

**IMPACT ANALYSIS OF LARGE-SCALE LEAN
MANUFACTURING INITIATIVES UPON
MANUFACTURING PROCESS INNOVATION IN
IRISH COMPANIES**

By

William McGrath

A Thesis Submitted for the Degree of Masters in Science in
Information Systems Processes

School of Science
Department of Physical and Quantitative Science
Waterford Institute of Technology

Head of Department: Dr. Mícheál Ó hÉigeartaigh
Research Supervisor: Liam Doyle

August 2007

Declarations

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed.....

Date.....

Statement 1

This dissertation is being submitted in fulfilment of the requirements for the degree of Msc in Information System Processes.

Signed.....

Date

Statement 2

This dissertation is the result of my own independent work/investigation, except where otherwise stated. Other sources are acknowledged giving explicit references. A bibliography is appended.

Signed.....

Date.....

Statement 3

I hereby give consent for my dissertation, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organizations.

Signed.....

Date.....

© William McGrath, 2007

To my magnificent parents,

Billy and Elizabeth

and my loving sister Tracey.

“To raise new questions, new possibilities, to regard old questions from a new angle, requires creative imagination and marks real advances in science”.

(Albert Einstein)

Table of Contents

<u>DECLARATIONS</u>	<u>II</u>
<u>LIST OF TABLES</u>	<u>XI</u>
<u>LIST OF FIGURES</u>	<u>XII</u>
<u>LIST OF ABBREVIATIONS</u>	<u>XIII</u>
<u>ACKNOWLEDGEMENTS</u>	<u>XIV</u>
<u>ABSTRACT</u>	<u>XV</u>
<u>CHAPTER 1- INTRODUCTION</u>	<u>1</u>
<u>1.1 BACKGROUND</u>	<u>1</u>
<u>1.2 THE NEED FOR GOOD LEAN MANUFACTURING PRACTICES</u>	<u>1</u>
<u>1.3 RESEARCH OBJECTIVES</u>	<u>2</u>
<u>1.4 PLAN OF RESEARCH</u>	<u>2</u>
<u>CHAPTER 2 - LITERATURE REVIEW</u>	<u>4</u>
<u>2.1 INTRODUCTION TO MANUFACTURING SYSTEMS AND LEAN</u>	<u>4</u>
<u>2.2 THE ORIGIN OF LEAN IN JAPAN</u>	<u>5</u>

<u>2.3 LEAN AS A PHILOSOPHY</u>	<u>6</u>
<u>2.4 TOYOTA PRODUCTION SYSTEM</u>	<u>8</u>
<u>2.5 HOW LEAN MANUFACTURING WORKS</u>	<u>9</u>
<u>2.6 MAIN PRINCIPLES OF LEAN</u>	<u>10</u>
2.6.1 VALUE	11
2.6.2 VALUE STREAM	11
2.6.3 FLOW	11
2.6.4 PULL	12
2.6.5 PERFECTION	12
<u>2.7 LEAN IMPLEMENTATION</u>	<u>13</u>
<u>2.8 BENEFITS OF LEAN MANUFACTURING</u>	<u>14</u>
<u>2.9 MAIN CRITICISM OF LEAN</u>	<u>16</u>
<u>2.10 ADOPTION OF LEAN MANUFACTURING PRACTICES</u>	<u>16</u>
<u>2.11 CONCLUSIONS</u>	<u>18</u>
<u>CHAPTER 3 – RESEARCH METHODOLOGY</u>	<u>19</u>
<u>3.1 INTRODUCTION</u>	<u>19</u>
3.1.1 RESEARCH QUESTIONS AND OBJECTIVES	19
<u>3.2 FUNDAMENTAL PHILOSOPHICAL ASSUMPTIONS</u>	<u>21</u>
3.2.1 POSITIVISM	21
3.2.2 INTERPRETIVE	22
3.2.3 CRITICAL	22
3.2.4 CHOSEN PHILOSOPHY	23
<u>3.3 RESEARCH DESIGN</u>	<u>24</u>
<u>3.4 QUANTITATIVE APPROACHES AVAILABLE</u>	<u>25</u>

3.4.1	Laboratory Experiments	25
3.4.2	Survey Questionnaires	25
3.5	QUALITATIVE APPROACHES AVAILABLE	26
3.5.1	Interviews	27
3.5.2	Case Study	27
3.6	SELECTED METHODOLOGY	28
3.6.1	REASONS FOR CHOOSING CASE STUDY METHOD	28
3.6.2	REASONS FOR IN-DEPTH INTERVIEWS	29
3.6.3	CRITICISMS OF QUALITATIVE RESEARCH	29
3.7	CONCLUSION	30
CHAPTER 4	- RESEARCH FINDINGS	31
4.1	INTRODUCTION	31
4.2	PREPARATION FOR SEMI-STRUCTURED INTERVIEWS	31
4.2.1	ANALYSIS AND LIMITATIONS OF INTERVIEWS IN EACH COMPANY	31
4.3	COMPANY A PROFILE	33
4.4	LEAN MANUFACTURING IN COMPANY A	33
4.4.1	PHASE 1 OF THE LEAN PROCESS – COMPANY A	33
4.4.2	PHASE 2 OF THE LEAN PROCESS – COMPANY A	34
4.4.3	PHASE 3 OF THE LEAN PROCESS – COMPANY A	35
4.5	COMPANY B PROFILE	36
4.6	LEAN MANUFACTURING STAGES IN COMPANY B	36
4.6.1	<i>SUMMARY OF THE 3 MAIN STAGES OF LEAN IMPLEMENTATION IN COMPANY B TO DATE</i>	38
4.6.1.1	The Kaizen Blitz Phase	38
4.6.1.2	The Works Systems Phase	38
4.6.1.3	The Continuous Improvement Phase	38

4.7 SAMPLING OF COMPANY A **39**

RESPONDENT	39
JOB TITLE	39
4.7.1 LEAN MANUFACTURING AS A PLANT OR CORPORATE STRATEGY	40
4.7.2 LEVEL OF SUPPORT FOR LEAN INITIATIVE FROM MANAGING DIRECTOR	40
4.7.3 PROCESS SELECTION FOR LEAN SAVINGS	41
4.7.4 HELPFULNESS OF TEAM CULTURE TO THE LEAN INITIATIVE	41
4.7.5 VISUAL AWARENESS OF LEAN WITHIN THE COMPANY	42
4.7.6 MAIN BARRIERS / OBSTACLES TO THE LEAN INITIATIVE	43
4.7.7 LESSONS LEARNED FROM LEAN EXPERIENCE/FUTURE HOPES	44
4.7.8 FUTURE OF LEAN ACROSS THE VALUE STREAM OF THE COMPANY	45
4.7.9 LEVEL OF DIFFICULTY IN EVALUATING FINANCIAL FIGURES IN TERMS OF SUCCESS OR OTHERWISE OF LEAN INITIATIVES	45

4.8 SAMPLING OF COMPANY B **46**

RESPONDENT	46
JOB TITLE	46
4.8.1 LEAN MANUFACTURING AS A PLANT OR CORPORATE STRATEGY	47
4.8.2 LEVEL OF SUPPORT FOR LEAN INITIATIVE FROM MANAGING DIRECTOR	47
4.8.3 PROCESS SELECTION FOR LEAN SAVINGS	48
4.8.4 HELPFULNESS OF TEAM CULTURE TO THE LEAN INITIATIVE	48
4.8.5 VISUAL AWARENESS OF LEAN WITHIN THE COMPANY	49
4.8.6 MAIN BARRIERS / OBSTACLES TO THE LEAN INITIATIVE	49
4.8.7 LESSONS LEARNED FROM LEAN EXPERIENCE/FUTURE HOPES	50
4.8.8 FUTURE OF LEAN ACROSS THE VALUE STREAM OF THE COMPANY	51
4.8.9 LEVEL OF DIFFICULTY IN EVALUATING FINANCIAL FIGURES IN TERMS OF SUCCESS OR OTHERWISE OF LEAN INITIATIVES	51

