of dies is often accomplished by identifying and separating internal and external set-up steps and is one of the techniques allowing for SMED.
35. Pareto chart: A Pareto chart graphs data in order of frequency of occurrence. Pareto charts are used to identify the main causes of an issue.
36. Poka-yoke/Error proofing: Poka-yoke is a quality technique where a process is error-proofed. The goal of Poka-yoke is to make it impossible for a defect to occur. Error proofing is an important element of Lean since defects are a significant contributor of waste.
37. S&OP: Sales and operations planning is a formal business process where one set of plans is developed by a team including sales, marketing, finance, engineering, procurement, and operations. All participants have responsibility and accountability for developing and maintaining the plan. This cooperative approach links the strategic plans to the tactical plans for the business and provides performance metrics that drive continuous improvement.
38. Six Sigma: Six Sigma is a quality improvement strategy focused on removing variability from a process. Although originally developed for manufacturing processes, the Six Sigma methodology has been successfully applied to a wide range of processes. As a tool for process improvement and reduction of defects, Six Sigma compliments Lean and is a component of many Lean programmes.
39. SMART goals: Goal setting is important with Lean. SMART is a goal setting tool that helps ensure that the goals that are set are effective goals for the organisation. For a goal to be SMART, it must be specific, measured, attainable, realistic, and timely.
40. SMED: SMED is an approach to machine set-up and design that strives to minimise set-up times. The goal of SMED is a 1-min change over. Although the name focuses on die changes, the goal and focus on short changeovers can be applied to any machine.
41. Spaghetti diagram: A spaghetti diagram monitors the actual flow of material or workers in a process. Because the diagram often depicts resources repeatedly crossing each other, completed diagrams have been compared to a bowl of spaghetti.
42. Standardised work: Standardised work is a technique where process procedures are documented so that an ideal standard work process is developed. This standardised work process can then be taught and managed improving consistency and overall performance.

43. Statistical process control: Statistical process control, often referred to as SPC, is a tool for monitoring processes for variability. By monitoring output closely, operators can detect variations in the process that may affect the quality of the end product or service. This will reduce the possibility of creating defective products or services as well as the likelihood that those defects will be passed on to the customer.
44. Takt time: Takt time is a measure of the maximum allowable time to meet customer demand. It is measured as the available production time divided by the rate of customer demand. For example, if you have 432 min of planned capacity per day and your demand is 500 units per day, the takt time is =432 min/500 units, which gives you a takt time of 0.86 min. This means that a completed unit must exit your production process each 0.86 min. This monitoring of takt time allows employees to properly pace activities and recognise when a problem is developing within a work cell.
45. Time study: A time study is a detailed measurement of the individual actions within a process. Time studies are used to establish production rates and to set product costs. In Lean manufacturing, time studies can also be used to identify wasteful processes and motion that can be eliminated. Data from a time study are often used within value stream maps.
46. Total productive maintenance: Total productive maintenance is a system for predicting the maintenance needs of equipment so that machine breakdowns are minimised. This methodology uses statistics and standardised work processes within the maintenance function. Another component of this technique is that machine operators are trained to many of the day-to-day maintenance tasks.
47. Value stream mapping: Value stream mapping is a tool for documenting a set of processes related to a single value stream, showing every step and activity from start to finish. Value stream maps highlight processing time, wait time, and material handling. The maps are extremely valuable in Lean for reducing lead times and eliminating unnecessary process steps.
48. Visual cues/painted floor: In a Lean organisation, making Lean easy to maintain is critical. One common technique is to provide visual cues that alert anyone in an area how a process should be completed, or how a workstation should be set up. 5S utilises visual cues to ensure that work cells maintain proper layouts. The cues often include lines painted on the floor and other markings in the area indicating where materials and tools should be staged and stored.
49. Visual metrics: Lean requires constant attention and focus, and implementing visual metrics is an effective way to provide this focus. Visual metrics can cover any aspect of an organisation. In Lean, some of the more common metrics that are tracked and posted are throughput, quality, safety, productivity, machine uptime, and customer service.
50. Visual status indicators: Visual status indicators are typically light-based indictors providing a simple status of a process. The indicators are often used to

signal a problem that must be addressed. In this case, the light turns on when the problem condition occurs.

51. Waste walk: A waste walk, also known as a Gemba walk, is a Lean technique for identifying waste. Typically, the walk will be conducted by several individuals, allowing the participants to learn from each other. In a rigorous waste walk, dozens or hundreds of opportunities can be quickly identified. Waste walks can focus on a particular area, a type of waste, or cover anything the participants see.
52. Zero quality control: Zero quality control is a methodology designed to shift quality to the process and eliminate the need for external quality inspections. A zero quality control system typically includes error proofing, "source inspection", and employee empowerment as well as other quality initiatives.

Summary

Adopting Lean has sparked in change in companies purchasing philosophies and policies; these are now based on a greater degree of confidence in supplier relationships. In reference to Lean and technology, it is important to appreciate that you cannot buy Lean in the format of a software package; it is much more complex; Toyota thrives because of the knowledge and strength of its team members and their kaizen thinking. IT technicians should be used to assist the practice to enable new process improvements. In essence the question is really whether technology adds value to the manufacturing process. If all you are undertaking is taking the existing processes and automating hem, then you are back to the Motorola adage, of moving information around in a very slick manner. The role of the supply chain management cannot be overstated; it is an important alternative to increase the competitiveness not only in a single company, but in the entire supply chain. 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. This can often be attributable to a cost-cutting outlook which consequently results in a long-term loss of market share. In the past, Fords, General Motors, Delphi, and Lomega are examples of this mindset. 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. 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.

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Chapter 5
Impediments to Lean

Abstract To better understand why Lean succeeds in some instances and not in others, it is necessary to study and determine factors of organisational change influencing successful outcomes, which ultimately result in improved performance for the organisation. Lean has been evident for several decades, and a number of implementation and barriers have been identified which have been evident in the author's own experience. Extensive up-to-date research emphases the prominent obstacles inhibiting organisations to either embrace Lean or frustrate its wider application. Whilst some of the aforementioned analysis has revealed definite blockades indirectly, this section will explore in greater depth the issues which organisations, Lean practitioners, and executives need to consider in their efforts to implement Lean within their organisations. Whilst the barriers to Lean need to be explored, it is their origins, interrelations, and relative importance that need to be understood. The ultimate aim for any organisation should be to link its Lean initiative to financial improvements. A perfect example is being a lack of senior management support which is often cited as a barrier; however, it is important to try and determine why some managers are more supportive than others and it is unclear regarding how this is measured. In respect to the numbers of successful Lean initiatives, we do need to ask the question, why have so many companies not been able to achieve the benefits they had hoped for through their Lean strategies, or in some cases abandoned their efforts altogether.

Lean Witnessed as a Never-Ending Process

The journey towards Lean is a relentless, long-term, and a never-ending process. Success is illustrated 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 is often quoted in research. Similarly, Lean cannot be achieved as an addition to one's everyday duties since it requires a determined and dedicated effort.

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Lean is ongoing because waste continuously creeps back into organisations and their operations. In the author's experience, it is possible to identify that there exist certain stages towards any kaizen events and the following could be identified as the typical stages that are required. Importantly, the last stage proceeds to identify a need to repeat the entire exercise again.

1. Determine current performance;
2. Establish a need to improve;
3. Obtain commitment and define the improvement objective;
4. Organise the diagnostic resources;
5. Research to discover the cause of current performance;
6. Define and test solutions that will accomplish the improvement objective;
7. Produce development plans (SMART);
8. Identify and overcome any resistance to the change;
9. Implement the change;
10. Implement controls to hold new performance levels and repeat step one.

Lean is Required to Transcend Beyond Manufacturing

Lean should never be viewed as a manufacturing manifestation alone. It is indisputably proposed that Lean has no boundaries. Often Lean is regarded as an indication to decrease waste, whereas it should be more about waste prevention than about waste elimination. 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. Whilst much of Lean is about getting rid of waste (Muda), there is also the elimination of variation (Mura) and overburden (Muri). Variation does often result in overburden, resulting in waste. In many implementations, it is innocuous to suggest that the organisation should stay focused on the elimination of waste for the early years whilst focusing on system-level causes of waste. Some of the proposed tools used in isolation may reap good results though lasting progress would only be achieved by concentrating on the end-to-end value stream.

Communication of Lean Internally

Lean should certainly not be viewed as a licence to reduce jobs; it is imperative to send a signal that every effort will be made to redeploy anyone displaced by the improvements. It is fundamental to implant confidence in people that their Lean efforts will not put them at risk according to Kincaid (2004) "*Lean isn't mean*" (p. 53); that over time, attrition will reduce the headcount as the Lean transformation

improves productivity. This was shown as early as 1996 by the Conference Board report (2006) which illustrated the consequences faced when companies used a downsizing strategy, namely that 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, to be effective and whilst promoting a sense of reality, it needs to be emphasised that cost cutting could be an option to an organisation when it is on the verge of collapse and who has no choice for survival especially when there existed a bloated bureaucracy and indicating that cutbacks are necessary to assure longer term success. The author has experienced this situation to arise when employees/unions are inflexible and there exist no other apparatus to advance productivity, in a major market downturn of, for instance, 15–30 % of sales volume, or when there are obvious situations of waste perhaps as a result of a merger. In this case, it could be concluded that, after all, one only needs a single CEO.

The relevance of the concept of "*Lean behaviours*" (Emiliani 1998, p. 621) should always be recognised through the numerous principles of value, value stream, flow, pull, and perfection. Lean behaviours can be simply interpreted as behaviours that add or create value. He examined the interpersonal associations to comprehend the wants and expectations of the people that we interrelate with. Any form of unpredictable behaviour will create queues which threatens responsiveness to rapidly changing conditions. Pull applied in a behavioural context refers to the fact that as humans, we operate under many different mental models, which often requires us to amend our style or approach. In a similar perspective, perfection in a behavioural situation suggests 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 behaviour commonly found in the workplace are as follows:

- Micromanagement;
- Employee turnover;
- Unclear expectations; and
- Departmental or functional focus.

Nonetheless, it could be very easily proposed that we need to be attentive to not absolutely eradicate behavioural waste since, i.e., disagreements can contribute towards creativity. In fact, Toyota refers to "*countermeasures*" rather than "solutions" (Spears and Bowen 1999, p. 104).

Impact of Subcultures

There exist isolated cultures within an organisation which require managing. No one organisation has a homogeneous culture, and there are often several subcultures which are in themselves a source of conflict. There may still be people who opt out, and progressive organisations must sympathetically support these people to pursue

opportunities elsewhere. When we review statistics such as from the 30–40 % of the US manufacturers claiming to have implemented Lean, only about 5 % are truly operating Lean; these aspects become crucial. In every organisation, there will always exist a small group of managers, and a figure of 10 % is often quoted who simply would not accept new ideas. The aim for any organisation is that these individuals do not obstruct the Lean initiative.

Influence of Organisational Structures

By definition, there is often a need to adapt organisational structures. There exists a need to reorganise along the "*value streams*" concentrating on the customer and product families. Design, materials management, and production have to be included (Smalley 2009). Organisations will repeatedly implement the building blocs of Lean in a flawed 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. An archetypal reaction to this might be "*We tried to implement Lean, and things got worse*." Likewise, organisations can occupy an unreasonable time on training and an insufficient time on the implementation. Lean needs to take root in an organisation, and for this to materialise, executive management needs to be fully engaged. It could appear that many of the concepts of Lean may seem complex, but these need to be understood if the organisation hopes to successfully implement Lean. Table gives a general summary of the key concepts and the different perceptions as viewed under a traditional organisation and one viewed under Lean (Table 5.1).

The culture of the company needs to adopt an intellect of pragmatism regarding materials that they need to accept; essentially, not all inventories can be regarded as waste; it is only inventory beyond what is needed to run the process which should be regarded as waste. Likewise, it is essential that the value stream defines the Lean enterprise. When one function proceeds to make progress towards Lean, neither that

Table 5.1 Traditional and Lean perceptions

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

section nor the overall stream will earn the full paybacks if another function falls short. Similarly, inventory often exists as an indication of a problem in the process itself. Solving the problem can act as a rule or way to undertake things. Moreover, attaining rudimentary stability requires having standard methods for the work undertaken; the normal definition of a standard is also a rule or way to do things; in Toyota, a standard is regarded as a rule or a basis for comparison. Many organisations are realising that a healthy quantity of stability is required before advances to other methods of Lean can be contemplated. Lean is first and notably a system, which is an integrated series of parts with a clearly defined goal. One of the problems with Lean implementations in the last twenty years has been the tendency to cherry-pick activities, and both the so-called Lean organisations and proponents have often been guilty of this. Utilising Toyota as a benchmark, it is evident that the Toyota production system is a series of nested experiments through which operations are constantly improved.

Relevance of IT on Lean

In recent decades, organisations have spent fortunes on new IT systems to automate and improve their processes, only to subsequently find that they have not driven out the anticipated bottom-line benefits. Automation is not always the panacea for all process management challenges. It is always vital to ensure that people, systems, and technology change factors are synchronously considered to maximise the effectiveness of any IT deployment. There often exists a misconception regarding the association of Lean and IT. Lean does not discriminate against any technology that respects people and helps remove waste. A core Lean value is genchi genbutsu (actual place, actual product) which can be translated to as is the case often "go see" in English. Software solutions can assist to facilitate this process. It can be inferred that it could be too easy to keep smart people from going to where the theory meets reality (products meet customers). The technology nonetheless needs to proportionate; enormous LCD screens for visual management may be gee whiz for the visitors to the factory, but the team members who are required to inscribe down real problems that happened 5 min ago may be better advised to utilise white boards. Lean is not necessarily created from what you see; it is generated from how you think. We should always also recognise that Lean is a set of rules and principles, not just tools. It may well be feasible to be able to resolve one difficulty or process with a Lean tool today, but if the old thinking continues, it will recreate the old problems. The Lean proponents in an organisation are required to grasp the concept of people dynamics and emotional intelligence.

Within the environment of emerging technology, companies should be actively exploring ways of connecting the shop floor to its enterprise software and then to its customers' value chain. Enterprise resource planning systems alone are typically inadequate 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, and this facility needs to be effectively deployed. That instead of merely performing repetitive calculations on the data, the system proceeds to comprehend the intrinsic relationships; for example, an engineering design modification related to a specific product would be automatically disseminated throughout the various databases that are affected by this alteration. Ultimately, new processes and tools are, by design, then brought into the manufacturing system. The organisations need to be aware of potential conflicts with ERP implementations. Whilst ERP providers are increasingly supporting Lean techniques, many companies are finding it difficult to fine-tune Lean programmes with the simultaneous implementation of a major ERP system. There are intricacies which have to be considered; there have been occasions witnessed whereby the corporate IT managers implementing ERP may not understand the Lean concepts well.

Individuality of an Organisation's Lean Journey

There exists no stable formula for Lean to succeed since every company begins with a dissimilar set of elements (or issues and restrictions). Nevertheless, companies should look at a road map which needs to be in place. All companies are unique, and each one is potentially likely to reflect special difficulties and restraints. It is vital that Lean is entrenched in the organisation's culture permitting it to find its own answers. Many proponents have found hoshin kanri policy deployment (strategy deployment tool) vital for this process. Nonetheless, unfortunately, a small number of organisations employs it and even a smaller number of companies could be said, use it successfully. It will always remain an enigma how these companies can then determine what actually to kaizen if they are not sure of what precisely their actual priorities are.

In a similar fashion, the companies need to recognise that their supply chains are characteristically months or still longer. In this instance, the nearer the order indicator is to the actual use, the less instability is transferred upstream and a reduced quantity of buffer stock is necessary in order to guarantee obtainability. It often is necessary to enhance the regularity of production or delivery at all distinct points down the supply chain. This process can only be supported by coordinating the frequency of production with the configuration of demand. Accordingly, it is necessary that the fundamental steadiness in the organisation's order and product flows is attained. This often requires the need to use appropriate Lean tools in order to increase the rate of the cycle from approximately every month to precisely every week and eventually to shipping all products which are requested by customers on a daily basis. Many companies have also found their Lean initiatives thwarted by the increasing volatile demand environment and increasingly complex mix in product portfolio. Supply chain complexity has many costs, and one of them is making Lean techniques more difficult to adopt.

Promoting the Lean Benefits

Whilst this has been outlined, it will be demonstrated further that Lean does indeed have a strong business case for adoption; consequently, this needs to be effectively communicated. Whilst some of the research which is outlined in the book proceeds to document how Lean supports an organisation to become more competitive, it emerges that frequently organisations are not persuaded to degree which is necessary. Prominent authors (Womack and Jones 2005; Liker and Franz 2011; Henderson and Larco 2003) have suggested that the added value within both the manufacturing and service sectors is enhanced in the archetypal product delivery system, comprising the design, engineering, and administrative sections coupled with the manufacturing operations.

The Alliance Between Lean and Accounting Procedures

It is a misconception in the prevailing commercial world, in order to presume that standard costing systems or even activity-based systems can reliably cope with an organisation enduring the Lean transformation. Preferably, value stream/product-based costing including product development and selling along with production and supplier costs is required in order that all contributors in the value stream can perceive whether or not their cooperative efforts support more to value than cost. The issue most companies encounter is that organisations move forward with their implementation of Lean, whilst their own financial departments often continue to trail behind. In these circumstances, the financial departments besides fail to reinforce the Lean effort, but they actually can proceed to impede it. Undeniably, a financial accounting system is required to meet the prevailing statutory requirements. Nonetheless, most organisations tend to struggle at the initial impediment since they are incapable of linking the improvement metrics to the financial statements which are required.

The movement to embrace Lean accounting originates to a large extent from the annoyance of many who have tried to advocate rightly that Lean should never be gauged using the same technique such as traditional batch manufacturing. Lean adopts an uncomplicated understanding between inputs and outputs of a production process. Lean gauges costs with less precision, and costing out material at the stage it is pulled into production and eradicates work orders. Similarly, it traces transactions and reports on the discrepancies. Unfortunately, financial and accounting procedures adopted by organisations have represented obstacles to the Lean initiatives and continue to do so in many organisations. Without doubt, the majority of financial accounting and control systems in place within manufacturing are ideally invented for a different type of environment, namely

- Huge volumes of inventory;
- Extraordinary direct labour content; whilst his situation has now changed in many organisations as a result of increased mechanisation, it continues to pose issues;
- Lengthy standard runs, and in these situations, the schedules are characterised by high-volume runs of the similar products with very few changeovers with long lead times;
- Bulky volumes of direct suppliers; the underlying assumption in this case is that an excessive number of suppliers would deliver directly to the factory in big batches.

Many practitioners and academics have challenged the established financial systems by arguing that they are not structured to look at cost savings in the same way as a Lean organisation would; inventory, for instance, should never be viewed as an asset. In the author's view, 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) summarised the debate by stating 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*" (p. 47). Nevertheless, it could be stated that Maskell (2000), nonetheless, failed to fully 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. We should encourage organisations to have a set of top-level financial measures which may not be programmed towards the organisation's critical success factors.

It should be realised that Lean indeed induces excellent examples of operational improvement; in reality, 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 and Jones (2003) had highlighted important concepts which many accountants fail to comprehend, namely 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. It is important that organisations 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. It has been forwarded amongst many including Bicheno and Holweg (2009) who 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 and Wempe 2009). In the author's own experience, it is vital that as companies progress with their Lean implementations the financial functions do not lag behind. The aspects encountered which the companies need to recognise regarding possible explanations on 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 their ability to gain in-depth knowledge of the key processes and commercial issues;
- The departmental silos and physical proximity existent in many organisations. It is often the case that 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*" as initially outlined by Carnes and Hedin (2005, p. 34) whereby chartered and certified accountants feel that their education and understanding are superior to those in operations;
- Existence of 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 have to welcome this attitude;
- Unreasonable 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 contemporary research status; the modern 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 tend to be definite and implicit whereby both the producers and accountants fully understand the system, Lean has to be customised for each respective organisation's products and markets.

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 generally accepted accounting practices (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 which can cause concern amongst executives.

Need to Maintain the Lean Initiative

Considerable experience recently dictates that backsliding to the old ways of working has been 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 the actual performance. 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. It could be stated that this process is nothing but Dr. Deming's Plan-Do-Check-Act ideally employing A3 analysis. In fact, Womack and Jones (2005) does not propose a reorganisation, 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. The organisation in question needs to explore the gains that encourage partners to work together in collaboration. The biggest gain in practice is usually the smoother order signals in return for closer synchronisation of production and demand. 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 firefighting; this will result 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. Many factors impact the need to sustain the Lean initiative. These do make it challenging for organisations to get Lean correct in the first instance. There are also manufacturing cost pressures, and if a Lean initiative actually sends the cost bill in the wrong direction at the start, companies frequently cancel the programme rather than fixing what went wrong with the proven methodology.

Misunderstanding of Lean

Some companies continue to see Lean as a cost reduction hatchet, not a method for serving customers and removing waste. This can lead to a Lean "façade" that on the surface uses some of the tools of Lean, but does not really embrace its core philosophies. Unfortunately, this can lead to "cost-shifting" tactics within organisations; in essence, what happens is that they simply move inventory or other operating costs to trading partners, which can reduce internal costs in the short term but do nothing for total supply chain costs in the longer term. All too often, staff incentives, for instance, are placed upon hitting unit performance targets as opposed to end-to-end process objectives, with functional departments then behaving parochially as a result. This can force organisational and cultural misalignment between departmental and corporate aspirations. Such problems can only be addressed top down.

A Lack of Broad Organisational Development

Often Lean initiatives have sometimes made the province of a small group of Lean specialists, with little support from top management and little understanding from the shop floor personnel and other managers even as they are "trained" and

encouraged by this small group. Consequently, Lean develops no real roots in the corporate culture. Likewise, in many organisations, other improvement methodologies such as Six Sigma and total quality management can create internal conflicts with the Lean initiatives and can often lead to competing "camps" about which methodology should be used.

Mediocre Consultants

This aspect was very important to declare since often it is not awarded sufficient prominence by authors and consultants for obvious reasons (Marodin and Saurin 2014). Undeniably, a huge consulting industry has developed around Lean and spawned a virtual army of boutique Lean consulting firms. Almost every organisation uses consultants of some kind at least early in their Lean journey; similarly, many for longer periods after that. As is the case with most professions, there are good and not so good consultants; unfortunately, no straightforward process for separating the two. Some know Lean theory very well, but are unable to teach it nearly as well as they can undertake or execute it themselves. Many Lean projects have stalled because consultants could not move the project in the correct direction. There needs to be a greater level of accountability which is not generally evident. Furthermore, there may be room for many companies employing consultants to negotiate inventive contracts which proceed to gauge the performance of the consultants in greater detail. Many organisations proceed to spend large amounts on expensive amounts on expensive specialist consultants, who create great mystique around the topic in order to create longer term dependence on them.

An analysis provided by Mardin (2014) holds considerable credibility regarding the nature and type of barriers' organisations consistently encounter. These are detailed in Table 5.2.

Table 5.2 Summary of barriers

Nature of barriers encountered by organisations	
The barrier	Indicative example
Personnel become demotivated after a few years	Those promoting Lean seem to become demotivated after one or two years from setbacks encountered
An absence of technical Lean background and information from the support areas (IT, HR)	Isolated Lean practices are implemented; the connectors not considered appropriately
Deficiency of human or financial resources	Training not viewed as an investment or geared towards continuous improvement activities
Poor communication throughout the organisation	Gains not promoted; the overall mission and objectives remain vague

(continued)

Table 5.2 (continued)

Nature of barriers encountered by organisations	
The barrier	Indicative example
Problems in viewing the financial gains	Short-term metrics are used; the performance measures are not aligned to Lean, i.e. wastes
Middle management not providing sufficient support	Fail to check root cause analysis; spend less time on the shop floor and not convinced of Lean
Top managers not providing sufficient support	Not aligning continuous improvement to business targets; stay detached from the shop floor
Insufficient support from the shop floor	Lack of confidence in suggesting improvements; team leaders fear lack of resources
Insecurity amongst the shop floor operatives	Inadequate training; operatives not supported by their managers and senior managers
Fear of security from operatives	Operators dismissed as a result of kaizen savings
Operators do not feel responsible for using Lean or solving improvements	Not involved in the activities or the overall implementation process
Managers have insufficient technical knowledge to facilitate Lean practices	Top and middle managers struggling to align objectives; unclear statement regards the future of Lean
Not sustaining the Lean improvements in the middle or long term	Back sliding; poor standardisation practices and no checking that standards are continuously adhered to
Encountering problems to keep pace with the Lean implementation	The schedule dates and objectives are frequently postponed; problem-solving is often overcome by the daily fire fighting

Conclusions

Lean has been challenged to work in some complex manufacturing environments. However, many companies fail to both comprehend and plan effectively in order to deter possible obstacles of Lean from materialising. The research demonstrated that an organisation's Lean journey requires both human and financial commitment. Similarly, the choice towards Lean should not be made flippantly 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 research discovered that every organisation is unique and is likely to have distinctive problems and constraints. 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. There are certainly critical lessons that should be learnt from the research if the purpose is to improve the potential rates of implementation within manufacturing organisations in the UK.

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Chapter 6
Lean and Performance Management

Abstract Whilst performance measurement can be considered a challenging task, if incorrect or inefficient, it may represent a risk to the organisation. Companies will benefit if they understand the goals they expect to achieve from their performance measurement system before selecting which metrics they will represent. A balanced portfolio of metrics is required to address all dimensions. Lean does not easily associate itself to the traditional accounting systems; it is for this reason that organisations need to embrace systems which can appropriately gauge the impact Lean is making within their own organisations. Undeniably, Lean does entail a substantial investment which subsequently reaps exponentially a greater degree of savings. It is for this reason that it is important to gauge reliably the impact of Lean; this information is vital for policy makers within the organisations to make evidence-based decisions. Often one of the main barriers cited as an obstacle for Lean is cost which needs to be both monitored and controlled. This chapter focuses upon the importance of performance measurement to Lean and proceeds to highlight the importance of utilising indices beyond finance alone. In essence, the impact of Lean can only be assessed through the interrogation of a cocktail of indices; consequently, it is vital that an organisation embracing Lean uses a balanced scorecard approach.

Role of Performance Measurement in Lean

We realise metrics are important; they report progress and guide our decision-making. Used properly, metrics can provide key insights into our businesses that make the difference between success and failure. But as our capacity to track everything increases, and the tools to do so become easier and more prevalent, the question remains: What is a worthwhile metric to track? Before you can really figure that out, it is important to understand the basics of metrics. There are in fact good numbers and bad numbers. There are numbers that do not help and numbers that might save the day. If Lean is seen to be a successful business decision, then

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there needs to be a competent method to assess its impact within the organisation. The spectrum of Lean benefits is not always obvious. Managing and improving processes, customer and employee relations in conjunction with the organisational perspective should enable the financial perspective of an organisation embracing Lean to improve. During the last three decades, there has been a plethora of performance measurement systems with models dwelling both on the qualitative and on the quantitative perspectives. The experience of organisations that are and have implemented Lean dictates a need to adopt a more holistic and comprehensive approach to performance assessment. The Balanced Scorecard (Kaplan and Norton 1992, 1993) established the momentum for this viewpoint; other contributors (Bond 1999; Wade 1997; Maltz et al. 2003) coupled with the work of Dimancescu et al. (1997) provided the foundation for this work along with the work of Croll and Yoskovitz (2013).

The traditional methods of measuring results through accounting methods fail to incorporate the true valuation of an organisation's intangible and intellectual assets. These include high-quality products and services, motivated and skilled employees, and responsive and robust internal processes alongside both satisfied and loyal customers. The prevailing research and empirical evidence indicate that the latter are often much more critical to the long-term future of the organisation. There are many reasons why business performance measurement systems have become more prevalent and newsworthy; the literature and the practical evidence indicate the following

- Traditional accounting systems allocated overheads on the basis of direct labour (Neely et al. 2005). This may have been appropriate in the 1970s 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,
- The increased level of global competition faced by organisations encourages them to compete on service, flexibility, customisation, and innovation amongst other factors, and
- The varying external demands as customers who proceed to not only expect high levels of service but also insist on firms being able to operate in identifiable ways. This was evident over a decade ago whereby Ford, for example, demanded that their accredited suppliers introduce a scheme known as quality operating system (QOS) which essentially is a performance measurement process.

Initially, this debate was intensified since organisations began to recognise a need to embrace continuous improvement and consequently the need to measure and facilitate balancing external pressures, i.e. customer satisfaction, in conjunction with internal pressures, i.e. employee satisfaction. The fear is that when implemented in isolation, an internal measure could well intimate that a company is performing well, whereas in effect the external measures reveal poor performance; this could happen, for instance, by shrinking the defect rates which may be in line with internal strategy with related consequences to lead times, resulting in the company being viewed negatively by the market resulting in a deterioration of its

share price. This concept gained momentum by Haskin (2010) who summarised in an extensive study of 113 companies located in the USA, Europe, and Asia, and where 50 % had a $5 billion or more turnover, that companies with a formal strategic performance measurement (SPM) system performed better in the stock market.

Measures Beyond Traditional Financial Analysis

Business factors such as maximisation of profits, effective business planning, and better operational visibility coupled with corporate governance are often key factors in driving business performance initiatives. Seemingly, many organisations are beginning to witness that their organisation needs to move beyond the financial data in order to incorporate marketing and customer information in performance assessment; consequently, this is suggesting a more holistic and comprehensive approach. A typical customer satisfaction measure that could be utilised is one that could be used to try and determine 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) had demonstrated through his work across surveys within Europe revealing that car repairs are only performed RFTOT in six cases out of ten; this equates to 1.75 sigma!

By the year 2000, intangible assets had became the major source for competitive advantage for most organisations. Tangible assets accounted for a book value of less than 20 % of companies' market values (Kaplan and Norton 2001). Unfortunately, over a decade later, the problem remains for organisations to try and determine how to quantify intangible assets. Frequently intangible assets such as knowledge affect financial outcomes through chains of cause-and-effect linkages involving several or more stages. Consequently, often they need to be bundled with other intangible and tangible assets in order to demonstrate any creation of value; an apt example encountered recently was whereby an organisation needed to devise a growth strategy which required customer knowledge, training for sales employees, new databases, new information systems, a new organisational structure, and an incentive compensation programme. Concentrating on just one or, all but one, of the above could have caused the new strategy to fail.

In simplest terms, organisations recognise a need to both manage and improve the processes associated with the customer, employee, supplier, and the organisational perspectives; accordingly, the organisation will experience the financial standpoint beginning to improve. Non-financial measures such as quality, customer satisfaction, and innovation have become increasingly important in the modern competitive environment. 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 rate of return on capital employed (ROCE). Some Lean advocates suggest 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 and this can be measured by factors such as:

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

Experience of the more proactive organisations reveals that sustained Lean success does not come from targeting opportunities in a haphazard manner using few of the Lean tools alone. In order to build a sustainable Lean foundation which consistently yields dramatic company-wide improvements on a global basis necessitates a roadmap. It is maintained (Pullin 2005) that there are three "inhibitors" (p. 28) why performance can be impaired. The first is variability; i.e. fluctuations in demand, deliveries, and quality wander, and people and machines perform inconsistently; second is waste; and third is inflexibility whereby the company cannot react to changes in demand or alter its working practices. In this case, a "technical solution" (p. 29) is needed, i.e. value stream mapping. Moreover, a management system is needed to ensure that the solutions are adhered to. However, coupled with this, there has to be in place an effective change management policy; without any of these three elements, the philosophy breaks down as proven in many companies. It is often suggested that many mediocre companies focus on performance measures relating to the 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; however, if the organisation is not vigilant, the company can be heading in the wrong direction by focusing on the same processes and practices of the industry, without paying sufficient emphasis on the customers and their requirements. Companies need to understand how the key performance measures can guide and focus their respective organisations towards superior results within their chosen area. Many proponents recommend that organisations should consider a section occasionally referred to as the *Office of Strategy Management* since often within an organisation, i.e. finance, human resources, and information technology are catered for, but few organisations have a department with prime responsibility for managing strategy.

Qualities of Good Metrics

First, here is how the author views analytics; analytics is the measurement of movement towards your business goals. The two key concepts are "movement" and "business goals". Work on analytics by Croll and Yoskovitz (2013) reiterates that it is not about reporting for the sake of reporting, it is about tracking progress towards something you are trying to accomplish. With that definition in mind, here's how we define a "good metric". A good metric is as follows:

- Comparable: being able to compare a metric across time periods, groups of users, or competitors helps you understand which way things are moving. For example, "Increased conversion by 10 % from last week" is more meaningful than "We are at 2 % conversion". Using comparative metrics speaks clearly to our definition of "movement towards business goals".
- Understandable: a good metric is understandable. Take the numbers you are tracking now—the ones you think are the most important—and show those to outsiders. If they do not instantly understand your business and what you are trying to do, then the numbers you are tracking are probably too complex. And internally, if people cannot remember the numbers you are focused on and discuss them effectively, it becomes much harder to turn a change in the data into a change in the culture. Try fitting your key metrics on a single TV screen (and do not cheat with a super small font either!).
- A ratio or rate: A good metric is a ratio or a rate. Ratios and rates are inherently comparative. For example, if you compare a daily metric to the same metric over a month, you will see whether you are looking at a sudden spike or a long-term trend. Ratios and rates (unlike absolute numbers) give you a more realistic "health check" for your business, and as a result, they are easier to act on. This speaks to our definition above about "business goals" ratios, and rates help you to understand whether you are heading towards those goals or away from them.
- Behavioural changing: good metric changes the way you behave. This is by far the most important criterion for a metric: What will you do differently based on changes in the number? If you do not know, it is a bad metric. This does not mean you do not track it—we generally suggest that you track everything but only focus on one thing at a time because you never know when a metric you are tracking becomes useful. But when looking at the key numbers you are focused on today, ask yourself whether you really know what you would do if those numbers go up, down, or stay the same. If you do not, put those metrics aside and look for better ones to track right now.

Now that we have defined a "good" metric; let us look at five things you should keep in mind when choosing the right metrics to track:

(i) Qualitative versus quantitative metrics;
(ii) Vanity versus actionable metrics;
(iii) Exploratory versus reporting metrics;
(iv) Leading versus lagging metrics; and
(v) Correlated versus causal metrics.

Qualitative Versus Quantitative Metrics

Quantitative data are easy to understand. It is the numbers we track and measure, for example sports scores and movie ratings. As soon as something is ranked, counted, or put on a scale, it is quantified. Quantitative data are nice and scientific,

and (assuming you do the sums right!) you can aggregate it, extrapolate it, and put it into a spreadsheet. Quantitative data do not lie, although it can certainly be misinterpreted. It is also not enough for starting a business. To start something, to genuinely find a problem worth solving, you need qualitative input. Qualitative data are messy, subjective, and imprecise. It is the stuff of interviews and debates. It is hard to quantify. You cannot measure qualitative data easily. If quantitative data answer "what" and "how much", qualitative data answer "why". Quantitative data abhor emotion; qualitative data marinate in it. When you first get started with an idea, assuming you are following the core principles around Lean Start-up, you will be looking for qualitative data through problem interviews. You are speaking to people—specifically, to people you think are potential customers in the right target market; you are getting out of the building. Collecting good qualitative data takes preparation. You need to ask specific questions without leading potential customers or skewing their answers. You have to avoid letting your enthusiasm and reality distortion or rub off on your interview subjects. Unprepared interviews yield misleading or meaningless results.

Vanity Versus Actionable Metrics

As intimated above, if you have a piece of data that cannot be acted upon (you do not know how movement in the metric will change your behaviour), then it is a vanity metric and you should ignore it. It is important to note that actionable metrics do not automatically hold the answers. They are not magic. They give you an indication that something fundamental and important is going on, and identify areas where you should focus, but they do not provide the answers; for example, if "percent of active users" drops, what do you do? Well, it is a good indication that something is wrong, but you need to dig further into your business to figure it out. Actionable metrics are often the starting point for this type of exploration and problem solving.

Exploratory Versus Reporting Metrics

Reporting metrics are straightforward—they report on what is going on in your start-up. We think of these as "accounting metrics"; for example, "*How many widgets did we sell today*?" or "*Did the green or the red widget sell more*?" Reporting metrics can be the results of experiments (and therefore actionable), but they do not necessarily lead to those "eureka!" moments that can change your business forever. Exploratory metrics are those you go looking for. You are sifting through data looking for threads of information that are worth pursuing. You are exploring in order to generate ideas to experiment on.

Leading Versus Lagging Metrics

Leading and lagging metrics are both useful, but they serve different purposes. Most start-ups start by measuring lagging metrics (or "lagging indicators") because they do not have enough data to do anything else. Whilst this is acceptable, it is important to recognise that a lagging metric is reporting the past; by the time you know what the number is, whatever you are tracking has already happened. A great example of this is churn. Churn informs us of the percentage of customers (or users) that abandon our service over time. But once a customer has churned out, they are not likely to come back. Measuring churn is important, and if it is too high, you will absolutely want to address the issue and try to fix your leaky bucket, but it lags behind reality. A leading metric on the other hand tries to predict the future. It gives you an indication of what is likely to happen, and as a result, you can address a leading metric more quickly to try and change outcomes going forward. For example, customer complaints are often the examples of leading indicators of churn. If customer complaints are going up, you can expect that customers will abandon and churn will also go up. But instead of responding to something that has already happened, you can dive into customer complaints immediately, figure out what is going on, resolve the issues, and hopefully minimise the future impact in churn. Ultimately, you need to decide whether the thing you are tracking helps you make better decisions sooner. Remember, a real metric has to be actionable. Lagging and leading metrics can both be actionable, but leading indicators show you what will happen, reducing your cycle time and making you leaner.

Correlated Versus Causal Metrics

A correlation is a seeming relationship between two metrics that change together, but are often changing as a result of something else. Take ice cream consumption and drowning. If you plotted these over a year, you would see that they are correlated—they both go up and down at the same time. The more ice cream that are consumed, the more people drown. But no one would suggest that we reduce ice cream consumption as a way of preventing drowning deaths; that is because the numbers are correlated, and not causal. One is not affecting the other. The factor that affects them both is actually the time of year—when it is summer, people eat more ice cream and they also drown more. Finding a correlation between two metrics is a good thing. Correlations can help you predict what will happen. But finding the cause of something means you can change it. Usually, causations are not simple one-to-one relationships—there are many factors at play, but even a degree of causality is valuable. You prove causality by finding a correlation and then running experiments where you control the other variables and measure the difference. It is hard to do, but causality is really an analytics superpower—it gives you the power to hack the future.

Table 6.1 Metric elements

Metric elements	Explanation
Title	Use exact names to avoid ambiguity
Objective/purpose	The relation of the metric with the organisational objectives must be clear
Scope	States the areas of business or parts of the organisation that are included
Target	Benchmarks must be determined in order to monitor progress
Formula	The exact calculation of the metric must be known
Units of measure	What is/are the unit(s) used
Frequency	The frequency of recording and reporting of the metric
Data source	The exact data sources involved in calculating a metric value
Owner	The responsible person for performance of that part of the organisation, collecting data, and reporting the metric
Comments	Outstanding issues regarding the metric

The literature is somewhat vague regards outlining the criteria for a good metric; in essence, this could be summarised as needing to fulfil certain criteria:

- A strategic perspective: it should enable strategic planning and then drive deployment of the actions required to achieve the strategic objectives;
- Ensure alignment of behaviour and initiatives with strategic objectives; focus the organisation on its priorities;
- Quantitative: provide a clear understanding of progress towards strategic objectives;
- Provide current status, rate of improvement, and probability of achievement;
- Identify performance gaps and improvement opportunities; and
- Qualitative: be perceived as valuable by your organisation and the people involved with the metric. Table 6.1 below further explores this aspect.

Requirements of a Performance Measurement System

Frequently, in the author's experience, organisations continue to measure and evaluate operations based on their achievement of unit cost targets built into their standard costing systems. 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 root causes of cost and performance. The traditional metrics have not worked, and the major inadequacies can be easily summarised from experience of organisations that have pursued the Lean journey:

- The traditional accounting measures are not suited for strategic decisions;
- Traditional metrics are historical and difficult to correlate;
- They provide little information on the root problems;
- The connection between financial and non-financial measures is fragile;
- Little attention is paid to cross-functional processes as opposed to functional ones;
- Intangible assets are awarded modest attention;
- They largely ignore value creation;
- Often, there are too many measures;
- They encourage managers to minimise the variances from the standard rather than actively seeking to improve continually; and
- Rarely can we aggregate from operational to strategic levels.

A major challenge to most organisations remains the need to select the right measures for the appropriate levels of the organisation. The empirical evidence and past experience summarises the solid evidence towards an activity-based costing (ABC) system to work in concert with a scorecard system which will yield 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 as proven within many Lean initiatives. If not planned appropriately, the measures can run counter to the strategy and can often encourage the wrong type of behaviour. This theme often occurs whereby different measures at various stages are encouraged. In the early stages of a high-technology business, for instance, managers focus on the following:

- 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 ageing 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 are equally critical; an impatient organisation concentrating only on the corporate-level measures is undeniably doomed to fail in its attempt to formulate a performance measurement

Table 6.2 Classes of performance indices

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
	Information directed to appropriate personnel
Foundation level	Internal focus
	Mainly short term
	Top strategic levels are covered
	Information is easily accessible

system. Utilising appropriate measures for different organisations is equally important as is the need to use measures for different levels within any enterprise.

The following three classes are promoted: "third" (Tangen 2005, p. 48) are mostly the traditional measures whereby the requirements of these measures are low. "Second" (p. 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 6.2 adapts the proposal which has been customised by summarising the various classes and criteria dependent on the level.

Likewise, when we look at CPM or SPM systems, there are certain characteristics which need to exist and operate effectively:

- 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 6.2;
- By focusing on exceptions, they permit users to discover the real problems; and
- Real-time automation improves decision-making and evaluates information quicker.

Likewise, an organisation needs to decide what is significant to measure what is important to the enterprise in question. 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" as early as 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 within the UK proceeds to suggest that many organisations find this lateral translation difficult to organise.

It is equally vital for the organisation to involve staff in determining the respective measures which improves their motivation and securing their collaboration. 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; this aspect is very obvious in recent consultations undertaken. In this context, the system needs to be focused towards continuous improvement in line with the Lean philosophy. It is proposed 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.

In summary, certain aspects should be considered by any organisation in their attempt in evaluating a performance measurement system. Bearing in mind that performance measurement is a quantifying process for the efficiency and effectiveness of action:

- Does it clearly define what constitutes business excellence?
- Does it provide the information required to set aggressive yet achievable strategic objectives and stretch goals?
- Does it accurately portray our progress and probability of achieving both long-term strategic objectives and near-term milestones?
- Does it identify the root causes of barriers?
- Does it focus the organisation on the priority improvement needs?
- Does it drive the behaviour and actions required to achieve the objectives?
- Does it align work with value?
- Is it easy to use?
- Does it involve everyone?

Metrics to Use

It is vital to stress at this stage that the intention is not to provide a prescriptive list of indices or metrics to use. The choice will and should depend on the organisation and take into account the product life cycle which will determine which metrics are more important. It is merely the intention to provide an indicative list of the type of metrics which could be used which have been categorised and a brief description provided of what each metric endeavours to measure.

Time Metrics

How long does it take to produce a product or service? How long does it take to deliver that service to the customer? How much of that time is spent adding value to the product?

- *Lead time*: the total time from start to finish to develop a service/product and deliver it to the customer, including waiting time (*expressed in days; a lower number is better*);
- *Processing time*: "touch time", or the number of working hours spent on process steps, not including waiting time (*a lower number is better*);
- *Response (wait) time*: the number of working hours it takes to react to a customer request for a service or product (*a lower number is better*);
- *Activity ratio*: processing time divided by lead time (*expressed as percentage; a higher number is better*);
- *Best and worst completion time*: the range of variation in lead time or processing time may also include standard deviation if data are available (*a smaller range is better*);
- *Percentage on time delivery*: how often your lead time meets your target (*a higher number is better*);
- *Value-added* (*VA*) *time*: amount of processing time spent adding value to the service/product, where value is defined as "something the customer is willing to pay for" such as drafting a contract for a vendor (*a higher proportion of VA time is better*);
- *Non-value-added* (*NVA*) *time*: amount of time not spent adding value to the service/product, activities that the customer is not "willing to pay for" such as waiting for a signature or review (*a lower proportion of NVA time is better*); and
- *Essential non-value-added* (*ENVA*) *time*: non-value-added steps that cannot be eliminated (*goal varies by service or product*).

Cost Metrics

How much does it cost to complete the process and produce a service or product? What are operational costs relative to production levels?

- *Total process cost*: total costs, including labour, material, and overhead, to produce the service/product (a lower number is better, given the same level of production);
- *Cost per transaction*: total process cost divided by number of services/products produced (a lower number is better);
- *Cost savings*: dollar or percentage reduction in total process cost or cost per transaction (a higher number is better);

- *Cost avoidance*: dollar or percentage reduction in planned spending that would otherwise have occurred (a higher number is better); and
- *Labour savings*: reduction in labour hours needed to perform process, usually "soft cost savings" as staff hours are redirected to value-added activities (expressed in hours, FTEs, or percentage reduction; a higher number is better).

Quality Metrics

Did you succeed in creating value for the customer? Do services meet customer satisfaction criteria? How often does the process generate mistakes that require rework?

- *Customer satisfaction*: qualitative or quantitative data derived from surveys, number of complaints, thank you notes, or other feedback mechanisms (goal varies by measurement technique);
- *Defect rate*: percentage of services/products that are "defective", where a defect is defined as "something the customer does not like" (a lower number is better);
- *Rework steps/time*: amount of a process spent correcting mistakes or going back for missing information (a lower number is better);
- *Percentage complete and accurate*: percentage of occurrences where a process step is completed without needing corrections or requesting missing information (a higher number is better); and
- *Rolling first pass yield*: percentage of occurrences where the entire process is completed without rework, or the product of all steps' percentage complete and accurate rating (a higher number is better).

Output Metrics

How many services or products are completed or produced every month or year? How many are in the pipeline? Did you produce more than the customer needed?

- *Production*: total number of services or products completed or produced in a given amount of time (goal varies by service or product; the optimal level should align with customer demand to minimise backlogs and excess inventory);
- *Work in process*: number of services or products currently being processed (goal varies by service or product);
- *Backlog*: number of services or products that are waiting to start the process (a lower number is better); and
- *Inventory*: a supply of raw materials, finished products, or unfinished products in excess of customer demand (a lower number is better).

Process Complexity

Is the process overly complex? How many steps make up the process? How often does it change hands or require someone's signature?

- *Process steps*: total number of steps to complete the process (aim for reduction);
- *Value-added process steps*: number of process steps which adds value to service/product (aim to increase proportion of value-added steps or eliminate non-value-added steps);
- *Decisions*: Number of decision points where process changes for different situations and staff must decide the appropriate path to follow (goal varies by service or product, typically aim for reduction);
- *Signatures required*: number of approvals needed, usually involve delays and handoffs (aim for reduction);
- *Handoffs*: number of times the service/product changes hands can be a source of errors, miscommunication, or delays (aim for reduction); and
- *Loop backs*: when steps of a process must be repeated, usually to correct errors or find missing information (aim for reduction).

Organisational Metrics

Are Lean deployments creating a cultural shift in your organisation? Are you improving employee work environments and morale?

- *Lean events*: number of Lean events, such as Kaizen or value stream mapping events;
- *Lean participation*: number of employees participating in Lean events or projects;
- *Lean training*: number of employees receiving Lean training; and
- *Employee satisfaction*: qualitative or quantitative data derived from surveys, number of complaints, or other feedback mechanisms (goal varies by measurement technique).

Evaluation of Indices

It is vital that organisation implements system in order to ensure that the indices being used are still appropriate and moving the organisation forward. Whilst various proposals have been forwarded, one that has considerable credibility is that introduced by Tangen (2005) who developed a process to assist the evaluation process of the respective measures used by an organisation. Table 6.3 extends the

Table 6.3 Criteria to judge performance indices

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	

original principle which permits organisations to undertake a systematic review of their performance measures. The analysis would enable the measures that are no longer useful to be identified. The respective measures are scored against the type of parameters outlined in Table 6.3.

Organisations often seem content to introduce new measures of performance, but rarely do they delete obsolete ones. An evaluation of the measures against different criteria is important to the organisational systems and the notion of continuous improvement to be instigated. However, it is fully acknowledged that the evaluation of KPIs can be time-consuming. The average KPI evaluation can be progressively undertaken in shorter periods once the organisation has built systems to support this process. There needs to be an acceptance that if the organisation recognises 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. In the author's experience, often the metrics chosen show a result but the timing is too late to enable the 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 to be incorporated. However, a valid and candid assessment will only be achieved, if a portfolio of measures is used. 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 to the overarching strategy. There is ample evidence from organisations showing that good solid metrics can facilitate the implementation of a strategy, whereas poor or distorted ones actually obstruct enactment. It is reinforced by the same empirical evidence 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.

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 from organisations encourages the view that often the same 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, the research 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, in the author's experience, it is only a third of instances discovered whereby the organisations undertaking performance measurement had implemented BPM.

Indices to Consider All Dimensions

An investigation of the literature revealed that it is possible to divide the metrics used in particular classifications, namely

- Stakeholder value and benefits, i.e. customer satisfaction and market share,
- Programme objectives and requirements such as development and completeness of product requirements,
- Results from the products such as cost and quality,
- Results from processes, such as utilisation of resources, and
- People related such as training and culture.

However, the subsequent investigation on the prominence or popularity reveals the following information:

- 30 % address the process results;
- 27 % focus upon the stakeholder values and benefits;
- 25 % product process results;
- 9 % programme objectives; and
- 9 % are people-related metrics.

The survey results revealed the usefulness of the metrics; ironically, on average:

- 48 % of the metrics assessed were used by the organisations;
- 32 % of the metrics were not used; and
- the remaining 20 % are not being used, but organisations would like to do so.

From the analysis undertaken, it was interesting to discover that two metrics:

- "Customer contentment" and
- "Employee contentment"

were rated as the most useful metrics in their respective categories; however, they were amongst the least used metrics. It was also recognised that no metric in any Lean principle was considered not at all useful or extremely useful. Likewise, whilst the traditional financial metrics have been historically reported as highly used by industry as they are both easily understood alongside senior management familiarity, 42 % of the financial metrics surveyed in this study were considered only "reasonably useful".

A "Balanced Scorecard" Approach to Assess Lean

Recent literature cites that more than 70 % of organisations claim to be using a scorecard. 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 and its principles emphasise 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 could be made to the recent experience of many organisations whereby it was discovered 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 would therefore be recommended 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. However, it is important to reiterate that no single performance indicator can capture the complexity of an organisation's performance and heavy reliance on this can pose supplementary issues. Undoubtedly, measuring organisational success is a continuous challenge for both managers and researchers.

Generic Scorecard Precautions and Considerations

There are certain criteria which when fulfilled ensure that the organisation reaps the full benefits of a scorecard. It is important to do the following:

- Align a balanced set of performance metrics with business strategy and vision; it needs to provide management and work teams with the information necessary and sufficient to meet their objectives and goals;
- Create "line-of-sight" at lower levels of the organisation; foster and support process continuous improvement initiatives;
- Performance Measures should support the strategic intentions of the organisations; and
- Managers at all levels should understand both drivers and results of their activities; explicating cause–effect relationships between drivers and results.

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 in most instances. 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 naturally. 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 can vary between similar sized organisations; it is the organisation's remit to decide how and which measures to use in order to progress. It remains imperative that all companies utilise their own version of the scorecard as the measures used may contrast between similar organisations within the same sector.

Equally, recent evidence seems to suggest that the main perceived benefit from linking rewards and measurement is the directional benefits that result, rather than the motivational benefits. Equally, it has been proven that many companies rely more heavily on personal objectives to reward individual performance. Management by objectives (MBO) is still the dominant factor for rewarding executives.

Womack and Jones (2005) 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",
- Lean operates in the context of a value stream; most of the evidence has shown 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 found to be the case with performance reporting in many present-day companies,
- 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", and
- 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 areas. 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. Radziwill (2013) 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. As indicated earlier, with the example of late deliveries which acts as an output metric for the delivery process. By considering the Pareto principle, twenty per cent 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.

Summary

The balanced scorecard has to be tailored to each specific company. The resulting scorecard of indicators should be driven by the firm's strategy if it is not to consist merely of a listing of indicators; in regard to indicators, individual firms have to be selective by linking a potentially long list of non-financial measures explicitly with their choice of indicators to their corporate strategy. In summary, it is necessary to recognise the characteristics of good metrics:

- Metrics are meaningful, quantified measures;
- Metric must present data or information that allows us to take action;
  - Helps to identify what should be done;
  - Helps to identify who should do it;
- Metrics should be tied to strategy and to "core" processes—indicate how well organisational objectives and goals are being met; and
- Metrics should foster process understanding and motivate individual, group, or team action and continual improvement.

Different performance measurements are needed for a Lean manufacturer. A system needs to be developed which reinforces the goals of Lean, with improvement results that can be measured like shorter cycle times, less inventory, higher quality, on-time delivery, visual management, and pull systems. A Lean

performance measurement system needs to be developed to support these improvement results. It needs to be strategically focused and aligned to primarily non-financial indices, simple and easy to use, visual and obvious, provides immediate and timely feedback, and fosters continuous improvement. It is important that you keep a focus on strategy deployment and that measurements are linked throughout the organisation, not just on the manufacturing floor but in accounts, procurement, HR, and other back-office processes, to the objectives of the company so that everybody is pulling in the same direction.

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Chapter 7
Appropriate Measurement Tools

Abstract Any investigation should involve primary research in order to validate or refute the findings. This book is no different; however, it is important to illustrate the methodology which was adopted and the rationale for this. The methodology used intended to substantiate the judgments of Saunders et al. (Research Methods for Business Students. Prentice Hall, London, 2003). It was decided to investigate the issue under question from diverse viewpoints in order to secure validity, credibility, and triangulation. It was considered fundamental to utilise a variety of research methods and techniques. In an effort to obtain validity and reliability, two discrete data capture mechanisms were utilised. Predominantly, the data were secured through comprehensive survey questionnaires and case studies undertaken in 15 manufacturing companies; this was consequently supplemented by a thorough international case study in order to try and validate the findings. Remenyi et al. (Doing Research in Business and Management, Sage, London, 2000) proposed that an enhanced level of validity and reliability is sought through the use of a varied methodological approach.

Methodology Choice

Wilson (2010) outlines the importance of outlining the rationale for selecting the appropriate methodology. The case study methodology predominantly relied upon both questionnaires and interview schedules which were directed towards managers and operatives. Table 7.1 specifies the alternative choices which were considered and a rationale provided for the decisions made; the two generic paradigms available were as follows:

- Positivist and
- Phenomenological.

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Table 7.1 Methodological choice

Possible methodologies	Rationale
Positivist	
Experimental studies	Whilst allowing causal associations to be acknowledged, within Lean there exist too many variables Lings and Lee (2008)
Cross-sectional studies	Take account of a particular aspect of the prevailing situation, trying to detach a particular occurrence; consequently, not suitable to any correlation (Collis and Hussey 2003). In Lean, there are too many variable requiring simultaneous consideration
Longitudinal studies	They scrutinise the similar situation or people for some time; there are access issues which were felt may not be overcome (Anderson 2007)
Surveys	Provide an opportunity to capture information from a large sample effectively; the costs are kept low as they only require to produce the survey questionnaire; the flexibility offered, i.e. face-to-face or through emails; there was an opportunity to eliminate any observer objectivity with considerable statistical significance demonstrated. However, it was important to combat possible short-comings, namely inflexible design which it was possible to explore further. Furthermore, whilst surveys have endured criticism for not being able to deal with complex issues, the face-to-face option assisted to combat this possible critique
Participative enquiry	Collis and Hussey (2003) have referred to it as "*research with people rather than research on people*" (p. 75); this once again besides the credibility of the findings would have put into question the accessibility necessary
Phenomenological	
Action research	Inherently, accepts a constantly altering situation whereby the researcher and the research are integral to this situation (Wilson 2010); however, the intention was that to remain detached from the research aiding credibility to the findings
Case studies	Case studies permitted the use of questionnaires and interview schedules whereby a greater degree of credibility was feasible
Ethnography	Ethnography was founded in the biological, social, and cultural areas of anthropology and in general sciences with particular emphasis within sociology. It stresses the concept of reflexive—trying to comprehend the interpretation of the social life of humans. Participant observation is the leading method of data capture which made it an unlikely candidate. This level of access was unlikely to happen (Robson 2011)
Feminist perspective	From a structured level, this challenges the conventional research paradigm from a perspective stemming within the philosophy of the women's movement Saunders et al. (2003); this was regarded unsuitable for this investigation
Grounded theory	The intention was to remain independent in order to secure validity, reliability and it was felt grounded theory would not be appropriate (Anderson 2007)
Hermeneutics	Often related to the explanation of historical text; often applied within the legal field whereby a rationale is needed in relation to rulings or statutes (Saunders et al. (2003). Once again considered inappropriate as a result of the input variables encountered within Lean

The Survey Questionnaire

The Survey questionnaire was fragmented into the various categories in order to try and decipher information on various aspects, namely:

- Factors contributing to the rationale for Lean;
- The possible issues and obstacles that emerged;
- What the organisation's objectives were from the adoption of Lean;
- The extent to which Lean embraced;
- Determine whether the culture was conducive to Lean; and
- Performance indices were incorporated in an effort to determine whether Lean had resulted in operational improvements.

In an effort to strengthen the reliability of the data, the stratification selected endeavoured to denote the separate features (Robson 2011). A stratified system was chosen since it is most appropriate whereby the population is divided into noteworthy bands. It was considered that this would permit the representation of each stratum. The companies were grouped in terms of proximity, entity size, and stages of Lean the organisation had reached and from numerous manufacturing sectors. Anderson (2007) stated surveys are generally cross-sectional and consequently, it was vital that they created a considerable degree of confidence (Lings and Lee 2008). Every effort was made to guarantee that the failings of the survey results never materialised; consequently, efforts were made to ensure that interview bias did not materialise; the data were not influenced by the connections of interviewer/respondent; interviewees were informed that sources would not be able to unidentified in order to induce information.

This system allowed great quantities of data to be collected in both an efficient and effective manner. It awarded a considerable degree of control over the research practice. It was recognised that even with the aid of SPSS and Excel, the analysis can take a considerable time. Attempts were made to secure external validity and it was important to be able to generalise the findings. Efforts were made to use standardised questions in order to maintain the findings translucent, which consequently facilitated the overall analysis. Care was taken to eradicate interviewer bias. It was considered imperative to integrate various variables which were considered would decipher patterns of correlations to decide the level of the correlations.

Regardless of whether the Survey questionnaire or questionnaires are utilised within the case studies, every effort was taken to consider the questionnaire designs since it was felt this would influence responses, validity, and reliability. Consequently, it was deemed necessary to:

(i) Vigilantly, design each individual question;
(ii) Consider the layout and format of the forms;
(iii) Coherent clarification of the questions and purpose provided;
(iv) Test the forms to evaluate their effectiveness, and this was substantiated by a;
(v) Thorough and well-planned and accomplished administration.

Research dictates that standardised questions assist to improve the levels of interpretation from the respondents view (Lings and Lee 2008). Saunders et al. (2003) warn about "*uninformed response*" (p. 283) whereby respondents deliberately guess the correct answer; "*socially desirable*" responses occur after a discussion of the answers which aids greater distortion. Other factors were taken into consideration, namely:

(i) The available time,
(ii) Financial consequences,
(iii) The access and availability of suitable companies, and
(iv) Simplicity of automated data entry process.

The literature (Wilson 2010; Saunders et al. 2003) dictates various advantages surveys offer which it was important to try and explore:

(i) They award an opportunity to clarify the questions to aid further understanding;
(ii) A presence assisted to encourage both participation and involvement;
(iii) In general, they are regarded as being moderately inexpensive;
(iv) Few other methods of observation can permit this degree of general capability;
(v) Numerous questions can be asked about an agreed topic;
(vi) This permits a considerable degree of permitting flexibility to the analysis;
(vii) When executed correctly, they allow a high level of reliability since respondents receive a standardised stimulus.

It is proposed (Anderson 2007) that the interface enables a superior quality of data capture. The survey formed part of the positivistic methodology; the organisations were chosen to represent:

(i) Proximity from the researcher;
(ii) The organisation' size;
(iii) Stage of Lean the organisation had reached;
(iv) How mature the company was;
(v) Length Lean had been adopted;
(vi) Intricacy of the processes and products;
(vii) Lean of success from Lean; and
(viii) Representing various manufacturing sectors.

Robson (2011) outlined issues which can arise from surveys which it was important to try and deter from emerging, namely:

(i) Guarantee that interview bias was never permitted to materialise,
(ii) The data were not impacted by interviewer/respondent contact,
(iii) Respondents informed that the information supplied would remain anonymous,

(iv) Prevent the intention of too much standardisation,
(v) Remain consistent in how the questions were communicated in order to prevent interview bias.

Combating possible interview issues

The surveys and case studies facilitated the use of interviews which helped to combat some of the criticisms against surveys and questionnaires. The amount of information provided to the candidates remained constant. Efforts were made to recognise the behaviour during the interviews since it was considered that a neutral, though not a dispassionate, reaction would yield the best responses (Robson 2011). In regard to the interviewing, the respondents were awarded an adequate time to enlarge their own responses (Collis and Hussey 2003).

Using the questionnaires (Survey questionnaire and the interview schedules), it was felt questionnaires could be linked to both positivistic and phenomenological methodologies. Both closed and open-ended questions were used for both the shop floor and managers. It was recognised that response rates can be low, consequently by contacting the respondents initially and chatting with them on the phone eradicated this possibility (Hussey and Hussey 1997; Robson 2011). In order to secure both reliability and validity within the questionnaires, a generic protocol was pursued (Remenyi et al. 2000; Robson 2011; Collis and Hussey 2003; Anderson 2007) which stressed that

(i) Any indistinct metaphors were circumvented;
(ii) A question was asked at a time;
(iii) Tactless questions were not included thus avoiding awkwardness;
(iv) Respondents were instructed regards their purpose;
(v) The questions were without doubt clear and free of slang;
(vi) Any questions which could be classed as a memory test were avoided; and
(vii) Respondents were only awarded clarification when necessary.

Case Study

In regard to the case study, the principles suggested by Robson (2011) were adopted 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*" (p. 52). Yin (1993) quoted various examples of designing a case study in line with whether it is to be an exploratory, explanatory, or descriptive case study. Considerable emphasis was placed upon Yin's (1993) nine steps, namely:

(i) Try and develop the theory;
(ii) Selection of the case(s) carefully;
(iii) Look at a collection protocol;
(iv) Undertake the case study;

(v) Writing up stage;
(vi) Probe for the cross-case conclusions;
(vii) Analyse its connection or association to the theory;
(viii) Further explore potential policy implications; and
(ix) Final compilation of the broad case report.

Undeniably, securing the suitable level of access to an organisation was not easily achieved. Wilson (2010) suggested that if not careful, a case study can be devoid of rigidity and independence as a consequence of the prejudice and partiality; in this case, it was felt that by interviewing both the operatives and managers, this would aid towards securing both validity and reliability. Lings and Lee (2008) proposed that a case study is holistic in nature and attempts to capture the information within the prevailing circumstances.

Case Study Benefits

It was possible to determine the impact Lean has made on an organisation from a broader perspective and from the perspective of various stakeholders. It could be channelled from either a positivistic or a phenomenological perspective. It was possible to explore further the technical and cultural implications surrounding Lean. It was also possible to explore in more depth issues raised within the survey questionnaires, but was not possible to examine in detail. It was considered that triangulation was possible since a case study was used in conjunction with survey questionnaires which were undertaken in various organisations.

The case study permitted a broader investigation whereby it was possible to assess the overall findings from a more

holistic perspective; it facilitated a broader analysis and permitted looking at other evidence which was not feasible with the survey questionnaires, namely:

(i) Documental evidence; i.e. published financial statements and other internal documentation looking at aspects such as labour and capital utilisation;
(ii) Interviews of both operatives and managers; this allowed a personal consultation with the managers and operatives;
(iii) Direct observation; the Lean processes enabled direct observation to be undertaken in order to view existing layouts and stock levels. It was possible to gain a further insight of the prevailing culture too;
(iv) Participant observation; it was vital that reliability was not compromised; subsequently, efforts were made to try and confirm information that was received from individuals in the company;
(v) Physical artefacts; the type of aspects that was possible to view included the departmental layouts, remuneration systems and on occasions the type and level of communications undertaken within the organisation;

(vi) Archival documents; Lean requires considerable transformation; consequently, efforts were made of any layout changes, remuneration systems, and historical information on performance indices which could provide an insight into the Lean journey and experiences encountered by the organisation.

Interviews

The principle of interviews was pursued since they can be linked with both positivist and phenomenological methodologies. Undeniably, whist it is possible to pursue the very fluid approach and open-ended questioning, it was considered that subsequent analysis may be difficult to undertake. Consequently, it was felt that the semi-structured interviews whereby the interviewer retains a clear and very defined purpose were pursued. However, a certain degree of flexibility was retained in both the terminology and sequence to extract the appropriate information. In essence, the interview was viewed as a conversation with a function (Robson (2011). It was also considered that face-to-face interviews allow a degree of modification to be undertaken, i.e. non-verbal indications can provide a greater understanding of the verbal response, possibly altering and in extreme cases, reducing its meaning. It was vital to listen and not to use the interview as an opportunity for personal views. The questions were delivered in an uncomplicated, lucid, and an unintimidating manner. Collis and Hussey (2003) suggested that when people are perplexed or distrustful, the information required is not secured.

Long, linked, or "double-barrelled" questions were avoided in an effort to retain credibility and validity. Every effort was taken to abstain from asking leading questions and jargon in order to secure professionalism. Whilst interviewing can be time-consuming, it was important to undertake very careful preparation; in essence, this included the following:

(i) Ensuring that all the necessary permissions were undertaken;
(ii) Confirm all the arrangements; and
(iii) Re-scheduling appointments, where necessary, in the view of absences and crisis.

Assurances were provided regarding confidentiality to the respondents. The responses were documented exactly and devoid of superficial adjustments, validating them, or concocting the process. All the interviews were undertaken in the same manner since consistency was important.

It was possible to use the semi-structured interviews as a gauge to deduce the qualitative information too. This permitted a considerable degree of flexibility, namely:

(i) Allowed a prospect to explore further when necessary in order that the respondents could explicate or construct further upon their responses;
(ii) It was recognised that the questions may have seemed complex as companies and interviewees knowledge of Lean varied;
(iii) On occasions, it was necessary to fluctuate the order and logic of the questions being asked;
(iv) The concept of Lean and its application of principles can be complex; consequently, it was considered that this method of data capture was the most suitable.

It was necessary to pursue a framework to the manner in which the questioning was undertaken, i.e.

(i) Provide an introduction and rationale;
(ii) Provide few easy "warm-up" questions;
(iii) Concentrate upon the main component of the interview;
(iv) Use some "cool-off" questions; and then,
(v) Follow-up with a conclusion by thanking the interviewee and explaining the next steps of the research process. Attention was also paid to one's own body language to ensure that it did not influence opinions; in this case, probes were utilised where necessary, i.e. Robson (2011) suggested four methods which were adhered to:
(i) Permit a interlude of silence when necessary
(ii) When applicable, present an enquiring glance
(iii) Use verbal signals, i.e. "Mmhmm"
(iv) Proceed to repeat some aspect of what had just been mentioned.

Where necessary, a summary was provided, when suitable, in order to retain the focus and to elucidate that the interviewee comprehended the issues. Similarly, an accurate record was always maintained, with the forms completed in the interviewee's presence.

Ethical Considerations

It was imperative that every attention was paid ensuring that ethical considerations were not compromised; the relevant processes under consideration were the organisation, individual contributors, the assembly, analysing, and writing of the data involved. Ethics were perceived as an orientation for the suitability of one's behaviour relative to the rights of those who are stakeholders of the research or may be impacted by it. It can be 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, p. 59).

The investigation undertaken also followed the general Code of Professional Conduct (CIPD 2005):

- Exertions were made to assess the accuracy of the data;
- Discretion was awarded to the personal information;
- That identical opportunities and non-discriminatory procedures and processes were followed;
- Individuals were treated fairly.

Furthermore, five ethical principles promoted by the CIPD Code (2005) were adhered to, namely:

(i) Confidentiality and discretion;
(ii) The data were collected in a suitable fashion;
(iii) There always was present informed agreement from those subject to the research;
(iv) There existed no deceit; and
(v) That the research was correctly inferred.

Management research can induce various ethical issues. Privacy is a prominent aspect; within this research, the participants were as follows:

- Awarded the right to not partake;
- Only contacted during periods suitable to them;
- Only retained for a period previously negotiated; and
- Privacy and discretion were respected in regard to the contact with the respondents.

Similarly, in regards to the actual data capture, several ethical considerations were also observed:

(i) Impartiality; in essence, the bias was minimised where suitable;
(ii) Discretion and anonymity were awarded to the company and individuals;
(iii) Unbiased conduct was executed; no individual was put under excessive pressure;
(iv) Privacy was always awarded prominence;
(v) The appropriate permissions and access were secured at the commencement;
(vi) No observation was started without the unequivocal authorisation of those involved;
(vii) Approval was fortified before any company documents were copied.

Chapter Summary

The essential differences between surveys and case studies made them perfect choices for the primary data capture which was required as part of this investigation. The surveys and case studies supplement each other. The survey and case

study methodologies have varied goals and whilst should not be observed, as transposable; however, that makes them exceptional harmonising tools. One fully recognises that every research can involve bias though every effort, including the ethical considerations were recognised in an attempt to eradicate this possibility. The reader has also been awarded an opportunity to consider possible data capture instruments which can be used within manufacturing. The nature of the data capture greatly influences the findings and subsequent analysis.

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Chapter 8
Impact of Lean

Abstract Camp (Sustainable lean. Productivity Press, New York, 2013) argued that in order to effectively compete on a global scale, manufacturers need to discover methods to reduce costs without impacting quality levels. Lean principles assist organisations to become more competitive by enabling them to eradicate waste from the manufacturing process (Celani and Singh in Pers Rev 40:222–238, 2011). In order to achieve this, it is necessary to simplify, standardise, and persistently improve the processes (Cross in Lean innovation. Productivity Press, New York, 2012). Consequently, Lean has grown in popularity within the prevailing economic climate (Bicheno and Holweg in The lean toolbox. Picsie, Buckingham, 2009). However, in contrast to the opinion held by many, Lean does not advocate reducing costs through headcount reductions (Gill in Worker job stress effects of JIT/lean production: design and operating policies. Cambridge University, Cambridge, 2003). Lucey et al. (Manag Serv J 2:9–24, 2008) stated that whilst Lean has a proven record, their investigation discovered that "*the number who claim to be quite close to becoming Lean was only 7 %*" (p. 19) of the organisations. This chapter acts as a preamble to the findings of the empirical investigation which have been discussed within the following chapters. Nonetheless, it was necessary to summarise the prevailing fundamental background and issues concerning Lean, and this chapter endeavours to undertake this role.

Impact of Lean

The general objective for Lean is the sustainable enhancement to an organisation's profitability reinforced through better performance (Lee 2008). Hines et al. (2008) confirmed that Lean is undeniably a commercial initiative that can result in superior performance levels for an organisation. Lean advances operational competence and efficiency through reducing or eradicating waste; the organisation needs to attack waste in the entire aspects of its business (Haskin 2010). An analogy can be drawn with Toyota whose mission is not to produce cars but to discover better ways to manufacture cars. Nonetheless, the challenge for organisations is to provide the customer precisely what they require whilst operating more efficiently in order to

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supply additional value to the customer from the prevailing resources without increasing the costs (Baggaley 2006).

Lean's prominent goal is to deliver the uppermost quality at a competitive cost, in a short span of time by continuously attacking the Muda or waste (Stump and Badurdeen 2012). In order to achieve success, Lean should not be viewed as a collection of tools, methodologies, or a business system; it should ideally be viewed as an overarching business ideology (Bicheno and Holweg 2009). This business ideology needs to transcend throughout the organisation and not to be concentrated within the manufacturing element alone (Camp 2013). In these circumstances, the organisation is expected to redesign the assets and associations with the supply chain companions to make the transition in order to create more value for its customers (Henderson and Larco 2003). The Lean organisation has to view itself as an assortment of horizontal processes or value streams alongside the more accustomed vertical organisation of functions and departments (Bicheno and Holweg 2009). Womack and Jones (2005) suggested that the vertical functions assist to arrange knowledge, whilst the horizontal value streams will proceed to generate value.

The incorporation of Lean into the business journey for an organisation is an absolute and imperative obligation (Maskell and Baggaley 2004). The advocates of Lean (Womack and Jones 2005; Bicheno and Holweg 2009; Liker and Franz 2011; Ransom 2008; Shook 2010; Montgomery 2010) suggest that amongst the potential prominent benefits, it can assist in numerous ways: reduce the cycle time, reduce WIP, minimise the lead times, reduce the overall cost base through the persistent attack on waste, quicker response time, improved production flexibility, better quality levels, higher levels of customer service, better revenues, and consequently profits and increased quantities of throughput amongst others.

Lean Review

The Amnis White Paper (2011) suggested that the British manufacturing companies are under threat from many perspectives, namely a high-cost base and skills shortages impacting the aspiration to continuously improve. It proceeds to state that the UK manufacturing sector encompasses 18 % of our national GDP whilst accounting for 62 % of our exports. It employs 2.6 m people directly which in essence accounts for 10 % of the jobs within the UK. "The Lean Survey" undertaken by the "Manufacturer Magazine" (2011) suggested that 70 % of the organisations which responded were utilising the Lean principles. The Amnis White Paper (2011) suggested that decreasing lead times to handle the demand unpredictability and efforts to decrease stock levels remain the key instigators for improvement. Hines et al. (2008), Bicheno and Holweg (2009), and Stefanie et al. (2012) stressed that Lean can aid organisations to reduce the need to outsource activities which subsequently assists to shrink both the costs of production and the associated overall business risk.

The process of Lean embraces an ideology of continuous development demanding relentless appraisal and modification (Tangen 2005). Jones (2009) suggested that it

needs to be viewed as a never-ending journey. Any organisation cannot implement Lean and feel that the principles are self-sustainable (Cocolicchio 2008). Womack and Jones (2005) proposed that Lean needs to be viewed as a long-term journey, often resulting in other short-term detriments. Pullin (2005) suggested that when Lean reaches a stage whereby the company understands and identifies the context and shape, its primary and supporting value streams should reflect across the organisation; it could be deduced that a third of the Lean encounter has been effectively completed. It is at a stage whereby a company is on route towards generating a Lean management system in order to oversee its process-focused enterprise, that it could then be deduced that another third of its task has been fruitfully achieved. The difficult and concluding obstacle is about reflection of the organisation's customers whilst considering forward from its existing capabilities of its Lean processes towards reshaping the commercial mould for the industry (Pullin 2005). Once again the empirical research suggests that sustaining the Lean journey and its associated benefits can never materialise through steering openings in a random fashion, utilising only a limited number of the Lean tools (Schonberger 2008a, b; Montgomery 2010; Smalley 2009; Jones 2009; Fullerton and Wempe 2009; Bicheno and Holweg 2009).

In order to achieve a maintainable Lean foundation, which constantly harvests impressive company-wide developments on an international foundation demands a road map suggest (Bicheno and Holweg 2009). Samuel (2010) stated that suppliers have to become important stakeholders in a beneficial working relationship; there are pressures through just-in-time delivery and reducing stock levels. Bicheno and Holweg (2009) stated that supply chains have transformed and this has reinforced the concept of "*partnership philosophy*" (p. 189); they mention how the current trend has been towards outsourcing rather than controlling the value chain through vertical integration. Subsequently, it is logical to expand the order accomplishment mapping to both the customers and suppliers. There is a need to work closely with suppliers in order to enhance the value chain; in this way, the organisation has a much improved opportunity to influence its competitiveness (Cocolicchio 2008). This means that supply chain associations need to be encouraged further, i.e. to adhere to the same quality standards, involvement in transport, and the deployment of communication systems such as EDI.