4.9 CONCLUSION **52**

CHAPTER 5: DISCUSSION **53**

5.1 LEAN MANUFACTURING AS A PLANT OR CORPORATE STRATEGY **53**

5.2 LEVEL OF SUPPORT FOR LEAN INITIATIVE FROM MANAGING DIRECTOR **54**

5.3 PROCESS SELECTION FOR LEAN SAVINGS **54**

<u>5.4 HELPFULNESS OF TEAM CULTURE TO THE LEAN INITIATIVE</u>	<u>55</u>
<u>5.5 VISUAL AWARENESS OF LEAN WITHIN THE COMPANY</u>	<u>55</u>
<u>5.6 MAIN BARRIERS / OBSTACLES TO THE LEAN INITIATIVE</u>	<u>56</u>
<u>5.7 LESSONS LEARNED FROM LEAN EXPERIENCE/FUTURE HOPES</u>	<u>56</u>
<u>5.8 FUTURE OF LEAN ACROSS THE VALUE STREAM OF THE COMPANY</u>	<u>57</u>
<u>5.9 LEVEL OF DIFFICULTY IN EVALUATING FINANCIAL FIGURES IN TERMS OF SUCCESS OR OTHERWISE OF LEAN INITIATIVES</u>	<u>57</u>
<u>5.10 CONCLUSION</u>	<u>58</u>
<u>CHAPTER 6 - CONCLUSION</u>	<u>59</u>
<u>6.1 INTRODUCTION</u>	<u>59</u>
<u>6.2 LIMITATIONS OF THIS RESEARCH</u>	<u>59</u>
<u>6.3 FUTURE RESEARCH DIRECTIONS</u>	<u>60</u>
<u>6.4 CLOSING REMARKS</u>	<u>60</u>
<u>REFERENCES:</u>	<u>61</u>
<u>APPENDIX A – INTERVIEW QUESTIONS</u>	<u>67</u>

List of Tables

Table 2.1	Lean Implementation Phases.....	28
Table 2.2	2004 LEI Survey Results – Member breakdown by Industry.....	32

List of Figures

Figure 2.1.	A 4P model of the Toyota Way.....	21
Figure 4.1.	Respondent List of Company A.....	54
Figure 4.2.	Respondents List of Company B.....	61

List of Abbreviations

AMT - Advanced Manufacturing Technology

CIM - Computer Integrated Manufacturing

CIP - Continuous Improvement Program

MD - Managing Director

IS - Information Systems

JIT - Just-in-Time

LEI - Lean Enterprise Institute

MO's - Manufacturing Orders

OECD - Organisation for Economic Co-operation and Development

OEM - Original Equipment Manufacturer

SOP's - Standard Operating Procedures

TQM - Total Quality Management

TPM - Total Productive Manufacturing

TPS - Toyota Production System

VSM - Value Stream Mapping

Acknowledgements

Firstly, I would like to thank my supervisor and course leader Liam Doyle. His expert guidance, support, enthusiasm, timely feedback, constructive criticism, and most importantly patience kept me on the right track. Thank you Liam!

Secondly I would like to say a huge 'thank-you' to all the people from both organizations that took part in this study. Without their knowledge and insights there would be no thesis!

Finally, I am forever indebted to my friends and family for their understanding, endless patience, and encouragement when it was most needed.

Abstract

Lean manufacturing is a strategic tool that is used to reduce waste and to generally improve the efficiency and competitiveness of many companies and organisations. Many industries that have implemented lean manufacturing have achieved improved performance over time. This dissertation focuses on two medical device companies based in the South of Ireland and their views on the many issues involved in implementing lean in their respective companies.

The purpose of this dissertation is to determine the extent to which the main principles of lean manufacturing have been and/or still being carried out in both companies. Also this dissertation aims to establish some of the main issues involved in the execution of those principles over time in each of the processes. In general this dissertation aims to provide a theoretical guide to understanding key concepts of lean manufacturing and the practical issues that occur in the implementation of the methodology in both companies. Semi-structured interviews were carried out in both companies in order to extract the key findings and lessons learned from the implementation of the lean process. The respondents in each company were chosen for their experience and expertise in lean manufacturing and production areas.

The research findings indicate that both companies have made some great improvements in terms of the value streams of their respective plants and also in the reduction of waste and inventory. One of the main benefits that both companies have seen in implementing lean initiatives is continuous improvement that delivers sustained value to customers and stakeholders and provides a platform for future business growth.

In conclusion, lean manufacturing is considered a strategic tool to help improve the competitive position of an organisation. Although there have been several barriers and obstacles to get by, it can be seen that lean has been a huge success in both organisations involved in this study and the future hopes of each company include lean initiatives to help both plants compete more strongly in their individual markets.

CHAPTER 1- Introduction

1.1 Background

Lean manufacturing is a management philosophy focusing on reduction of many different types of waste in order to improve overall customer value. By eliminating waste, quality is enhanced and production time and costs are compressed (Jordan, *et al.*, 2001). To solve the problem of waste, lean manufacturing has several tools at its disposal. These include regular process analysis (kaizen blitz), pull production (by means of kanban) etc. More information on how these tools work can be seen further on in the literature review.

There is considerable evidence to suggest that although more and more companies are attempting to adopt lean manufacturing practices, that very few have actually been fully successful. This is despite a huge amount of information and advice being available.

1.2 The need for good lean manufacturing practices

The case studies undertaken by the author shows specific application of lean in different areas of two Medical Device industries, with each application of lean different to each other, but similar methods used in each to varying degrees.

So the question remains, is lean applicable? The answer is that not only is lean applicable, but looking at the data, there is a large opportunity in the Medical Device industry to apply lean further in order to gain satisfactory results.

So what is the best course of application? There is little agreement on the absolute best method of applying lean. There appears to be some small differences in method between the Medical Device industries, although with a low sample size of two organisations, this cannot be proven.

1.3 Research Objectives

This dissertation aims to provide a theoretical guide to understanding key concepts of lean manufacturing and the practical issues that occur in the implementation of the methodology. The author purports to answer the following research questions through qualitative research techniques with the help of two Irish companies that carry out lean initiatives and on which the research will be based.

- The first research question aims to determine the extent to which the main principles of lean manufacturing are carried out in a small number of Irish manufacturing companies in the south east of Ireland.
- The next research question endeavours to establish some of the main issues involved in the execution of those principles over time in each of the processes.
- Overall this dissertation aims to provide a theoretical guide to understanding key concepts of lean manufacturing and the practical issues that occur in the implementation of the methodology.

1.4 Plan of Research

Chapter 1: Introduction

This chapter provides a comprehensive background to lean manufacturing detailing the emergence of the research topic and clearly identifying the objectives of the study undertaken. An outline of the ensuing chapters is also included, which presents a thorough overview of the structure of the thesis.

Chapter 2: Literature Review

Chapter two is the literature review. It starts by looking at how lean manufacturing first began. This chapter then seeks to identify the philosophies, core principles and characteristics of lean manufacturing. Finally the barriers to lean are examined.

Chapter 3: Research Methodology

Chapter three examines the suitability of existing research philosophies and methodologies for gathering the required data for this study. It concludes with the justification for selecting the research approach utilised in this study of lean manufacturing initiatives.

Chapter 4: Findings

Chapter four presents and summarises the findings of the research study detailed in the preceding chapter with a view to generating common perspectives and opinions.

Chapter 5: Discussion

Chapter five discusses in detail the findings from the research in order to compare and contrast the issues discussed with the firms on which the research is based.

Chapter 6: Conclusion

Chapter six is the final chapter in this thesis and summarises the main findings while also identifying the limitations of the study. The thesis concludes by outlining future research directions that emerged from this research.

Chapter 2 - Literature Review

2.1 Introduction to Manufacturing Systems and Lean

The role of manufacturing enterprises in a competitive economic country is of utmost importance and the threat from other developing countries is an increasing problem for industrialised countries such as Ireland. It is imperative for Ireland's economic stability that they continue to manufacture high quality products in an efficient and timely manner and in a way that keeps their customers satisfied both in Ireland and worldwide (Nagalingam *et al.*, 1999).

Also, computer integrated manufacturing (CIM) has evolved overtime to deal with some manufacturing issues especially with the help of intelligent information systems. With such systems in place it can help the economy to become much more competitive in the global marketplace and generate enough revenue for the manufacturing sector to help become more successful. Recent data indicates that Ireland has the highest ratio of high technology industries represented in its manufacturing exports of all Organisation for Economic Co-operation and Development (OECD) countries (OECD, 1999).

Womack *et al.*, (1990) depict lean production as being lean "*because it uses less of everything compared to mass production, half the human effort in the factory, half 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 than ever growing variety of products*". This view is repeated by Standard and Davis (1997, Pg. 71), who state that the goal of lean manufacturing is "*to achieve the shortest possible cycle time by streamlining the flow of production material throughout the value stream*".

Womack and Jones (1996) also make a distinction between 'lean thinking', 'lean enterprise' and 'lean manufacturing'. Lean thinking is the generic name for the operation strategy. Lean manufacturing is the application of the strategy in a manufacturing capacity. Lean enterprise is the total function of lean concepts and philosophies throughout all aspects of the business. In essence 'lean' is the elimination of waste and the addition of value to the process of delivering a product or service to a customer.

2.2 The origin of lean in Japan

Lean production or lean thinking (Womack *et al.*, 1990; Womack and Jones, 1996) has its origin in the philosophy of achieving improvements in gainful ways with special focus on reducing *muda* (waste). The concept of *muda* became one of the most significant concepts within quality improvement activities that primarily originated from Taiichi Ohno's famous production philosophy in Toyota in the early 1950s (Dahlgard-Park, 2000, Pg. 128). This process is also known as the "*Toyota production system*".

Taiichi Ohno once commented that by looking at the value stream as a whole it can make it easier for an organisation to manage its workload in phases in an efficient manner that also coincides with the pull of the customer (Jones *et al.*, 1997). Ohno wrote that "*All we are doing is looking at the timeline from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that timeline by removing the non-value-added wastes*". (Ohno, 1988)

Womack and Jones (1996) portray Ohno's vision as lean thinking in their book on '*How to banish waste and create wealth in your corporation*' in which they document the remarkable gains achieved by organisations that have followed Ohno's example.

2.3 Lean as a Philosophy

The concept of Lean as a philosophy and its strengthening of all other elements within a lean organisation are well captured by Liker (2003) in his description of the 4P model of the Toyota Way. Liker identifies 14 Business Principles that have made the Toyota Way so successful and the author goes on to represent these principles in four categories as shown below in Figure 2.1, beginning with Philosophy.

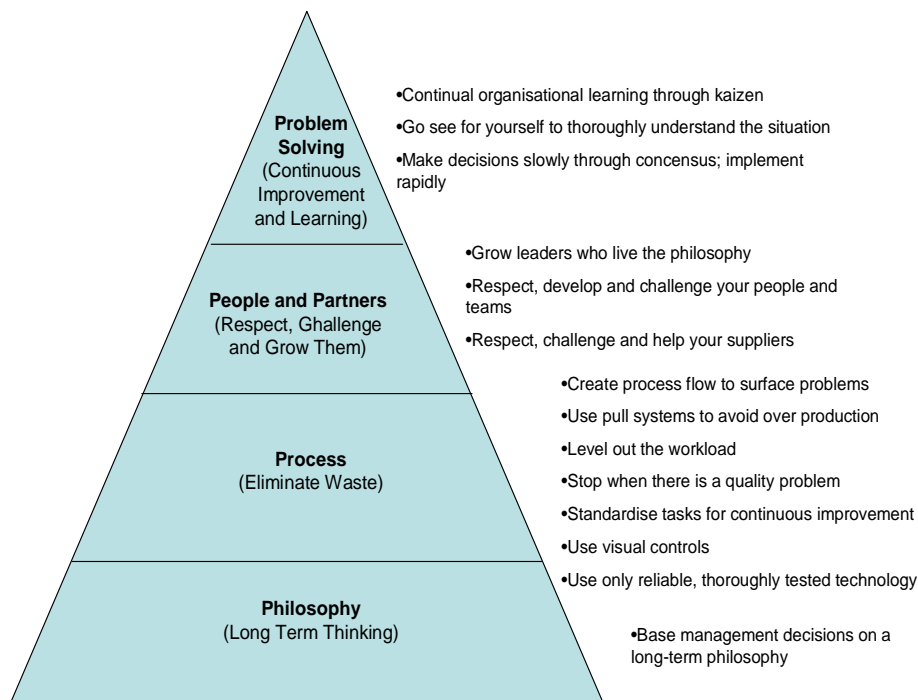


Figure 2.1. A 4P model of the Toyota Way (Liker 2003, Pg. 6)

The concepts described in the 4P model of the Toyota Way are not necessarily new. In effect lean is a grouping of principles that are well established. The flow/pull concept has been around for many years as part of the Just-in-Time (JIT) concept of manufacturing.

The overall focus on continuous improvement in all areas of activity and the involvement of all members of staff is a fundamental aspect of Total Quality Management (TQM) that has its origins in the 1940's and 50's. (Liker, 2003)

The extent to which this is the case in Toyota was articulated by Spear and Bowen (1999) when they outlined the 4 rules of the Toyota Production System following their four year study:

Rule 1 - All work shall be highly specified as to content, sequence, timing and outcome.

Rule 2 - Every customer-supplier connection must be direct with instantly recognisable communication methods.

Rule 3 - The pathway for every product and service must be simple and direct.

Rule 4 - Any improvements must be made in accordance with the scientific method.

So from looking at the model above in Figure 2.1 it is understood that lean can be seen as a customer focused philosophy that seeks to take full advantage of customer value by the elimination of waste in the value stream. It has at its core the application of Just-in Time and Total Quality Management philosophies, and in a manufacturing context, lean relies heavily on the elimination of the sources of variation and the standardisation of performance in order to deliver a consistent flow of materials (Spear and Bowen, 1999).

The next section describes the Toyota production system in more detail.

2.4 Toyota Production System

The fundamental idea behind the Toyota Production System (TPS) is to manufacture the correct amount of raw materials needed by each process, in a given time so that unnecessary product inventories can be eliminated from the final product. TPS works by eliminating waste in three ways. These are cost reduction, quality control and quality assurance (Monden, 1983, p. 2). The method used by the system to eliminate this waste includes standardising the labour of the workers so they understand their role in the process. Uninterrupted work-flows are also brought in to speed the process up and meet the demands of the customers. Direct links are also made between suppliers and customers so that there is no time delays or miscommunication in the overall process (Spear and Bowen, 1999).

The secret behind Toyota's outstanding quality is enclosed in a single word: *kaizen*, which defines Toyota's approach to business. Kaizen is not just a set of tools; it is the dedication of Toyota to strive for improvement constantly. Constant development requires nonstop learning in an environment that embraces change. Toyota's other main principle is respect for its people and it is this combination of kaizen and respect for workers that made the Toyota system so successful and a guide for others to follow. (Liker, 2003)

Consequently, the TPS can be described as an effort to make as much goods as possible in a continuous flow and generating an understanding from the people involved in the process (Ohno, 1998). The four main concepts of the TPS are Just in Time management (JIT), a flexible workforce, capitalising on worker suggestion and automation – *'a feature of intelligent machine design that implements supervisory functions to help prevent the production of defective products'* (Hopp and Spearman, 2004). These concepts are discussed in more detail further on in the subsequent sections of the literature review.

The next section of the literature review discusses how lean manufacturing works and the many benefits it brings to companies that follow its main principles.

2.5 How Lean Manufacturing Works

The main principle underlying how lean systems work is to draw out the processes in order to identify any problems that exist. This in turn will help to create a healthy stability between the production process and the systems that support them. The whole system together can help to integrate the roles of everyone involved with the process. The process then becomes leaner as workers' roles change towards the same way of thinking through all levels of the organisation. (Forrester, 1995)

Technical advances (autonomation) have indicated further changes in the role of individuals in business. Walton *et al.*, (1987) argue that the beginning of advanced manufacturing technology (AMT) has made the need for “*skilled, committed employees more important than ever*”.

They also highlighted the greater than before “*interdependencies between functions; skills requirements; speed, scope and cost of errors; sensitivity of performance to variation in skills, knowledge and attitudes; pace and dynamics of change and development capital investment per employee and dependence on a smaller number of skilled people*” which advanced manufacturing technology can produce.