Lean Aiding Competitiveness

It is hoped that once the Lean principles are well comprehended by an organisation, then it becomes a way of thinking; the ideology has respect for its people and proceeds to empower the same people. It proceeds to transform the culture by advocating that the customers become the central focus which subsequently proceeds to create a competitive advantage. Table 8.1 provides a high-level summary of the existing literature; it proceeds to state the evidence and research undertaken regarding the impact Lean can make towards improving the performance levels of organisations; it details

Table 8.1 Lean aids competitiveness

Source	Summary of findings
Engineers Employment Federation (2001)	One in four organisations stated that Lean had resulted in higher productivity and reduced manufacturing costs; the larger organisations overall tended to perform better at Lean
McKinsey & Company's Production System Design Centre (PSDC 2002)	60 % of the strongest performing organisations within their sample were making good use of Lean; consequently, a higher correlation was discovered between Lean and performance levels
Shah and Ward (2007)	Reiterated that larger organisations were more likely to implement Lean; just in time, total quality management, total productive maintenance, and HR displayed a positive association with performance levels. Interestingly, there was no association discovered between the age of an organisation and the willingness to adopt Lean
The NIST report (2003) (NIST Manufacturing Extension Partnership; 2003)	This report splits the benefits between operational; i.e., whereby cycle time shrunk by 90 %, productivity raised by 50 % and WIP condensed by 80 %. Equally, the spin-off advantages included less time spent on processing orders and quicker response rates to customers which benefitted the overall efficiency levels. They also recommended the outsourcing of non-critical aspects which were undertaken by the more progressive organisations
Manufacturing foundation (2004)	45 % of the case study sample organisations reported huge reductions in Lead time; in most cases, it resulted in a over 40 % improvement
"*The lean strategies benchmark report*" (Bartels 2005)	From a strategic perspective, those organisations at the later stages of Lean were between 2.5 and 6 times more able to deal with customer pricing pressures. It showed that Lean aided response rates and flexibility
"Manufacturer" (2005) ("Manufacturing Research Centre")	Over 52 % of respondents stated that costs of production were reduced between 15 and 35 % as a result of Lean. This made the organisations more price competitive and able to compete on several dimensions, namely price, flexibility, and response rates
Koenigsaecker (2005) from work of "AME" ("Association of Manufacturing Excellence")	Those organisations on the Lean journey within the sample were experiencing a 90 % drop in lead times and faults; furthermore, coupled with this, they were utilising 60 % less floor space in some operational processes. The impact of this was that it facilitated better costing structures
Oliver (2007)	In his benchmark study, he was able to show that the Lean adopters' defect rates were often reduced by 70 % in reference to ppm
Ransom (2008)	Looked at the impact of Lean on organisations quoted on the stock market, he concluded that Lean has lead to revenue increases of 6–8 % for the respective organisations; furthermore, the income escalation of 12–15 % was experienced by those organisations that had adopted Lean principles
Lucey et al. (2008)	44 % of the organisations had stated that vast cost reductions happened as a result of Lean; there were also intangible benefits such as increased customer satisfaction and enhanced staff morale. The intangible benefits are not always recognised, and the study stated that they have a significant role to play

(continued)

Table 8.1 (continued)

Source	Summary of findings
Ahmad and Rose (2009)	The study concluded that whilst Lean is applicable in small, medium, and large entities, it was considered that larger companies performed much better at Lean as it was generally applied across the value chain, more concerted tool application, and better performance measurement of their respective Lean initiatives occurred
"The Manufacturer" "The lean report" (2011)	The report stated organisations in the UK that had fully implemented Lean experienced over 35 % reduction in lead times and a 40 % reduction in the costs of production
Bhasin (2012)	His comprehensive study concluded that Lean promotes efficiency which was demonstrated through a performance scorecard devised. In his study of 68 organisations, Lean aided both operational and HR benefits; however, the efficiency improvements were correlated to the levels of Lean adoption. Likewise, larger organisations performed better as a result of their Lean initiative

i. The source of the research and
ii. The summary of the relevant findings that have been included.

Lean Conditions Needed for Performance Improvements

To build a sustainable Lean foundation that consistently yields dramatic company-wide improvements on a global basis, there is a necessity to develop a road map (Cross 2012). Frigo (2003), Laureani and Antony (2012) proposed that the lesser performing companies concentrate upon performance measures which focus upon the internal processes without establishing linkages to customer requirements in the respective targeted markets. The conversion to Lean needs considerable determination (Stump and Badurdeen 2012). Wincel and Kull (2013) stated that an organisation striving towards achieving a sustainable Lean foundation would be required to undertake considerable operational and cultural transformations.

Performance of Lean in Various Organisations

Shah and Ward (2007) analysed three sets of characteristics, namely unionisation, plant size, and plant age. 22 separate Lean practices were chosen, and these were grouped into 4 bundles, namely:

(i) Just in time,
(ii) Total productive maintenance,

(iii) Total quality management, and
(iv) Human resource management.

They summarised that older plants are only less likely to implement five practices relative to newer plants. However, the larger plants are more likely to extensively implement all, but five of the Lean practices. Shah and Ward (2007) discovered that JIT, TQM, TPM, and HRM were positively associated with operational performance.

Larger Organisations and Lean

Bhasin (2012) discovered that 40 % of the larger organisations applied Lean across the whole value chain; this was a major contrast with the small and medium organisations since only 20 % of the smaller organisations utilised Lean across the whole value chain. Furthermore, in regard hoping to widen the remit of Lean, this issue was reinforced by the responses given regarding the expectations of improving the value chain; 74 % of the large organisations, 53 % of the medium, and only 47 % of the small organisations indicated this to be an ambition. Furthermore, Bhasin (2012) found that a bigger proportion of departments and employees were operated under the Lean principles within the larger organisations. The extent to which Lean is monitored was also investigated by Bhasin (2012); in reference to weekly and monthly tracking, large organisations undertook this 60 % weekly and 83 % monthly; medium-sized organisations 38 % weekly and 63 % monthly, whilst the small organisations stated 50 % weekly and 50 % monthly. In an investigation of the length that the top six Lean tools that had been in operation, Bhasin (2012) found that it was 4.7 years for large organisations, 3.3 years for the small, and 3.1 years for the medium-sized organisations.

Radziwill (2013) is resolute in suggesting that in order to secure Lean success, six or more appropriate and timely Lean tools need to be concurrently utilised within an organisation. It was once again intimated that as a result of the availability of resources and skill sets, this is more likely within the larger companies. Unfortunately, there is not ample literature which examines the performance of Lean across sectors; this has been undertaken in the previous chapter, and the main variations are discussed further in this chapter. Lucey et al. (2008) had stated that within their survey, engineering had a much greater concentration of Lean which was twice the amount to its nearest rival, electronics. Lucey et al. (2008) suggested that larger organisations seem to have greater success with Lean. The larger organisations in their sample applied Lean to a greater degree within their respective organisations; this included the application of tools. It was forwarded that the larger companies may already have instilled a culture of continuous improvement which establishes the foundation required for Lean to flourish.

Ahmad and Rose (2009) stated that small and medium organisations could be expected to be more adept at implementing Lean since

i. They usually depict fewer layers of management,
ii. The top management are generally more visible,
iii. Cross-functional working is easier within smaller entities since barriers are reduced,
iv. They generally tend to have greater staff loyalty.

However, on the negative side, the small and medium organisations also tend to:

i. Make decisions that are often based upon the short term,
ii. Depict a situation whereby they constitute a lack of skills, time, and resources,
iii. Whilst often not embracing a dedicated training budget.

Ahmad and Rose (2009) proceeded to state that as a result of the available resources, namely skill sets and choice of personnel, finance, and equipment, the larger organisations may find Lean easier to implement. They also discovered that the key components for Lean such as

- Quality circles,
- Quality control systems,
- TPM,
- The set-up reduction, and
- Kanbans

generally had a better record of implementations within the larger organisations than was the case in smaller and medium-sized companies.

Crucial Success Factors

It has been clarified that Lean is not easily achieved and that it requires a concerted effort in terms of time, skills, and finance; though the evidence suggests that when organisations do persevere, it does reap business benefits (Wilson 2010). Likewise, the Amnis White Paper (2011) identified the prominent factors which aid a successful implementation which has overall been substantiated within the literature, namely

- The need to develop an appropriate culture to support Lean (Wheatley 2005; Smalley 2009);
- A clear concise Lean strategy has to be developed which the employees are familiar with (Montgomery 2010; Angelis et al. 2011);
- Effective evaluation of the implementation is needed with remedial processes and actions implemented (Camp 2013; Clarke 2011);
- A consistent communication system is needed aiding to eradicate any potential mixed messages (Halliday 2005; Laureani and Antony 2012; Liker 2004 and Marksbury 2012);
- Enjoy and rejoice the individual successes during the Lean journey (Manufacturer 2011; Radziwill 2013);

- The Lean facilitators need to cascade their knowledge and expertise within the organisation; this assists to widen the empowerment (Samuel 2010; Skabelund 2012);
- Resources are to be made available for the Lean initiative (Womack and Jones 2005; Bicheno and Holweg 2009; Waurzyniak 2009);
- Endeavour to build the internal Lean expertise and not merely rely upon the external agents (Celani and Singh 2011; Wincel and Kull 2013);
- Secure the senior management support and sustain this during the Lean journey (Radziwill 2013; Atkinson 2010);
- Adopt a root cause analysis to combat possible issues which may emerge (Bicheno and Holweg 2009; Stump and Badurdeen 2012).

It would be accurate to suggest that the above list whilst useful could not be viewed as comprehensive, since certain factors were not awarded the prominence that they deserved, namely

- Try to include the supplier relationships and associations (Bicheno and Holweg 2009; Zokaei et al. 2013; McVay et al. 2013; Johnston 2009);
- Need to look at applying Lean throughout the organisation's value chain, else the improvements made by the organisation will never reap the full benefits anticipated (Jones 2009; Hines et al. 2008; Cross 2012);
- Appropriate performance management systems need to be implemented which subsequently support the Lean initiative and ensure that their Lean initiative remains on course (Baggaley 2006; Black 2007; Neely et al. 2005).

Differences and Variations in Lean Between the Sectors

The empirical evidence is not forthcoming upon comparing the performance of Lean in various sectors; nonetheless, the research reveals that larger organisations seem to perform better at Lean than their small- or medium-sized counterparts. Numerous factors have been uncovered which have assisted to contribute the enhanced performance of larger organisations, namely that the organisations adopt Lean to a greater degree; essentially, they tend to function under Lean to a broader extent across the value chain. This concept was reiterated by the increased aspiration regarding the intention to involve suppliers to a greater degree. Furthermore, the subsidiary cultural considerations were found to exist to support a conducive Lean implementation in the larger organisations. Equally, the Lean inputs in reference to the tools were discovered to have been embedded to a greater extent within the larger organisations. The research also indicates that Lean needs to be viewed as a business ideology; in this respect, it was interesting to find that the larger organisations were tracking the performance of their Lean initiatives more ardently than was the case with in the smaller and medium-sized companies.

Summary

Some of the differences between the sectors also included the following factors:

i. As Lucey et al. (2008) summarised that engineering had a much greater concentration of Lean which was twice the amount to its nearest rival, electronics, automotive parts had a greater level of concentration than the general components sector,
ii. "Electronic weekly News" (2013) suggested that the main tools used within electronics are SMED, TPM, 5S, and efforts to improve the WIP; McKee and Ross (2012) suggested that this largely resembles the situation within the components sector; however, within the automotive components sector, supply chains have altered. The concept of "*partnership philosophy*" is much more evident with recent efforts of outsourcing rather than controlling the value chain through vertical integration,
iii. Prakash and Kumar (2011) stated that companies have instigated vertical integration to a much greater extent within the automotive parts sector,
iv. Kohlbauer (2013) reiterated that the automotive components sector leads the way in creating long-term partnerships with customers whilst looking to embrace the latest robotic technology,
v. Paloma Consulting (2013) suggested that within the automotive parts sector, supplier development is becoming more popular; Haber (2013) suggested this is not so apparent within the electronic sector or the components sector (McKee and Ross 2012),
vi. Titcomb (2013) argued that unlike other sectors, within electronics, skills shortage is a particular problem posing as a barrier,
vii. Pitcher (2013) suggested that the main factors effecting the UK electronics sector are

- access to new technology,
- skills,
- innovation pressures, and
- design pressures.

These are not so prevalent within the components (Lee 2013) and automotive parts sector (Camp 2013)

(i) Wincel and Kull (2013) forwarded that the automotive sector is more advanced in its Lean application which could be attributable to the history of Lean,
(ii) Zokaei et al. (2013) discussed the whole issue of ecology and environmentalism which is more evident within the automotive parts sector,
(iii) Ironically, there are similarities too; Garcia and Bonavia (2012) proposed that despite the prevalence of Lean within the automotive parts sector, only a minority of companies manage to integrate the operations strategy into the overall business strategy adequately. This reflects the situation within the components (Lee 2013) and electronics (Haber 2013),

(iv) Camp (2013) continued to reiterate that despite Lean being popular within the automotive sector, that people and culture management remain crucial issues; this situation is also reflected within the electronics and components sectors (Feng et al. 2012).

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Chapter 9
Gauge the Adoption of Lean Within the: Automobile's Parts, Electronic, and Small Components Sectors and Understand the Reasons for Any Differences

Abstract This chapter looks at more detail through existing empirical evidence whether any differences regarding Lean exist between the components, automotive, and electronics sectors. This was an ambitious attempt to explore in greater detail the parallels or otherwise of the Lean experiences within these three sectors. Various aspects are considered, namely the triggers to adopt Lean, the barriers encountered, the strategic aims, the level of Lean adoption within the sector, the impact upon performance levels of the organisation, possible sustainability, and the recent trends in reference to Lean within the respective sectors. This chapter acts as a preamble to the subsequent chapters which resulted from comprehensive primary research conducted in 15 organisations through surveys and case studies which provided the appropriate information needed. Consequently, this chapter explores the existing evidence which was subsequently tested by the research undertaken.

Lean Applied Within Components Sector

This sector is facing pressures of superior quality and performance being expected at the lower levels of the supply chain (Feng et al. 2012; MAS East 2005). Efficiency, superior quality, and more cost-effective procedures are being sought in order to be able to compete on the international stage (Feng et al. 2012; MAS East 2005; Forth 2004). The Aberdeen Group (2006) proceeds to summarise that whilst 66 % of the components' organisations surveyed were relatively new to Lean (namely had been on the Lean journey for less than three years), the more proactive organisations were reaping the benefits from their Lean initiatives. The Aberdeen Group (2006) study quoted five key indices which acted as a gauge to success; in ranking order, they were given as follows:

(i) On-time delivery,
(ii) Inventory turnover,
(iii) Manufacturing cycle time,
(iv) Quality levels, and
(v) Cost per unit.

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Triggers for Lean in Components Sector

The Aberdeen Study (2006) revealed few main triggers for the adoption of Lean within the components sector; in ranking order these were given as follows:

(i) A need to improve operational performance levels,
(ii) A demand stemming from customers requesting shorter cycle times, and
(iii) A need to secure an advantage regarding price and service.

Sharma and Chetiya (2010) suggest that the components' sector is following a trend experienced within the automotive sector regarding the adoption of Lean. Ahmad and Rose (2009), Forth (2004) suggest that a trend is whereby customer order delivery times are being shrunk by using a make-to-order or an assemble-to-order system whereby the bills of material are compressed coupled with postponing the work processes up to a stage whereby a order is received from the customer (Forth 2004; Sharma and Chetiya 2010). Munroe (2008) and Motley (2005) suggest that organisations are adopting kaizen initiatives, naturally expecting their staff to constantly seek improvement ideas.

Barriers to Lean Experienced Within the Components Sector

Focusing upon the components sector, the Aberdeen Report (2006) stated that in ranking order, the main obstacles were given as follows:

(i) Culture (85 %),
(ii) Top management support (35 %),
(iii) Costs (31 %),
(iv) Applying Lean to a wider supply chain (27 %),
(v) Business disruption (27 %),
(vi) Internal expertise (25 %),
(vii) IT support (21 %), and
(viii) Qualifying benefits of Lean (19 %).

Forth (2004) reinforced the role of top management support and culture; Feng et al. (2012) also stressed the importance of adopting a strategic approach to Lean, implying the need for the DMAIC methodology without specifying the terminology. Fascinatingly, the Aberdeen Study (2006) also stressed the strategies adopted to overcome the Lean Barriers by the small components sector, namely

(i) Top management support (70 %);
(ii) Small kaikaku events (59 %);
(iii) Lean value methodology adopted (55 %);
(iv) External Lean expertise sought (50 %); and
(v) Quantified the Lean benefits (28 %);

Strategic Aims of the Components Organisations

The Aberdeen Report (2006) identified the top strategic aims and aspirations of the Lean organisations within this sector;

(i) Shrink manufacturing and supply chain costs (61 %);
(ii) Culture (52 %);
(iii) Lessen inventories (45 %); and
(iv) Modify manufacturing and supply chain flexibility (35 %).

Lean Adoption Within the Components Sector

The Aberdeen Group study (2006) revealed visible differences between the leaner organisations and those not adopting the Lean principles with the same vitality; Table 9.1 reflects the difference between the highest performers and those struggling in respect to their adoption of the Lean principles.

Similarly, it was interesting to note that the Aberdeen Group study (2006) identified those indices which the organisations revealed to be directly correlated with overall performance; there were as follows:

(i) On-time delivery (62 %);
(ii) Inventory turnover (47 %);
(iii) Manufacturing cycle time (41 %);
(iv) Quality (26 %); and
(v) Cost per unit (30 %).

Performance Improvements Within the Components Sector Through Lean

The empirical evidence indicates a direct correlation existed between Lean and performance; the more measurable advantages quoted were as follows:

Table 9.1 Adoption of Lean within the components sector

Adoption of Lean requirements	High performers (%)	Poorer performers (%)
Intensive lean training	91	16
Ascertaining improvements	80	21
Line manufacturing systems	75	8
5s	75	19
Kanban	73	7
Value mapping	68	4
Continuous improvement events	67	13

- 10 % increase of market share for the better organisations as a result of Lean (Aberdeen Report 2006),
- Over 100 % increase in throughput (Aberdeen Report 2006),
- Productivity improvements rose from $40 to over $104 per operative hour (Aberdeen Report 2006),
- Feng et al. (2012) reflected how losses were reduced from $7.6 k to $6.4 k (18 %),
- Cultural improvements were made, namely empowerment and morale which are difficult to quantify,
- MAS East (2005) within their case study revealed how productivity rose by over 80 % with a 47 % improvement in space utilisation,
- Forth (2004) intimated how finished goods inventory fell from $1.2 m to $200 k for a medium-sized organisation, and
- Forth (2004) demonstrated that lead time was reduced from four weeks to several days.

Strategies to Improve Component Sector Performance Through Lean

Feng et al. (2012), Aberdeen Report (2006), MAS East (2005), Ahmad and Rose (2009), and Motley (2005) revealed possible strategies for organisations hoping to compete in this sector; they suggested the following guidelines:

- Clearly focus upon key customer-related indices such as delivery,
- Consistently measure the KPIs whilst using standard operating procedures,
- Improve the supply chain flexibility,
- "Pull" systems instigated,
- Secure external Lean sensei to start off the Lean journey,
- MAS East (2005) particularly stressed the importance of team work and Kaizen contributed as part of the culture and keep them cross-functional in nature,
- Map the value stream,
- Role of preventative maintenance was forwarded by Feng et al. (2012),
- Implement Lean production principles, and
- Analyse existing bills of material and process; contemplate deferring assembly instructions until the final order has been received; this may involve using FIFO systems (Feng et al. 2012).

Feng et al. (2012) also suggested how Lean and Six Sigma can operate effectively "*to overcome the limitations of each programme when implemented in isolation*" (p. 225). Furthermore, they suggest three important lessons for the component sector:

(i) that a culture of detecting variability needs to be fully embedded,
(ii) the role of training is reinforced in order to create this awareness, and
(iii) a systematic DMAIC methodology is to be adopted.

Similarly, Forth (2004) placed considerable emphasis upon flexibility within production; dedicated machinery to be used for flow lines required to produce high volumes; small volume parts require the in-built flexibility. Motley (2005), Ahmad and Rose (2009) stress that organisations will also require a flexible workforce and consequently highlight the importance of training.

Recent Trends Within the Components Sector

Quantifiable benefits are possible through Lean as suggested by Feng et al. (2012); however, some of the qualitative aspects are more difficult to determine. Undeniably Lean can yield efficiency improvements but it is reliant upon overcoming the obstacles and implementation issues encountered in other sectors (Lee 2013). Lean is relatively new to the electronics sector. There are moves to look at applying Lean into the overall supply chains (Lee 2013).

There are various challenges facing the component sector, namely overseas competition (Carr 2013), domestic economies (Lee 2013), need for mixed methodologies (Feng et al. 2012), and the need to implement Lean throughout an on organisations supply chain (Lee 2013). Feng et al. (2012) suggested that product design limitations surrounding packaging, ergonomics, and legal restrictions can pose problems for Lean. Feng et al. (2012) suggested that efforts to apply Lean as a strategic weapon is also relatively new in the components sector. McKee and Ross (2012) suggest that the next logical step for the electronics sector is implementing a Lean supply chain which integrates "*internet-enabling technologies*" (p. 14).

Lean Applied Within Automotive Parts Sector

Prakash and Kumar (2011) stated that the automotive parts section has been affected considerably by the world recession; the sector is expected to provide customer value whilst facing considerable competition (Tan et al. 1998), price pressure (Skabelund 2012) diminishing sales (Mohanty et al. 2007) and rigorous environmental targets (Paloma Consulting 2013). Liker (1998) intimated that whilst the automotive sector has a long history of Lean engagement, its success levels are not at a level that may be erroneously anticipated.

Triggers for Lean Within the Automotive Parts Sector

There exist various triggers for Lean initiatives being instigated within the automotive parts sector; the following summarises the causes from the literature regarding engagement with Lean in this sector:

- Inventory control (Oliver 1996),
- Decreasing order, delivery sizes, and high delivery reliability are mentioned by Cakmakci (2009),
- Lowe et al. (1997) suggested that reducing lead times is a key factor,
- Mohanty et al. (2007) suggested that the automotive components sector has evolved to a degree that the more competitive organisations strive to secure a tighter logistical relationship within a value chain; this assists to ensure that less defects are then passed on from the suppliers,
- Jayaram et al. (2008), Lowe et al. (1997), Skabelund (2012), and Tan et al. (1998) pointed towards the need for a conducive culture to be developed which ultimately aids towards establishing an environment of continuous improvement.

Barriers to Lean Within the Automotive Parts Sector

Prakash and Kumar (2011) state that the challenge for Lean initiatives within the automotive parts is the creation and sustaining of a culture whereby top management support is secured. Mohanty et al. (2007) pointed towards the need to secure standardisation and flow lines in order to try and reduce the lead time. Mohanty et al. (2007) also suggested the need to accomplish a successful amalgamation of the various functional areas of their business which results in a greater probability of success. They alongside (Cakmakci 2009; Jayaram et al. 2008; Oliver 1996; Prakash and Kumar 2011) proceeded to mention the importance of a conducive culture in order to establish an environment of trust and respect. Liker (1998) revealed the traditional aspects of collaborative continuous improvement initiatives between managers and the shop floor in order to secure ownership and empowerment. Paloma Consulting (2013) reiterated the need for sustainability of the Lean initiatives. Often organisations in this sector are adopting Lean but then encountering slippage to the old ways of working (Prakash and Kumar 2011).

Strategic Aims of the Automotive Parts Organisations

Interestingly, there seems to be some association within the evidence regarding the triggers and the objectives that organisations within the automotive components wish to accomplish as a result of their engagement with Lean:

- Lowe et al. (1997) suggested various objectives, namely lower inventories, tighter schedules, and a rapid flow of materials from the suppliers,
- Oliver (1996) stated that organisations seem to work better through reducing defects as a consequence of better supplier relationships,
- Mohanty et al. (2007) suggested that organisations strive towards greater cross-functional operations which facilitates a culture of a learning organisation to be developed; this also enables a greater degree of flexibility within the workforce,
- Skabelund (2012) proceeded to identify the need for supplier relationships; this has a positive impact upon the internal workings of an organisation,
- Tan et al. (1998) also dwelled on the need to establish better supplier relationships which effects the internal efficiency levels of the organisation in question.

Lean Adoption Within the Automotive Parts Sector

Liker (1998) in a study of seven automotive parts suppliers discovered a mixed record of Lean adoption; Liker (1998) revealed that when a committee approach to tackling, continuous improvement was used; this proved more effective; however, the membership needs to be representative and work with team leaders in general. Equally, the committee should have the support and cooperation of the senior management team; otherwise considerable effort and time delays were discovered. Prakash and Kumar (2011) suggested that whilst Lean within this sector encounters similar problems as others, a distinguishing factor is that efforts are being made to implement Lean within the entire value chain (Jayaram et al. 2008). Mohanty et al. (2007) suggested that there is a greater emphasis to engage with the supplier; this takes the form of supplier involvement (Bicheno and Holweg 2009), supplier associations (Jayaram et al. 2008), and more effective supplier selection (Tan et al. 1998).

Performance Improvements Within Automotive Parts Through Lean

Jayaram et al. (2008) found a positive correlation between the overall performance and Lean design within their sample organisations. Fascinatingly, they discovered a positive relationship between Lean and manufacturing performance in particular; they did summarise that firms often find it difficult to translate this into overall organisational performance. Jayaram et al. (2008) also revealed a positive correlation between linkages within the value chain model and overall efficiency. Prakash and Kumar (2011) indicated some benefits Lean accrued:

- a 75 % reduction in product development time-to-market,
- plant space utilisation improved by 50 %,
- number of suppliers reduced fivefold, and
- time for raw material to shipping dock reduced from 4 weeks to 2 days.

Oliver et al. used the term "*world class*" performance in reference to "*simultaneous high performance on the main measures of productivity and quality*" (p. 32). In their comparative study, they discovered a heavier concentration of plants in Japan. The prominent factor was process discipline and control across the value chain. Cakmakci (2009) found positive links between set-up reduction (SMED) and product design productivity levels. Lowe et al. (1997) suggested that the evidence exists to ensure Lean leads to higher performance.

Strategies to Improve Automotive Parts Performance Through Lean

Jayaram et al. (2008) stated that many organisations in this sector are attempting to introduce supplier development in an attempt to ensure that the latter's performance regarding quality in particular. In fact "supplier partnering" is being used widely whereby the supplier is treated as a "*strategic collaborator*" (p. 38). In this situation, the partners work in conjunction with safeguarding higher quality whilst reducing costs. Likewise, better customer relationships are being actively sought within the automotive parts sector; "*the firm that is close to the customer is better able to synchronize or match its products and services with its customers needs and expectations*" (p. 38). Liker (1998) declared a need for continuous improvement to be a joint management and worker programme if it is to be successful. Similarly that the production and improvement aspects have to be tacked in conjunction; from this perspective, "*you can view the outputs not as a function of static production routine but as a function of dynamic production routines that embody continuous improvement*" (p. 454).

The research (Tan et al. 1998; Jayaram et al. 2008; Prakash and Kumar 2011) also points towards successfully implementing product–process integration which leads to greater success. Tan et al. (1998) discovered a direct positive relationship between a longer term supply chain relationship and the firms' performance. Cakmakci (2009) pointed out the need to reduce the set-up times which should be integrated into the design phase of such equipment. Lowe et al. (1997) suggested strategies for automotive parts sector, namely the importance to allocate process control throughout the value chain. The general significance for developing a conducive culture was clearly evident, namely Cakmakci (2009), Jayaram et al. (2008), Lowe et al. (1997), Mohanty et al. (2007), Prakash and Kumar (2011), and Skabelund (2012).

Trends Within the Automotive Parts Sector

Oliver (1996) summarised that Lean aids superior performance with better process discipline and control facilitating this. However, the softer aspects such as team working whilst necessary may not necessarily themselves improve performance levels. Equally, global variations are worth considering, i.e. in Japan, traditionally suppliers are linked into longer term relationships from which it is very challenging to exit. Mohanty et al. (2007) stressed the need to combine the Lean practices with a commitment towards the quest for perfection. It could be concluded that whilst Lean adoption has a long history within the automotive parts sector, that its success levels are not different to other sectors (Lowe et al. 1997; Liker 1998; Prakash and Kumar 2011; Cakmakci 2009).

More recently, Prakash and Kumar (2011) has forwarded that those organisations that have been able to extend Lean into their value chain have tended to operate more effectively. As a sector, the automotive sector is UKs largest exporter; annually generating around £30bn of annual revenues according to the CBI "*Voice of Business Report*" Report 2013. They propose that the more competitive organisations are controlling costs. Similarly, the access to finance remains a precarious issue. Kohlbauer (2013) reiterated that the successful companies are creating long-term partnerships with customers whilst looking to embrace the latest robotic technology. He proceeds to state that competition is fierce and organisations are looking to contribute to weight reductions across the finished products.

Paloma Consulting (2013) stated that supplier development is becoming more popular as reiterated by Marksbury (2012). Williams and Duray (2012) proposed the need to use IT as a competitive weapon is used by the more progressive organisations within the automotive parts sector. Camp (2013) reiterated that despite Lean being popular within this sector, that people and culture management remain crucial issues to address; this was reiterated by Wincel and Kull (2013). A particular innovation which the sector has started to embrace in order to secure a competitive edge according to Zokaei et al. (2013) surrounds the whole issue of ecology and becoming more environmentally attentive. Garcia and Bonavia (2012) proposed that despite the prevalence of Lean, it is only a small percentage of organisations within this sector that have managed to integrate operation strategy into the overall business strategy adequately. Garcia et al. (2012) suggested that experience suggests that forming a project to lead Lean implementations through a pilot-driven system seems to work more effectively.

Lean Applied Within the Electronic Sector

Industry Forum (2013) states that in 2012, the value of world trade in electrical and electronic goods was $1.83 trillion which was second only to fuels and oils. This provides an indication of the potential for efficiencies through Lean in this sector

(Minter 2010). This sector is facing fresh challenges in the form of ever evolving regulations (Minter 2010), product development times (Wong et al. 2009), finding reliable suppliers (Perumal et al. 2010), and the need to implement robust performance measurement systems (Herron and Braident 2007). Consequently, this has encouraged the sector to try and embrace Lean throughout the value chain (Haber 2013) since lead times have to be competitive (Doolen and Hacker 2005).

Triggers for Lean Within the Electronic Sector

Cimento and Knister (1993) suggested that product costs can represent in excess of 60 % of revenues in regard to the cost of goods sold; this makes cost effectiveness a major target for Lean. In summary, there are other triggers to embrace Lean, namely:

- Team working and communication systems (Jeyaraman and Teo 2010),
- Doolen and Hacker (2005) stressed the need to improve the cultural aspects of an organisation,
- Cimento and Knister (1993) advocated the importance of improving the supply chains,
- Minter (2010) indicated the need to look at training which includes coaching and mentoring,
- Sivilota (2009) emphasised the muda still prevalent within the sector.

Barriers to Lean Within the Electronic Sector

Better communications (Taj 2005), delegation (Wong et al. 2009), and a change in perspective from existing managers (Daniel et al. 2011) pose considerable threat to Lean initiatives within this sector; this has been reiterated by Lucey (2008). Herron and Braident (2007) stated the need to embrace various Lean tools simultaneously. Wong et al. (2009) in their study highlighted the five main barriers highlighted in Table 9.2.

Table 9.2 Barriers to Lean

Barriers to Lean in electronics		Percentage
1	Slippage back to the old ways	41
2	Resistance encountered from employees	37
3	The cost implications	32
4	The prevailing organisational culture	32
5	Deficiencies in knowledge to implement Lean	25

Strategic Aims of the Electronic Organisations

Industry Forum (2013) suggests that the ability to develop innovative supply chains is a key driver for this sector. This assists the process of product development whilst securing flexibility for possible production levels (Micrsoft.com 2013). Sivilotti (2009) suggest that the electronics sector is working towards improving:

- Floor space utilisation,
- Better employee engagement, and
- A need to streamline the administrative processes within the organisations culture.

Minter (2010) indicated that the sector needs to strive towards lowering costs through quality, waste reduction, and minimising processing time. Microsoft.com (2013) proposed the need to reduce lead times as a result of levels of competition faced. Haber (2013), Minter (2010), and Perumal et al. (2010) are insistent regarding the need to integrate Lean throughout the value chain.

Lean Adoption Within the Electronic Sector

Wong et al. (2009) discovered that the larger organisations in this sector seem to have a better record of Lean implementation; this aspect is discussed subsequently in more detail. Lucey (2008) stated that the level of adoption varied from the industries included in the survey, and the following levels of Lean adoption were discovered:

(i) Engineering 34 %,
(ii) Electronics 14 %,
(iii) Pharmaceutical 8 %,
(iv) Telecommunications 7 %, and
(v) Food and drink 6 %.

Performance Improvements Within the Electronic Through Lean

Industry Forum (2013) and Perumal et al. (2010) identified the various advantages organisations have experienced through Lean, namely:

- Improved safety, quality, and cost efficiencies,
- Shrinking lead times,
- New product and process introductions, and
- Better knowledge transfer.

Cimento and Knister (1993) suggest that the more successful organisations produce an additional $40 in extra value per employee hour as a result of Lean. Cimento and Knister (1993) proceeded to demonstrate that the better performers managed to secure a 10–20 % higher pre-tax profit as a result of Lean. Jeyaraman and Teo (2010) stated that the intangible benefits should not be underestimated.

Wong et al. (2009) stated that in excess of 80 % of the respondents stated that cost, followed by better productivity and shrinking waste levels were the dominant benefits from Lean. Sivilotti (2009) pointed towards how Lean aided:

- a 73 % reduction in the lead time in material replenishment time,
- 40 % more available floor space,
- cycle time reduced by 80 %, and
- floor WIP was reduced by 80 %.

Strategies to Improve Electronic Sector Performance via Lean

Cimento and Knister (1993) in their study highlighted three management principles necessary, namely:

(i) Determined organisational wide commitment with a heavy emphasis upon training aiding delegation and empowerment,
(ii) A resolute customer focus which assists to develop an inventory control process, and
(iii) Sustaining Lean through more rigorous performance indices.

Cimento and Knister (1993) proceeded to indicate that organisations should pursue better supplier relationships. This aids a strategy to stop any design changes up to a month before market launch; the weaker organisations undertook this five months prior; with a later "*freeze the easier to incorporate changes well along the development process and greater the chance of market success*." (p. 25). Perumal et al. (2010) reiterated the need to ensure that Lean process management is in place for the inputs to operate effectively. Integral to this is the role of coaching and mentoring systems.

Sivilotti (2009) stated a need to Lean the supply chains which requires a considerably greater customer focus. Daniel et al. (2011) stressed the importance of inventory turnover within this sector as a result of lower margins. Microsoft.com (2013) advocates a greater engagement with appropriate software; this will aid to connect demand schedules directly to manufacturing, supply, and distribution. Jeyaraman and Teo (2010) indicate a requirement for:

- Management commitment,
- Reward and recognition of team members,
- Clear communication systems dwelling upon the success stories, and
- Clear systems of performance measurement with remedial strategies embedded.

Summary of Trends Within the Electronic Sector

Some of the benefits declared through Lean whilst evident are difficult to quantify. Once again as indicated by Cimento and Knister (1993) and the Industry Forum (2013), strategically organisations within the electronic sector are willing to trade-off certain features for reduced costs. Wong et al. (2009) stated that there is a clear association between Lean and productivity though not necessarily flexibility. In regard to the obstacles to Lean within electronics, the "people" aspects continue to dominate, namely employee resistance, culture, and slippage to the old ways of working (Daniel et al. 2011; Dong-One and Johngseok 2005; Doolen and Hacker 2005; Taj 2005).

Presently, the "Electronic weekly News" (2013) proposed the need to develop a partner with supply chain experience as the way forward for the sector. The "telegraph.co.uk" (2013, June 24) reiterates that the Electronics sector "*accounts for £78bn in GDP*"; it also stresses the need to look at vertical integration to aid cost reductions and efficiency. Titcomb (2013) proposes that the sector is facing crucial skills shortages at the top end which companies need to develop particular strategies to ensure that this does not act as a barrier. Microsoft.com (2013) also dwells on the need to examine the supply chains of the organisations; they propose that enhanced collaboration is making the most competitive organisations within the electronics sector more competitive through added flexibility.

Likewise, Haber (2013) proposes vertical integration to a greater degree as those organisations pursuing this route have benefitted through better quality levels and speed of delivery. Pitcher (2013) lists the critical factors impacting the UK electronics sector; in ranking order:

(i) access to new technology,
(ii) skills,
(iii) innovation pressures, and
(iv) design pressures.

Pitcher (2013) suggests that outsourcing is very popular with companies adhering to their core competencies. Lee (2013) also promoted that the more efficient organisations in the electronics sector tend to control their supply chain to a greater extent; this is helping the more progressive organisations to cope with fluctuating customer orders.

Summary

A detailed investigation of the prevailing situation regarding Lean within the electronics, components, and automotive components sector revealed that Lean aided towards an improvement of performance levels within these sectors. The level of Lean adoption does vary since within the automotive components sector, efforts

are being made to broaden the application of Lean to the wider value chain with greater supplier involvement and further efforts of vertical integration. Both the small components and electronics sector have in the last few years recognised the need to embrace Lean beyond their immediate organisation. The three sectors face similar issues regarding implementation, namely culture and change management. However, the electronics sector is facing considerably bigger threat with skills shortage. Whilst the electronics sector has a heavier concentration of Lean adoption, the evolution seems to have moved further ahead within the automotive parts sector with supplier partnerships and considerably greater links with customers. There does seem to be recognition that more work is needed to adopt robotic technology and IT systems integral to a company's Lean initiative; likewise, it is necessary to become more ecologically conscious in order to compete effectively. These aspects will assist the three sectors, since in general they are all facing stern global competition with a need to reduce costs without compromising quality levels.