Walton *et al.*, (1987) set forward that some key responses are needed in order for a business to be successful in its lean implementation. Firstly, a highly skilful workforce is essential and these skills need to be put to good use in order to designate instructions to others. Secondly a flexible and innovative management structure needs to be in place to ensure a lean and flat organisation. Lastly, there needs to be a good relationship between the union and management in order for the lean process to run as smoothly as possible and to keep altercations to a minimum.

Lean is in essence all about getting products and raw materials to their correct destination in a timely and efficient manner whilst minimising waste and being flexible to change. More importantly all the issues surrounding lean need to be understood and embraced by the organisation as a whole if its to have any chance of being successful.

The intention of the lean approach is to make available techniques that permit companies to define value in their products, suggest where and how this value is added, and construct plans for these activities so that minimum waste is incurred. (Jordan *et al.*, 2001). In their book Lean Thinking, Womack and Jones (1996) broaden the concept of lean slightly and outline what they consider to be the five lean principles that are detailed in the following section:

2.6 Main Principles of Lean

1. **Specify Value** – what does and what does not create value from the customer’s perspective and not from the perspective of individual firms, functions and departments.
2. Identify all the steps necessary to design, order and produce the product across the whole **value stream** to highlight non-value adding waste.
3. Make those actions that create value **flow** without interruption, detours, backflows, waiting or scrap.
4. Only make what is **pulled** by the customer.
5. Strive for **perfection** by continually removing successive layers of waste as they are uncovered. (Womack and Jones, 1996)

2.6.1 Value

The first thing that a company must do is establish accurately what their customers recognise as value. There is no point in being the most efficient producer of something that does not satisfy the requirements of the customer. Womack and Jones (1996, Pg. 71) stated that *“Value is created by the producer. From the customer’s standpoint, this is why producers exist”*.

2.6.2 Value Stream

Next an organisation must identify its value stream. Rother and Shook (1999, Pg. 3) define a value stream as being *“all the actions (both value added and non-value added) currently required to bring a product through the main flows essential to every product: (1) the production flow from raw material through to the arms of the customer, and (2) the design flow from concept to launch”*.

A value stream can focus on a particular product or product family or products purchased by a specific customer or market. In effect the value being supplied to a customer flows across departmental, functional and even company boundaries. If the value stream is not identified it cannot be optimised.

Hines and Taylor (2000, Pg. 4) state *“in order to go lean, you need to understand customers and what they value. To get your company focused on these needs you must define the value streams inside your company...and later the value streams in your wider supply chain as well”*.

2.6.3 Flow

The suggestion of making the actions in the value stream flow is another main principle of the lean process. Interruptions to this flow, or restrictions in its channel can cause waste in the value stream.

Waste in the lean context refers to non-value added activities. There are seven wastes defined by the Toyota Production System. These are described by Womack and Jones (1996, Pg. 309-310) as follows:

- *Overproduction* ahead of demand
- *Waiting* for the next production step
- Unnecessary *transport* of materials (to the next process or facility)
- *Over-processing* of parts (due to poor tool or product design)
- *Inventory* (more than the absolute minimum)
- Unnecessary *movement* by employees (looking for parts, tools, help etc.)
- Production of *defects*

2.6.4 Pull

The next principle is that of customer pull. To all intents and purposes this means that no process step should produce anything unless the downstream customer (internal or external) has a requirement for it. According to Bowen *et al.*, (1998) the way organisations best achieve pull systems is by not producing in huge numbers in order to “*attain scale economy*”.

2.6.5 Perfection

The final lean production principle is continuous improvement meaning that perfection is the only goal throughout the production lifecycle. Continuous improvement involves operators helping to solve problems in order to improve the manufacturing process and to become a more learning organisation by criticising every aspect of the production lifecycle. (Liker, 2003)

Overall lean allows organisations to make more with less; that is less people, less material, less space and shorter lead times (Bicheno 2004). However it can also create a knowledge workforce where employees’ contributions at the shop floor level are valued every bit as much as those at a senior level. The author proposes that without these employee contributions many companies could struggle the severe competition facing them today. Evidence to support this can be seen later in the findings chapter.

2.7 Lean Implementation

A plan for how lean manufacturing is to be implemented properly can take up to five years in order to have any chance of success and the method put forward by Womack and Jones (1996) from lean thinking is divided into four main phases as shown in the following table.

Table 2.1 Lean Implementation Phases:

Phase	Steps involved	Time frame
Get started	Find a change agent Get lean knowledge Map value streams Expand company scope	First six months
Create a new organisation	Reorganise by product family Create a lean function Devise a growth strategy Instill a “perfection” mindset	Six months to two years
Install business systems	Introduce lean accounting Relate pay to firm performance Initiate policy deployment Introduce lean learning Find right size tools	Year three and four
Complete the implementation	Apply previous steps to suppliers/customers Develop global strategy Transition from top-down to bottom-up improvement	By end of year 5

Womack and Jones (1996, Pg. 63)

According to Liker (2003) the advancement throughout the first year's implementation will be slow. Liker (2003) also mentions mapping one of the product streams primarily and starting a cross-functional team in determining activity and to also demand results immediately so that the seeds of flow can be introduced into the organisation. A lean strategy office may also be needed as a link to the organisational structure and to help the development process of building systems into a model that helps assess and encourage change.

The next stage in the development is the imbedding of lean into the business. A policy deployment document ensures that all staff are made aware of the vital lean goals. A lean accounting system can help to encourage the removal of inventories and right-size equipment in use to suit the production process. (Liker, 2003)

The final stage according to Womack and Jones (1996) is to *“make sure your suppliers and distributors follow your lead, that you are creating value as close to the customer as possible, and that you are making lean thinking automatic and bottom-up, rather than merely top-down”*.

The literature review now moves on to show the many benefits lean manufacturing can bring about to a organisation but it is also essential to detail some of the criticisms or disadvantages that may come about from the use of lean also.

2.8 Benefits of lean manufacturing

Lean manufacturing has been shown to greatly improve quality, customer service, and profitability (Standard and Davies, 1999). Lean manufacturing is also not just limited to large organisations as it can also be applied to smaller firms as well (Jordan *et al.*, 2001).

In 2001 a study was carried out by the Engineering Employers' Federation (EEF), a manufacturer's organization, of 352 companies into US and UK productivity. The study found that over 70% of companies surveyed had indicated that the most important incentive for pursuing lean manufacturing was to "*increase performance*". This was defined as increased productivity, profitability and lower costs.

In the 2004 Lean Enterprise Institute (LEI) survey when respondents were asked "*What are the biggest trends in your industry right now?*", the single biggest response (32%) was cost reduction.

Sheehan (2002) reported that over 60% of medical device/pharmaceutical companies surveyed in Ireland indicated that either cost reduction, increased productivity or competitiveness was their "*main reason*" for pursuing lean.

So the evidence would seem to indicate that for many if not most companies, the main driver for becoming lean revolves around a drive to save money either directly by removing costs or indirectly by improving productivity.

The view that lean will lead to productivity improvements is supported by many lean texts. Womack and Jones (1996, Pg. 27) apply the rule of thumb that "*Converting a classic batch-and-queue production system to continuous flow with effective pull by the customer will double labour productivity all through the system*".

Standard and Davis (1999, Pg. 55) state that "*another important advantage that companies realize as they become lean is a marked increase in productivity*".

Liker (2003, Pg. 96) when referencing the work of the Toyota Supplier Support Centre claims that "*in every case.....when they changed a mass-producing supplier to a TPS style line, they achieved at least a 100% improvement in labour productivity*".

2.9 Main Criticism of lean

Although there are many benefits of lean manufacturing, there are also some criticisms of how lean is implemented.

The main criticism mentioned is the human aspect of lean manufacturing. Williams *et al.*, (1992) put forward that lean production is de-humanising and unequal. Over the years the word lean has been associated with being “*mean*” (Bicheno 2004, Pg. 4) and with exploiting the work force.

Garrahan and Stewart (1993) argue that the introduction of lean is not a situation that leads to job development, but rather a series of social and technical organisational processes that ensures worker disempowerment. They argue for example that Kaizen is a method for stealing the workers ideas and using them for the company’s benefit, while standardised work in their view is really just management – by – stress.

Hines *et al.*, (2004) argue against Garrahan and Stewart’s view by stating that it is “*not a vision shared by many other lean specialists or authors*”. As well as this, Hines *et al.*, (2004) declare that the argument has raised a significant reason for any organisation looking to apply lean to their processes in that they should look at lean “*as more than a set of mechanistic hard tools and techniques and the human enormity of impetus, empowerment and admiration for people are very important*”.

2.10 Adoption of Lean Manufacturing Practices

The 2004 Lean Enterprise Institute (LEI) survey had 999 respondents, mostly from the US, but also from a number of other countries. It gives a good indicator of the industry spread of lean. A summary of the results is listed below in Table 2.2.

Misc. Manufacturing Industries	19%
Business Services	17%
Automotive	16%
Aerospace	10%
Electrical & Electronic Machinery, Equipment & Supplies	8%
Fabricated Metal Products, Except Machinery And Transportation Equipment	8%
Rubber & Misc. Plastic Products	4%
Food & Kindred Products	4%
Chemicals & Allied Products	4%
Machinery, Except Electrical	3%
Other Transportation Equipment	3%
Furniture & Fixtures	2%
Printing, Publishing & Allied Industries	2%
Primary Metal Industries	2%
Measuring, Analyzing, & Controlling Instruments	2%
Paper & Allied Products	1%
Lumber & Wood Products Except Furniture	1%
Petroleum Refining & Related Industries	1%
Apparel & Textile Products Made From Fabrics	1%
Stone, Clay, Glass & Concrete Products	1%
Textile Mill Products	1%
Leather & Leather Products	1%
Tobacco Manufacturers	1%

Table 2.2 2004 LEI Survey Results – Member breakdown by Industry

As can be seen from the results, along with the expected high level of representation from the automotive industry, virtually all industry types are represented including service industries. This demonstrates the expansion of lean from its origins within the automotive industry. The results of the survey show that lean is now recognised as being applicable to practically all manufacturing industries as well as a service and other industries.

2.11 Conclusions

Lean systems are rational, convenient, responsive, and team-based and they must add value to the enterprise. It might sound straightforward, but achieving it can prove to be very difficult.

Spear and Bowen (1999) went a long way towards explaining some of the reasons for such difficulty when they observed that “*lean is a philosophy, whereas many people only see tools*”. Therefore when organisations attempt to implement these tools out of the context in which they were originally applied, then they are likely to fail. The central part of Toyota’s underlying philosophy was captured by Spear and Bowen (1999) in the same article when they outlined the four rules of the Toyota production system referenced previously in section 2.3.

The first of the four rules states that: “*All work shall be highly specified as to content, sequence, timing and outcome*”. This rule is about control. Spear and Bowen (1999) observed that “*..activities, connections, and production flows in a Toyota factory are rigidly scripted*”. Without first achieving this level of specification it would seem that any attempt to become lean is fundamentally flawed.

In the EEF (2001) study previously mentioned in section 2.8, only 30% of companies claim to be doing daily or weekly reviews. A fundamental part of the control cycle is review. Most management texts would claim that it is very difficult to maintain control with infrequent reviews. Another part of the LEI (2004) study not previously covered in section 2.10 indicates that the largest obstacle to lean at 36% is “*backsliding into old ways*“ again an indication of poor control. So it would seem clear that not establishing and/or maintaining control of operations is one of the main issues that needs to be addressed among western companies trying to implement lean successfully.

That concludes the literature review section of the study; the next section covered describes some proposed research methodologies and philosophies.

Chapter 3 – Research Methodology

3.1 Introduction

The key factor while conducting IS (Information System) research is to have an impact on practice. The IS research conducted should, in an ideal world be reflected back into IS practice, thus improving the progress of IS and their use within an organisation (Orlikowski and Baroudi, 1991). Accordingly, IS researchers should not only be addressing the IS technical issues but should expand their focus to include the organisational, behavioural, and social implications of IS. The IS discipline started out in the 1960's and has seen unparalleled growth since then. A lot of the early research concentrated on technical issues, with the spotlight moving towards the management of IS in the 1980's. The 90's witnessed a major widening of the focus to include issues such as the relationship between the information system and the organisation, communication, interpersonal relationships, and social issues (Myers and Avison, 2002).

Given the mammoth scope of the IS field, a great number of research methodologies are presented for researching in the discipline of IS. Selecting the most appropriate research methodology is essential to any research design programme (Falconer and Mackay, 1999). As the research methodology influences the manner in which the data is collected, particular attention should be afforded to ensure that the methodology is fitting for the subject matter being studied by the researcher (Myers and Avison, 2002).

3.1.1 Research Questions and Objectives

The literature explored in the previous review chapter put forward that lean manufacturing has a huge impact on innovation in large scale manufacturing companies. If not properly analysed and implemented according to the philosophy and principles of the Toyota production system then how will lean manufacturing's methods of organizing and coordinating production allow for a faster and more timely coordination between different manufacturing operations.

Also from the previous literature the question needs to be asked “*if companies do not carry out the proper lean procedures than how will it result in a subsequent reduction in costly inventory for those particular companies involved?*”.

In order to successfully answer the above objectives, some key research questions emerged following wide-ranging illumination of the relevant literature.

- The first research question aims to determine the extent to which the main principles of lean manufacturing are carried out in a small number of Irish manufacturing companies in the south east of Ireland.
- The next research question endeavours to establish some of the main issues involved in the execution of those principles over time in each of the processes.

Overall this dissertation aims to provide a theoretical guide to understanding key concepts of lean manufacturing and the practical issues that occur in the implementation of the methodology.

Myers and Avison (2002, Pg. 5) define a research methodology as a “*strategy of enquiry which moves from the underlying philosophical assumptions to research design and data collection*”. This definition provides the underlying structure to this chapter, which is organised into the following sections:

The next section, entitled Fundamental Philosophical Assumptions, details three known epistemological approaches adopted when conducting research. The most appropriate epistemology is selected based on its suitability for the present research. The Research Design section sets out a selection of the most popular research methodologies that fall under the quantitative and qualitative area. Each methodology is detailed together with an evaluation of its strengths and weaknesses and its suitability for this research. This section concludes with the selection and detailed analysis of the most appropriate methodology for this research.

3.2 Fundamental Philosophical Assumptions

Before embarking on any research study, it is important that the researcher is clear about their philosophical assumptions and approach to the phenomena under investigation (Falconer and Mackay, 1999). This is important in that it helps the researcher to set out the research strategy.

This section discusses epistemology and the influence it has on IS research. Philosophy of knowledge is known as epistemology. Epistemology assumes a separation between knowing and being. Philosophers have different visions of what constitutes knowledge. A researcher needs to support his or her personal viewpoint with a philosophy, which will add force to the assumptions of a study. (Byrne, 2006)

The three diverse epistemological categories are ‘positivist’, ‘interpretive’ and ‘critical’. It is essential, for effective research, to understand the research perspective of each epistemological category and adopt a research strategy that yields required knowledge (Easterby-Smith *et al.*, 1997).

3.2.1 Positivism

Burrell and Morgan (1979) define positivism as “*explaining and predicting events by searching for relationships between the constituent elements*”. Positivists view reality without prejudice “*as a series of properties that are measurable and that exist independently of the researcher and their instruments*” (Easterby-Smith *et al.*, 1997). Positivists also believe that the world conforms to fixed relationships between phenomena and their aim, as researchers, is to investigate these informal relationships using structured approaches. The positivist philosophy emphasises objectivity, repeatability, and generalisability of the research findings (Chen and Hirschheim, 2004).

3.2.2 Interpretive

In contrast, interpretive studies view reality as not being objective and exterior but as being socially constructed and given meaning by people. The interpretive researcher believes that they can understand the phenomenon being studied by analysing these meanings in their natural settings (Fahy, 1995).

Interpretive studies are primarily concerned with observation and narrative (Silverman, 1998). Interpretive studies seldom generalise the results of the study to the larger population; rather they favour using the in-depth understanding of the phenomenon to inform other situations (Orlikowski and Baroudi, 1991; Chen and Hirschheim, 2004).