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Chapter 10
Initial Empirical Findings

Abstract This chapter examines in detail the impact of Lean within three disparate sectors, namely automotive, components, and electronics. It proceeds to provide evidence of the data which is then statistically corroborated by the subsequent chapter. It was important that the hypothesis was reliably tested in order to make a valid judgement. This chapter illuminates the new understanding. This is achieved by reconsidering the original objectives in order to conclude whether or not they were met. The areas considered are as follows: reasons for adopting Lean and any barriers encountered within the various sectors; it proceeds to look at what the aspirations from Lean existed for the organisations and which Lean tools were adopted within the sectors and if there were any differences encountered. To complete the initial analysis, a cultural assessment was made of the prevailing Lean cultures of the respective sectors. It was vital that we also looked at the correlation and causal links between Lean and performance of the organisation. This is awarded particular prominence since the author is determined to investigate whether Lean facilitates greater levels of performance and a balance scorecard formed part of the investigation in order to decipher this hypothesis.

The Research Objectives

The predominant objectives were as follows:

- **Clarify if Lean enables an organisation to secure a competitive advantage**
  It is necessary to try and determine whether those organisations adopting Lean, as part of their strategy, proceed to perform better than would have been the case otherwise. This needed a detailed investigation since often companies advocate to being Lean, though upon a closer investigation, it becomes apparent that only some components of Lean are instilled.
- **Performance measurement**
  In order to clarify that Lean resulted in a sustained improvement in the business's performance, the analysis adopted the performance measurement doctrine in order to gauge whether this actually happens in practice. A tailored adaptation

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of the balance scorecard was used which was based upon the idea forwarded by Maltz et al. (2003). This was used as part of the methodology and data capture in order to determine the impact of Lean on the organisation in question. In order to make a valid judgment, it was necessary to examine indices which explored an organisation's performance from a multifaceted perspective, namely:

- Financial,
- Operational,
- HRM,
- Procedural, and
- Sustainability, looking at the future prospects of the organisation.

Preliminary Analysis

The survey questionnaire coupled with the extensive case studies undertaken within the fifteen organisations sought to discover various aspects about the respective organisations' Lean journey which is summarised in the following sections; the more salient aspects have been identified which assisted to provide the data for the statistical analysis within the subsequent section:

- **Reasons for Adopting Lean** (Fig. 10.1)
  - It was interesting to discover that the most important triggers to Lean were team working, efficiency, and competitive pressures;
  - The least important causes to adopt Lean ironically were pressures from customers and marketing or promotional events advocating Lean.

- **Obstacles to Lean** (Fig. 10.2)
  - Evidently, these were all high for all fifteen organisations;
  - Operative ability, shareholders/owners, senior management LEAN skills, and operator resistance were the largest obstacles;
  - Ironically, finance and culture were not regarded as major obstacles;
  - Surprisingly, electronic companies reflected a higher average than automotive and component organisations.

- **Aspirations from Lean** (Fig. 10.3)
  - Over the fifteen organisations, market share, supply chain management, competitiveness, and profitability ranked the highest;
  - Ironically, improving culture and teamwork were the lowest aspirations from the Lean initiatives.

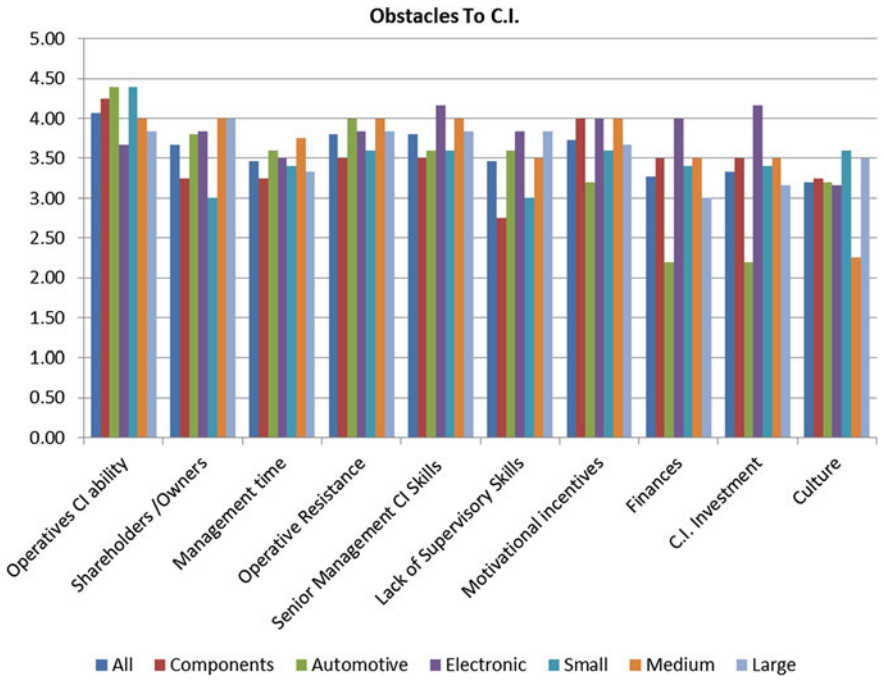

Fig. 10.1 Reasons for adopting Lean

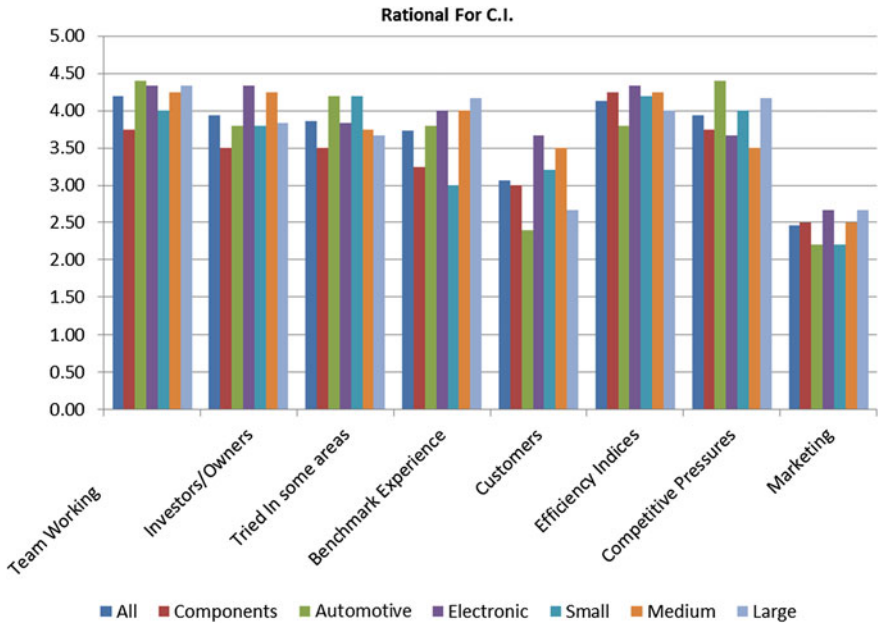

Fig. 10.2 Main barriers to the adoption of Lean

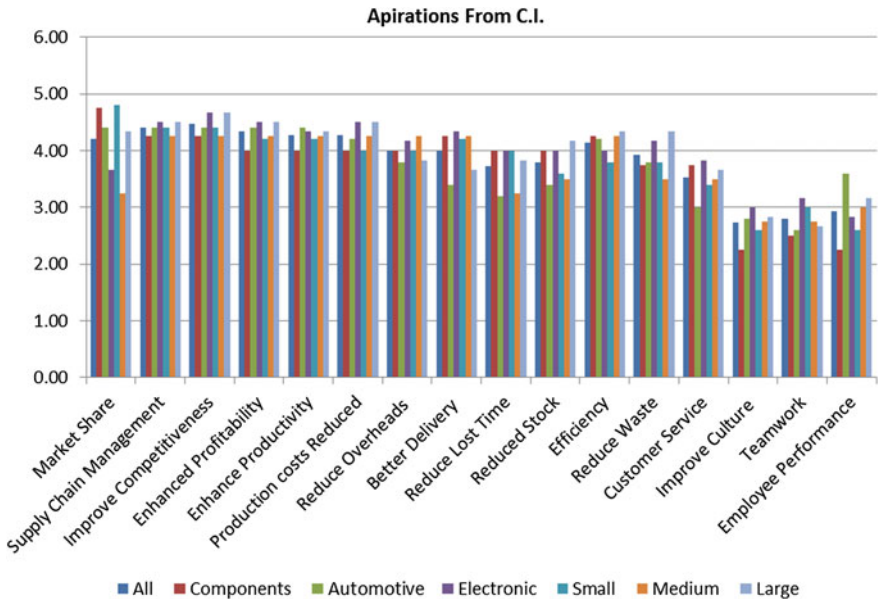

Fig. 10.3 Expectation from the Lean initiative

- **Lean Tools relevant to the organisation** (Fig. 10.4)
  - The joint lowest were regarded Hishin Kanri, PDCA, Poke Yoka, Andon Boards, and Jodoka;
  - The most popular tools were process mapping, visual management, TPM, CI;
  - 40 % of the tools had a very low level of implementation;
  - When comparing company sizes, large organisations on average had a higher level of implementation than small- or medium-sized organisations;
  - In regard to the sectors, the highest level of implementation was in electronic organisations when compared with automotive and components organisations.

- **Cultural assessment** (Fig. 10.5)
  It was decided to dedicate a complete section of the survey questionnaire towards an assessment of culture within the respective organisations. The rationale for this was the extensive literature review undertaken whereby it was indicated that the predominant reason for the low levels of successful Lean initiatives can be attributed to culture and change.
  - Training and senior management support coupled with clear communications were the highest rated;
  - Ironically, a better place to work, culture, and efforts to involve customers were the lowest scoring;

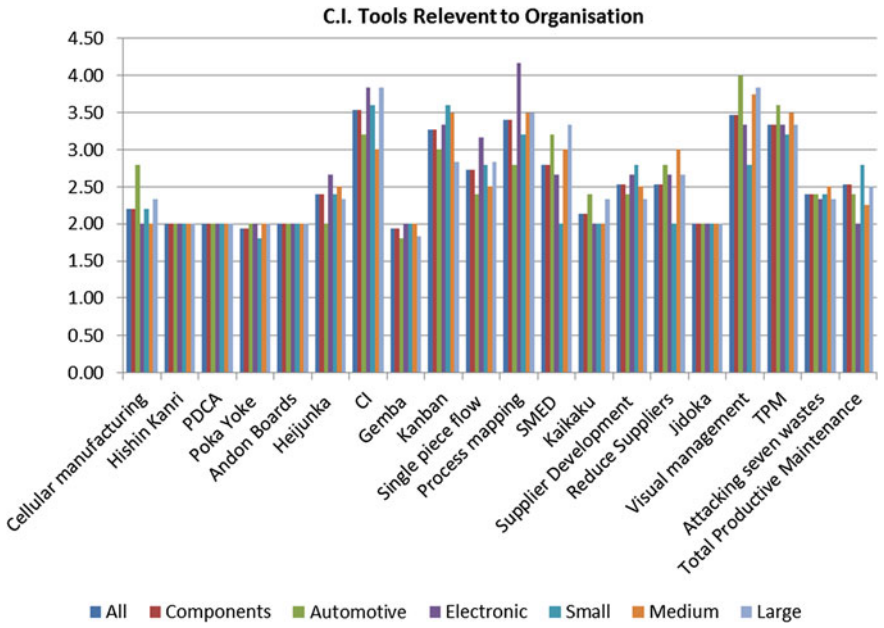

Fig. 10.4 Lean tools applied within the organisation

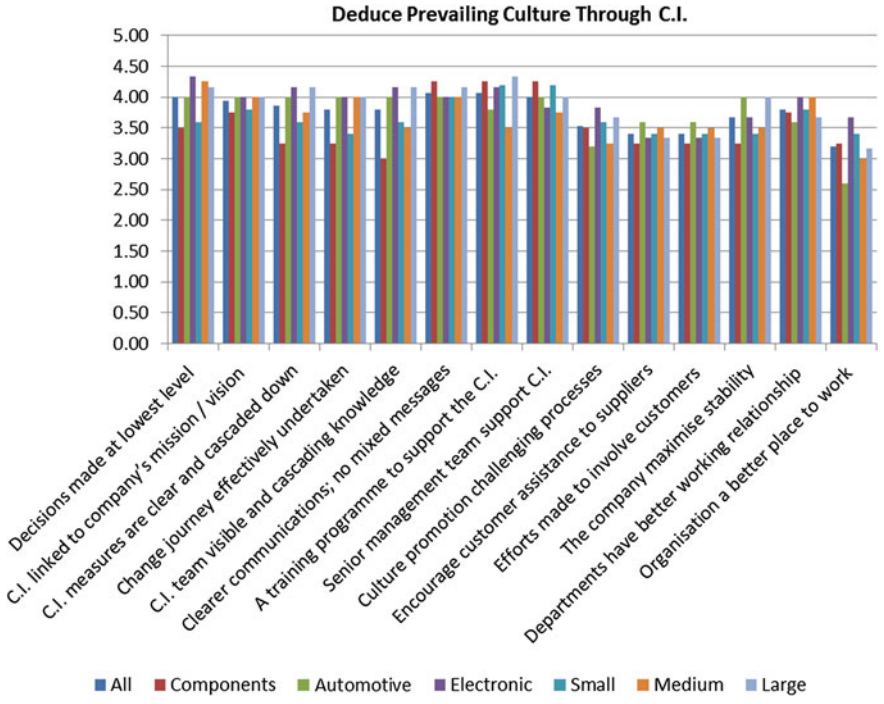

Fig. 10.5 Impact of culture upon the prevailing Lean initiative

- The larger organisations on average scored more favourably than the medium and small organisations; whilst this aspect is analysed within the subsequent chapter, it tends to reinforce the existing findings of much of the empirical evidence;
- Similarly, the electronics sector performed better than the components and automotive companies; once again, the next chapter endeavours to explore this further in order to determine whether the electronics sector depicted the more conducive conditions;
- "Organisation being a better place to work in" scored the lowest in large- and medium-sized organisations and was joint last with "*involving customers to a greater extent*" in smaller organisations.

Performance Review

The Survey questionnaire included a section seeking to find out the information from the respective organisations regards the impact their Lean journey had made on performance.

In order to aid the analysis, it is considered necessary to extend the data capture further than a review of an organisation's financial statements alone. The balanced scorecard methodology (Kaplan and Norton's 1992, 1993, 2001, 2005) was utilised, though it was felt appropriate to extend the remit; consequently, a tailored adaptation of the balance scorecard was used which was based upon the idea forwarded by Maltz et al. (2003). In order to make a valid judgment, it was necessary to examine indices which explored an organisation's performance from a multifaceted perspective, namely:

- Financial,
- Operational,
- HRM,
- Procedural, and
- Sustainability, looking at the future prospects of the organisation.

- **Financial assessment** (Fig. 10.6)
  - The electronics sector performed consistently better than the automotive or components' organisations;
  - The automotive organisations performed worst of the three sectors;
  - Larger organisations performed better than small- or medium-sized companies;
  - The greatest variation was within large organisations with the smallest within electronics which had a range of less than 2 % +.

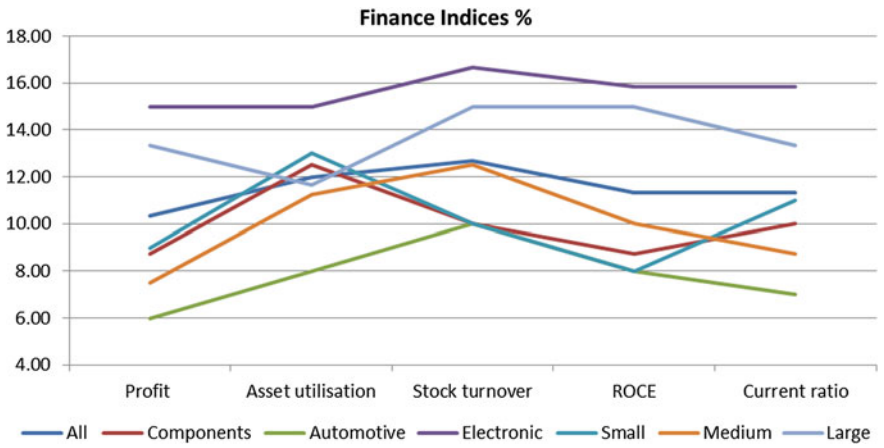

Fig. 10.6 Impact of Lean upon the financial-based indices

- **Procedures and processes performance** (Fig. 10.7)
  - The electronics organisations once again performed better than the automotive or components organisations;
  - Large organisations performed better than small- or medium-sized companies;
  - "Production flexibility" was the highest performing metric;
  - "Lead time for new products" consistently the worst performing metric.

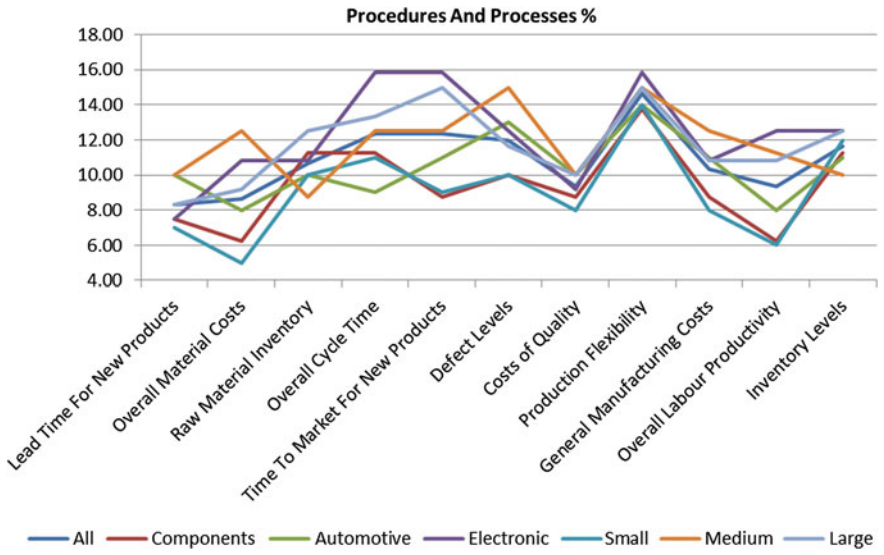

Fig. 10.7 Impact of Lean upon the processes-based indices

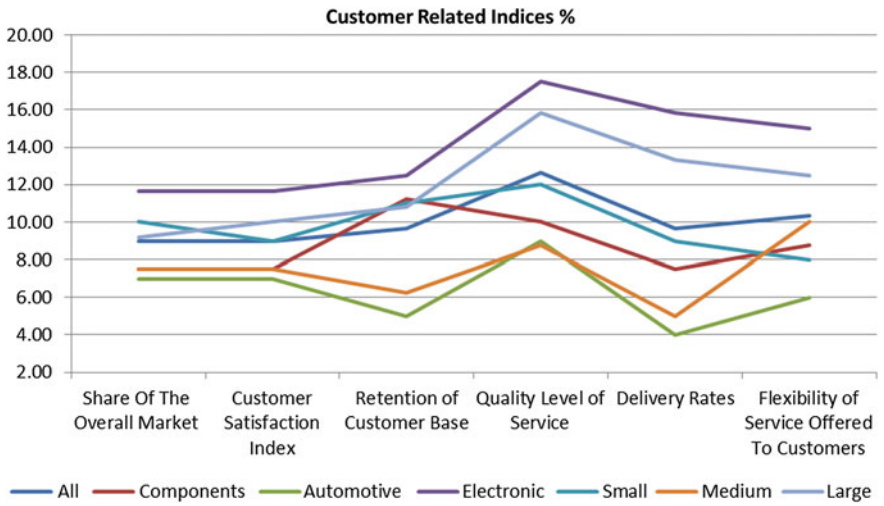

Fig. 10.8 Impact of Lean upon the customer-based indices

- **Customer-related indices** (Fig. 10.8)
  - The electronics organisations once again performed better than the automotive or components organisations;
  - Large organisations performed better than small- or medium-sized companies;
  - "Customer satisfaction" was the worst performing metric.

- **HRM-related indices** (Fig. 10.9)
  - The electronics organisations and components performed better than the automotive organisations;
  - Large and small organisations performed better than medium-sized companies;
  - "Training opportunities" were the best performing metric.

- **Projected potential-related indices** (Fig. 10.10)
  - The electronics organisations once again performed better than the automotive or components organisations;
  - Large and small organisations performed better than medium-sized companies;
  - "New technology development" was the best performing indice;
  - "Quality of strategic planning" and "planning for the future" were the worst performing indices.

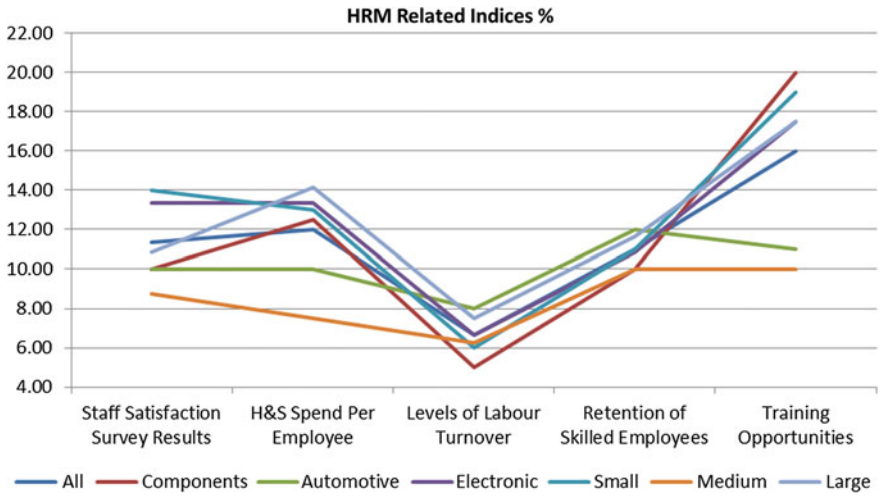

Fig. 10.9 Impact of Lean upon the HRM-based indices

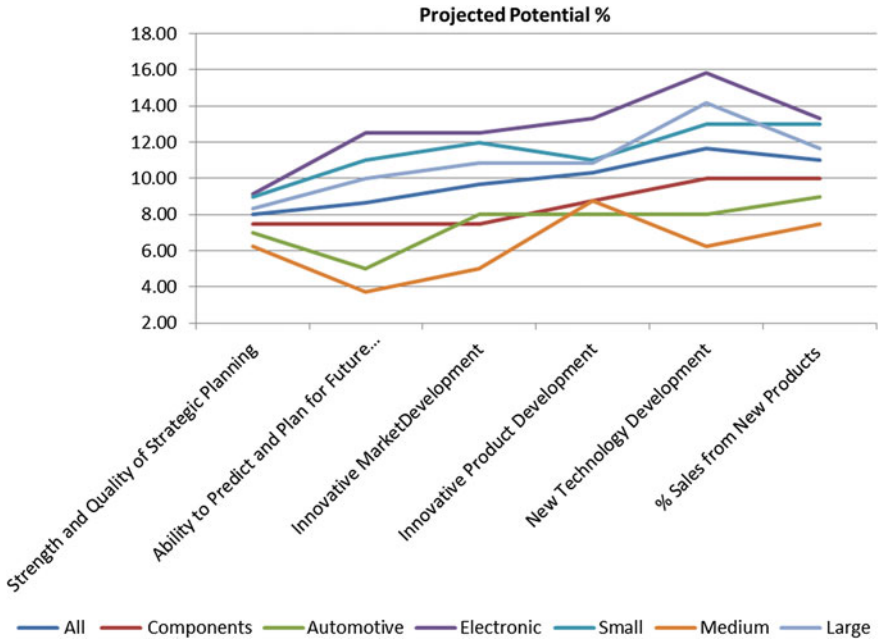

Fig. 10.10 Impact of Lean upon the potential-based indices

Summary

The chapter was a result of the fifteen case studies and surveys undertaken in organisations representative of small components, automotive, and electronics manufacturers. It has provided primary data on various aspects of Lean, namely the rationale for the adoption of Lean in the first instance and any hindrances encountered within the various sectors. It proceeded to analyse the aspirations from Lean which exist for the organisations and the Lean tools adopted within the sectors in order to determine any differences or trends. To complete the initial analysis, a cultural assessment was made of the prevailing Lean cultures of the respective sectors. It was vital that we also looked at the correlation and causal links between Lean and performance of the organisation. Interestingly, the electronics sector and larger organisations performed better than organisations representative of other sectors and organisations which could be classed as small or medium. The intention is to investigate this further in the next chapter through the application of various statistical techniques.

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Chapter 11
Empirical Evidence

Abstract The total number of companies involved in the survey questionnaire and case studies was $N = 15$, classified by size was small, $n = 5$; medium, $n = 4$; and large, $n = 6$ and type of sectors involved was components companies, $n = 4$; automotive companies, $n = 5$; and electronic companies, $n = 6$. The data were collected in the form of a survey questionnaires with a performance score card coupled with extensive case studies within each organisation in order to secure triangulation, validity, and credibility of the findings. The previous chapter has summarised the raw data which were collected through these methodologies. This chapter proceeds to apply statistical tools to enhance the analysis from the data which have been captured. Different types of companies were included in the analysis. The statistical comparison of the companies' data was analysed by using the software SPSS version 19.0 for Windows, with parametrical and nonparametrical tests where appropriate.

Chi-square analysis from survey factors ($p \leq 0.05$) indicated large organisations showed lower impact of *lack of finances* than small or medium companies as possible obstacles to adopt or widen the Lean remit; large organisations showed higher impact of application of Lean throughout the value chain including an attempt to involve suppliers than small or medium companies within the culture remit. Large organisations showed higher impact of application of Lean throughout the internal organisation than small or medium companies within the culture remit; small and medium organisations showed a higher impact of application of Lean in some parts of the organisation than large companies within the culture remit; electronic equipment companies showed higher levels of impact regarding the organisation being a better place to work as a result of Lean than components or automotive companies within the remit of prevailing culture.

Nonparametric analysis ($p \leq 0.05$) found that large companies revealed they had been engaged with Lean for longer. Discriminant analysis found great discriminatory ability of the survey factors ($p < 0.0001$) that should be considered as good predictors of the model, highlighting the following as best predictors:

- Flexibility of service offered to customers;
- Stock turnover, time to market for new products;

S. Bhasin, *Lean Management Beyond Manufacturing*,
DOI 10.1007/978-3-319-17410-5_11

- Profit, overall material costs;
- Raw material inventory; and
- Average for finance.

Costs of quality were also part of the discriminant function. Average of overall performance was 10.7 % ($N = 15$) but a mere 5.5 % when the best 5 performing companies were not included ($n = 10$). The best 5 performing companies according to performance indicators from the score card were given as follows: company 4 (average score = 15.6 %), company 5 (average score = 16.4 %), company 13 (average score = 15.9 %), company 14 (average score = 15.5 %), and company 15 (average score = 15.8 %). Three of these companies (numbers 4, 13, and 14) were large and belonged to the electronic sector, and one company (number 5) was also from the electronic sector, but was of medium size. Company number 15 was a small company from the components sector.

Descriptives

The following tables depict mean, standard deviation, median, range of scores, and maximum and minimum of each performance indicator (the standard deviation is a measure of dispersion around the mean, and the large figures on the standard deviation suggest the distribution is not homogeneous or uniform and therefore nonparametric analysis is recommended).

This was undertaken for all fifteen companies; small, medium, and large companies, alongside electronics, automotive, and component manufacturers which were also considered separately. However, Tables 11.1 and 11.2 reflect the performance indicators for all the companies and the smaller sized organisations only as an example of the analysis.

Correlational Analysis

Correlations measure how variables or rank orders are related. Spearman's Rho is the nonparametric option to the Pearson's correlation as a measure of association between rank orders. Only correlations $>|0.600|$ (absolute value) were considered to be statistically significant, which means the performance indicators and the questionnaire sections have a good association as shown in Table 11.3. In plain words, if the value of the correlation is high and positive, the greater the score in one of the factors considered, the greater the relationship with the other factor considered.

The figure above the correlation, i.e. Sig 2-tailed, means that 2 tails were considered (from the normal curve) and the significance should be no less than 0.05. When overall companies were considered, the number of years engaged with Lean showed not to be correlated to any of the performance indicators. Neither

Table 11.1 Descriptive statistics—overall companies

Performance indicators	Mean	Median	Std. deviation	Range	Minimum	Maximum
Profit	10.33	10.00	6.114	15	5	20
Asset utilisation	12.00	15.00	5.278	15	5	20
Stock turnover	12.67	10.00	4.952	15	5	20
ROCE	11.33	10.00	6.114	20	0	20
Current ratio	11.33	10.00	6.673	15	5	20
Lead time for new products	8.33	10.00	2.440	5	5	10
Overall material costs	8.67	10.00	4.419	20	0	20
Raw material inventory	10.67	10.00	3.716	10	5	15
Overall cycle time	12.33	10.00	6.779	15	5	20
Time to market for new products	12.33	10.00	6.510	15	5	20
Defect levels	12.00	15.00	3.684	10	5	15
Costs of quality	9.33	10.00	1.759	5	5	10
Production flexibility	14.67	15.00	2.289	10	10	20
General manufacturing costs	10.33	10.00	3.994	15	5	20
Overall labour productivity	9.33	10.00	4.577	10	5	15
Inventory levels	11.67	10.00	3.086	10	5	15
Share of the overall market	9.00	10.00	4.706	15	5	20
Customer satisfaction index	9.00	5.00	6.036	15	0	15
Retention of customer base	9.67	5.00	7.188	20	0	20
Quality level of service	12.67	5.00	9.232	20	5	25
Delivery rates	9.67	5.00	10.431	25	0	25
Flexibility of service offered to customers	10.33	5.00	7.432	20	5	25
Staff satisfaction survey results	11.33	15.00	5.815	15	5	20
H&S spend per employee	12.00	15.00	7.020	15	5	20
The levels of labour turnover	6.67	5.00	3.086	10	5	15

(continued)

Table 11.1 (continued)

Performance indicators	Mean	Median	Std. deviation	Range	Minimum	Maximum
Retention of skilled employees	11.00	10.00	3.381	10	5	15
Training opportunities	16.00	10.00	9.856	25	5	30
Strength and quality of strategic planning	8.00	10.00	2.535	5	5	10
Ability to predict and plan for future changes	8.67	10.00	6.935	15	0	15
Innovative market development	9.67	15.00	6.935	15	0	15
Innovative product development	10.33	10.00	5.164	15	5	20
New technology development	11.67	15.00	7.715	20	0	20
Percentage of sales from new products	11.00	15.00	5.071	10	5	15

correlated was the percentage of departments operating under the Lean principles or percentage of employees operating under Lean.

- Large companies

Differences between small and large companies were found: high correlations between higher numbers of performance indicators than for small companies were observed ($p \leq 0.05$). Likewise, the correlations for large companies were positive; for example, the high and positive value between strength and quality of strategic planning and innovative market development indicates that the higher the percentage of quality of planning, the greater the innovative market development ($r = 0.836$; $p = 0.038$), product development ($r = 0.826$; $p = 0.043$), and new technology development ($r = 0.836$; $p = 0.038$).

- Components companies

None of the correlations for medium companies were deemed significant, most likely due to the small sample companies to perform the analysis.

- Automotive companies

High and positive correlations between high numbers of performance indicators were found ($p \leq 0.05$); for example, unlike electronic companies, the high and positive value between delivery rate and staff satisfaction survey results ($r = 0.968$; $p = 0.007$) indicates that the higher the percentage change on delivery rate, the higher the staff satisfaction.

Table 11.2 Descriptive statistics—small companies

Performance indicators	Mean	Median	Std. deviation	Range	Minimum	Maximum
Profit	9.00	10.00	4.183	10	5	15
Asset utilisation	13.00	15.00	5.701	15	5	20
Stock turnover	10.00	10.00	3.536	10	5	15
ROCE	8.00	10.00	5.701	15	0	15
Current ratio	11.00	10.00	5.477	15	5	20
Lead time for new products	7.00	5.00	2.739	5	5	10
Overall material costs	5.00	5.00	3.536	10	0	10
Raw material inventory	10.00	10.00	5.000	10	5	15
Overall cycle time	11.00	10.00	5.477	15	5	20
Time to market for new products	9.00	10.00	4.183	10	5	15
Defect levels	10.00	10.00	3.536	10	5	15
Costs of quality	8.00	10.00	2.739	5	5	10
Production flexibility	14.00	15.00	2.236	5	10	15
General manufacturing costs	8.00	5.00	4.472	10	5	15
Overall labour productivity	6.00	5.00	2.236	5	5	10
Inventory levels	12.00	15.00	4.472	10	5	15
Share of the overall market	10.00	10.00	3.536	10	5	15
Customer satisfaction index	9.00	5.00	5.477	10	5	15
Retention of customer base	11.00	10.00	6.519	15	5	20
Quality level of service	12.00	5.00	9.747	20	5	25
Delivery rates	9.00	5.00	9.618	25	0	25
Flexibility of service offered to customers	8.00	5.00	6.708	15	5	20
Staff satisfaction survey results	14.00	15.00	5.477	15	5	20
H&S spend per employee	13.00	15.00	7.583	15	5	20
The levels of labour turnover	6.00	5.00	2.236	5	5	10

(continued)

Table 11.2 (continued)

Performance indicators	Mean	Median	Std. deviation	Range	Minimum	Maximum
Retention of skilled employees	11.00	10.00	4.183	10	5	15
Training opportunities	19.00	20.00	11.402	25	5	30
Strength and quality of strategic planning	9.00	10.00	2.236	5	5	10
Ability to predict and plan for future changes	11.00	15.00	6.519	15	0	15
Innovative market development	12.00	15.00	6.708	15	0	15
Innovative product development	11.00	10.00	4.183	10	5	15
New technology development	13.00	15.00	5.701	15	5	20
Percentage of sales from new products	13.00	15.00	4.472	10	5	15

Table 11.3 Correlational analysis

		Average for finance	Average for procedures and processes	Average for customer-related indices	Average HRM-related indices
Average for procedures and processes	Correlation coefficient	0.890			
	Sig. (2-tailed)	0.018			
	N	6			
Average for customer-related indices	Correlation coefficient	0.953	0.864		
	Sig. (2-tailed)	0.003	0.027		
	N	6	6		
Average HRM-related indices	Correlation coefficient	0.826	0.591	0.864	
	Sig. (2-tailed)	0.043	0.217	0.027	
	N	6	6	6	
Average for projected potential	Correlation coefficient	0.984	0.875	0.938	0.813
	Sig. (2-tailed)	0.000	0.022	0.006	0.049
	N	6	6	6	6

- Electronic companies

High and positive correlations between high numbers of performance indicators were found ($p \leq 0.05$); for example, the high and positive value between training opportunities and stock turnover ($r = 0.853$; $p = 0.031$), and ROCE indicator ($r = 0.826$; $p = 0.043$) indicates that the higher the stock turnover or ROCE percentage change, the higher the training opportunities for staff. This statistically significant result was not present for automotive companies.

Chi-Square Analysis

Chi-square is a statistical hypothesis test in which the test statistic has a chi-square distribution when the null hypothesis is true, or any in which the probability distribution of the test statistic (assuming the null hypothesis is true) can be made to approximate a chi-square distribution as closely as desired by making the sample size large enough. "Chi-square test" is often abbreviated for the Pearson's chi-square test. The chi-square test procedure tabulates a variable into categories and computes a chi-square statistic. This goodness-of-fit test compares the observed and expected frequencies in each category to test either that all categories contain the same proportion of values or that each category contains a user-specified proportion of values. It is useful because, under reasonable assumptions, easily calculated quantities can be proven to have distributions that approximate to the chi-square distribution if the null hypothesis is true. The following significant results were found:

- Large organisations showed lower impact of *lack of finances* than small or medium companies as obstacle to adopt or widen the Lean remit (See analysis below).

We can use this to clarify what the chi-square analysis means in practice. The chi-square test significance is the one we look for, if it is less than or equal to 0.05, it means the result is significant, and therefore, the three groups are different in the factor we are analysing, as reflected in Table 11.4. The chi-square has a value and "df" is the degrees of freedom used to obtain the observed significant level. "Asymp. Sig" is the significance level based on the asymptotic distribution of the test.

Table 11.4 Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson chi-square	13.429[a]	6	0.037
Likelihood ratio	17.991	6	0.006
Linear-by-linear association	0.287	1	0.592
N of valid cases	15		

[a]12 cells (100.0 %) have expected count less than 5. The minimum expected count is 0.27

The likelihood ratio test is a statistical test to facilitate the decision to be made between two hypotheses based on the value of this ratio. In practice, we only need to see whether p is ≤ 0.05 which means the result is still significant. Lack of finances as obstacles to Lean was not equally distributed for all companies by size; large organisations showed lower relevance of *lack of finances* than small or medium companies as obstacle to adopt or widen the Lean remit, χ^2 (6, $N = 15$) = 13.43, $p = 0.037$. Kendall rank correlation coefficient, also referred to as Kendall's tau (τ) coefficient, measures the association between two measured quantities. A tau test is a nonparametric hypothesis test for statistical dependence based on the tau coefficient. The Tau-b statistic used here, unlike Tau-a, makes adjustments for ties. Values of Tau-b range from −1 (100 % negative association) to +1 (100 % positive association). A value of zero indicates the absence of association. The denominator is the total number pair combinations, so the coefficient must be in the range $-1 \leq \tau \leq 1$. (If the agreement between the two rankings is perfect (i.e. the two rankings are the same), the coefficient has value 1; if the disagreement between the two rankings is perfect (i.e. one ranking is the reverse of the other), the coefficient has value −1):

- Large organisations showed higher impact of application of Lean throughout the value chain including an attempt to involve suppliers than small or medium companies within the culture remit (see Tables 11.5, 11.6, and 11.7 for analysis)

This factor was not equally distributed for all companies by size; large organisations showed higher impact of application of Lean throughout the value chain including an attempt to involve suppliers compared to small or medium companies within the culture remit, χ^2 (2, $N = 15$) = 8.18, $p = 0.017$. Positive association—or agreement—amongst the scores has been found by the phi coefficient.