3.2.3 Critical

Critical researchers believe that current social systems were historically time-honoured and are being constantly repeated by people. They recognise that even though individuals can take steps to change their social circumstances, that their ability to do so is often withdrawn by the social, political, and cultural resistances opposing them (Hammersley, 1995).

The main purpose of critical research is to analyse and make known the deep-rooted, oppositions and conflicts that exist in current social practice with a view to replacing them with other social structures in a bid to lessen and eliminate these alienating and makeshift social conditions (Orlikowski and Baroudi, 1991; Falconer and Mackay, 1999; Myers and Avison, 2002).

3.2.4 Chosen Philosophy

One important consideration in choosing an approach is whether or not a deductive or an inductive approach to theory is taken. A deductive approach is when a theory and hypothesis is developed and the research strategy is designed to test the hypothesis. An inductive approach involves carrying out the research, collecting the data and developing a theory as a result of the data analysis. Saunders, Lewis and Thornhill (2003) observe that “*the deductive approach owes more to positivism and the inductive approach to interpretivism*”.

The basis underlying positivist studies is the identification of research questions in an effort to test theory objectively and generalise from a sample population to the universal population (Guba and Lincoln, 1994; Snape and Spencer, 2003). Sample size is an important factor in the research effort. The positivist approach contends that a large sample size is required in order to statistically validate any findings. Added to this, the neutrality and generality characteristics of this philosophy make this approach unsuitable for this research.

As interpretive studies are conducted in their natural settings and are primarily concerned with observation and narrative, this study purports the adoption of an interpretive philosophy mainly because the author will be using an in-depth understanding of lean within a small sample of manufacturing companies to inform other situations.

The next section details a selection of popular quantitative and qualitative methods available to researchers, including an evaluation of their strengths, weaknesses, and suitability for this research. Following this, the researcher is in a position to justify their selection of the research methodology most appropriate for this study.

3.3 Research Design

The previous Literature Review chapter is compiled using secondary research applicable to the reasons why companies take up lean manufacturing, issues associated with the change process, and the benefits accrued with the process. Having examined these areas it has enabled the author to gain valuable insights into the formation of the research objectives. IS research incorporates behavioural and organisational issues as well as the technology itself. Vogt (1993) believes that research design is a “*science (and) art in order to conduct research with the aim of achieving the most valid findings*”.

Galliers (1992) suggests that the choice of research approach should be based on considerations of the nature of IS systems themselves together with the research objective. There is a varied range of research methodologies available for researchers to use. However, the decision of when to use them depends on their strengths, weaknesses, and applicability to the research. The fundamental of research evaluation, whether qualitative or quantitative, is the truth value and the applicability of the study.

Truth value relates to the honesty of the design and the methods used to collect and weigh up data. Applicability relates to the meaningfulness and significance of the findings in experimental practice. Investigative assessment comprises of two straightforward questions: (1) Is this a significant area of study? (2) Is the design appropriate for answering the research question? Research designs should match the nature of the research question. (Pickler, 2007)

The primary procedural assumptions determine which research methodologies and techniques are applicable for gathering information concerning phenomena (Orlikowski and Baroudi, 1991). There are several classifications of research methodologies, however the main division is between qualitative and quantitative (Mingers, 2003).

3.4 Quantitative Approaches Available

Quantitative research methods originated in the natural sciences and were originally developed to study natural phenomena (Chen and Hirschheim, 2004). The primary objective of quantitative research is to study facts, test hypotheses, and identify relationships using mathematical and statistical approaches.

The results obtained from the selected sample population are usually generalised to the larger population. When using quantitative methods, the time that the researcher is engaged in the research process is generally minimal (Chen and Hirschheim, 2004). Chisnall (1991) believes that quantitative research findings tend to be relatively “*hard data*” in contrast to the “*soft data*” obtained from qualitative.

3.4.1 Laboratory Experiments

The intention of laboratory experiments is to “*test the impact that a treatment or intrusion has on an outcome, while controlling all other factors that could have an influence on that outcome*” (Creswell, 2003). This methodology is not suitable for this research as there will be no intervention or influence on the part of the researcher while studying the phenomenon.

3.4.2 Survey Questionnaires

According to a study performed by Orlikowski and Baroudi (1991) quantitative surveys are the most prevailing research method in the IS discipline. Quantitative surveys aim to reveal data on respondent’s attitudes, opinions, and experiences using predetermined questionnaire material. In addition, survey methods are well-known for their quick respondent turnover when collecting data (Creswell, 2003).

3.5 Qualitative Approaches Available

The term ‘qualitative’ captures such a broad scope of research methods that a single definition is more or less impossible; however, one could attempt to define qualitative research as “*inquiries of knowledge that are outside the framework prescribed by the scientific method, as well as assumptions of inferential statistics*”. (Byrne, 2006)

Qualitative research methods involve the efficient collection, organisation, and understanding of textual material derived from talk or observation. (Malterud, 2001). Simply put, the investigation being carried out is on the why and how of decision-making, as compared to what, where, and when of quantitative research. Hussey *et al.*, (1997) state that qualitative research involves “*examining and reflecting on perceptions*” in the hope of achieving a better understanding of the social situation.

While quantitative approaches tend to target a large sample population to smooth the progress of the generalisation of findings, qualitative approaches tend to select smaller samples with a view to identifying patterns or explanations (Snape and Spencer, 2003). Unobtrusive measures are measures that do not require the researcher to intrude in the research context. A questionnaire is a distraction in the natural stream of behaviour. Respondents can get tired of filling out survey forms or put out by the questions being asked and this can one of the main reasons for carrying out qualitative research over quantitative research (Malterud, 2001).

Identifying a concise topic area and having a well-planned research procedure will smooth the progress of completion of a qualitative research study; however, the research process may become known as the researcher gains more knowledge from reviewing the literature, consulting experts, or beginning data collection. Qualitative research assumes that the researcher is a fundamental part of the research process. When beginning a study, a qualitative researcher should provide an overview of his or her personal and professional perspectives and assumptions. (Byrne, 2006)

3.5.1 Interviews

There are a number of methods that can be used to carry out qualitative research, one of these being in-depth interviews with members of the teams on which the research is based and the companies being focused upon. The purpose of the interview is to probe the ideas of the interviewees about the phenomenon of interest (Trochim, 2006). There are three basic approaches for collecting qualitative data through personal interviews and these are – informal conversational interview, standardised open-ended interview and in-depth interviews (Patton, 2002). Informal conversational interviews are open and adaptable to the interviewee where no predetermined questions are asked.

Open-ended questions allow interviewees to respond freely to answers and to provide further information rather than just one-sentence answers. In-depth interviews can provide rich and in-depth information about the experiences of individuals. It must also be recognised that many interview questions can be quite difficult to answer and investigators should perform a thoughtful analysis of all the possible methods that can be used to answer the research question asked (DiCICCO-BLOOM, 2006).

3.5.2 Case Study

The case study is a thorough research strategy used to investigate phenomenon deeply within the context of their natural settings. Case studies focus on describing an explicit situation and relationships in that state of affairs usually within an organisation. Researchers relate an assortment of methods of data collection to gather well-off, detailed information on events, activities, and processes from one or more individuals over a particular period of time (Benbasat *et al.*, 1987; Yin, 1994).

At the beginning of a case study, the boundaries of the phenomenon are not specified and the study begins with the researchers identifying research questions. One of the main strengths of case studies is that reality is captured in great detail and more variables can be analysed.

However, case studies commonly target a small number of respondents, thus limiting their reliability when generalising from the small sample to the overall population (Stapleton, 2001). An additional drawback related with the small sample size of case studies is the high risk of producing misleading results (Wall, 2003).

3.6 Selected Methodology

Easterby-Smith *et al.*, (1997) define a research methodology as being a combination of techniques used to enquire into a specific situation. At this stage, it has been established that an interpretivist philosophy would be suitable for this research study. The methodology used will be one of qualitative research through the use of a case study involving two Irish based manufacturing companies whereby an in-depth understanding of human behaviour regarding lean manufacturing and the reasons that govern such human behaviour will be examined.