The phi coefficient (also referred to as the "mean square contingency coefficient") is a measure of association for two binary variables. The square of the phi

Table 11.5 Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson chi-square	8.182[a]	2	0.017
Likelihood ratio	9.759	2	0.008
Linear-by-linear association	6.084	1	0.014
N of valid cases	15		

[a]6 cells (100.0 %) have expected count less than 5. The minimum expected count is 0.07

Table 11.6 Symmetric measures

		Value	Approx. Sig.
Nominal by nominal	Phi	0.739	0.017
N of valid cases		15	

Table 11.7 Throughout the value chain including an attempt to involve suppliers

Small/medium/large organisation	Mean	N	Std. deviation	Median	Minimum	Maximum	Range
Small organisation	0.00	5	0.000	0.00	0	0	0
Medium organisation	0.00	4	0.000	0.00	0	0	0
Large organisation	0.67	6	0.516	1.00	0	1	1
Total	0.27	15	0.458	0.00	0	1	1

coefficient is related to the chi-squared statistic for a 2 × 2 contingency table. The phi coefficient has a maximum value that is determined by the distribution of the two variables. For example, if both have a 50/50 split, values of phi will range from −1 to +1.

- Large organisations showed higher impact of application of Lean throughout the internal organisation than small or medium companies within the culture remit (see Tables 11.8, 11.9, and 11.10 for the analysis).

This factor was not equally distributed for all companies by size; large organisations showed higher impact of application of Lean throughout the internal

Table 11.8 Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson chi-square	8.403[a]	2	0.015
Likelihood ratio	10.285	2	0.006
Linear-by-linear association	7.526	1	0.006
N of valid cases	15		

[a]6 cells (100.0 %) have expected count less than 5. The minimum expected count is 1.60

Table 11.9 Symmetric measures

		Value	Approx. Sig.
Nominal by nominal	Phi	0.748	0.015
N of valid cases		15	

Table 11.10 Throughout the internal organisation

Small/medium/large organisation	Mean	N	Std. deviation	Median	Minimum	Maximum	Range
Small organisation	0.00	5	0.000	0.00	0	0	0
Medium organisation	0.25	4	0.500	0.00	0	1	1
Large organisation	0.83	6	0.408	1.00	0	1	1
Total	0.40	15	0.507	0.00	0	1	1

organisation than small or medium companies within the culture remit, χ^2 (2, N = 15) = 8.40, p = 0.015. Positive association—or agreement—amongst the scores has been found by the phi coefficient.

Additional analysis revealed using similar methodology identified:

- Small and medium organisations showed higher impact of application of Lean in some parts of the organisation than large companies within the culture remit.

This factor was not equally distributed for all companies by size; large organisations showed higher impact of application of Lean throughout the internal organisation than small or medium companies within the culture remit, χ^2 (2, N = 15) = 8.40, p = 0.015.

- Electronic equipment companies showed higher levels of impact regarding the organisation being a better place to work as a result of Lean than components or automotive companies within the remit of prevailing culture.

This factor was not equally distributed for all companies by sector; electronic equipment companies showed higher scoring regarding the organisation being a better place to work as a result of Lean than components or automotive companies within the remit of prevailing culture, χ^2 (4, N = 15) = 9.58, p = 0.048.

- Electronic equipment companies showed higher percentage change on stock turnover than components or automotive companies.

This performance indicator was not equally distributed for all companies by size; electronic equipment companies showed higher percentage change on stock turnover than components or automotive companies within the remit of finance indices, χ^2 (6, N = 15) = 13.61, p = 0.034.

Nonparametric Analysis

In order to identify the differences between the types of companies based on the percentage change of the performance indicators, nonparametric independent samples Kruskal–Wallis tests were carried out and medians were compared across (a) small, medium, and large companies; (b) components, automotive, and electronic companies. Due to the small sample available, nonparametric tests were used as they do not assume the data follow the normal distribution, as it is the case here. The analysis was customised; customise analysis allows fine-grained control over the tests performed and their options.

- Overall number of years

The distribution of number of years engaged with Lean showed to be different across companies of different size; for small companies, the median number of years was 5.00 %; medium was 9.50 % and large was 16.00 %. Therefore, large

Table 11.11 Standardised canonical discriminant function coefficients

	Function
	1
Profit	1.216
Costs of quality	0.699
Flexibility of service offered to customers	0.963

companies showed they had been engaged with Lean for longer than small or medium size companies ($p = 0.005$).

- Analysis by company sector

Only the distribution of average for finance showed to be different across companies of different sector; for components companies, the median change was 9.50 %; automotive was 7.00 %; and electronic equipment was 18.5 %. Therefore, electronic equipment companies showed that they reached higher percentage of change on this performance indicator than components or automotive companies ($p = 0.035$).

- Profits,
- Costs of quality, and
- Flexibility of service offered to customers

showed to be important in predicting good levels of performance. Table 11.11 summarises this information since the discriminant function for our model would be as follows (where different indicators have different weights on the equation).

Di = −12.923 + 0.483 profit + 0.399 costs of quality + 0.408 Flexibility of service to customers

Summary

The research demonstrated that Lean facilitates competitiveness by developing overall performance. Nonetheless, Lean needs to be seen as a dynamic phenomenon since it is developing constantly. Lean is a long-term commitment and the more that the organisations embrace it, the better their performance levels. It is a package which transcends beyond the technical tools alone and needs to look at the supporting infrastructure including the prevailing culture. The better performers demonstrated a need to look at Lean throughout the value chain and a need to embrace customers and suppliers. To become Lean requires a concerted effort though most organisations reap business benefits from this initiative. The analysis revealed that large organisations are performing better; interestingly, it assisted to highlight the key ingredients required for Lean to operate effectively.

Chapter 12
Lean Sustainability Audit

Abstract This chapter has naturally evolved as a result of the previous research the author has undertaken and as a direct consequence of feedback from clients that it was necessary to be able to decipher the journey an organisation encounters in its quest to become a truly Lean organisation. This formed a vital output of my cumulative research, since I considered it imperative to be able to clearly identify which stage of the Lean journey that an organisation had accomplished; inherent in this is the need to be able to subsequently advise the policy makers of the organisation in question regarding their next course of action. Undeniably, there does exist extensive body of knowledge which attempts to undertake this role, namely measuring the "leanness" state of an organisation; however, there is a definite void of a comprehensive Lean audit which proceeds to undertake several associated roles, namely:

- Determine which stage the organisation has reached on its Lean journey in comparison with achieving a state whereby the organisation has adopted Lean as a philosophy;
- Provide an organisation with detailed and constructive feedback regarding areas which need improving;
- Specifically recommend the course of action needed for it to achieve the next stage of its Lean journey;
- The scrupulous audit which examines all the inputs which need to be considered by an organisation in its quest to achieve Lean status; and
- The indices were determined after considerable research which also considered the potential barriers to Lean and consequently the appropriate prominence paid to culture and change management systems adopted by organisations.

The chapter ultimately highlights the extensive Lean audit which evolved as a direct result of experience of consulting within disparate manufacturing organisations and subsequently piloted within several organisations achieving the desired results. In accepting the proposition that Lean must always be deemed as a journey, it is essential to be able to classify the expedition an organisation is required to accept in its pursuit to be regarded as an authentic Lean organisation.

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Concept of the Lean Audit

On the whole, it has been through my links with many dissimilar organisations both as a consultant and as a researcher whereby a definite requirement for an extensive Lean audit became evident. Often, senior policy makers of organisations have requested feedback upon their Lean initiatives, and I have felt that a tangible, credible, and visible audit would assist to provide the sought after reaction. I have been in numerous organisations which have tried to embrace the concept of Lean as an ideology. They have often tried to utilise the proposals documented by both:

- Henderson and Larco (2003) and
- Kobayashi (1996).

However, without failure upon a closer scrutiny, I have found them to be deficient and not instructing the organisation suitably. Furthermore, an extensive search of the literature has already acknowledged the necessity for an explicit audit since the frameworks acknowledged assist to ascertain the state of a Lean implementation, though two particular deficiencies have been identified:

- The existing audits did not entirely scrutinise the accurate state of Lean as evidently there exists a heavy reliance on the operational aspects of Lean within most of the audits. Consequently, the sustainability and ideological facets relating to Lean were largely ignored; and
- The distinct correlation of the audit results to an organisation's position on its Lean journey was not clearly recognised.

The investigation undertaken for the book and past experience do proceed to dictate the numerous ingredients necessary for Lean to both be initiated and ultimately sustained within an organisation. The various ingredients necessary should an organisation hope to succeed at implementing Lean and numerous others include the following:

- Suitable rationale for the adoption of Lean in the first instance,
- The procedures and instruments to challenge the barriers to Lean,
- The overall procedures to track the results of Lean and feedback mechanisms,
- The overall company's aspirations from its Lean journey,
- Extent of Lean adoption within the organisation,
- The breadth and depth of tools adopted,
- The cultural factors evident and the need to
- Measure the impact of Lean using various performance indices, and
- The need to adopt the ideology of Lean and integrate it into the organisation's mission.

With this in mind, it was considered necessary to be able to establish how these factors were measured.

Review of the Prevalent Lean Assessment Tools

There are no real "best" or "perfect" studies or methods. The general critique of the literature recognises that each assessment tool or method focuses upon a different side of Lean operations but rarely on the complete picture. Whilst some focus upon the perceptions of employees using a qualitative approach (Goodson 2002; Shah and Ward 2007), others utilise various performance metrics creating a quantitative assessment though what is required is a qualitative and quantitative approach being applied simultaneously. This assists to provide an overview of an organisation's leanness efforts. Frequently, the literature inaccurately proposes that the Lean measures are synonymous to an audit assessment of Lean as initially suggested by Schonberger (1987). In a similar fashion, the QCDMMS measures identified by Bicheno and Holweg (2009) whilst facilitating the overall continuous improvement journey do generally lack the adaptability of evaluating the standing of an organisation's complete Lean journey. Likewise, Goldratt (1990) profoundly emphases upon an organisation's supply chain alone.

The DTI 7 measures (2014) proceed to offer a wider perspective to many of the previous offerings and can be employed to advance production performance throughout manufacturing. Nonetheless, they along with Goodman (2002) and Shah and Ward (2007) undeniably fail to recognise the impact of change management, culture and a need to embrace Lean as an ideology on an organisation's quest to implement the Lean philosophy. In a similar fashion, Schonberger (1996), Kobayashi (1996), Goodman (2002), Mann (2005), Henderson and Larco (2003) and Lee (2008) do strive towards attempting to integrate Lean beyond the manufacturing sections of an organisation and endeavour to contemplate suppliers (Lee 2008) marketing and promotion (Goodman 2002); nonetheless, they are still profoundly attentive on performance and neglect to understand the necessity to view Lean as an way of life as steered by Toyota. Schonberger (1996) had already not fully appreciated the true extent of the impact that an organisation's employees have upon that company's Lean journey.

Kobayashi's (1996) "20 keys" deliberate on conveying together 20 of the world's best manufacturing improvement approaches; the overall intention is to assimilate them into a vibrant arrangement whereby permitting organisations to acclimatise to a continuously changing economic and competitive environment. Whilst Kobayashi (1996) endeavours to incorporate the significance of particular workplace practices such as teamwork and empowerment, it is considered that the indices reflecting upon the impact of and on the people are largely disregarded. The EFQM Excellence model (Graben 2006) is the most widely used organisational management framework in Europe, and it is suggested to be used by at least 30,000 organisations across more than 25 European countries; this is being widely applied outside European countries too and has become accepted within the Middle East and South America (WWW.bpic 2009). In areas where it is utilised as an assessment, it provides an indication of how the organisation is performing in comparison with other companies which may or may not be similar kinds of organisation. The model can be used as a business-wide

framework in a all-inclusive, focused, and concrete fashion. The greatest influence of the excellence model is appreciated from the linkages between the results and enablers which proceed to provide an indication of the potential areas for improvement. These linkages may be discovered at two distinct 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 support a methodical sequence and assist to identify which areas of the chain may be fragile which inform the company of the areas and particular indicators for improvement. The model has many subsidiary advantages besides from those resulting from the self-assessment. The EFQM can be considered as a monitor to the introduction of a TQM initiative since the model combines the ideologies or essential concepts of TQM in perfect and concise language. WWW.bpic. (2009) has come under some scrutiny; Bou-Lluser et al. (2005) state that the empirical research on the causal relationships within the model are still limited since the model is largely grounded 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 detailed enough for Lean.

Goodson's Rapid Plant Assessment (RPA) guidelines and overall process permit a team to determine a factory's leanness precisely solely from visual indicators and discussions with employees. At the core of the RPA process, there exist two key assessment tool, namely:

- the rating sheet and
- the questionnaire.

The rating sheet includes eleven categories including safety, scheduling, inventory, teamwork, and supply chain which assist to establish a plant's leanness. The questionnaire features a set of twenty "yes" or "no" questions which focus upon the underlying behaviours contained within the categories. The assessment tool is intended at valuable benchmarking and assessment of supplier plants; proceeding a plant tour, the team can make an assessment using the Goodman methodology. The prominent benefit of this tool is that in total, eleven categories are employed. Each category is rated from "poor" to "best in class". The categories appraise customer satisfaction, safety, and H&S issues. Furthermore, HR is taken into account and since certain indices evaluate teamwork and motivation. In addition, supply chain integration is also acknowledged precious of an exploration. Finally, in general, the model is effortless to learn, can be quickly applied, and can create results within a day. However, there are several limitations associated with Goodson's RPA; on the whole, it fails to recognise Lean as a never-ending journey. Furthermore, Lean is not observed as an ideology which accordingly means that the sustainability indices are not awarded adequate consideration. In addition, the change process necessary for Lean is not directly scrutinised by this model; there is a limited reference made to the concept of recognition of employees and possible workforce involvement. Lastly, it is considered that the indices are reviewed in isolation with very scarce verification examining the existent relationships between the categories.

Schonberger (1996) commonly could be regarded to be a concise channel to Leaner operations. This aspect is reinforced by the fact that whilst focusing at customers, workforce involvement, training, and marketing, it proceeds to appraise the general concept of waste including variation and the root cause principles. The possible influence of performance measurement is examined to an extent, and generally, the indices can assist an organisation to become further demand led and facilitate a greater level of organisation by customer groups. Likewise, the model allows comparisons to be made with other organisations; this can assist a benchmarking exercise. However, there are present certain concerns with Schonberger's model too. It commonly fails to encapsulate that Lean must always be regarded as a never-ending journey. Similarly, the whole ideology of Lean is not fully embraced and not assesses. The sustainability indices are not paid sufficient emphasis; moreover, the change process is not openly investigated although some reference is directed towards a need to recognise employees and workforce involvement.

Kobayashi (1996) acquired impetus both as a manufacturing and implementation channel to Lean. As a result of its subsequent analysis, it is feasible to make comparisons with other organisations; this also assists to establish benchmarking exercises to be embarked on. A five-point scale is offered for each key by means of initiating a self-assessment exercise to be carried out; the categories span between a level 1 "beginner" to level 5 "ideal". In addition to integrating good links with other keys, the assessment promotes the need to achieve in one area, which permits the organisation to excel in most of the remaining keys. In addition, the model appropriately considers waste, 5S, team working, continuous improvement, and cross-functional working and looks at supplier relations too. Conversely, Kobayashi's model (1996) exhibits several imperfections too. It inspects the processes and operations, but does not examine in vigour into the role of Lean and the change process. The whole idea of sustainability and culture is awarded insufficient emphasis which accordingly results in the matter of culture and the requirement to treat Lean as an ideology being abandoned on the whole. Likewise, there is a profound focus devoted towards the shop floor; as a result, the need to recognise that Lean should enable the organisation to achieve encouraging business results is by and large ignored too.

Goodson's (2002) and Shah and Ward's (2007) Lean assessments are totally devoid of the obligatory organisational development needs if an organisation is to flourish at Lean. Similarly, Mann (2005), Henderson and Larco (2003), Lee (2008) and Shah and Ward (2007) do not fully appreciate the full influence of culture on the success of Lean. Lee (2008) suitably concentrates on the nine key areas of manufacturing comprehensively. Nonetheless, he proceeds to appraise the nature of teamwork within any organisation and proposes a need to build long-lasting and successful associations with suppliers. On the other hand, the importance of sustainability, the change process and culture are not totally acknowledged through the indices utilised. This results in the fact that the need to treat Lean as a philosophy is not entirely appreciated. Furthermore, Lee's audit (2008) does not recognise the need to treat Lean as a business ideology neither.

Henderson and Larco (2003) correctly observe in depth the procedures and the function Six Sigma plays in a Lean implementation. Correspondingly, the audit focuses upon teamwork and change management through the "continuous pursuit of perfection" (p. 279) indices. Nonetheless, Henderson and Larco (2003) do not scrutinise in ample depth the part sustainability and culture play in a triumphant Lean implementation; consequently, the need to treat Lean as a philosophy is not followed within the exploration. A critical constituent also absent within the audit is the need to measure whether an organisation's Lean endeavours have resulted in an enhanced business performance. Whilst virtually all Lean failure (Parks 2002; Mann 2005) can be accredited to a different causes, underlying all of them are the deep-rooted issues of corporate culture and change management. Lee (2008) rightly selects quality as a category but then proceeds to opt for four questions whereby three have a heavy SPC focus, whilst the other seeks to establish the defect rates.

Shah and Ward (2007) primarily endeavour to elucidate the concept of Lean by developing and authenticating a multidimensional measure of Lean. The results are split into three sections:

- *what* is Lean (i.e. identify critical factors),
- *how* are the various features of Lean associated with each other, and
- *why* are they interrelated.

Commendably, they analyse ten factors regarded as representative of the operational requirements for Lean to flourish, i.e. supplier development, customer involvement, and the process categories. They emphasise that it is the harmonising and synergistic effects of the ten different but highly interconnected essentials that give Lean its exclusive disposition and its advanced ability to accomplish multiple performance goals. Shah and Ward (2007) accurately endorse that none of the individual components are comparable to the system, but together, they represent the system. Nonetheless, the assessment looks at process and operations, but does not appraise in adequate intensity the role of Lean change, sustainability, and culture should an organisation hope to secure the full benefits that Lean has to offer. Like many other models, the indices do not completely identify the requirement to determine the performance of Lean in order to interpret the accurate impact Lean has made to an organisation.

Mann's audit (2005) was a product of deductions he was able to make; essentially, he recognised that whilst the Lean tools were in place, the operators and team leaders did not instinctively appreciate how to manage the changes. According to Mann, the "Four Principal Elements of Lean Management" which are well documented within the audit are as follows:

(i) Leader standard work,
(ii) The visual controls,
(iii) The daily accountability process, and
(iv) Leadership discipline.

Mann's (2005) highlights the eight categories of process and behaviour defining the assessment with 5 levels, with 1 = "pre-implementation" to 5 = "sustainable

system". The audit provides a good method of self-assessment which appraises processes vigilantly and process development in considerable detail and strongly examines process improvement too. However, the unconstructive aspects of the audit whilst analysing the control and accountability process, there is a derisory emphasis placed upon performance measurement. Similarly, Lean is not viewed as an ongoing journey, and overall, the measures are too static and do not really promote development. Intrinsically, inadequate prominence is placed upon culture and change measurements within the audit.

The Shingo Prize (2014) is very adaptable and can be practically applied to all industries, public or private sector, profit or non-profit sectors, and individual sites, plants or entire businesses. Furthermore, the Shingo Prize criteria assist to diminish uncertainty, clarify objectives, and provide intensely useful advice to organisations that have selected to pursue this prize. Furthermore, the Shingo Prize criteria have been slightly changed after the criticism received for awarding a prize to Delphi which subsequently went bankrupt. Shingo Prize has developed from a manufacturing focus to one expanded to "operational excellence". Further categories were added for the public sector and research. Nonetheless, the Shingo Prize intrinsically possesses certain limitations also. The assessment procedure is exceptionally stretched and involves six stages. These procedures entail:

(i) The initial application an organisation makes for the Shingo Prize, 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-day lead time. The report must be written in the format that closely aligns it to the Shingo Prize model and can be up to 75 pages in length. Characteristically, a Lean mature organisation will take six months preparing their achievement report and could receive notice of their award status within another three months,
(iii) Reports with encouraging recommendations receive a site visit designated examiners; the time period for this can be between 30 and 60 days after the application notification,
(iv) Based on a site visit, recommendations are made to the "Executive Committee" for bronze and silver medallion or the Shingo Prize,
(v) Organisations are often informed of the decision, no later than 30 days after the site visit; official recognition occurs at the annual conference or regional conference; in certain circumstances and where appropriate, applicants receive written feedback, and
(vi) Companies requesting additional recognition at a local facility may request Shingo representative whereby travel expenses would need to be covered.

In addition, the costs involved with the application can be extreme; the application fee is £1400 for a small category and £3800 for a large category. The "Achievement Report" can cost between £7k and £12k for large organisation, £3k for medium, and £1k for small companies. The site visit can total to £7k–£12k for larger organisation. Clients are expected to attend a two workshop; the cost of

attending is nearly £1k per candidate. In addition, the decision is always final with no appeal; the awards are valid for five-year cycle whereby at this stage, the organisation must rechallenge for the prize.

Like any other awards, one feels it appropriate to pursue the prize though for the right reasons; the award should be viewed in a manner whereby the results are actioned upon from feedback received from customers and other stakeholders; executing tools for the rationale of achieving a prize is like cramming for an exam—one may achieve a high score but not excellence. The Kotani forging plant near Himeji, for instance as Miller (2008) suggests, would probably not score highly on the Shingo Prize criteria as there are no cells, no 5S, no kanbans, and no instruction sheets. Nonetheless, Kotani is a second tier supplier to Toyota with sales per employee twice the US average for forging shops and has managed to achieve its results by focusing on technology. In addition, Table 12.1 (Miller 2008) illustrates results of companies based on public reports. Whereas the Shingo Prize winners were 10 % more profitable, they lost market share and cut costs, whilst their competitors did the opposite.

Critics have been critical regarding the Shingo Prize; Graben (2006) 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 %. Justifiably, there are other factors involved in a company's performance which may not have been fully accommodated within the criteria.

Overall, any assessment should be able to understand the notion of quality and integrate this into an organisation's Lean journey. The criteria selected should be carefully considered which should enhance a company's overall effectiveness. The criteria utilised also need to gauge whether Lean is viewed as a journey, which consequently means that the initiative will be sustained. Any organisation needs to be creating value presently, but whether they will be doing similarly in five years' time is not readily considered in most of the assessments outlined. Lee (2008) and the WWW.bpic. (2009) neglect to maintain the notion of viewing Lean as an expedition. Equally, Mann (2005), Henderson and Larco (2003), Lee (2008), and Shah and Ward (2007) are also culpable of not recognising the significance of organisational development requirements of Lean, such as the:

- Organisation's prevailing culture,
- Lean pay systems,

Table 12.1 Performance in the market

	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

- Performance reward systems,
- Lean measurement systems,
- Impact on and of the workforce, and the
- Change management process.

Although reference was made of the DTI seven measures (2014) promoted by the *Industry Forum* of the *Society of Motor Manufacturers and Traders* (SMMT) beneath the umbrella of quality, cost, and delivery (Q, C, D), they are, nevertheless, proposed to support a structure for continuous improvement, raise potential levels of customer satisfaction whilst greatly improving the management of production. Undeniably, measuring QCD provides noteworthy benefits, namely:

- accuracy; these indices can emphasise the priorities for improvement in production management with lucidity and focus,
- minimalism since even an intricate manufacturing process can classify a straightforward direction towards performance improvements,
- Feedback, as the seven QCD indices can be utilised to compute the results of changes to the process. The outcome of a change can be compared with the status of the process prior to the change. QCD provides speedy feedback and quantifiable numeric comparisons,
- Benchmarking since QCD facilitates the basis for concrete comparison with benchmarked processes or the performance of a benchmark company. This then assists to illustrate processes which offer better methods and practices, and
- An invaluable gauge since the business survival is reliant on the profit generated from gratifying customers. QCD is a strong production tool which enables a computable impact on manufacturing efficiency; it assists to advance competitiveness, develop businesses, and increase profit.

Nonetheless, these indices are designed to provide a rational and inclusive analysis of production performance and proceed to offer the basis of continuous measurement and improvement but are not intended to be treated as a Lean audit. Likewise, Bicheno and Holweg's (2009) essential measures of Lean are given as follows:

- Lead time,
- Customer satisfaction,
- Schedule attainment, and
- Inventory turns.

Similarly, Goldratt's (1990) proposed measures for supply chain effectiveness:

- throughput dollar days and
- inventory dollar days coupled with

the QCDMMS, an acronym for a set of measures that many Lean organisations exhibit at each line or area (Henderson and Larco 2003):

- Quality,
- Cost,

- Delivery performance,
- Morale,
- Management, and
- Safety

are admirable measures to support efficiency but not intended to be used as an audit to measure Lean. Table 12.2 provides a summary by emphasising the most salient points of the Lean audits discussed and evaluated earlier.

Table 12.2 Analysis of the Lean audits

The comparative strengths and weaknesses of the important Lean audits		
The Lean audit	Strengths	Possible shortcomings
Eugene Goodson	• Easy to grasp; rapid application is possible and it facilitates results in a day or less • Focuses upon customer satisfaction, safety, and H&S issues • Also focuses upon HR, i.e. teamwork and motivation	• The sustainability indices are inadequately covered • Change procedures are very indirectly analysed although make reference to recognition of employees and workforce involvement • Indices are reviewed in seclusion with few interconnections explored between the categories
Shingo Prize (2014)	• Its flexibility and application are appealing as it can be applied to all sectors • The criteria assist to reduce confusion which assists to elucidate objectives, and • The criterion has changed to represent expectations	• Reasonably prolonged assessment process • The application outlay involved may dissuade some organisations • Substantial deliberation remains regarding its business value
EFQM Excellence model	• Regarding its assessment qualities; it can assist benchmark comparisons • The associations between the enablers and the results • Allows other benefits of self-assessment such as a guide to TQM	• Too generic as a framework and not specific towards Lean • The empirical evidence of the correlations is blurred • It does not specifically identify the stage of a Lean journey achieved
Schonberger's principles	• Analyses the role of performance measurement • The measures suggest that organisations become more demand led, to be organised by customer groups • Comparisons are possible with other organisations; accordingly, a benchmarking exercise is possible	• Unable to view Lean as a journey and subsequently does not view Lean as an philosophy • The sustainability indices are paid less emphasis • The change process lacks any concentration though it does make reference to the acknowledgement of employees and workforce involvement

(continued)

Table 12.2 (continued)

The comparative strengths and weaknesses of the important Lean audits		
The Lean audit	Strengths	Possible shortcomings
Kobayashi	• Judgments can be made with other companies; subsequently, a benchmarking exercise is feasible • Good associations with other keys; to achieve in one area, it is necessary for the company to stand out in most of the keys • Looks at waste, 5S, team working, continuous improvement, cross-functional working, and the supplier relations	• Analyses process and operations, but inadequately into the influence of change on Lean • Consequently, culture and the need to treat Lean as an ideology are not examined • Main concern—Lean should produce results—whole field not judged in any depth
Mann's audit	• Offers a firm and valuable system of self-assessment • Focuses at procedures connected with Lean carefully • Does concentrate at overall process improvement and kaizen ideology	• Whilst examines the control and accountability process—inadequate prominence on performance measurement • Not viewed as a journey with indices too immobile and not meant to sponsor improvement • Culture and change not paid sufficient prominence
Henderson	• Focuses at the overall processes and the role of Six Sigma • Also concentrates on teamwork and change management through the "continuous pursuit of perfection" indices • Broadens the concept of Lean away from the shop floor and looks at management styles too	• Sustainability and culture awarded inadequate emphasis • Accordingly, culture and the need to treat Lean as a philosophy are not promoted • Main concern—Lean should result in business results—whole area not awarded sufficient prominence
Lee	• Concentrates expansively at nine key areas of manufacturing • Does appraise the nature of teamwork within the organisation • Tries to analyse the requirement to build long-term and successful relationships with the suppliers	• Culture coupled with the prerequisite to treat Lean as an ideology is not explored • Prominent concern—Lean has to reap business results—whole area awarded insufficient attention • Change is also not awarded sufficient consideration
Shah and Ward	• Ten factors are scrutinised regarding the need to constitute the operational accompaniment • The matching and synergistic effects of the ten separate but highly interconnected essentials give Lean its unique character • A recognition that no component is equivalent to a system, but together, they constitute a total system	• Concentrates at process and operations, but unsatisfactorily into the change systems needed for Lean • Accordingly, culture and the necessity to treat Lean as a philosophy are not promoted • Major issue—Lean should facilitate business results, and this area is once again insufficiently tackled

(continued)

Table 12.2 (continued)

The comparative strengths and weaknesses of the important Lean audits		
The Lean audit	Strengths	Possible shortcomings
Pakdil and Moustafa Leonard (2013)	• Looked at qualitative and quantitative measures • Good underpinning process recommending way forward for organisations • In total, fifty-one evaluation items are used	• Looks at process and impact of people, not viewing Lean as a journey • Insufficient emphasis paid to Lean principles and culture, and • Interlinkages are not recognised and not explored in any depth

The Role of Lean Audits

An assessment should take place at regular intervals in order to explore the general status of an organisation's Lean position. In an extensive literature review, it was discovered that whilst there were nine books which made reference to Lean assessments, none included a particular chapter or materials enabling a quantitative assessment of managerial or organisational leanness to be made. In fact, it was only Mann (2005) who endeavoured to look at quantitative assessment of managerial or organisational leanness. This through the authors experience is particularly important at the early stages of Lean. Likewise, the questions should correspond to the values an organisation is striving towards. In many instances, within any Lean evaluation, an organisation may need to reiterate the values it aims to achieve; this is since Lean is dynamic in character. The appraisal should always inform an organisation of the progress it has made since the inception of Lean. This is vital to be able to promote the benefits securing further buy-in. Moreover, the outcomes of the appraisal should facilitate an organisation to focus its efforts towards areas requiring further energy. Research (Mann 2005) proposes that quarterly assessments are satisfactory. The assessments must not merely be regarded as a customer-based activity but embarked on frequent basis and embrace the ideas of time and speed as important components of Lean.

Similarly, when the appraisals are undertaken on a three-month cycle intervals, it is significant to keep them uncomplicated and devoid of bureaucracy. It is also important to contemplate the size of the organisation in question before commencing upon a habitual programme of assessment. Similarly, it is vital to persuade team leaders to carry out the appraisal. Preferably, a unit's appraisal score should be based on the assessment by the team leader of the next level in the organisation. However, when this becomes unfeasible, a mixed model of assessors should be considered in order to retain the credibility and validity. The senior management teams could be involved since this assists to sustain a common understanding of appraisals. Larger sub-units could be measured by a nucleus of managers from other areas supported by internal expertise. The amount of categories will be dependent on the intricacy of the operations and the company itself. Similarly, an assessment of different dimensions is essential since a single average may possibly not induce

suitable action. An appropriate proposal is a radar screen profile which should be utilised subsequently. When feasible to compare one unit over time, a "*consistency*" (Mann, p. 168) index may well be developed.

A Comprehensive Lean Assessment

The audit that is proposed attempts to determine the prevailing status of an organisation in question and then ensues to fit into the contemporary models. We should recognise the various opinions of Lean implementation which are as follows:

- Feld (2001) splits the Lean implementation journey into five segments; the Lean appraisal looks at the current state gap, the future state design, alongside the implementation and finally reiterates the need for continuous training,
- Harbour (2001) utilises the four stages, namely the organisational development, discipline construction, tool employment, and continuous improvement,
- Motley (2004) splits the Lean implementation journey into six stages; these are as follows: classify value from the final customer's perspective, classify the value stream, map current and future states, build up a product-focused organisation, introduce pull systems, and proceed to achieve the earlier steps of continuous repetition, and
- Drew et al. (2004) on the other hand scrutinise five phrases; the foundation stage, an appraisal of the current state, defining a desired future state, implementing a pilot, and finally the continuous improvement.

The Position of Lean Audits

Whilst a Lean audit may prove a challenging task, nonetheless when undertaken inappropriately, it can represent a substantial risk to an organisation. The organisations that benefit most are those which recognise the goals they anticipate to meet and ensuring that the audit measures the most appropriate aspects. 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 programme 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, p. 168) index should be developed.

Application of the Lean Audit

Significantly, all the ten categories with the complementary set of indices within each cluster were employed in the assessment. Having acted as a Lean champion and subsequently consulted and advised numerous organisations, the prominence of culture, change, and sustainability became apparent and naturally formed distinct areas to scrutinise in a Lean appraisal. During the compilation process, it transpired that indices relating to culture had a natural focus relating to either the organisation's processes as a whole or the employees as individuals. In this case, a 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 is 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 as follows:

(i) General visual management and organisation;
(ii) Manufacturing, general flow, and processes;
(iii) Quality planned within the product;

(iv) Continuous improvement;
(v) Change strategy;
(vi) Sustaining the Lean journey;
(vii) Culture regarding processes;
(viii) Culture regarding people;
(ix) Lean viewed as a commercial venture; and
(x) Lean ideology.

Experience suggests that certain aspects are not adequately covered in many audits and the literature reinforces this since often the sustainability, the respect for people, culture, and the need to embrace Lean as an ideology are often lacking which proves to be detrimental to an organisation. An important weakness of most existing studies is that particular performance indicators are employed using a very limited perspective. It is necessary to present a comprehensive model which examines all the primary aspects of Lean operations. Each performance dimension within the audit measures a unique part of the Lean implementation. Likewise, the association to the seven wastes and the audit should be obvious. This has been summarised in Table 12.3. Although the Lean concepts have a strong quantitative component, a qualitative perspective is needed. Perceptions are vital which cannot always be incorporated within quantitative methodologies. The proposed audit should be integrated into a comprehensive problem-solving methodology.

As identified previously that many organisations have tried to implement Lean, nonetheless, most attempts do not provide a true picture since organisations decide to implement parts of the Lean system. Similarly, Lean performance is not evaluated using a comprehensive measurement system or tool; often, managers feel that the analysis will cost too much.

Table 12.3 Links between the audit and the wastes

The audit dimensions	Links to the wastes
Manufacturing, general flow, and processes	Waiting time, possible delays
Quality planned within the product	Transportation of parts and materials, inventory-associated costs
Continuous improvement	Not make defective parts
Change strategy	Transportation of parts and materials
Sustaining the Lean journey	Overproduction
Culture regarding processes	Over-handling, possible delays
Culture regarding people	Over-motion, underutilised personnel
General visual management and organisation	Motion
Lean viewed as a commercial venture	Delivery, inventory-associated costs
Lean ideology	Possible delays, underutilised personnel

CI/Lean Assessment

Scoring system

A scoring system of 0–6 is to be used against each of the respective indices or metrics:

0 = no adherence or compliance to the listed criteria specified within the metric,
6 = complete adherence to the listed criteria outlined within the metric,

(As an aid to the scoring, the prevailing situation that should be in place is indicated under each criterion; this assists to score the organisation against the specified metric on a scale ranging between 0 and 6.)

General visual management and organisation	Score
Health and safety 0 = Wholly unsafe; many dangers can be identified; no observance of policies 6 = Entirely safe; no dangers and complete observance of polices	
Hygiene 0 = Completely cluttered with no systems implemented for cleaning 6 = Impeccably clean with a programme for all supporting areas	
Overall orderliness 0 = Haphazard and no systems for markings or to find any tools 6 = Just necessary items readily available; clear markings for tools	
Graphical appearance 0 = Totally avoided and no structures; no performance statistics evident 6 = Complete prominence; team performance stated in administration areas too	
Warehouse stocking 0 = No locations allocated; levels not specified nor optimum or minimum 6 = Fixed locations with strong minimum and maximum levels	
Shop floor stocking 0 = No locations allocated; levels not specified nor optimum or minimum levels 6 = FIFO adherence, static locations with kanban systems	
Pictorial indicators 0 = Never used or assisted to inform employees 6 = Constantly used	
Finished good inventory/total inventory 0 = 10 % worse than industry average 6 = 20 % better than industry average	
Total inventory/total sales 0 = 10 % worse than industry average 6 = 20 % better than industry average	
Score = /54	

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Manufacturing, general flow, and processes	Score
Continuous flow 0 = Poor or no flow systems with no established batch sizes 6 = Advanced flow and smaller batches	
Documentation of processes 0 = No processes are evident, and where they exist, they are totally unstandardised 6 = Processes are apparent and standard	
Pull systems 0 = No evidence that systems are built to meet customer demands 6 = Systems are built to meet customer demands	
Line flexibility 0 = Little or no line flexibility built in; slow changes 6 = Quick switches within acceptable TAKT time including batch changes	
Customer provision and forecasting 0 = The integration between forecasting and customer provision is totally unclear 6 = Complete integration; scheduling occurs at the lowest level	
Reaction to product mix alteration 0 = Any product mix changes pose considerable issues and disruption 6 = No issues caused	
Manufacturing stages controlled in work cells 0 = Little or no manufacturing stages are controlled in work cells 6 = Exceed 75 %	
Production process 0 = Anything but one-piece flow; no real structures 6 = Wholly one-piece flow	
Total productive maintenance 0 = TPM is not evident and no culture to promote this in place 6 = A meticulous process	
Time spent on unplanned or emergency repairs/total maintenance time 0 = Very high maintenance required on unexpected repairs >70 % 6 = Fewer than 10 %	
Average OEE of the production apparatus 0 = OEE generally less than 0.15 % (nature of product to be considered) 6 = Generally 0.85 or above	
Set-up time/total production time 0 = More than 20 % 6 = Less than 5 %	
Total downtime/total machine time 0 = More than 20 % 6 = Less than 5 %	
Score = /78	
Quality planned within the product	Score
5S is relentlessly undertaken 0 = 5s is virtually non-evident and no culture to promote 6 = Completely integrated	

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Equipment devices recognise defects 0 = The equipment devices not instilled to recognise defects 6 = Full stoppage when faults happen	
Permission to operatives to stop manufacture 0 = No authority for operatives to question quality or faults nor stop manufacture 6 = Complete authority is granted	
Mistake proofing to avert defects 0 = Mistake proofing nor evident; not promoted 6 = Total usage on all essential processes	
FIFO systems for stock 0 = No FIFO systems in place or any particular stock management system 6 = Complete observance	
Closed-loop quality problem-solving 0 = No closed-loop problem-solving; culture of "firefighting" 6 = All issues contain a detailed development plan	
Root cause problem-solving 0 = To systems or processes in place to examine or promote root cause analysis 6 = Routine methodological approach to root cause solutions	
Standardised working 0 = No standardised practices in place and no reviews evident or promoted 6 = Completely standardised with constant reviews	
Reception quality 0 = Supplier quality levels vary; no standards established 6 = Main suppliers are self-certified and maintained	
Visual organisation 0 = Little or no analysis undertaken to determine the root cause analysis 6 = Frequently analysed to decipher issues	
Percentage of manufacturing protected by SPC 0 = SPC virtually non-existent 6 = Exceeding 70 %	
Process of product engineering 0 = New designs taking twice the industry standard; still inherent issues identified 6 = Combined effort for new designs taking less than six months	
Regimented obedience to process 0 = No reviews of manufacturing and connected processes; no structures 6 = Pareto driven with regular reviews of manufacture and connected processes	
Defect rates 0 = More than 10 % 6 = Less than 2 % with downward trend	
Total scrap £/total sales 0 = More than 10 % 6 = Less than 2 % with a downward trend	
Score = /90	

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Continuous improvement	Score
Practice of change functioning 0 = Virtually non-existent change systems in place; disjointed 6 = Organisational-wide response	
Change implementation 0 = No one leading the change necessary; no real plans and systems in place 6 = Delegated responsibility to implement change	
Effect of change is gauged 0 = Communication systems are very poor; mixed messages constantly forwarded 6 = Clear and lucid communications and considered impartially	
Operators and administration staff have recurring meetings 0 = Silos apparent between admin and operators 6 = Absolutely no issues	
Continuous improvement team 0 = CI teamworks in isolation; no attempts to cascade responsibility 6 = Many involved within recognised rules with scientific results	
Process improvement 0 = No structures are evident looking at process improvement 6 = First-line leaders responsibility	
Culture of waste 0 = No real recognition of waste; no commitment or promotion for its eradication 6 = Complete commitment	
Tracking the results of the Lean initiative 0 = No real evidence of tracking the results of Lean; haphazard 6 = Weekly meetings	
Use of innovative equipment 0 = little or very isolated evidence of innovative equipment; culture of distrust 6 = Incorporated solutions with company-wide performance measurements	
Total cost of poor quality/total costs 0 = More than 10 % 6 = Less than 2 %	
Total prevention costs/total sales 0 = More than 15 % 6 = Less than 5 %	
Score = /66	
Change strategy	Score
Senior management support 0 = No evidence of SMT support or direction 6 = Absolute support from senior managers	
Existing cultural considerations 0 = No recognition of the impact culture has on Lean 6 = Extensive effort to change behaviour	
Evident Lean champion 0 = Not clear who is leading the Lean initiative 6 = Visibly communicated	

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Culture linked to the company's performance 0 = Role of culture to company's performance is vague and unclear 6 = Overall recognition of the relationship	
Reliable vision is needed 0 = No tangible vision nor mention of Lean in this respect 6 = Lean forms part of the vision	
Widening the Lean remit 0 = No efforts to widen the remit of Lean or its breadth 6 = Genuine audit trail	
Future state mapping occurring 0 = Considered that the Lean journey will occur by chance; no structures 6 = Methodical Lean journey apparent	
Sensei and other professionals utilised 0 = No efforts in place to widen the Lean empowerment or sensei established 6 = Journey towards internalising the process	
Lean and compensation linkages established 0 = No efforts made to recognise linkages between Lean and compensation 6 = Complete endeavours to recognise the association	
Encouragement of a positive culture 0 = Little or no attention paid to culture 6 = Amalgamating culture and strategy; Lean is a journey	
Culture promoting greater stability 0 = No efforts made to explore efforts for stabilisation 6 = Endeavours made to exploit stability	
Subcultures acknowledged 0 = Evidence of subculture not aligned to Lean; no efforts to address this issue 6 = Laborious efforts to ensure that the vision and efforts remain	
Total percentage of managers/total employees 0 = 10 % worse than industry average 6 = 20 % better than industry average	
Score = /78	
Sustaining the Lean journey	Score
Lean tool application 0 = No considerations of using correct or a mixture of appropriate Lean tools 6 = Concurrent application of more than six opportune and appropriate tools	
Tool sustainability 0 = No considerations of persistent use of correct or cocktail of appropriate tools 6 = At least three-year concurrent application of six or more appropriate tools	
Tool application 0 = No strategy to apply tools suitably where required or across boundaries 6 = Entire value chain and incorporating supplier chain	
Lean sections 0 = Lean applied in one or two isolated areas with no direction or conviction 6 = Excess of 70 % of the cost centres are Lean	
Market development 0 = No concerted efforts to explore new markets 6 = New markets relentlessly pursued	

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Association of Lean with company's vision 0 = No associations of the Lean initiative with the mission or vision 6 = The Lean initiative is engrained on to the company's mission and vision	
Value streams promoted 0 = Heavy concentration upon one-product value stream 6 = An acknowledgement of viewing combinations of value streams	
Revenues from new products 0 = Less than 10 % of revenues accounted for from new product ranges 6 = Exceeding 50 %	
Customer retention rate 0 = 10 % worse than industry average 6 = 20 % better than industry average	
Score = /48	
Culture associated with the organisational practices	Score
Structured by customer families 0 = Not organised in alignment of customer families and no evidence 6 = The organisation is influenced through customer families	
Process focus culture 0 = No evidence of processes supporting customers 6 = Complete possession of people realising how customers are supported	
Organisation structures 0 = Little or no integration between the organisational structures 6 = Complete integration	
General self-dependence 0 = Little evidence of control; likewise with suppliers 6 **=** Complete control whilst company preserves internal potential	
Purchasing methodology 0 = Kanban systems not followed in reference to purchasing methodology 6 **=** Complete kanban oriented	
Early supplier involvement 0 = Supplier involvement is virtually non-existent 6 = Organisation culture promotes this	
Finance and administration sections 0 = Departments operate in silos with no recognition of Lean accounting systems 6 = Conducive accounting with metrics assisting operatives	
Organisation by customer families 0 = No emphasis placed upon organising flow to product families 6 = Total company actively encourages organisation by customer families	
Human resources and Lean direction 0 = Lean direction not evident amongst HRM nor clarity of its role with Lean 6 = Completely discernible Lean direction at all levels	
Recompense 0 = Little or no recognition of skills in compensation systems 6 = Totally skill based	
Lean conversion duties allocated 0 = Duties and responsibilities of Lean left to chance with no strategy or systems 6 = Excellent communication with the duties of Lean allocated	

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HRM evaluations 0 = Traditional and conventional HRM evaluations; not conducive to Lean 6 = A 360° system with persistent support for both CPD	
Total indirect employees/total direct employees 0 = 20 % worse than industry average 6 = 20 % better than industry average	
Score = /78	
Culture related to people	Score
Team empowerment and employee participation 0 = No promotion of empowerment and employee participation 6 = Full allocation of responsibility and authority	
Human resources 0 = Role of human relations and Lean not explored; not utilised to look at culture 6 = Recognised that training and communication will bring the culture in line	
Overall leadership styles 0 = Leadership style too autocratic 6 = Complete participation	
HRM coaching and training 0 = Little or no evidence of coaching and training 6 = Very widespread with solid accomplishments	
Overall professional development and Lean awareness 0 = No CPD permitted and Lean awareness and empowerment not encouraged 6 = CPD actively promoted and Lean awareness advocates empowerment and appropriate delegation	
Every day responsibility procedures 0 = Everyday responsibilities remain vague and imprecise 6 = Personnel are fully aware of the concepts and expectations	
Communication channels 0 = Poor communication systems; channels operate ineffectively 6 = Exceptionally open and democratic	
The number of hierarchical levels 0 = 20 % worse than industry average 6 = 20 % better than industry average	
Score = /48	
Lean viewed as a commercial venture	Score
Recognised strategic planning happens 0 = No recognised strategic planning; role of Lean imprecise 6 = Comprehensive five-year plans integrating Lean journey	
Future state mapping 0 = No or little evidence of future state mapping 6 = Evidently happening	
Indices embrace variety of indices 0 = Very narrow indices; financial considerations alone 6 = All areas are covered methodically	
Indices to the KPIs permit company to differentiate from its competition 0 = Indices not aligned to Lean; may be contrary to Leans development 6 = Indices fully associated to the instant and continuing Lean journey	

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Indices are fully comprehended at employee and organisation level 0 = Indices used in isolation where in existence; not aligned to the Lean journey 6 = All comprehend the indices and its association to company's performance	
Connection of value streams and support functions is obvious 0 = The linkages between value streams not recognised 6 = Appreciate that changing a value stream impacts other stream(s) and functions	
Market share 0 = Downward trend 6 = 20 % better than industry average	
Lean not restricted to operational improvements 0 = Scope of Lean viewed narrowly and restricted to operational improvements 6 = Broad view of Lean; Lean promoted to every aspect of the organisation	
Profit after interest and tax/total sales 0 = Worse than industry average 6 = 20 % better than industry average	
Total orders delivered late/total deliveries 0 = Worse than industry average 6 = 20 % better than industry average	
Score = /60	
Lean ideology	Score
Complete lucidity of the vision 0 = No evidence of direction for Lean or association with the vision 6 = The Lean journey is completely evident and mapped	
Lean is viewed as a dogma for the organisation 0 = Lean viewed very narrowly as few isolated tools 6 = Seen as an dogma	
Tools are seen as effective techniques 0 = Lean tools viewed in isolation and their remit nor widened 6 = Lean tools viewed as a techniques assisting to solve problems	
Learning and development culture 0 = No promotion of the Learning and development culture 6 = The learning and development aspects are aimed at altering behaviour	
Process resolute management 0 = Processes used in an ad hoc fashion; not process oriented towards customers 6 = Leaders concentrate on processes focused upon the customers	
Establish a victorious and healthy business 0 = No clear direction regarding the company's aspirations 6 = Profitability is still the main goal	
Reflection is ingrained into the culture 0 = Culture not promoting reflection nor its benefits fully realised 6 = Overall reflection is completely evident and applied	
Total % employees involved in Lean/total employees 0 = Worse than industry average 6 = 20 % better than industry average	
Score = /48	

Proposed Seven Stages of Lean

Any organisation should regard Lean to be comprising of a journey consisting of seven stages, which are depicted in Table 12.4. In this context, any organisation 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 philosophical 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 (Fig. 12.1) outlines the seven stages an organisation is regarded to encounter in its journey 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 standard of training, and choice of the appropriate tools and their implementation in a suitable manner and at an appropriate time. Suffice to mention at this stage that the terminology that is applied to the seven proposed stages of an organisation's Lean journey is as follows:

(i) Preparation;
(ii) Developmental;
(iii) Mechanical;
(iv) Enhanced;
(v) Holistic;
(vi) Innovative; and
(vii) Philosophical.

Further clarification is awarded to the specific categories and percentages applied below.

Table 12.6 proceeds to list the seven phases or junctures and endeavours to provide the indicative characteristics which will often be found to be in place within each juncture. The intention for the organisation in question is to evaluate the progress made to date but to then systematically plan how it needs to achieve the next stage of its Lean implementation journey. It needs to be clarified that the timelines and milestones will vary amongst organisations; these are largely determined by existing structures, size of organisation, commitment levels, skill sets available, financial availability, and age of the organisation and product groups and lines amongst others.

Figure 12.1 illustrates graphically the percentage scores allotted to each juncture of the Lean journey. Essentially, the methodology to derive the percentage scores is as follows:

Total score that an organisation could secure = 648 points (Table 12.5).

Table 12.4 Lean stages clarified

Junctures of a Lean journey	
Seven stages	Indicative characteristics displayed by the organisation
Preparation	• No implementation has taken place • The benefits are clearly evident • No infrastructure and no organisational decisions have been implemented • Implementation plans may have been formulated • Sensei or Lean champion sourced or in place • The policy makers and senior management teams in agreement with unions regarding the commitment towards Lean
Developmental	• Implementation started or beginning to be rolled out • Pilot area selected and work commenced • No evidence of widening the application to other areas • Few tools with little subsequent commitment evident • Importance of culture not recognised • Implementation plans may have been formulated • No promotion of Lean to other areas
Mechanical	• Pilot progressing well and being promoted • Few tools embedded within internal organisation but largely within manufacturing only • Tools are implemented in a piecemeal fashion with little consideration of correlations • Some implementation plans may have been formulated • Importance of culture not recognised • Team leaders or proponents of Lean encouraging its spread within the internal organisation
Enhanced	• Pilot has proven successful and very well promoted • A roll-out programme progressing in other key areas within the internal organisation • Predominantly manufacturing base concentration of Lean • Team leaders or proponents of Lean encouraging the spread within the internal organisation and being used extensively • Good lessons learnt culture and evidence of more systematic plans for wider Lean adoption • A realisation that Lean can aid overall efficiency levels • A recognition that culture and the organisational practices need addressing, but few tangible signs visible towards accomplishing this
Holistic	• Roll-out programme on track • Most of the internal organisation nearly incorporated • Suppliers incorporated and signs towards integration of the whole value chain • A recognition Lean aids overall efficiency levels and being promoted strategically • A realisation that culture and organisational practices need addressing; some perceptible signs visible towards accomplishing this • Organisational and cultural developments still in their infancy
Innovative	• Lean values 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

(continued)

Table 12.4 (continued)

Junctures of a Lean journey	
Seven stages	Indicative characteristics displayed by the organisation
	• Lean has been ingrained as an overarching strategy • Suppliers have been encouraged to adopt the Lean principles and obvious indications towards integration of the whole value chain • Lean practices adopted within the supporting structures such as inbound logistics, recruitment, and finance sections
Philosophical	• 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 • Lean forms part of the vision • Suppliers not viewed as adversaries • Lean yielding genuine business benefits

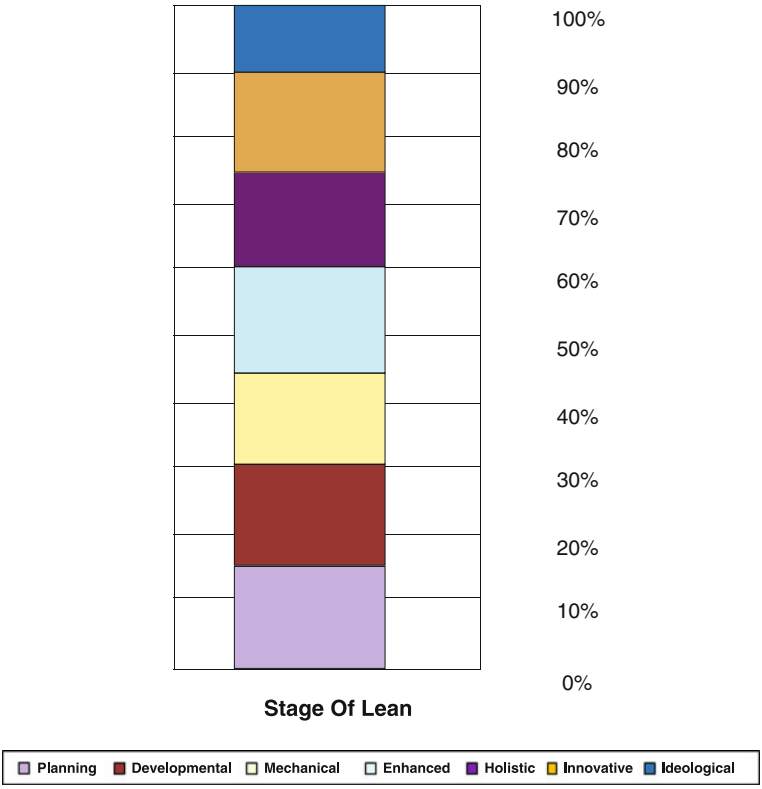

Fig. 12.1 Lean stages

Table 12.5 Audit scores

Audit categories	Total score available
General visual management and organisation	54
Manufacturing, general flow, and processes	78
Quality planned within the product	90
Continuous improvement	66
Change management	78
Sustaining the Lean journey	48
Culture regarding processes	78
Culture regarding people	48
Lean viewed as a commercial venture	60
Lean ideology	48
Total	648

(i) This total score **648** equates to **100 %**.
(ii) Consequently, the score the organisation achieves is divided by the total possible score; this provides the organisation with an overall percentage.
(iii) These percentage scores can then be classified as follows:

- Preparation—0–15 %,
- Developmental—more than 15 %,
- Mechanical—more than 30 %,
- Enhanced—more than 45 %,
- Holistic—more than 60 %,
- Innovative—more than 75 %, and
- Philosophical—more than 90 %.

(iv) Consequently, an organisation could score 335 points—Table 12.6. According to the audit, it has achieved the "enhanced" stage. This means 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 philosophical 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.

Table 12.6 Audit classification

Lean stage	Percentage of the maximum score of 648 points available	Percentage score (%)
Philosophical	584+	>90
Innovative	487+	>75
Holistic	389+	>60
Enhanced	292+	>45
Mechanical	195+	>30
Developmental	98+	>15
Preparation	0–97	≤0–15

Summary

Whilst the quantitative assessment leads an organisation to an acceptable leanness level, the respective stakeholders perceptions about leanness levels could well result in an opposite result. In order to minimise the probability of this occurring, organisations should be able to employ both perception-oriented and measurement approaches simultaneously in order to assess their implementation efforts. The audit proposed proceeds to deploy an evaluation approach which includes both quantitative and qualitative sources. In reality, it is hoped that the audit can assist organisations to assess their Lean implementation in a systematic way and eventually develop stronger Lean systems, resulting in a tremendous competitive advantage. The analysis is overwhelming in its evidence that Lean should be regarded as a journey, an end destination that may never be achieved by most organisations. Nonetheless, there is a need for a flexible audit which can be customised permitting an organisation to gauge the level or stage of leanness that it has accomplished. The audit devised is a comprehensive which besides the technical inputs necessary for Lean also scrutinises the change management and cultural components necessary for Lean to be successful. Likewise, the metrics take into account a consideration of whether Lean has led to improved performance levels for the organisation.

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Chapter 13
Lean Promoted as an Ideology

Abstract The fundamental theme of this research focused upon the notion promoting that organisations need to be construing Lean as a philosophy. Whilst the investigations revealed testimonials to this vision, it was discovered that frequently there was a heavy bias towards only the operational elements of Lean. The organisational development, culture, and supporting mechanisms are still not be fully acknowledged, whilst sustainability along with the need to view Lean as an ideology equally was not fully confronted. For the context of this investigation, an analogy is drawn with philosophy whereby philosophers are striving towards a fundamental understanding of whatever exists, including us. It is advocated that 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:

i. The first is "*What is the nature of whatever it is that exists*" (ontology) and
ii. Secondly "*How, if at all, can we know*?"

The second branch is referred to as epistemology. Many put forward the debate that philosophy aims to provide not knowledge, but understanding and proceeds to develop a complete and coherent vision. This should always be undertaken without making it a question of religious faith or appealing to the say-so of an authority. Whilst individual philosophers may hold religious beliefs, the genuine ones will not attempt to support their philosophical arguments with appeals of religion. Of complete relevance, in this case, a philosophical argument, should in all circumstances, carry its own credentials with it, in the form of reasons. Equally, it should also seek for rational assent, not faith or obedience.

On the grounds identified, it is emphatic that Lean should be viewed more as a philosophy or condition than as a process. It has been rightly forwarded that "*Leanness is a relative measure*". It should be clarified that Ohno (1988) demonstrated that the Toyota Production System was not just a production system, but a total management system. As a philosophy, it involves and hopes to inevitably secure complete commitment from every level within the organisation. Lean should go beyond the engineering and management disciplines by emphasising that value

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and the elimination of waste needs to occur in a continuous manner based on common sense. Likewise, organisations to be successful in Lean implementations are required to separate the Lean philosophy from the techniques and tools used to support the philosophy.

Whilst it is fair to suggest that Lean is a set of techniques comprised from a system that is derived from a philosophy, equally it should be suggested that Lean should always be viewed as a philosophy with the tools such as Six Sigma acting as enablers. The development of suppliers upstream from manufacturing should only be regarded as 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 as has been evident in many Lean initiatives within the UK. 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. Lean thinkers recognise that as soon as you begin to think that you are done, another set of issues emerge. In this case, it could be argued that instead of viewing Lean as a programme we should instead view it as a 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. and in this approach, it stands a better chance to sustain the initiative.

Lean Forwarded as Synonymous to a Religion

Undeniably, 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; instead, they used scientific principles to promote the doctrines of Lean. 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 towards achieving efficiency which is increasingly being applied in many sectors. 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. The tools without the conviction and belief can be regarded as analogous to a body without a soul and purpose. 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 not based upon

evidence. The Lean philosophy may need to be modified to be relevant in different business, social, or cultural backgrounds; this is the aspect which besides making it difficult is also a fascinating concept.

The Longevity of Lean

Ohno (1988) has already eloquently articulated that the Toyota Production System did not happen overnight but through a series of innovations spanning over three decades. Many subsequent eminent proponents such as (Womack and Jones 2005) summarised 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 requiring constant supervision. 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 necessary or in this context possible. Within the boundaries of Lean, it could be said that as far as the shop floor is concerned, 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 better in many ways. 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*" (Campbell 2006, p. 52). Consequently, Lean needs to be seen as a journey and not an end state.

Toyota is constantly under creative tension to continually improve towards what they call the "*true north*" or an ideal state of perfection; this is being emulated by many organisations presently. Likewise, practitioners with considerable knowledge of the TPS state 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 which many organisations struggle to achieve the right balance. 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:

- 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.

Within this context, it does need to be recognised that there exist a wide variety of factors which can influence the time frames, that is,

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

The Lean Traditions

In an analysis of how the Toyota organisation developed, we find that it 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 as a whole. Toyota's principles were shaped by the personalities, values, and experiences of its founders in the Toyoda family. Even when Gary Convis was named as the first American President of "The Toyota Motor Manufacturing" in Kentucky in 1999, it materialises that it took the Toyota executives over 15 years to develop Convis into someone they could trust to carry the banner of the Toyota Way. Liker (2004) talked about the "*Lean learning enterprise*" (p. 306), in reference to how Toyota continually adapts its culture to local conditions. This aspect has been clearly evident in the author's recent experience; many Lean consultants trying to superimpose tools, methods, and techniques which have worked within one organisation on to another. The absolute core of the Toyota philosophy is that the culture must support the people doing the work. Appropriate leadership and talent management are crucial if an organisation is to succeed. It is only through this that the overall capability of the organisation is enhanced. Unfortunately, many UK organisations still struggle to accept his premise.

Lean requires a specific set of skills and experiences which often have to be learnt. 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 who is central to this aspect. 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 programmes were collectively referred to as "*Training within Industry*". 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. The journey for Toyota is by no means over and once again recent experiences encountered have reinforced this. 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.

From experience, it is possible to try and advocate the four different areas where learning needs to take place for a true Lean transformation:

- The initial step is the jishuken activity in the workplace; this concentrates on some of the basic Lean tools and techniques.
- 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.
- The third level of learning, which can take about 6 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.

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. 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. Despite the consistent message from Toyota, many Lean plants have felt that Lean involves pursuing the implementation of tools such as the following:

- "one piece flow",
- "value stream mapping",
- "standardised work", or
- "kaizen events".

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 in an appropriate manner.

Rarely, at a Lean conference or in a Lean, article does anyone discuss in any detail the notion of profits and improvement when discussing Lean. It is almost as though profit is not an appropriate topic for public discussion in these situations. 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 when viewed closely. It should be suitably stressed that at the start of their careers in Toyota, the executives [as has been indicated by Smalley (2009)] are exposed to and that amongst one of the first slides he was shown at Toyota during an employee orientation was the simple equation:

$$(\text{Price} - \text{Cost}) \times \text{Volume} = \text{Profit}.$$

In this highly mature competitive automotive sector, the organisation already believed that Toyota rightly 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. Smalley (2009) stressed that the Japanese proverb "*you must wring water out of a stone if necessary*" (p. 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 as is evident in many occasions.

The Technical Application

Many Lean proponents have echoed the underlying message in the following quote that "*people say they are implementing Lean when they're just implementing one or two of the elements*". 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 always needs to remain the same. 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 inevitably. 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.

Throughout its history, Toyota has either invented or led in the development and implementation of many tools. 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. 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. Often kaizen teams are implemented, and 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. 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. 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. 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 many Lean champions or change agents. 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 in an appropriate context. 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. It is only when the counter measure is actually proven or is seen to act as a good analytical aid that it should ever become a standard tool in the Toyota arsenal; this philosophy has been advocated from the start. Subsequently, this is taught to other members so that it could be utilised whenever applicable. Toyota uses the term countermeasure 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. Earlier proponents (Shingo 1989) stated that the TPS is just 5 % kanban, 15 % production system, and 80 % waste elimination.

Table 13.1 gives an indication of Tool development in the TPS:

Toyota began its Lean journey in 1945 and is still progressing and changing today.

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 by modern organisations and Lean champions, namely 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.

The Proposed Rules to Follow

It is impossible to discuss, Lean doctrines and a requirement to view Lean as an ideology without looking at the work of Spear (2004); he exposed a standardised way of working at Toyota that commences with four rules; whilst the language has been customised, the original intent has not been altered. The four rules are as follows:

Table 13.1 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 where there was man/machine combination	One man and one machine layout and work assignment	Separation of man from machine. Create standardised work. To promote a multiskilled work force with job instructions

- to structure each activity,
- clearly connect every customer/supplier,
- specify and simplify every flow, and
- 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 from one another. 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. Lean is and should always remain an appropriate interaction of man, tools, and material (physical or intellectual), to produce an outcome efficiently. Nonetheless, 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 13.1 represents this aptly. Each principle symbolises a deeply embedded way of thinking of the true Lean systems thinkers. 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.

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

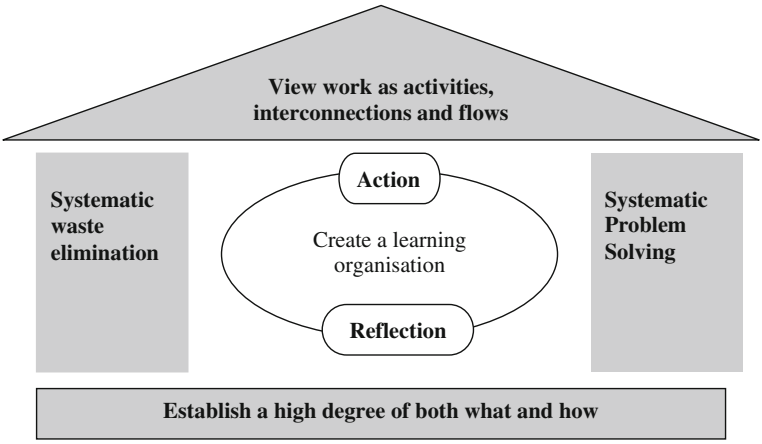

Fig. 13.1 Lean principles

production engineering experiences and requirements. Standardisation 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 whilst aligned to the underlying Lean principles. 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. 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 become. 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 within Lean thinking. 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 (Spear 2004). 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 Fig. 13.2.

An important aspect which many current Lean advocates forget to recognise is that 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 (2004) 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

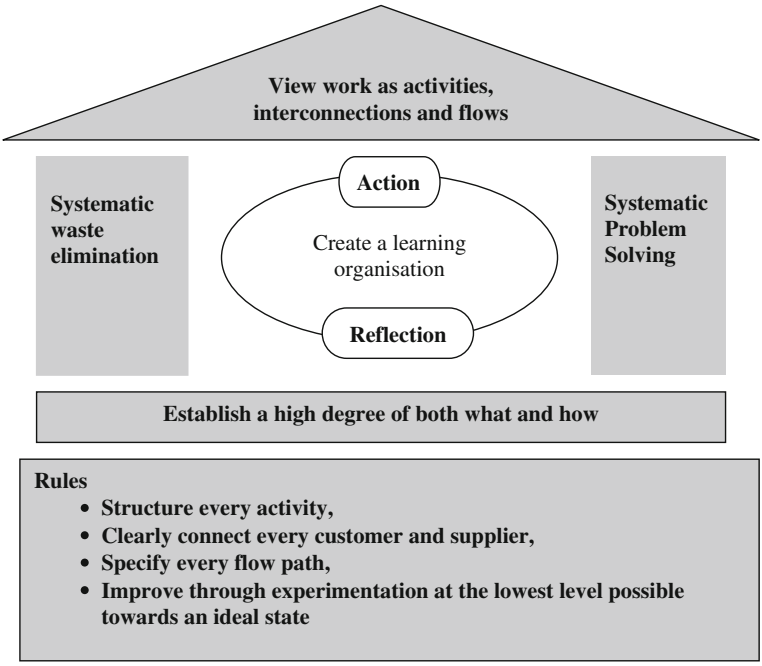

Fig. 13.2 Lean principles with rules

within current economic conditions. 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.

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 which acts as a prerequisite. 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. Toyota can teach us the mechanics, but it is up to each of us to evolve and improve these mechanics. It is important to clearly outline and recognise that the TPS is not the Toyota way. The Toyota way comprises of the essential principles of the Toyota culture, permitting the TPS to function effectively for the organisation. Regrettably, many reinforce the misunderstanding that the TPS is a collection of tools that lead towards greater efficiency, whereas it is a total system supporting and encouraging

its employees to continuously improve the processes they work on. The Toyota way is a philosophy embracing a set of tools that are required to be applied appropriately in every situation. They are part of a greater system that seeks to achieve harmony and perfection to sustain success. 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.

Many organisations have been convinced that "value stream mapping" is a universal tool for identifying all problems in manufacturing processes, often through poor guidance. 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. 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 in general principally that of flow and lead time related issues.

Summary

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 50 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 programme today. The generally held presupposition is that a value stream map must be drawn for each product family and then appoint a value stream manager, and this should reveal all the plant's problems. It is seen as a prerequisite for Lean. Smalley (2009) revealed 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 2009). 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.

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. Alternatively, the tool was used to

discover ways to convert lines into more efficient ones. The TPS can be neatly summarised as, 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.

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Chapter 14
Lean Is Green

Abstract The link between Lean practices and environmental performance has been supported in the literature. Lean can contribute to enhanced environmental performance. It could be forwarded that the next waste under attack in Lean is energy. Recent research undertaken in the USA stated that the vast majority of all energy used in America is consumed by industrial sources—a staggering 31 % according to the "US Energy Information Administration Annual Energy Review". It is not just because "being green" is in vogue for marketers. The very remise of Lean is about eliminating waste and unnecessary energy use. Forecasts continue to suggest rising energy costs globally, largely because of expected spikes in demand out of China and India, which has increased the focus on saving energy. The most obvious benefits of Green and Lean are cost savings which are synergistically coupled with value creation opportunities. Cost savings may include energy savings, productivity savings, and savings from improved utilisation of materials. Value creation opportunities may include innovations that involve creation of new products out of waste materials and finding ways, in service delivery processes, to enhance customer's experience. Whilst the pursuit of Green and Lean is not a destination but a journey, it is clear that organisations that stretch themselves to build a culture around the values of sustainability, excellence, and equity will ultimately have a big advantage those who do not. Green and Lean is not a dichotomy rather it can be said being Green is Lean.

Lean Is Green

The traditional way of thinking suggests that "green" business initiatives add costs, whilst implementing "Lean" processes is about streamlining and saving money. Many manufacturers today have evolved their thinking so that Lean and green initiatives work hand in hand, achieving the same goal of increasing profits. In fact,

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a 2009 study by the University of South Florida suggested there is a "synergistic relationship" between Lean and green systems and that there are "philosophical and structural similarities" between the two models. Lean manufacturers follow stringent manufacturing processes designed to eliminate or minimise waste and non-value added steps in seven categories. You can think of them as the "seven deadly sins" of wasteful manufacturing: defects, overproduction, transportation, waiting, excess inventory, unnecessary movement and over-processing. Some manufacturers have also adopted a "Six Sigma" improvement process, which includes a set of disciplined tools and problem-solving methodologies for reducing or eliminating process variation and product defects.

Going Lean and green is a trend that identifies new business opportunities for organisational improvement and for competitiveness. Besides, there are quality awards to assist organisations to improve their performance amongst them the Shingo Prize, the Malcom Baldrige National Quality Award, the European Foundation for Quality Management. The aim of this study was to develop a conceptual framework for Lean and green business organisations. To attain the paper objective in a first stage, a comparison between quality awards is developed to provide a comprehensive understanding of each framework and to explore how they assist to model a Lean and green organisation. After defining Lean and green management approaches, it seeks to cross-reference between the awards frameworks and Lean and green culture; a number of assessment guidelines and criteria were designed to connect and integrate Lean and green principles and tools. It is proposed seven different criteria and respective criterion score to assess a Lean–green business organisation.

Global warming, oil spills, and other environment disasters seem to be on everyone's mind. Business magazines write about "green" businesses. Movie stars drive hybrid cars to look "green". But most companies overlook the single biggest opportunity they have to go green by simplifying, streamlining, and optimising their internal operations.

Since most businesses, even profitable ones, spend a third or more of their budget on waste, scrap, and rework, it does seem reasonable to assume that eliminating that waste would reduce various planetary problems? Reducing and eliminating waste is the goal of Lean production. Reduction in waste will reduce consumption, which will reduce the energy required to produce the stuff in the first place. Less energy use means less warming. Less waste means a greener planet.

Leaning the Business

Most of us grew up learning about Henry Ford and mass production. Mass production led to economies of scale that reduced costs as long as the company was making a single model with no options. Today, customers demand a customised product, whether it is a new car or a burger at the local restaurant. Then along came

Lean (the Toyota Production System). Lean focuses on eliminating unnecessary delays and movement. It creates economies of speed that not only reduce costs and boost profits, but also minimise environmental impacts. Whilst mass production focuses on big batches, Lean focuses on small batches and quick changeover. With mass production, it is easy to commit the sin of overproduction that creates inventory that has to be warehoused and managed. Lean only creates a small batch when a customer requests it, resulting in no unnecessary production or inventory. There is nothing to warehouse. You make it; you ship it.

It no longer makes sense to make a thousand units of a product quickly if customers want a product customised to their needs. A business can easily end up with thousands of units that no one wants. All of the energy and materials used to create these products are wasted. Similarly, it takes energy and landfills to recycle or dispose of the stuff. When the economy slides into recession, mass production can keep making more and more inventory that has to be stored and managed. Imagine for a moment the environmental impacts of the shift from mass production to Lean production. If a company only produces enough products or services to meet customer demand, it does not have to inventory, store, or manage a lot of raw materials or finished goods. This prevents unnecessary movement of inventory, reduces storage costs, and reduces overtime. One chemical company had £230 million in finished goods sitting in rail and shipping yards all over the planet. Managing that inventory costs a fortune. One metal fabricator recycled a million pounds of finished, but flawed product every month. It had to be chopped up and fed back into the furnaces. Saving the energy used to chop and melt the recycled metal could help save the planet. A magazine printer had high-speed presses that could print a million magazines in a day, but the bindery could only handle 200,000. The other 800,000 had to be stored where they could be gored or toppled by forklifts over the next five days. Simple solution is to print 250,000 the first day and 200,000 every day after. This made the production schedule more flexible, which allowed more jobs and less rework and less overtime.

The Tools of Lean

To maximise the value of Lean, reduce delays and unnecessary movement of people or materials. The two main tools are value stream mapping (VSM) and spaghetti diagramming. To create either one, use sticky notes and a flip chart. Value stream maps, much like a flowchart, show the workflow from a time perspective. Spaghetti diagrams show the movement of people and materials through a work-space. On a value stream map, the arrows between steps are where the product or service spends most of its time. Eliminate the delays between steps to increase productivity, reduce errors, and maximise profits. On a spaghetti diagram, calculate the distance an employee or a work product moves through the space. Often,

workspaces are poorly designed leading to lots of unnecessary movement. If one wants to see a well-designed Lean production "work cell"? Visit any Subway, where you will find a small oven for fresh bread (right-sized machines), and small buckets of meats, cheeses, and vegetables. Chips and drinks are self-service.

A possible consideration; walking is waste. Have employees wear pedometers for a week and record their movements. In one hospital laboratory, technicians were walking three to four miles per week. Redesign cut their travel by almost 60 %.

Earth Impacts

Eliminating delays and movement whilst reducing batch sizes and inventory not only speeds things up, but it also reduces the chance for error by 50 %. Faster production combined with less rework cuts costs, boosts profits, and reduces environmental impacts ranging from overuse of raw materials to energy savings. Use the tools of Lean to reduce delay and movement that will benefit Mother Earth as well. Lean is not just about the bottom line, worker satisfaction, or customer satisfaction; it is also about the future of the planet and its inhabitants. We have waited long enough to start using the simple tools of Lean to go green.

Applying Lean thinking to your sustainability efforts will help ensure that your green initiatives will have long-term staying power because of the added value to your business.

If you are a manufacturer seeking to do the right thing for the environment for altruistic reasons, you may be able to achieve this goal more effectively by implementing Lean systems. Green initiatives are going to be more justifiable long term if they create more success for your business. Establishing a culture that embraces both concepts can attain significant results. Some 80 % of European businesses have cited reducing energy costs, particularly transport, as a major objective. In Edinburgh, Scotland several entrepreneurs have shown how it can be done. The result is less pollution and greater competitiveness. EAE, a distributor of posters and publicity material, states respecting the environment is one of its core values. Most of its delivery fleet runs on bio diesel.

Last year it was audited and advised by the European project Ecostars. The outcome was significantly improved energy performances. "Since 2005, they reduced their carbon emissions by 70 %. Thanks to Ecostars, they have managed to reduce carbon by vehicles by 40 tons per year", according to Glen Bennet, EAE's Managing Director.

The energy saving approach had a number of follow-on benefits for this innovating company. It gave it an edge in competing for public contracts, enabling it to secure a major deal with the Scottish government, as explained by Bennet "*This contract is worth 350,000 pounds a year over three years. It's allowed us to create two new full-time jobs, and it's increased our turnover by 14 % in 12 months*".