Qualitative research methods should go well together with a philosophy of knowledge. Qualitative researchers must read expansively to enlarge their views and classify their personal epistemology. This will create an awareness of the various methodologies and the likeness or conflict with specific research methods. Commencement of a qualitative study begins with choosing a topic area and identifying plans for generating and analysing data.

3.6.1 Reasons for choosing Case Study method

The main reason for deciding to carry out a case study is because it is an intensive study of a specific context and it will help to gain more understanding of the activities involved in lean manufacturing which help it to be a success or failure in its given environment. Case-based research is a practical enquiry that investigates a present-day phenomenon with a real-life context when the boundaries between phenomenon and context are not clearly understood (Brannick, 1997).

Saunders, Lewis and Thornhill (2003) observe that the case study strategy has considerable ability to generate answers to the questions “*why?*” as well as the “*what?*” and “*how?*” questions. Yin (1994) contends that the case study approach is appropriate for organisational and management studies. In organisations experiencing rapid change, statistical generalisations might be out of date by the time they are unravelled whereas a description of the processes might be valuable.

3.6.2 Reasons for In-depth Interviews

In-depth interviews are chosen as the means to put into operation the primary research in this case study. According to Cooper and Schindler (1998), advantages include a superior depth of information and detail can be obtained when compared to other techniques. The researcher has more flexibility to improve the quality of the information received than with any of the other methods also. Interviewers can search for additional questions and gather additional information through observation. Easterby *et al.*, (1991) claim that interviewing has often been described as “*the best*” in order to collect information. In addition, a further reason why this approach was chosen for this research was its appropriateness to gather data with this complex issue and the time constraints imposed for writing a masters dissertation.

3.6.3 Criticisms of Qualitative Research

Although the author believes that qualitative research is the correct methodology to use for this study, there must be some limitations to be wary of when carrying out qualitative research. Aaker *et al.*, (1998) argue that it is not so much the qualitative procedures that have limitations but more the fact that results are often misused and not projected to represent the population as a whole. Reliability of the information retrieved can also be questionable.

Silverman (2000) argues that when interviews carried out on tape, and are then transcribed onto paper some valuable communication insights such as pauses or overlaps from the interviewee can be left out, hence reducing the reliability of the information retrieved. Also qualitative research can be time consuming and expensive with data obtained being hard to interpret.

3.7 Conclusion

Through the explanation of existing research philosophies and methodologies, this chapter set out the research design for the present study. This study purports the adoption of an interpretive philosophy in conjunction with the methodology of qualitative research. The next chapter sets out the findings of the study, which gathered and analysed data using this research design.

Chapter 4 - Research Findings

4.1 Introduction

The objective of this chapter is to analyse the findings from the interviews that were undertaken during the research study. The interview questions were developed based upon the information gathered in the literature review chapter. This findings chapter begins with a brief description of the two plants involved in the case study as well as the different lean stages they have implemented up to the present day. In addition, the many issues discussed and answers to those issues from the respondents are discussed in order to extract the key findings and lessons learned from the research.

4.2 Preparation for Semi-Structured Interviews

Before carrying out interviews the researcher collected and analysed academic literature on lean manufacturing techniques, which helped to form part basis for the interview guide. Relevant company information was also sourced prior to the interviews taking place. Also, the researcher had been able to observe some of the processes first hand in both companies and this helped the interviewer to carry out the interviews appropriately and to apply relevant questions to the research.

4.2.1 Analysis and Limitations of Interviews in each company

The interview responses will be transcribed in order to record and analyse the data from each interview carried out. This allows comparisons and contrasts to be drawn by the researcher. Further discussion and thoughts are to be found in the next chapter. Sensitivity of information is a major constraint of this study. Both companies have been extremely co-operative, however, they still have to have some control on the disclosure of information, as this is a public document. The author has adhered to the requests of both companies involved so it was decided for the anonymity of the companies that they be referred to as Company A and Company B.

The interview questions were designed to develop an understanding of lean implementation in the medical device sector and are based on the many issues discussed in the literature review chapter. The lean assessment questions were also written in such a way as to derive the extent and detail of the lean programs in place in both companies, while leaving the questions open-ended with the idea that the benefits and barriers to lean implementation could be discussed.

The interview questions asked to each member interviewed are as follows:

1. Is lean manufacturing a plant/or corporate strategy?
2. How often does the managing director become involved or be asked for support?
3. How does the company go about selecting a process for lean savings?
4. How has the team culture been helpful to the lean initiative?
5. Do you think there is a visual awareness of lean within the company, and in what ways is it seen?
6. What do you think are the main barriers/obstacles to the lean initiative?
7. What have you learned so far from the lean experience and is there anything you feel could have been done better?
8. What is the future for lean across the value stream of the company?
9. Does the company have financial figures to evaluate the success or otherwise of the lean initiative and how difficult is it to predict such figures?

4.3 Company A Profile

Company A was established firstly as a manufacturer of glasses. It was not until the 1960s that the plant started to develop contact lenses. During the 1990s the company began to develop more surgical and lens products related to the eye in a bid to become the number one eye care specialist in the world. The company set up its plant in Ireland in 1981 and this was its first plant overseas. Today, this plant is the principle contact lens manufacturing site for its organisation worldwide.

4.4 Lean Manufacturing in Company A

When the concept of lean was introduced to Company A, with a two day lean training session and wholesale reading of “*Lean Thinking*” by Womack and Jones (1996), a senior person in the company expressed that “*lean is not that applicable to us, we are a process industry, which is different to the assembly industry that lean comes out of and anyway, there are not many companies in our sector talking about lean*”.

The company still decided it best to begin its lean initiative in the plant in 1999 as an attempt to reduce waste within the plant. At the outset the then plant and business process improvement managers contacted the Lean Institute in Cardiff, Wales in order to learn more about lean methodologies. A lean committee was then formed and six waste reduction projects proposed to cut down the cost of manufacturing throughout the plant.

4.4.1 Phase 1 of the lean process – Company A

In 1999/2000 the lean process began with two change agents being brought into the role to develop lean across the plant. A production manager from one process and a quality engineer from another process were put in charge of phase one. The primary lean project was based around waste reduction contained by raw materials while at the same time strengthening understanding on value stream mapping.

One process in the company was chosen to roll out the first phase of the lean initiative as this area was suffering from low on-time delivery levels. Another reason why this area was chosen for the first phase was because it was a relatively small area and therefore deemed easier to control and measure the overall lean performance from a management point of view. Phase one was deemed a success as it resulted in the removal of some unnecessary steps in the process flow as well as some documentation used also.

4.4.2 Phase 2 of the lean process – Company A

The next phase of the lean initiative began with the diffusion of lessons learned from phase one. A process vial method was set-up in a similar way to that of another vial with a kanban at the start of the process. Documentation was also reduced and the overall process realigned to meet lean standards set by management. The printing of manufacturing orders (MO's) on-line was set-up at the first stage of material supply also. Standard operating procedures (SOP's) were also replaced throughout the plant by a new visual work instruction (WI) format.

As lean became better known during this period it was decided that a workplace organisation would need to be put in place to fit the overall needs of the company. The cleanliness standards of the plant were also of utmost importance so a 5s program was implemented factory-wide to ensure every individual's workspace met with the highest quality cleanliness standards possible. Also during this phase, it was decided by the Vice President of the company for Europe to roll out lean strategies across other manufacturing plants in the European Union (EU) due to its early success in its Irish plant.

4.4.3 Phase 3 of the lean process – Company A

Phase three began with the movement of the value stream mapping process into a manufacturing process where many lean strategies had not been implemented during the first two phases because that process had originally been ramping up to meet market demand. The value stream in this process was extended to help spot impediments to the flow and to help develop further projects along the way.

One thing that was noted from this process was that while the manufacturing end of the process became quite lean, there still remained a large level of inventory in the warehouse and distribution centre. Also, within the processes implementing lean strategies it was noted that there was a lot less waste and that more opportunities would be provided further down the supply chain.