From Lean to Green Manufacturing

Let us first briefly define Lean and Green: "Lean" is about resource-efficient manufacturing; producing more with less. It is based on the philosophy of the Toyota Production System and is still the most popular business strategy for improving the product quality (Q), the delivery performance (D), and reducing production costs (C). Lean aims at removing eight types of waste: **t**ransport, **i**nventory, **m**otion, **w**aiting, **o**ver-production, **o**ver-processing, **d**efects, and **s**kills. Hence, "Tim Woods" is the persona-non-grata of Lean production. "Green" is also about resource-efficient manufacturing, but the core goal is environmental performance (E). Even if Tim Woods is also an enemy of Green, there are other types of wastes that Green would like to fight first: energy usage, Co_2 (and other) emissions, water pollution, and surplus rest material and products. The leading similarity between the benefits of Lean and the benefits of green is waste, and so it makes perfect sense that in order to achieve higher levels of environmental performance, your organisation must first adopt the principles and practices of Lean manufacturing.

Lean manufacturing practices and sustainability are conceptually similar in that both seek to maximise organisational efficiency. Where they differ in regards where the boundaries are drawn, and in how waste is defined. Sustainability expands the definition of waste to include the wider range of consequences of business actions including environmental and social consequences. Lean processes are inherently less wasteful, and in this sense, promoting Lean processes can help organisations become more sustainable. When companies expand the definition of waste to include not only product and process waste, but also the business consequences of unsustainable practices, Ohno's list (1988) of wastes takes a different form:

(i) Waste of natural resources
(ii) Waste of human potential
(iii) Waste due to emissions
(iv) Waste from by-products (reuse potential)
(v) Terminal waste, waste from by-products that have not further usefulness
(vi) Energy waste
(vii) Waste of the unneeded (e.g. packaging)

When the definition of waste is expanded and when it is understood that the consequences of corporate decisions extend past the company parking lot, Lean can indeed be green. Less waste is good for the environment and the company's bottom line whilst reducing waste in both products and processes is what Lean is all about. So, it makes perfect sense that in order to achieve higher levels of environmental performance, your organisation must first adopt the principles and practices of Lean manufacturing.

Efficiency Savings from Being Green

Two examples from the EPA's research on Lean and the environment, Eastman Kodak and Baxter International Healthcare Corporation, illustrate this point. Eastman Kodak Company has been focused on Reliability-Centred Maintenance since the early 1990s and built a Lean business model upon its already excellent reliability foundation. From 1999 through 2006, Eastman Kodak conducted numerous kaizen events focused on energy reductions within its manufacturing processes by defining the problem statement as "*what do we use energy to do*?" The company found that there were two main areas where energy reductions would produce significant savings:

1. Steps within the manufacturing process used to generate heat and
2. The magnitude of energy used to turn motors and mechanical drive systems.

Over the seven-year period, Eastman Kodak energy reductions resulted in savings of nearly $15 million. Baxter International Healthcare Corporation, a worldwide leader in global healthcare products, found environmental performance improvements through the Lean practice of VSM. In one specific plant, VSM was used to walk through the manufacturing process in order to identify major water usage steps. Overall, 96 opportunities for environmental impact improvement were identified, prioritised, and implemented, with an estimated energy reduction value of 170,000 gallons of water per day.

Whilst there is no doubt that Lean manufacturing will result in lower material and labour costs and greater production revenues, there is less discussion about the benefits of Lean in relation to green manufacturing. Just few examples cited in the US Environmental Protection Agency's "The Lean and Energy Toolkit" (www.epa.gov):

- A Baxter International facility combined Six Sigma and energy-efficiency efforts to save $300,000 in energy costs in one year
- Eastman Kodak conducted numerous Lean kaizen events focused on energy reductions by asking "what do we use energy to do?" They found that over the seven-year period, energy reductions resulted in savings of nearly $15 million
- Toyota Motor Manufacturing North America has reduced average facility energy consumption per vehicle by 30 % since 2000. In fact, Toyota has reduced its landfill contribution down to functionally zero and achieved ISO 14,000 certification because of it.

When implementing Lean within our organisations, equipment reliability is the predominant foundational element that enables Lean operational performance. Embracing green manufacturing requires giving more focus to environmental and energy concerns during the implementation of reliability improvement projects. Improvements geared towards refining equipment reliability have distinct linkages to environmental performance, such as reducing the amount of product and raw material waste through:

1. The elimination of catastrophic breakdowns through formalised root cause analysis;
2. Providing routine monitoring of system parameters through predictive technologies; and
3. Preventing interruptions to production cycles with a focus on overall equipment effectiveness (OEE).

Sustainable green Reliability Excellence requires a focus in three holistic areas:

(i) **Green-Centred Maintenance**; this approach evaluates the impact of functional failures on environmental performance and administers the appropriate condition monitoring and preventive maintenance actions. This will adequately predict when energy consumption becomes excessive, or material degradation has the ability to threaten the environment, effectively mitigating these risks before accruing operational costs. The result of these enviro-friendly strategies is twofold:

   (a) Optimised environmental performance, such as energy consumption; and
   (b) Operational costs are reduced or sustained.

(ii) **Designing for Green Reliability**; whether your organisation is considering upgrading existing assets or purchasing new assets, environmental performance impact must be quantified and considered in the decision-making process. In a model organisation like GE, life-cycle cost analysis is performed during conceptual design to evaluate engineered solutions for implementations based on the total life-cycle cost. This helps identify the financial gains or losses resulting from predetermined operational and maintenance practices designed to ensure ideal levels of reliability, availability, and maintainability. When bridging the environmental gap, organisations like GE have begun to evaluate the energy consumption of each engineered alternative as a sustaining cost category. Those solutions or alternatives that effectively utilise higher efficiency motors, alternative fuels, or inherent energy sources (e.g. passing exhaust gases or condensing fluids through heat exchangers in order to heat the workspace as an alternative to a stand-alone HVAC system) will cost less over the life-cycle period—be that 5, 10, or 30 years. The additional benefit of a green-focused life-cycle cost analysis is that it will be easier to identify oversized equipment that could be replaced by smaller, more energy-efficient alternatives. In many cases, we tend to over-engineer our plant assets and, therefore, spend more than we should to operate and maintain the system or asset over the life-cycle period.

(iii) **Sustainable Life-cycle Management**; from conceptual design of new assets to the disposal of depleted assets, all functions of your business must be integrated to efficiently manage plant assets over the entire life-cycle period. Life-cycle asset management, with regard to environmental performance, requires that your organisation is capable of determining the environmental impact associated with components and materials installed in the manufacturing system, be that energy consumption or the generation of harmful

by-products and waste. Sustaining businesses have demonstrated an ability to control cost and curb environmental impact through life-cycle thinking and, therefore, have created additional value within their products which can be recognised by their customers.

Efficient asset management is implemented via systems and structures to capture data for the purpose of decision-making in eight aspects of the asset life cycle:

(i) Design—conceptual design of new assets or modification of existing assets;
(ii) Procurement—purchasing new assets or reengineered components in order to support configuration changes in the manufacturing process;
(iii) Storage—holding new assets or components in stores until they are installed in the manufacturing process;
(iv) Installation—installing new assets or components in the manufacturing process;
(v) Commission—initial start-up of new assets or components;
(vi) Operate—daily operational standards of practice;
(vii) Maintain—routine maintenance standards of practice and maintenance strategies;
(viii) Decommission—shutdown and disposal of manufacturing assets, or shutdown and handling of components which are uninstalled for reconditioning.

Business Rationale for Being "Green"

In recent years, many companies have established a fundamental goal to minimise the environmental impact whilst maintaining high quality and service for all business processes and products. This is commonly referred to as sustainability or green manufacturing. Sustainable manufacturing is the creation of manufactured products that use processes that minimise negative environmental impacts, conserve energy, and natural resources, are safe for employees, communities, and consumers, and are economically sound. As most manufacturers are starting to realise, the quest to become green takes them right back to Lean. In applying the "Lean Principles", a systematic approach to identifying and eliminating waste through continuous improvement is one of the key ways to enhance environmental performance. Lean and sustainability are conceptually similar. Both seek to maximise the efficiency of a system. This is accomplished through waste and time minimisation. The difference lies in where this system (or process) boundary is drawn and how waste is defined. Lean sees waste as non-value added to the customer; green sees waste as extraction and consequential disposal of resources at rates or in forms beyond that which nature can absorb.

Other Lean concepts such as operator care, kanban, and SMED can potentially improve the environmental performance of your organisation as well. Operator care programmes focused on developing standards of practice within the operating units

decrease variation in the manufacturing process, which reduces the amount of product and raw materials waste. For example, a global leader in alumina refining and the manufacturing of aluminium products successfully reduced energy consumption as a result of training operators in better standards of loading, starting, and operating manufacturing equipment. Operator care programmes have also helped this manufacturer improve workplace safety and reduce lost workdays. Kanban, or pull-systems established within the manufacturing process, has greatly contributed to material and waste reductions. Kanban practices are designed to provide the right materials at the right time to support manufacturing needs. This concept focuses on reducing excess inventories of raw or work-in-process materials which cannot be consumed immediately by the production cycle. Cell-based manufacturing processes that signal a pull for materials based on the demand for product can significantly reduce raw material consumption, decreasing the amount of waste material delivered to landfills as well as reducing the demand on raw material resources.

SMED, or single minute exchange of dies (a practice that helps your organisation reduce changeover durations in order to adjust the manufacturing process based on product demand), has the potential to reduce the amount of waste generated from raw and unprocessed materials left over in the manufacturing processes. For example, an aluminium door and window manufacturing facility conducted SMED events to reduce the amount of paint wasted per changeover from 50 gallons per day to less than 10 gallons. Paint disposal costs dropped by as much as £310,000 annually, and paint and solvent disposal were reduced by more than 40 %. Using a cross-functional team, they identified waste elimination opportunities that included:

- Redesigning paint piping systems;
- Moving low-volume part painting closer to the paint booth to eliminate lengthy piping systems;
- Changing out hoses;
- Standardising processes; and
- Using alternative methods to clean the lines

"Leanovations"

Whilst there is no doubt that Lean results in lowered waste, material, and labour costs, there is less discussion about the benefits of Lean in relation to green manufacturing, warehousing, the office, health care, and the like. Consumers, regulators, shareholders, and stakeholders are all asking for more sustainability. It is a different world than it was even 10 years ago. Leanovations—Lean to Green strategies provide companies the ability to convert activities into real business benefits and opportunities with positive results in three areas of:

(i) People,
(ii) Planet, and
(iii) Profits

through social benefits, environmental improvements, and financial performances.

Companies such as Toyota and GE are at the forefront applying Lean and Green manufacturing which has become a focus worldwide. Environmental waste is just as bad as any other waste that creates an inefficient production process. Lean manufacturing activities are renowned for being focused on increasing production efficiency, but environmental wastes, such as excess energy and water use, and the costs involved with them need to become a bigger component of Lean.

If cost-reduction opportunities from environmental wastes are overlooked, then the true costs of production are not really being accounted for, which is not Lean. Lean is about companies embracing change to reduce waste in how they produce a product or service. It engages and empowers employees to develop and implement ideas and requires a culture of continuous improvement. Making this change is cultural, and necessary for any company to survive, but it is incredibly difficult. Companies that adopt "Lean and Green Manufacturing" are embracing the environment at the same time embracing change itself, and starting down a path towards more efficient processes, less waste of all kinds, and empowered innovative employees. Going green can be a tremendous motivator for Lean, and going Lean will become much easier if you connect it to going Green.

Here are seven examples of how these Lean innovations can yield sustainability results for manufacturers:

- **Fewer product defects**: if you have improved your processes to minimise product defects, this means you are using fewer raw materials to manufacture those products. In addition, you do not need as much plant space, systems, and equipment to rework or repair those products, which equals less energy consumption
- **Less overproduction**: overproduction means manufacturing in excess of your customer orders. Eliminating overproduction is a major focus of Lean. In traditional manufacturing reasoning, if a production line is running and you have already made all of the products to meet customer demand, you make more of something to justify the expense of your equipment and people. Lean concepts require that you only produce what you need, when you need it. If you do not overproduce then you consume fewer raw materials, use less energy to operate, and eliminate the risk associated with not selling the excess inventory and eventually disposing of it as waste
- **Minimising wasted movement**: a great example of a wasteful motion is when a production area is poorly designed so that workers are wasting time and effort lifting things unnecessarily or needing to walk an excessive distance back and forth to find tools or complete a task. An ineffective layout requires more space increasing heating, cooling, and lighting demands. It can also increase the time to produce a product resulting in increased energy requirements

- **Reducing transportation**: an example of wasted transportation is by having your production facilities not located near your customers, requiring that you transport materials over long distances. It can also relate to the movement of materials within your facility. Internal movement of materials adds no real value to the product, but increases the energy used and the costs associated with the product. Lean thinkers look to minimise transportation wherever possible
- **Less excess inventory**: similar to overproduction, if you have less product inventory sitting around, you can use your plant space more efficiently (saving heating and cooling demands) whilst also consuming less packaging and raw materials. Lower levels of inventory also reduce the risk of waste due to obsolescence and undiscovered defects
- **Reduced waiting**: nobody likes waiting, especially those of us who are Lean thinkers. A key Lean concept is reducing waiting for things like equipment to be available, information, or materials. A great example of waiting is when your production processes are not balanced, so when an operator has finished part of a task, he needs to wait for a machine to complete a cycle before finishing that task. Harmonising these processes to reduce waiting can cut down on production downtime, which means you have less wasted energy
- **Less over-processing**: over-processing means you are adding more steps or materials to something than what the customer will pay for. In other words, every step of a production process should add customer value. Improving your processing to just what is needed allows you to cut down on waste and lower your environmental footprint.

Social Returns of Being Green

It is important to add some green to your Lean by looking over the next horizon and thinking about what else you might achieve in your Lean efforts. It might be reducing your landfill contributions by composting, using less cardboard packaging by using totes that are standardised, or by reducing the work-in-process that leads to waste. Capitalism and environmentalism are not mutually exclusive. Many business leaders have invested time, energy, attention, and financial resources in environmental protection, but sometimes their efforts are not consistent, appreciated, or even encouraged. There is a need to reinforce a simple message; namely, "Lean" refers to an approach of continuous improvement and the elimination of non-value-adding activities, and it is mainly used in the manufacturing sector. "Green" refers to practices and actions that reduce negative impacts on the environment. Whilst "green" and "sustainability" are often used interchangeably, the term "green" is more appropriate in this discussion, because unless materials are replenished at the same rate they are depleted, the practice cannot truly be considered "sustainable".

Green benefits can be a by-product of Lean practices. By definition, using fewer resources and streamlining is better for the environment. However, when

undertaking process improvements with just the Lean philosophy in mind, the environmental benefits may not be fully achieved. This is because Lean principles are not focused on reducing energy, water, waste, and transportation costs, although these may be by-products. A smaller warehouse results in less energy used; reuse or repurpose of materials that would otherwise go to landfill reduces waste. It begs the question: is it better to start with Lean or green principles, or both?

If Lean and green principles were to be married from the outset, the result would be a more comprehensive look at the life cycle of a product or service. This would include the upstream and downstream inputs and impacts. The life-cycle approach is a more rigorous path to pursue, and some companies have found that it is easier to start with one (either Lean or green) and follow with the other rather than implement both at the same time. Steve Brenneman, president of the Aluminum Trailer Company (ATC), learned this firsthand.

He founded ATC in 1999; the company manufactures precision-built trailers. He began implementing Lean principles in 2009, following the economic contraction and a resulting drop in sales. He and his team improved the flow of materials, information, and parts; identified wasted processes; established simple standards; communicated them across the organisation; and implemented a materials replenishment system. Because of this, ATC was able to decrease its warehouse space from 105,000 to 50,000 square feet. Brenneman and his team then turned to the office and applied the same principles there. The result was a reduction in sales cycle time from seven weeks to three weeks. In 2010, whilst in the middle of focusing on Lean processes, Brenneman also began applying green principles. Initial goals included lighting upgrades, making recycling easier for line workers, and providing adequate bins for recycling cardboard, plastic, wood, wire, and wood on the floor. These goals were met, as was a 50 % decrease in paper use in the office.

Many of these reductions came out of processes that ATC learned through the Lean improvement cycle, which they refer to as the Deming Cycle (Plan, Do, Check, Adjust [Act]). This begins with a root cause analysis and asks whether a specific action or process is necessary, and what might be a better, faster alternative. The purpose is to rethink processes and come up with an answer other than, "*This is how we have always done it*". Conversely, they also found that green practices such as recycling, reducing, and reusing have helped them be more mindful of the details; this in turn moved them closer to the Japanese philosophy on which Lean principles were founded. Therefore, the two principles reinforced each other.

Although some green practices were implemented at the same time as Lean practices, others had to be put on the back burner to better focus on the Lean initiative. Now that the floor and the office are structured following Lean principles, Brenneman plans to redirect his attention to green actions. His goals range from eliminating cups for coffee and water and implementing machinery and equipment shutdowns on the shop floor to decreasing water usage by 50 % and developing an education plan for plant employees. When asked why he chose to implement eco-friendly initiatives, Brenneman pointed to his Mennonite upbringing, which taught him to care and respect other living creatures and the environment. He also pointed out that green principles make business sense: "*If you think about* '*green*' *in the*

right way, it doesn't have to cost extra; it may take a little more care and a little more thought, but you will find that it saves costs and saves money".

Although being "green" was important to him, operational improvements to address the tougher economic environment had to be the first focus, hence the redirected focus on Lean practices. Brenneman plans to move the culture of the organisation to one more in line with the Japanese philosophy of caring. This is very much aligned with eco-friendly principles and focuses on taking pride and care in how everything is done, which also leads to a neater and cleaner work environment and less waste. There are many synergies between Lean and green principles, and businesses including non-manufacturing ones can benefit from Lean and green practices. In today's economic reality, both can save money and help streamline processes. Both can be implemented, albeit maybe not simultaneously, and provide companies with a competitive advantage and even improved branding, in the case of green or eco-friendly practices.

A Step Guide for Going Lean and Green

Lean has a well-developed tool box that can be used to achieve Green production. Therefore, to develop and introduce a completely new Green tool box would not be advisable. Lean and Green should be packed together. There is already evidence of companies using various techniques:

- **Operator care programmes** focus on developing standard work within the operating units to decrease variation, which reduces the amount of product and raw materials waste. For example, a global leader in alumina refining and manufacturing of aluminium products successfully reduced energy consumption as a result of training operators in better standards of loading, starting, and operating manufacturing equipment
- **Kanban** is designed to provide the right materials at the right time to support manufacturing needs. Kanban reduces excessive inventories of raw or work-in-process materials. Cell-based manufacturing processes that signal a pull for materials based on the demand for product can significantly reduce raw material consumption, decreasing the amount of waste material delivered to landfills, as well as reducing the demand on raw material resources
- **SMED, or single minute exchange of dies**, has the potential to reduce the amount of waste generated from raw and unprocessed materials left over in manufacturing processes. For example, an aluminium door and window manufacturing facility found that they could reduce the amount of paint wasted per changeover from 50 gallons per day to less than 10 gallons. Paint disposal costs dropped by as much as £310,000 annually, and paint and solvent disposal were reduced by more than 40 %.

Zokaei et al. (2013) book is packed with case studies and examples that illustrate how leading firms use Lean and green as simultaneous sources of inspiration in

various sectors of industry—from automotive and retail to textile and brewing. This book shows that Toyota tops the green chart too, describing Toyota's notion of Monozukuri: sustainable manufacturing. Outlining a systematic way to eliminate harmful waste whilst generating green value, the book explains how to:

- Become economically successful and environmentally sustainable by adopting the Lean and green business system model
- Adopt a systematic approach to become Lean and green and develop your own road map to success
- Use the cutting edge tools, techniques, and methodologies developed by the authors
- Translate the techniques and culture that underpin Lean into environmental improvements.

Sobral et al. (2013) summarised the economic and environmental benefits for the Shipbuilding and Ship Repair Sector; their main findings were as follows:

- Lean manufacturing initiatives are generating significant economic and competitiveness benefits in the US shipbuilding and ship repair sector
- Despite these benefits, research indicates that the failure to explicitly connect an organisation's Lean initiatives and environment initiatives can leave significant business benefits on the table
- Shipyards can enhance business and environmental results by explicitly connecting Lean initiatives with an environmental management system (EMS) or other environmental initiatives
- Lean and EMS are highly complementary business improvement systems.

They proceed to make recommendations on how shipyards can incorporate environmental considerations into Lean methods and tools without distracting Lean efforts from their core focus on time, cost, and quality, namely:

- Involve environmental personnel in Lean events that address processes with significant environmental impacts and opportunities, such as painting or metal finishing
- Overlay key environmental metrics and costs, such as energy and water use or hazardous waste generation, on value stream maps to help identify improvement opportunities
- Incorporate environmental criteria in 5S/6S inspection checklists to equip employees on the shop floor to reduce environmental impacts and ensure regulatory compliance in their work areas.

The main conclusion has to be that Lean and Green should be two sides of the same coin. If you treat them as isolated projects, they will end up fighting for the same organisational resources and result in not much more than frustration. People are generally concerned about our society, and, as environmental issues are raised to the top of the political agenda in the world, individuals want to contribute. The virtuous circle is then complete: use Green to get Lean and go Lean to get Green. Embracing Lean and green manufacturing requires giving more focus to

environmental and energy concerns than just the implementation of reliability improvement projects. It is easy to do, but it requires a subtle change in perspective. Improvements geared towards equipment reliability have distinct linkages to environmental performance, such as reducing the amount of product and raw material waste through:

- The elimination of catastrophic breakdowns through formalised root cause analysis;
- Providing routine monitoring of system parameters through predictive technologies; and
- Preventing interruptions to production cycles with a focus on OEE.

There are possible steps which the organisation should consider in order to improve the likelihood of implementing both Lean and Green strategies, namely:

1. Know what Lean and Green really means. It is a process where you use more eco-friendly processes and products that help reduce or eliminate the 7 wastes in manufacturing processes plus the 8 wastes of Environmental
2. Identify, assess, and manage risks to employees, customers, suppliers, contractors, visitors, and the environment
3. Conduct operations in compliance with all relevant legislation and other requirements as a minimum condition
4. Consult and communicate regularly with employees about Lean Environmental Health & Safety (LEH&S) issues, improvements and about individual responsibilities
5. Develop improvement strategies and Key Performance Indicators (KPIs) on a continual basis, with appropriate targets, which aim to eliminate unsafe conditions, reduce non-value wastes, and prevent environmental pollution
6. Prepare and provide the necessary resources and investment in time to meet the targets
7. Continually conduct a Plan-Do-Check-Act (PDCA) review on performance and reassess the goals
8. Develop procedures, work instructions, and training material to assist the workforce to develop:
    - A Safer place to work
    - Lean Systems to reduce non-value steps
    - Processes that eliminate environmental pollution and energy wastes

Despite the relationships between Lean's 7 wastes and environmental wastes, many Lean implementation efforts often overlook opportunities to prevent or reduce environmental wastes. I have found adding the following 5 environmental wastes with the acronym **WASTE** to the traditional wastes helpful:

- **Water**: leaks, waste streams from processes
- **Air**: evaporation of chemicals, dust, particulate

- **Solid Waste**: filters, excess material scrap
- **Toxic/Hazardous Waste**: solvents, process residuals
- **Energy**: machinery on when not in use, heat loss, oversized motors

These five wastes raise awareness of the opportunities for improvements that not only affect the process, but also working conditions and overall environmental impact.

Environmental benefits from Lean alone are often incidental; they are not a result of an environmental focus or concern. Green and Lean should be synergistic not just additive or complementary concepts. The integrated whole of both methodologies is often greater than the sum of the impacts from each approach. The tools in the toolkit for Green and Lean improvements are one in the same. They include techniques such as VSM, workplace organisation and standardisation with 6S, spaghetti chart, waste walk or treasure hunt, kaizen activities, and standardised checklists. As in Lean, these tools are used to visualise and identify the wastes in our processes so we can eliminate or reduce them. You can get started today with a number of simple efforts in conjunction with your improvement activities.

1. Turn-off equipment when not in use
2. Set computers to hibernate after 30 min of no use
3. Use light sensors or turn-off lights when not in use
4. Rent or buy a thermal camera to find lose electrical connections in panels and transformers or overheating motors
5. Rent or buy an ultrasonic detector to find compressed air leaks
6. Work with your utility company to upgrade to energy-efficient lighting
7. When purchasing new equipment buy Energy Star® rated equipment
8. Establish a recycling programme at your facility
9. Look at ways to reduce paper usage with smarter printing and paperless approaches
10. Reduce the amount of packaging you use to protect or contain your product.

The most obvious benefits of Green and Lean are cost savings which are synergistically coupled with value creation opportunities. Cost savings may include energy savings, productivity savings, and savings from improved utilisation of materials. Value creation opportunities may include innovations that involve creation of new products out of waste materials and finding ways, in service delivery processes, to enhance customer's experience.

Considerations to Take into Account

Typical metrics for measuring environmental performance include scrap or non-product output, materials use, hazardous materials use, energy use, water use, air emissions, hazardous waste, and water pollution. None of these is directly

optimised in a typical Lean implementation, so it is difficult to know whether a Lean process is operating at optimal environmental performance. VSM, a standard tool in the Lean toolkit, examines the time it takes to produce a product and the proportion of that time that is value-added and provides the basis for optimising performance over the single dimension of time. But it does not explicitly consider the resources consumed and waste generated in manufacturing a product. To help address this question, as was undertaken by Young and Kanwalroop (2002) who developed *sustainable VSM* by adding a sustainability metric (supply chain carbon dioxide divided by market weight of product) to the conventional VSM process. Similarly, we could add environmental aspects to value stream maps. In the UK, road transport has been identified as the largest source of carbon dioxide emissions. Transportation is the fastest growing energy consumer in the European Union with a 47 % increase since 1985 compared with 4.2 % for other sectors. The idea of Lean location logic recognises this and attempts to minimise the total cost of operating a supply chain, albeit without internalising the environmental costs. It suggests that firms consider locating high-volume manufacturing in low-wage countries that are close to the region of sale, such as Mexico rather than China for the US market.

When cold storage is required along the supply chain, it is advantageous to keep inventory levels low. But this increases transportation emissions due to more frequent deliveries; consequently, there is likely to be an optimal order size that balances inventory level and delivery frequency. It could be forwarded that most of the analysis suggests that Lean supply chains are not necessarily green, although they could turn out to be green in specific cases. The main impediment appears to be distance. If a Lean supply chain is located entirely within a small region, then it would almost certainly be green from an emissions perspective due to the low levels of inventory and short shipping distances. As distances increase, it is quite possible for Lean and green to be in conflict, which may require additional modifications to the supply chain (perhaps moving it away from the ideal Lean configuration) if emissions are to be minimised. Thus, minimising carbon dioxide emissions in supply chains is likely to involve trade-offs between Lean principles and green principles. Another way for Lean supply chains to minimise emissions is by using more efficient transport modes, such as heavy-duty trucks in our examples, and sharing the trucks with other product lines and companies in order to use their full capacity. But the logistics of just-in-time deliveries could become quite complicated when large distances and multiple product lines are involved.

Supply chain restructuring enables supply chain participants to work towards overall supply chain effectiveness. Firms will try and increase the levels of coordination and implement supplier development programmes and select suppliers that are capable to meet up-to-date environmental regulation standards. This type of integration can ensure environmentally safe component parts are processed, distributed, and delivered to customers. These initiatives are conducive to reducing environment hazard materials and emissions and to increase employee's satisfaction and knowledge to do more with less.

Conclusions

Lean and Green initiatives need not be incompatible; sufficient evidence exists to indicate that they can complement each other. It is the case that in organisations that attempt to treat green initiatives as isolated projects; in this case, the organisation will end up fighting for the same organisational resources and result in not much more than frustration. If Lean and green principles were to be married from the outset, the result would be a more comprehensive look at the life cycle of a product or service. If cost-reduction opportunities from environmental wastes are overlooked, then the true costs of production are not really being accounted for, which is not Lean. Lean is about companies embracing change to reduce waste in how they produce a product or service. It engages and empowers employees to develop and implement ideas and requires a culture of continuous improvement. Lean manufacturing practices, which are at the very core of sustainability, save time and money which is an absolutely necessity in today's competitive global marketplace. Whilst the pursuit of Green and Lean is not a destination but a journey, it is clear that organisations that stretch themselves to build a culture around the values of Sustainability, Excellence, and Equity will ultimately have a big advantage those who do not. We could argue, is not the ultimate definition of "sustainable manufacturing" to be able to compete and not only survive, but thrive? We have sufficient examples depicting that violating environmental laws resulting in fines, damage awards, and remediation costs damages a firm's reputation and causes market value loss.

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Chapter 15
Potential Issues with Lean

Abstract Lean not only has proponents, but also has critics who should be deliberated in any discussion in reference to Lean. Critics allege Lean to be a throwback to the group piecework systems of the 1920s where supervisors engage in full-time monitoring and disciplining underperforming workers, a return to Taylor's scientific management approach from the more advanced behavioural approach to managing workers. The purpose of this chapter is to offer the reader a structured overview of the various commentators who have objected to Lean over the years. The purpose is not only to offer opinion as to the validity or otherwise of these objections but also to raise awareness. The Lean movement is strong on both sides of "the water". In fact, the practitioner community was barely impacted by the polemics within the academic community. This is in spite of the fact that the academic origins of Lean are frequently cited by practitioners is being key to their belief in the effectiveness of Lean. It is the author's hope that this brief overview will augment the readers' knowledge and understanding of the some of the dissent and debate that has taken and continues to take place in a world that often seems irrelevant and even alien to Lean practitioners. Equally, in an investigation of this kind, it is important to initially explore the potential pitfalls of Lean before highlighting possible solutions to the issues raised by the critics of Lean.

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 USA and Europe, where many of the needs of the individual are often regarded more highly than the needs of a group. 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, the TPS, or Lean for that matter is not perfect; critics argue that its Toyota's cars are dull, and

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its performance in Europe has often been lacking. Even Toyota in Japan has in recent history failed to produce in several circumstances cars to actual customer order. Any organisation needs to recognise that in an overzealous campaign to reduce waste and focus value-adding activities, that a company may focus on obvious short-term benefits and ignore long-term competitive advantages. The return on investment for many innovations is very difficult to quantify when the ideas take shape, especially before the potential market has been clearly identified and developed, it could be that those ideas especially the ones offering long-term contributions will be considered non-value adding and consequently be cut-off.

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 and Bennett 1996, p. 8). Likewise, the original process of measuring the five-year study has come under suspicion in certain circles. It is suggested 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 and subsequent researchers 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. Several researchers (Cooney 2002; Mason-Jones et al. 2000; Yusuf and Adeleye 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.

It has been forwarded 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) suggest that Lean may have reflected particular market conditions at a specific point of time. Likewise, it has been proposed that Lean finds it difficult to deal with turbulent and consistent change. This coupled with the continuous pursuit for perfection can adversely affect flexibility. Similarly, 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. Presently, it is evident that Toyota relies on policy management (hoshin kanri) at the macro level and a cadre of line managers auditing their areas at the micro-level.

Public Reaction Towards Lean

From a purely operational and marketing concept, we find some sceptics towards the perception of Lean. There exists a school of thought providing some evidence concerning the public reaction towards the plethora of new products and the ever-increasing alternatives that appear at an accelerated rate. 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. 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. Lean could damage sales in some sectors. 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. The most efficient plants strip out the overengineering; "*why produce a car that can exceed* 150 mph" type of arguments. 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 from an added value concept. 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 regard to sales and profit margins that occur with attracting the strata of society with the highest disposable incomes. 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 in the current climate.

During the 1970s, Nissan discovered that the Toyota practice of having suppliers make or deliver components "just-in-time" to assembly lines several times a day, with deliveries controlled by the physical exchange of production or parts delivery tickets (kanban cards), did not work well in congested urban areas. As more and more Japanese factories in different industries have adopted the Toyota practice, traffic worsened to the point where, in the 1990s, the Japanese government mounted a media campaign encouraging companies to reduce the frequency of their parts deliveries. Traffic congestion pollutes the environment and wastes time, whilst people are stranded in traffic and in manufacturing plants, waiting for components

to arrive. Nissan's plants have always been more dispersed than Toyota's plants, so Nissan management was convinced that it was indeed more practical and economical to keep a greater amount of inventory on hand than Toyota did. Nissan did this even though it had adopted the practice in the early 1950s, along with Toyota, of reducing unnecessary inventories to save on operating expenses and catch mistakes that might be hidden or take too much time to identify if parts were stored for weeks or months. Ultimately, Nissan reduced average inventories from a month to a day or so, but not to the extreme of a couple of hours as Toyota did. Other Japanese automakers in other parts of Japan encountered similar problems; traffic congestion even in formerly rural areas such as Toyota City and Aichi Prefecture (where most of Toyota's suppliers are located) has forced companies to make JIT a bit less timely.

Regular accusations are made that smaller deliveries just-in-time proceed to make producers more vulnerable to disruptions in supply. 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 do not actually improve utilisation in many ways. 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 their Western counterpart suppliers. Lean aimed 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 offline.

Supplier Management

A prominent driving idea that most companies adopt when they begin their conversion to Lean is to consolidate their vendor list. A reduction in vendors can save resources; however, it can also limit innovation. The author spent some time with a Lean organisation recently and witnessed an unfortunate issue as the engineering staff explored a new quality process. The engineers had identified a promising new measuring device, but they were unable to purchase it for testing since the vendor was not "on the approval list". This led to considerable delays and additional expenses for bringing innovation into the company. If not careful, organisations can encounter similar problems as an effect of vendor and supply chain control in Lean enterprises. Another obvious limitation of Lean manufacturing is the need for cooperative and reliable suppliers, which account for approximately 75 % of manufacturing work in the automobile industry and

approximately half of product development, measured by costs http://sloanreview.mit.edu/article/the-limits-of-lean/-ref5. For the system to work, suppliers must agree to manufacture components in small lots and then deliver frequently to assembly plants; otherwise, they will simply hold inventory, raising their own carrying costs and eliminating their ability to improve quality and productivity through short production runs and correction of errors or process improvements made with each new set-up. As Japanese companies disperse their plants throughout Japan and other parts of the world, however, they have been able to move only some of their suppliers. Non-Japanese suppliers have not complied exactly with Japanese pricing and quality requirements, nor have the Japanese trusted foreign suppliers fully in product development. Until the recent recession (which is lasting longer than anybody in Japan predicted), Japan had experienced a severe shortage of factory labour domestically. The Japanese government allowed foreign workers from south-east Asia, the Middle East, and South America to come to Japan and work in Japanese factories, mostly at the smaller suppliers. This practice helped the labour shortage, but it also introduced new problems: the need to train the foreign workers and manage people with little or no literacy in Japanese. Many companies report quality problems and reductions in worker flexibility as a result of using less-skilled foreigners; this has lowered supplier productivity by forcing managers to reduce work schedules and use more inspection and rework to ensure that they still deliver high-quality components to Japanese assembly plants.

The Shortage of Blue-Collar Workers

Today, there are usually more factory jobs than there are young Japanese people willing to take these jobs. The result has been intense competition for blue-collar workers, not only by small suppliers but also by the assembly facilities of major companies. In addition, young Japanese workers leave blue-collar jobs and, increasingly, even white-collar jobs, if they feel overworked or unhappy for other reasons; for example, in the early 1990s, Toyota encountered serious difficulties staffing its factories near Toyota City because of the severe shortage of blue-collar workers (women are still not permitted to work in most Japanese auto assembly factories) and had employee turnover rates in its factories of approximately 30 % annually, including the seasonal hiring of temporary workers. Although this is not actually a new problem for Toyota, the labour shortage and turnover problem are likely to worsen rather than improve if the Japanese economy recovers. As a result, a necessary change in strategy and tactics will likely reduce the productivity advantage Toyota has enjoyed at home. It should be recognised that the Lean concepts of teamwork were first developed by Taiicho Ohno. Critics suggest that as Lean practices reach an extreme level, the shrinking size of the workforce and busy schedules of employees who have multiple responsibilities will make it much harder to get workers together for formal discussions.

Micro-strategy

Whilst somewhat dated now, this argument summarises the contemporary debate aptly.

Stergiou (2014) persist 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" (p. 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. Chen et al. (2010) suggest that by blindly following customers' demands may lead a company to focus on technology development that overshoots customers' demands and lose the market to disruptive technologies that had been initially denied by the same group of customers. Subsequently, exclusively following customers' definition of value and the elimination of all "non-value" adding activities can lead a Lean organisation to failures since the customers can be wrong, or at least short-sighted.

Product Variety

The virtual explosion in Japanese product variety, during the 1980s and early 1990s, particularly for Japan's domestic market, enabled the most successful companies to expand their market shares and regularly convince customers to buy new versions of automobiles, video recorders, stereos, laptop computers and word processors, microwave ovens, and dozens, if not hundreds, of other consumer products. Toyota and other companies designed JIT/kanban-like systems to facilitate small-lot production when combined with fast equipment set-up or changeover times, synchronised parts production and rapid delivery, and versatile workers who can quickly move to solve problems or shift to parts lines and assembly lines for rapidly selling products. But large engineering organisations and independent heavyweight project managers, encouraged by marketing organisations, have created too much product variety and offered too many options to customers. The result is that parts makers and assembly plants have to accommodate very small and very rare orders too frequently. This variety requires constant equipment set-ups and kanban exchanges, as well as many deliveries of small lots of components—just when total sales are stagnant, and workers, suppliers, and traffic systems have reached a sort of practical limit. Not surprisingly, many Japanese firms have concluded that, in the short term, they need better scheduling and control systems to

handle so much variety, and more importantly, they need to treat the root cause of the problem and reduce variety to the 20 % or so of models and product variations that generate 80 % of their profits and sales.

It has also become impractical to let the manual exchange of kanban cards "pull" new orders of components into the production system and relay all production information. There are now better methods available (such as the use of barcode readers and other electronic forms of moving information) for plants with very high levels of variety which covers most Japanese automakers and producers in many other industries. Too much product variety has also created environmental concerns. Japanese automakers have been introducing replacements of existing models every four years, in addition to continually expanding their product lines, for example, into new luxury segments. Japanese government regulations and mandatory fees or maintenance charges for automobile inspection also encourage consumers to replace their vehicles every four or five years. One outcome is consistently high domestic demand for new Japanese cars and trucks. But another outcome is the need to dispose of all the replaced vehicles. Some become used-car exports to other parts of the world, but Japanese companies now realise they need to think about how to recycle automobile materials more effectively.

Perhaps, the most pressing concern for Japanese managers is the cost of new model development and model replacement now that money is expensive in Japan. Bank interest rates have reached international levels, and banks can no longer make large cheap loans because their portfolios of stocks and real estate (needed as a basis for loan limits as a percentage of bank assets) and the portfolios of their customers (normally used as collateral) have declined in value. Companies can no longer raise much capital on the stock market because of the Japanese investors' reluctance to buy securities in a market that has dropped 50 % in value during the past several years. The only source of truly "free" money used in the past for product development as well as capital investment is operating profits. In the current recession, however, operating profits have also declined dramatically for Japanese firms. Thus, for the intermediate term, Japanese managers have realised that they need to reduce their overall investments in new product development (which also requires major investments in manufacturing preparations) as well as cut the amount of variety they have in components and final products. Companies in the automobile industry, for example, are now reducing unique parts and product varieties by 30–50 % or more for new models. Japanese companies have also been reining in the heavyweight project managers, placing some limits on their budgets and choice by establishing platform managers and chief engineers. These higher-level managers, who are above the project managers, coordinate the development of a group of technically related models, making sure that they share more key components and manufacturing facilities. These reductions in unique parts and greater sharing of components across models should ease problems in assembly plants and at suppliers, as well as save money in engineering and manufacturing–preparation costs. The risk, of course, is that sales will no longer grow as fast as they did when Japanese companies continually introduced streams of new models with lots of new technology and replaced old models quickly. Sales may even

decline, although profits may rise as a percentage of sales if the Japanese learn how to generate more profits from each product development effort, rather than simply look for expansion of sales and market share.

Some proponents of Lean remain unconvinced regards its ability to deal with variability. Some Lean approaches such as mixed model scheduling and level scheduling (heijunka) essentially seek to compress down or control the demand supply. 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. 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.

Universal Production System

An argument forward over a decade ago is still posing many searching interrogations. 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.

The advocates of Lean assume that the Japanese style of long-term contracts between buyers and suppliers is standard industry practice within the Western economies. 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:

- 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, many still insist that Lean suits environments that are characterised by low technical uncertainty. 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 as evidenced in recent ears. Sharp reductions in buffers inevitably lead to reductions in timing control for operators and can lead to increased stress levels. Many authors noted that successful Lean implementation is dependent upon several organisational factors such as management strategies, labour–management cooperation, employee, and union involvement, investment in training (Hines et al. 2008). Other authors observe that Lean is also conditioned by external forces such as market situations, international division of labour, local institutional environment, and social culture. Some authors stress the importance of considering the evolution of firms and transplants in the light of their own trajectories and particular histories.

Impact of Lean on the HRM Issues

Past empirical research identifies the management of human resources as a significant issue in the implementation of Lean. Bamber and Graves (1999), Yauch and Steudel (2002), and Doolen and Hacker (2005) stated that the "*rigid hierarchical organisational design*" (Doolen et al. p. 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 in fact achieve world-class performance with a positive effect on employees. There are potentially negative effects on jobs and outcomes because of the workflow formalisation inherent within Lean, provided this has not been managed appropriately. It is considered within organisations that this situation may arise, namely when jobs are designed to be coercive, methods by which management can attempt to coerce employee effort and compliance.

In contrast, it could be forwarded that by rotating jobs and sharing responsibilities, multiskilled workers can solve quality problems; this freedom replaces the stress of repetitive and monotonous tasks undertaken in a non-Lean environment. 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 on several occasions. The studies reflect that the personnel requirements and system requirements were not often aligned. Evidence has 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 these empirical studies that the respective organisations have failed to fully integrate human behaviour into the process. In a similar way, it has been argued 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. When proponents make reference to developing the people and workers, we should not refer to their spirituality, intellectual curiosity, or moral judgement. 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.

Stress

It has been forwarded that Lean makes the workplace too clinical and impersonal, with workers under relentless pressure to do better than before. Whilst such pressures lead to workers stepping out of their comfort zone and assuming a sense of urgency, it also increases stress levels considerably, and high stress levels can have determinable effects on productivity and efficiency. Stewart et al. (2009) examined worker responses to Lean at Vauxhall-GM and Rover/BMW and found that they are intimately tied to changing patterns of exploitation in the car industry. They concluded that:

> at the heart of Lean lies the irreconcilable contraction between the rhetoric of success, security and a range of enriching employment experiences, and the reality for many millions of workers, of exclusion, insecurity and deteriorating employment experience … many workers whose work and lives have been devastated by the ravages of Lean production (p. 11)

Critics argue that Lean creates intensified work pace and demands, so Lean work is a potential source of job stress and increased rates of musculoskeletal disorders and other health problems. In an overview of international and Swedish studies regarding Lean and work-related musculoskeletal disorders, Brannmark and Hakansson (2012) suggest that when Lean is implemented, there is a tendency to increased work pace, workload, stress, and risk of work-related musculoskeletal disorders. They argue that the risk of work-related musculoskeletal disorders increases if the Lean implementation is not accompanied by an ergonomic intervention with the aim of reducing repetitive work and monotony. There is a recognition that jobs within a mature Lean system are supposed to make employees

feel important and challenged, and respected by the company. However, workers would not be able to be innovative when they have been under too much stress for too long. When a company becomes Leaner, a naturally expected result is lay-offs; workers in the West do not have a luxury of a lifetime employment guarantee.

Overfocus on Waste

Another major criticism of Lean manufacturing is the overfocus on elimination of waste overriding other concerns. Lean strives to ensure productivity and efficiency primarily trough cutting flab, but in the process ignores other crucial parameters such as employee wellness and corporate social responsibility. A company, for instance, might recruit additional workers than necessary as part of its corporate social responsibility necessary to establish good relationships with local communities. Similarly, top management might need to spend an extensible amount of time to lobby and socialise with external agencies to secure orders and negotiate extensively. Lean does not cater to such unconventional requirements.

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 in any Lean initiative within any country or organisation. 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. 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. 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 and 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.org) assists to identify and measure best practices in the implementation of Lean in a manufacturing organisation.

Certain Situations Are Regarded as More Conducive Towards Lean

This book has looked at how the success rates of Lean can vary amongst the sectors and sizes of organisations owing to a multitude of factors. It was discovered within the research, for instance, that larger companies had implemented Lean practices to a greater degree. These findings were consistent with the findings of other pieces of research which 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, become 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.

This concept stems back to the times of Shah and Ward (2007) whereby the research 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 as follows:

- Cross-functional workforce
- Cycle time reduction
- JIT/continuous flow production
- Maintenance optimisation 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. 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.

Recent proponents admit that logistically smaller organisations are more able to fully apply Lean within their own organisation. Nonetheless, it could be argued 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 multiskilled 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. Craft work methods based upon buffered flows, such as the dock assembly method, are still widely used in bus and truck assembly. 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 influences 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 decoupled 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. 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. 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. We see situations whereby 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. Equally, production levelling and production smoothing based upon small-lot production, using standard times, become 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 decoupled 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.

No Margins for Error

Lean tools such as just-in-time inventory and six sigma allow for no safety stock or margin of error and vilify any deviance from the codified optimal process. Whilst striving for such perfection leads to better performance, attaining such precision standards may not always be possible, and at times, unrealistic owing to vagaries of the external environment and human nature. For instance, traffic jams can delay arrival of an inventory and thereby, hold up production in a JIT system. Similarly, excellent employees might have certain off days where they do not work at their productive best. Incorporating Lean requires a favourable external climate. Incorporating Lean principles, for instance, is not possible in places with unreliable energy supply, inadequate transportation infrastructure, and or poor work culture in the society.

Overfocus on Present

Lean's constant pressure to eliminate waste and ensure optimal output places all energy on the present. Lean does not allow reflection or experimentation for the sake of development in the future. Such a focus on only the present may lead to missing out on the bigger picture, failing to comprehend the relevance of the task in the first place, or taking time to anticipate future challenges and make necessary changes to respond to such challenges. Lean also stifles creativity, innovation, or experimentation, which not only hampers the organisation from responding to changes better, but also makes it difficult to realise sudden opportunities that have become the norm in a fast changing external environment. In a similar context, it is also forwarded that employees in a Lean company are trained and expected to take multiple responsibilities. As a trade-off, employees may lose special expertise as they change roles frequently. If the job responsibilities are shared too broadly and shifted too often, the employees may never get a chance to deepen their understanding and keep up with the development of technologies in any area.

Lack of Standard Methodology

Lean is more a culture than a method, and there is no standard Lean production model.

The implementation of Lean takes place through various tools such as, and others. The absence of a standard methodology, with any or all such tools achieving the elimination of waste in a process, whilst allowing for flexibility of approach, can also work against Lean with people remaining confused on which tool serves the

desired purpose. The success of any adopted Lean production model depends largely on the extent to which each individual member of the workforce masters the relevant tools and understands the methodology. Even if one individual amongst the workforce refuses ownership of Lean and fails to adopt Lean practices, the entire Lean system collapses. An important issue that has been highlighted by the opponents to Lean is that Lean with its strong focus on standard operations might lead to decreased worker autonomy and low levels of job control; this could result in a situation that according to the job-strain model, creates work-life stress. That, in the long term, may negatively impact productivity, product quality, costs, and competitive strength.

Financial Systems

It is also within the area of financial systems that sceptics of Lean have voiced their concerns. Whilst often it is the shadow pricing strategy, which is used by both Lean and mass production companies, the Lean organisations tend to use it more aggressively. The notion being that there exists an expectation whereby, through the learning curve effect and economies of scale, that there will materialise a drop in the average unit cost if the sales reach the projected volumes. Both producers (mass and a Lean entity) decrease the product price, often on several occasions, as their products reach the later stages of a product life cycle in order to beat potential competitors and succeed in penetrating the market. The main difference, often, is that the Lean producer attempts to set the selling price lower than that of the mass product organisation and lower than its actual initial cost; the concept behind this being that by applying the Lean practices, that the unit cost will drop more quickly and dramatically as more customers are attracted to purchase the product. The consideration being that profits secured through the expanded market share will compensate for the losses incurred at the beginning of the products life. However, whilst the aggressive shadow pricing strategy encourages initial purchases and can succeed in an expanding market, applying it in a shrinking market, without being able to differentiate one's product through superior features and quality from its competitors will likely, only expedite the fall of the company. It should be recognised that simply being cheap is not the answer to sustainable success; innovation and technological advancements are the ultimate driving forces of product leadership.

Possible Solutions to Augment Lean Benefits

Whilst it is not the intention to offer an exclusive list of solutions, a few suggestions are proposed which would assist any organisation hoping to successfully implement Lean. In any review of a company that has a strong survival instinct, we often find

that this organisation has embraced the ability to be agile and flexible in their product design and manufacturing environment. Lean organisations will not focus upon achieving high profit margins solely; they will cultivate an innovation-conducive culture whereby value will be defined in a manner whereby innovation driving activities are not viewed as muda. Setting aside some creative times not only assists to reduce job anxiety but also awards employees an opportunity to stimulate out-of-the-box thinking. A R&D portfolio that builds both short- and long-term competitiveness will better prepare a Lean organisation. An essential component of the Lean system needs to be the respect and involvement, as far as possible, of all in the decision-making process. In this manner, a sense of importance, enjoyment, and satisfaction will be provided to motivate employees' creativities.

As a result of the added flexibility, a Lean company should be able to respond to the changes more effectively if contingency plans are developed ahead of their absolute need. This type of organisation is also likely to closely monitor and forecast the market demand and technology trends, assess its own competitiveness, conduct sensitivity analysis, and generate scenario analysis. A variety of decision-making tools are available to facilitate such activities and sharpen decision-makers judgment. Flexible product platforms can be designed to effectively share common components and deliberately project uncertainties into flexible elements that are residue-modified in different product families or product generations. In this way, the need of redesign as well as changes in manufacturing tooling and equipment will be minimised in an event of new product introduction.

Owing to the strong dependencies of a Lean company on its suppliers, it is critical for the Lean company to support those suppliers. This calls for more transparent financial systems and cash flows along the chain, since the system is only as strong as the weakest component of the whole chain. A cash-strapped supplier who is unlikely to support innovation could be saved and ultimately deliver better products, a component supplier to a vehicle seller, for instance; the latter could achieve this most likely by increasing its prices by a few dollars per vehicle and passing the added revenue directly back to the struggling supplier with a very small impact on number of sales over the short term. This could clearly be seen as a "shadow pricing" initiative that would reap huge benefits in the future. Closely working with the suppliers also assists the Lean organisation to keep updated with the most recent developments in manufacturing technologies. This may require additional personnel from the Lean company to work with supplier organisations. Nonetheless, it is critical for the organisation to maintain its ability in designing and debugging the manufacturing system and to optimise the whole value chain. Consequently, in difficult economic times, when the company's initial reaction would be to bring the extra people in the suppliers or customers plants, "back home" to address local needs as the workforce is carved down to its "leanest levels", this is often the worst means to tackle the issues posed by the tough economic conditions.

Summary

Evidently, the term "Lean" is used by many organisations and Lean facilitators referring to bundles of different systems which do share the same fundamentals. The prominent objective of any business naturally is to make money. It is logically discovered that when a combination of low production volumes, extensive product, and process innovation, the continual negotiation of new business contracts and the prevalence of customer switching occurs, frequent and severe disruptions to production had to be managed. Unfortunately, many organisations play at implementing Lean and utilise direct labour as their primary cost driver. Consequently, this becomes a dominant objective for the elimination and optimisation; in turn, this results in the organisation to become too focused towards headcount reduction and labour efficiency measures. This sends the wrong message regards the true objectives of Lean. With respect to the HR aspects, organisations should be considered to advance their personnel's skills and attitudes in ways that will serve towards continuous improvement of the processes and ultimately to everyone's benefit within the setting of success in their collective activity. Once again, inopportunely, within organisations, a situation is often witnessed, namely when jobs are designed to be coercive, it follows the techniques used by management which can attempt to coerce employee effort and compliance. However, the overall research in this book has demonstrated whereby it is possible, from a strategic perspective to integrate other approaches without challenging the core objectives of Lean. Good examples would be OEE and OSCE. Equally, six sigma attacks sources of variation by applying a rigorous set of quality tools that are highly compatible with Lean. A review of the criticisms levied against Lean manufacturing suggests that much of the drawbacks stem from the method of implementation rather than any inherent flaw in the Lean culture. Proper planning, good implementation by incorporating effective change management practices and leadership, stress management interventions, and effecting a change of culture so that each member of the workforce inculcates the philosophy of Lean help resolve many of the limitations of using Lean manufacturing and overcoming the criticism of Lean manufacturing.

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Chapter 16
Lessons Learnt

Abstract Lean manufacturing is part of a business-wide strategy aimed to increase market share whilst at the same time attempting to minimise operating costs. In the face of ever increasing global competition, businesses are driven to improve flexibility, sharpen market responsiveness, improve output, and, simultaneously, reduce overall costs. Lean manufacturing is one of the key, but not only, means by which this is being achieved. Applying Lean into process or hybrid manufacturing industries can pose difficulties. Most companies are struggling with rapidly declining product life cycles and the need for many new product introductions. The need to get fast cycle products to market can often trump the perceived need to operate on Lean principles. Those organisations applying Lean appropriately will be able to maximise output, whilst eliminating unnecessary expenses. This chapter proceeds to summarise the prominent aspects covered in the book and draws suitable conclusions which would aid organisation and Lean proponents grasp a better understanding of Lean and its associations with both overall business efficiency and strategy formulation.

Lessons Learnt

It is vital that the Lean as a concept is considered as a philosophy or condition rather than as a process. In that respect "*Leanness is a relative measure*", Ohno's principles clearly reflected how the Toyota Production System was considerably more than a production system as he always advocated Lean to be a complete management system. Lean requires and expects commitment from all the various levels within the organisation. It transcends far beyond the engineering and management disciplines since at its core, it endeavours to promote the concept of value and the eradication of waste in a continuous method based on common sense. For a successful implementation, organisations need to separate the Lean Philosophy from the techniques and tools used to support the philosophy. It is a composition of techniques embraced from a structure that has been derived from a philosophy.

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Lean must always be observed as a philosophy with the tools such as Six Sigma acting as enablers. Customers are becoming more demanding, markets are becoming more customised, and product life cycles that are getting shorter are just a few of the reasons why Lean could be important to you. As the demands on our processes increase, they evolve and adapt accordingly which often results in processes that end up inefficient and wasteful. Lean is about challenging the way things are done and opening our eyes to that waste and inefficiency. The environment in which an organisation operates will continue to change; Lean can help organisations meet the challenge. Revealing results and conclusions were deducted from the detailed analysis undertaken. Despite the prominence of Lean globally, there exist obstacles to its adoption and dispersion with organisations.

Whilst the following list is only meant to be indicative, the overall evidence suggests that short- and long-term benefits will accrue through Lean which are evident provided an appropriate level of commitment and planning occurs:

- **Improved quality**: a considerable amount of the activity in a Lean environment is geared towards improving quality. As quality issues arise, problem-solving techniques are used to analyse the root cause of the problem. From there, mistake proofing is put in place to strengthen the process and prevent recurrence. As a result, the quality of your product will be improved.
- **Improved Visual Management**: Lean is management by sight. If done correctly, your plant will be set up so you can evaluate an entire area with a visual scan. Any abnormalities will stand out and be easy to identify as a problem.
- **Increased efficiency**: line balancing will ensure each person in the process is working in the most efficient manner. Standardised work will ensure they are doing it correctly following the same method every time. This leads to repeatability and increased efficiencies.
- **Manpower reductions**: undeniably, Lean is getting more done with less people. With standardised work and increased efficiencies, the ability to do the job with less people becomes a very real possibility. This does not mean you have to send these people to the unemployment line. The concept of Lean would have these freed-up people utilised to perform further kaizen activity, training to enhance skill level, or maintenance of the system once it is implemented.
- **Easier to manage**: the work instructions and standardised work let people know what they have to do and when. This makes managing an area much easier. And problems will still arise. But they will be much easier to deal with in a team environment where the support groups are eager to help solve problems.
- **Total Company Involvement**: Lean is meant to involve the whole company. It is not intended to be put into action in only one area. It is a management philosophy which should include every part of your organisation. This helps promote the concept that everyone in the company is part of the team.
- **Problem Elimination**: Lean manufacturing forces you to attack an issue and continue to investigate it until it has been eliminated. Root cause analysis and cross-functional teams are utilised to ensure a problem receives the level of attention it deserves to correct it.

- **Reduced Space**: as part of the waste reduction process, space will be created. Reduction of finished and raw inventory will save space vertically in your racking as well as horizontally across your floor.
- **Safer Work Environment**: visual management and 5S will help identify when things are out of place. When unnecessary elements are removed from the operation, the workplace becomes much more organised. And an organised work environment is a safe work environment.
- **Improved employee morale**: this may not be realised during the initial stages of your implementation; but once the concept of Lean starts to get accepted by the employees, you will see employee morale on the rise. Employee involvement and empowerment will make all members of your company feel like a contributing part of the team. The reduction of uncertainty in the workplace, as a result of Lean, will reduce stress in your team members and lead to improved employee morale.

Most Lean journey failures can be attributed to the organisation's prevailing culture. Integral to this is the concept of appropriate communications and the role of leadership and management. Employees should not be regarded as a significant resource to the company; instead, they need to be viewed as the organisation. An organisation's culture encapsulates the conventions, principles, norms, and noticeable artefacts of its employees and their behaviours. It was apparent that managing around the culture is a distinct possibility; nonetheless, this may result in sustained success. In order to induce organisational change, there is a need to initially change behaviour as depicted by Laureani and Antony (2012), Montgomery (2010), and Stefanie et al. (2012). Likewise, attempts to replicate a formula which has proven effective in one organisation under different restrictions would prove reckless in another organisation. A popular view advocates that it is ineffective to bring about organisational change by attacking attitudes and values. In order to induce organisational change, there is a need to initially change behaviour. Zokaei et al. (2013) suggests that companies hoping to secure Lean success need to relinquish the conventional disciplinary and personnel administration and instead look to adopt strategic human resource management (Stefanie et al. 2012). The research showed that this will facilitate fresh resolutions, a quicker acceptance of innovative ideas with the intention to fulfil customer needs (Wincel and Kull 2013).

Lean exists as a complex interrelated set of processes. There is a requirement for strategic and operational alignment between the different links of the supply chain. Within this supply chain, Lean can be introduced to product design, process planning, and organisational control. We explored at great length that Lean can not only survive but prosper when linked to and applied with outsourcing, IT systems, Six Sigma, and agility. Outsourcing, for instance, aids to relieve the pressures of sustainability demands and a struggling global economy; in this situation, a Lean supply chain becomes imperative to success. When undertaken correctly and this is explored within the book, it can also save time, advance creativity, improve quality, and make a company more flexible. The book also looks at other links whereby Lean has inaccurately not been viewed positively with. The Lean community, it needs to be stressed, is not and should never be against IT but equally must not be obliged to

sprint towards automated solutions; through experience, this tends to institutionalise large amounts of waste. Having said that Lean cannot afford not to embrace technology, it may permit a much more complex or advanced manufacturing process to occur. In a similar context, organisations wishing to knit Lean and Six Sigma together are doing so—'**Lean Sigma**'. Whilst Lean and Six Sigma differ, they are also complementary. Organisations must innovate, not just improve. Despite its heritage, Lean Sigma is well suited for this step change in target and scope.

In a similar context, Leagility has proven beneficial for organisations as Lean and agile can accompany each other; the decoupling point indicated could be used effectively by the organisations since the supply chain implications would have to be managed effectively. Any increase to the organisation's product or a change in the volumes would enable the decoupling point to shift upstream which would consequently make the supply chain more agile. The implementation of leagility requires a situation of a complete business philosophy which should integrate both the "socio-technical systems", namely recognising that all work organisations conglomerate a technical, i.e., technology, and a social system, i.e., people and organisational structures. Leagile 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 various functions. Lean needs to form an organisations strategy to be successful and be treated as a system comprising of more than the sum of its components. Lean is an entire business philosophy; it essentially needs to ensure that the whole business is analysed its entirety, including how orders are processed, the way materials are purchased, and the way manufacturing is done. Lean is successful where organisations see it as a never-ending process. An organisation always strives to be Lean, but will often never quite achieve it. Essentially, there is always a gap between where the organisation is and where its ideal state is. 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. It was also necessary to outline the often flawed perception regards the tools for Lean. It has developed over the last five decades and has yielded a wide array of tools and techniques. An attempt was made to outline 25 of the essential tools; the list is not intended to be exhaustive, but once again in one's experience, it has become evident that these components need to be evident for Lean to thrive. Subsequently, another list of 52 tools was explored. The core concept which every organisation should recognise is that a collection of appropriate and timely tools will be required for Lean to thrive. Equally, the type and application of the tools should and will depend on the stage of the Lean journey that the organisation has managed to reach.

Despite Lean existing for several decades, a number of implementation and generic barriers have been identified whilst evidence in the author's own experience required greater scrutiny. Contemporary research was used to emphasise the prominent obstacles inhibiting organisations to either embrace Lean or frustrate its wider application. Whilst some of the aforementioned analysis has revealed definite blockades indirectly, we explored in greater depth the issues which organisations, Lean practitioners, and executives need to consider in their efforts to implement Lean within their organisations. Whilst the barriers to Lean need to be explored, it is their

origins, interrelations, and relative importance that need to be understood. The ultimate aim for any organisation should be to link its Lean initiative to financial improvements. A perfect example being a lack of senior management support which is often cited as a barrier; however, it is important to try and determine why some managers are more supportive than others and it is unclear regards how this is measured. In respect to the numbers of successful Lean initiatives, we explored the question why have so many companies not been able to achieve the benefits they had hoped for through their Lean strategies, or in some cases abandoned their efforts altogether.

A central theme explored whether Lean results in improved performance levels which required performance measurement to be considered. Evidently a balanced portfolio of metrics is required to address all dimensions. Lean does not easily associate itself to the traditional accounting systems; it is for this reason that organisations need to embrace systems which can appropriately gauge the impact Lean is making within their own organisations. Undeniably, Lean does entail a substantial investment which subsequently reaps exponentially a greater degree of savings. This makes it vital for an organisation to gauge reliably the impact of Lean; this information is vital for policy makers within the organisations to make evidence-based decisions. The need to integrate indices beyond those of a financial focus alone became apparent. The conclusion suggested that the impact of Lean can only be accessed through the interrogation of a cocktail of indices; consequently, it is vital that an organisation embracing Lean uses a balanced scorecard approach.

In order to test many of the findings, primary research was undertaken. The methodology intended to substantiate the judgments. Two discrete data capture mechanisms were utilised. Predominantly, the data were secured through comprehensive survey questionnaires and case studies undertaken in 15 manufacturing companies reflecting the components, automotive, and electronics sectors. Various aspects are considered, namely the triggers to adopt Lean, the barriers encountered, the strategic aims, the level of Lean adoption within the sector, the impact upon performance levels of the organisation, possible sustainability, and recent trends in reference to Lean within the respective sectors. It proceeded to analyse the correlation and causal links between Lean and performance of the organisation. It was necessary to be able to decipher the journey an organisation encounters in its quest to become a truly Lean organisation. The analysis is overwhelming in its evidence that Lean should be regarded as a journey, an end destination that may never be achieved by most organisations. A flexible audit which can be customised permitting an organisation to gauge the level or stage of Leanness that it has accomplished was devised. The comprehensive audit besides the technical inputs necessary for Lean also scrutinises the change management and cultural components necessary for Lean to be successful. Likewise, the metrics take into account a consideration of whether Lean has led to improved performance levels for the organisation.

Lean not only has proponents, but also critics. Unfortunately, many organisations play at implementing Lean and utilise direct labour as their primary cost driver. Consequently, this becomes a dominant objective for the elimination and optimisation; in turn, this results in the organisation to become too focused towards

headcount reduction and labour efficiency measures. However, the overall research in this book has demonstrated whereby it is possible, from a strategic perspective to integrate other approaches without challenging the core objectives of Lean. A review of the criticisms levied against Lean manufacturing suggests that much of the drawbacks stem from the method of implementation rather than any inherent flaw in the Lean culture. Proper planning, good implementation by incorporating effective change management practices and leadership, stress management interventions, and effecting a change of culture so that each member of the workforce inculcates the philosophy of Lean help resolve many of the limitations of using Lean manufacturing and overcoming the criticism of Lean manufacturing.

Capitalism and environmentalism are not mutually exclusive. Many business leaders have invested time, energy, attention, and financial resources in environmental protection, but sometimes their efforts are not consistent, appreciated, or even encouraged. There is a need to reinforce a simple message, namely "Lean" refers to an approach of continuous improvement and the elimination of non-value-adding activities, and it is mainly used in the manufacturing sector. "Green" refers to practices and actions that reduce negative impacts on the environment. While "green" and "sustainability" are often used interchangeably, the term "green" is more appropriate in this discussion, because unless materials are replenished at the same rate they are depleted, the practice cannot truly be considered "sustainable." Many manufacturers today have evolved their thinking so that Lean and green initiatives work hand in hand, achieving the same goal of increasing profits. Going Lean and green is a trend that identifies new business opportunities for organisational improvement and for competitiveness. If cost-reduction opportunities from environmental wastes are overlooked, then the true costs of production are not really being accounted for, which is not Lean. Lean is about companies embracing change to reduce waste in how they produce a product or service. It engages and empowers employees to develop and implement ideas and requires a culture of continuous improvement.

Empirical Evidence of Lessons Learnt

Revealing results and conclusions were deducted from the detailed analysis undertaken. Despite the prominence of Lean globally, there exist obstacles to its adoption and dispersion with organisations. The analysis showed consistently higher levels of barriers which stressed the need for external sensei since the largest obstacles indicated a lack of operative and management skills to adopt Lean. SPSS version 19.0 was used to undertake the statistical analysis with parametrical and nonparametrical tests employed. Correlations of 0.6 and above only were considered significant. The aspirations from the Lean initiatives were not surprising since:

i. market share
ii. supply chain management, and
iii. profitability ranked the highest.

Ironically, improving culture and teamwork ranked the lowest. The literature also states a need for various appropriate tools to be used and applied simultaneously for Lean to succeed. 40 % of the tools were sparsely applied. Similarly, the empirical evidence quoted in the literature suggests that the prominent reason for most Lean failures is culture oriented, yet amongst the fifteen organisations the worst results were found for:

i. culture
ii. a better place to work, and
iii. involving customers to a greater extent than was the case before Lean.

SPSS version 19.0 was used to undertake the statistical analysis with parametrical and nonparametrical tests employed. Correlations of 0.6 and above only were considered significant. The balance score card used as part of the survey questionnaire revealed the importance particularly of the customer, financial and projected potential groups of indices which is depicted in the following correlations discovered:

- projected potential and finance = 0.984 correlation,
- customer and finance = 0.953 correlation, and
- projected potential and customer = 0.938 correlation.

The five best performing organisations revealed particular characteristics which are further discussed below; ironically, three of the five were large and in electronics, one was a medium-sized organisation but still in electronics and only one of the top five organisations was a small enterprise and involved in component manufacture. The scorecard employed revealed interesting results for each of the five categories of indices employed:

- **Financial** indices: electronic companies performed better than their automotive and component counterparts;

  larger organisations performed better than the smaller and medium companies;

- **Process** and **Procedure**: electronic companies performed better than their automotive and component counterparts;

  larger organisations performed better than the smaller and medium companies;

- **Customer** indices: electronic companies performed better than their automotive and component counterparts;

  larger organisations performed better than the smaller and medium companies;

- **HRM** indices: electronic companies performed better than their automotive and component counterparts;

  larger and smaller organisations performed better than the medium companies;

- **Projected** related indices: electronic companies performed better than their automotive and component counterparts;

  larger and smaller organisations performed better than the medium companies.

It was important to try and determine the underlying reasons for large organisations and those from the electronics sectors performing better as has been indicated previously. The subsequent analysis revealed the following key considerations:

i. Culture: large companies scored better than their small and medium counterparts as did electronics companies opposed to those manufacturing automotive parts and general components.
ii. Larger companies made use of a greater variety of Lean tools in operation; theses were being applied simultaneously and considerably in greater depth than those of smaller and medium-sized organisations.
iii. Electronic companies had better tool application than automotive and component manufacturers. This made reference to the nature of tools which suited the respective organisation's Lean journey and culture. This aspect clearly reinforces the empirical research which specifies that tool selection and application should be aligned to an organisation's Lean journey and juncture it has reached.
iv. Application of Lean across the value chain; large companies scored better than their small and medium counterparts as did electronics companies opposed to those manufacturing automotive parts and general components. Once again, this has been proposed by Lean practitioners as otherwise the benefits of Lean remain localised.
v. Correlations for larger organisations discovered that the *strength and quality of strategic planning* and

   - *innovative market development* = 0.838 with
   - *product development* 0.826 and with
   - *new technological development* = 0.836.

vi. Lean engagement showed to be different across companies of different size; for small companies, the median number of years was 5.00 %; medium was 9.50 %; and large was 16.00 %. Therefore, large companies showed they had been engaged with Lean for a longer period than small or medium size companies ($p = 0.005$).
vii. Correlation for electronics manufacturers: training and stock turnover = 0.853 and with rate of return n capital employed 0.826.
viii. Chi-square for large companies: they experienced a

   - reduced impact regards finance acting as a potential barrier,
   - a greater application of Lean throughout the value chain, and
   - a greater willingness to involve suppliers than was the case within medium and smaller organisation; likewise,

- larger organisations displayed a greater willingness to apply Lean throughout the internal organisation,
- whereas smaller and medium-sized organisations displayed a greater application of Lean within some parts of the internal organisation.

ix. Chi-square for electronic companies: the analysis showed that they were better places to work in after Lean. They scored much higher whilst the stock turnover performance was better too
x. The analyses determined that

- profits,
- costs of quality, and
- flexibility of service offered to customers

were important parameters of performance. Once again, the better performing organisations seem to recognise this clearly.

The research demonstrated that Lean certainly can lead to considerably greater efficiencies which would assist to make the respective organisation more competitive. The companies displaying certain specific characteristics were verified to perform much better. There are certainly additional and corresponding lessons to be learnt from the research, namely:

i. Undeniably, the organisations that implemented Lean considered that it did result in improved performance levels; however, the extent of the return on this investment varied and could be attributable to various factors listed below.
ii. Small- and medium-sized companies performed less favourably, and this reinforces the literature review findings; it could be stressed that a concerted strategy would need to be put into practice for the small and medium organisations to try and improve their implementation records; this would include the aspects such as culture and strategies to combat potential cultural issues which may require additional concentration within these organisations.
iii. The barriers to the adoption or dispersion of Lean within a company remain strong, and it is vital that organisations take preventative action and try to combat these. The analysis did suggest that organisations felt that the prominent barriers were a lack of relevant Lean skills which suggests that companies should consider the services of a sensei when commencing their Lean journey. However, it is vital that gradually the organisations develops its own Lean capabilities since this aspect figured prominently within the culture analysis.
iv. Poignantly, improving culture and teamwork ranked the lowest in reference to the potential aspirations from Lean; however, it is vital that these aspects are not permitted to negatively impact the respective organisations' Lean journeys. This should indicate to prospective adopters of Lean that these factors are vital and cannot be permitted to create potential issues subsequently.
v. The literature strongly advocates that various appropriate tools are required to be applied simultaneously if it is hoped that Lean proves successful; the evidence showed that 40 % of the tools were sparsely applied. This indicates

the need to methodically plan the Lean implementation within a company and not allow it to develop fortuitously.

vi. It is imperative that additional consideration is awarded to the reasons why electronic and large organisations performed better and the fact that a greater extent of the cultural requirements were in place alongside the necessary Lean tools which assists to signify the importance of these factors.

vii. Bearing in mind that correlations *strength and quality of strategic planning* and *innovative market development* (0.838) with *product development* (0.826) and with *new technological development* (0.836) were discovered for the best performing organisations, this does suggest the importance of strategic planning. Once again, this substantiates the literature which advocates the need to view Lean as a strategic initiative and not an operational programme.

viii. The better performing companies depicted a greater application of Lean throughout the value chain and a superior willingness to involve suppliers which is an important lesson for any prospective Lean companies; this once again supports the literature which suggests that this aids scheduling and battles potential supply issues.

ix. The investigation had reflected that

- costs of quality and
- flexibility of service offered to customers

were significant factors in explaining the superior levels of performance of the more successful companies. Consequently, this indicates to companies that these two factors should be considered important and would facilitate a greater return of investment on their Lean expenditure

x. The balance scorecard was effectively utilised and the Lean engagement reflected that the medium for small companies (5.00 %), for medium (9.50 %) companies and for the large companies (16.00 %) indicates that companies hoping to succeed at Lean need to sustain with the initiative for a longer period since it is a long-term journey which will reap benefits.

xi. An imperative lesson for organisations to grasp is the need to measure the impact of Lean; this investigation used an adapted version of the balance scorecard which was able to gauge the impact Lean had made within respective organisations. Undeniably, Lean requires a considerable investment and it is vital that a reliable gauge is undertaken of this expenditure.

xii. The analysis showed consistently higher levels of barriers which stressed the need for an external sensei since the largest obstacles indicated a lack of operative and management skills to adopt Lean.

xiii. The aspirations from the Lean initiatives were not surprising since:

- market share,
- supply chain management, and
- profitability ranked the highest.

xiv. Similarly, the empirical evidence quoted in the literature suggests that the prominent reason for most Lean failures is culture oriented, yet amongst the fifteen organisations the worst results were found for:

- culture,
- a better place to work, and
- involving customers to a greater extent than was the case before Lean.

xv. The balance score card used as part of the case study and survey questionnaires revealed the importance particularly of the customer, financial and projected potential groups of indices which is depicted in the following correlations discovered:

- projected potential and finance = 0.984 correlation,
- customer and finance = 0.953 correlation, and
- projected potential and customer = 0.938 correlation.

To be successful, there has to be 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. 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. 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.

Limitations of the Research

In a discussion of generalizability, 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. 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 19.0 for Windows embracing both parametrical and nonparametrical tests.

Every effort was made to prevent any potential issues surrounding validity, reliability, and generalizability which overall were never experienced. Within the empirical primary research, a greater degree of validity and reliability was fortified than would have materialised through a single methodological approach since surveys were supplemented by case studies in fifteen organisations. Likewise, a forewarning was awarded to participant organisations in respect to the performance measures applied. They were enlightened to ensure that the responses should only account for the actual impact Lean has made to the respective indices; consequently, they should recognise the naturally projected growth rates since this research was solely focusing upon the sway Lean had on their respective organisations. It could be suggested that this research experienced the perpetual issues of securing access to organisations; nonetheless, fifteen organisations were represented in the survey investigation coupled with extensive case studies within each organisation whereby a more comprehensive exploration was possible.

Future Research

A perceptible natural addition to this research could be the replication of the enquiry though within a service environment. The primary prominence within this investigation focused upon the suitable tools, procedures, cultures, and performance management of Lean within the UK manufacturing companies. Bearing in mind that one in five workers within the UK is employed within the public sector, there is considerable scope to widen its remit (Amnis 2011). It would be principally beneficial to conclude:

- Any resemblance of the obstacles which were confronted;
- The actual impact of the prevailing culture and change management systems;
- Does the Lean journey mirror across both sectors?
- Main aspects to consider when applying performance measurement;
- Sustainability comparisons between the sectors; and
- The significance of processes within the company when attempting to secure a Lean system.

Summary

The research demonstrated that Lean facilitates increased competitiveness by developing overall performance. Nonetheless, Lean needs to be seen as a dynamic phenomenon since it is developing constantly. Lean is a long-term commitment and

the more that the organisations embrace it, the better their performance levels. It is a package which transcends beyond the technical tools alone and needs to look at the supporting infrastructure including the prevailing culture. The better performers demonstrated a need to look at Lean throughout the value chain and a need to embrace customers and suppliers. To become Lean requires a concerted effort though most organisations reap business benefits from this initiative. 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 synchronised 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. 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. 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.

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