The documentation redesign was concluded in all major manufacturing areas at the end of September 2002. 5S was also applied to all areas, both manufacturing and non-manufacturing including storage areas and offices. 5S is a system to reduce waste and optimise productivity through maintaining a tidy workplace in order to achieve more consistent operational results. A booklet was also distributed to personnel outlining the best way to apply 5S effectively. The 5S pillars, Sort, Set in Order, Shine, Standardize, and Sustain provide a methodology for organising, cleaning, developing, and sustaining a productive work environment. Phase 3 ended with the elimination of a warehouse towards the end of 2004 and lean been extended to all areas of the plant in 2005. Sustainment of lean standards is now key to the firm's success at present time.

4.5 Company B profile

Company B is an American original equipment manufacturer (O.E.M.) to the medical device industry with a plant based in the south of Ireland with over 500 employees. The company was started over 35 years ago in the US and was founded by the same family that continue to control the company today.

Company B was established in 1994 in a small town in Ireland. The firm does not own-brand its products, instead it opts to sell its product offerings to a range of companies, some in direct competition with each other.

4.6 Lean manufacturing stages in company B

In 1995-6, the whole manufacturing cell was converted from batch-based operations to flow-based operations. All machines were put in-line and manufacturing was continuous. Following on from this, the supply of raw materials into the assembly hall was put on a kanban supply where raw materials were made on a replenishment basis. All machines built to fit in to this company's manufacturing platform have been built to be movable and easy to operate.

The company is a direct supplier to medical device companies, so supply has to be met on time. This has not been done with increased stocks, but with flexibility in the manufacturing area. The main reason for the use of lean practices in this company is to reduce costs to a minimum. This is driven by the fact that this is still a family run company that would not have large reserves of capital available to be tied up in inventory and waste.

In June 2003 Company B invited lean manufacturing consultants to carry out a number of projects at its facilities in both Ireland and the US. Although company B's management team consisted of people with a great amount of experience drawn from various industries such as electronics, pharmaceutical and medical, none of them had previous experience in lean manufacturing concepts. Each of these continuous improvement initiatives had varying degrees of success, and also prompted the owners to take an overall view of their businesses from a lean manufacturing perspective.

The main advantage of doing this was that any managers and workers involved in these projects developed a detailed understanding of the basics of lean and how to implement it. As waste was being identified and eliminated it created an energy for continuous improvement activities throughout the plant all of which served to make the company more competitive. Since June 2003 Company B's overall lean policy has grown to become an essential part of the company's long-term strategy.

Company B next announced its plans to transfer its coating operation from the US to Ireland in January 2004 as part of its newly developed strategy of consolidating possible product value streams in to one location. This strategy is still ongoing in the plant today. In retrospect this can now be seen as a big step on the journey towards becoming a lean manufacturing facility.

Over the past three years the company has introduced lean tools such as value stream mapping (VSM), total productive manufacturing (TPM), 5S, visual management systems and demand smoothing. Growth in the facility over the past few years has resulted in a 60,000 square foot expansion and the recruitment of an additional two hundred and fifty employees.

During this expansion a new layout was designed to facilitate and improve the flow of material through the manufacturing processes using lean manufacturing tools and principles. This involved the creation of a single floor, open plan manufacturing area comprising of all the component and assembly processes.

4.6.1 Summary of the 3 main stages of lean implementation in Company B to date

4.6.1.1 The Kaizen Blitz Phase

During this phase isolated areas within the production departments were subjected to various lean tools that yielded productivity improvements. The results of the kaizen blitzes were impressive with efficiency gains of 40% and greater being achieved, as well as significant savings in space and equipment. These improvements were made possible by the supportive attitudes of both the operators and supervisors.

4.6.1.2 The Works Systems Phase

This phase involved smoothing the order book to facilitate the dedication of resources (both plant and people) to meet demand.

4.6.1.3 The Continuous Improvement Phase

This phase aimed at improving the flow of product through the manufacturing process. This creates the need for genuinely continuous problem solving and driving variation out of the system.

Company B is now just over three years into its lean journey. The improvements made have helped transform Company B into a lean supply chain, engineered for best possible operations and continuous improvement that delivers sustained value to customers and stakeholders and provides a platform for future business growth.

Those in charge of the lean initiatives in Company B ascertain that the future continuous improvement events will be focused on:

- Adapting processes to meet new or changes in customer demand.
- Focusing on improvements on products that have a very low profit margin.
- Reducing scrap and rework in the manufacturing process.
- Creating / converting space within the plant to increase production.
- Linking elements of the value stream to improve flow.
- Removing constraints in the value stream.

4.7 Sampling of Company A

In order to help answer the research problem the author chose five personnel connected with lean and continuous improvement in Company A. Due to the anonymity of this research only the job title of each person is disclosed.

RESPONDENT	JOB TITLE
A	Change Agent
B	Change Agent
C	Lean & Training & Development Manager
D	Human Resource Manager
E	Lean Director for organisation in Europe

Figure 4.1 Respondent List of Company A

4.7.1 *Lean Manufacturing as a plant or corporate strategy*

Respondent A stated that “*Lean started at the plant in 1999/2000, but it became a corporate strategy in 2003*”.

Respondent C expanded this by saying that lean was “*adopted as a corporate strategy within global manufacturing and engineering. It has yet to be expanded into marketing, commercial etc on any significant scale*”.

Respondent E added to the others' views by stating that “*The chief executive officer (CEO) has put a team in place to look at how lean might be rolled out across the whole company i.e. not just manufacturing but including commercial and all the corporate functions*”.

All other respondents agreed with the views stated above.

4.7.2 *Level of Support for Lean Initiative from Managing Director (MD)*

Respondent A commented that “*the MD is very supportive of lean. He is aware of all lean projects and will lend support when necessary*”.

Respondent E also noted that “*Generally in our environment the lean office runs the implementation with the managing director only involved or asked for support in cases where difficult issues need to be resolved*”.

Respondent D went on to say that “*the CEO of the company would also be supportive but not as visual*”.

All others respondents concurred with the views of their peers.

4.7.3 Process Selection for Lean Savings

From the response given from all involved there seems to be many ways in which a process is selected for lean savings.

Respondent A mentioned that *“all processes involved with lens manufacture and packaging are required to have lean savings every year. Each process has a lean champion who decides with the operations manager what the improvements/savings will be for the following year”*.

Respondent C also added that *“the plant has a culture of continuous year-on-year improvement that is built into our planning strategy. When this annual strategy is being devised all functions will have an opportunity to give input with regard to cost reduction opportunities. These are then selected based on the amount of potential saving, feasibility, required resources etc. If an opportunity arises in between annual strategy planning it will be assessed on the same criteria”*.

Respondent E expanded on the premise further by commenting how a process is selected by stating that *“The key value streams are mapped, waste is identified. Goals to reduce waste are set in terms of what is achievable. There is a constant effort to drive out waste. Sometimes, there may be a specific issue in manufacturing or supply that drives the need to initiate a project”*.

The rest of the respondents agreed that this is the way a process is selected for lean savings.

4.7.4 Helpfulness of Team Culture to the Lean Initiative

Respondent C noted that team culture is very helpful to the lean initiative by saying that *“People are used to working as a group or in teams to address issues and of operating on a cross functional team basis. This aided the introduction of lean in areas such as kaizens, operator involvement, full value stream analysis and the concept of mutual support inherent in lean”*.

Respondent E added that *“Obviously if there is a positive culture it is much easier to implement change. There is generally a very positive attitude to continuous improvement as this is something that has been ongoing for many years. However, the biggest difficulty encountered is in relation to sustaining change. So, it can happen that we sometimes slip back into the old ways”*.

All other respondents agreed that a good team culture plays a big part in lean initiatives throughout the plant.

4.7.5 Visual Awareness of Lean within the Company

All respondents agreed that there is visual awareness of lean throughout the company but that there could be further improvements made in future.

Respondent A stated that *“The lean group put up displays in the main corridors for employees to read. These are mainly to do with lean theory and strategy. However, I think more visual communication is needed for the lower level improvements that are made”*.

Respondent C added to this by saying *“I believe there is a high level of visibility regarding the lean programme and there is a great level of visibility on plant metric and performance in quality, service, lead time reduction etc. However I am not sure that people actually ‘take it in’. People tend to be interested only in their own area of operation and they know what is happening in such a narrow area without any visibility system”*.

Respondent D was of the view that *“There is a visual awareness of lean within the Company and I believe this is best evidenced by the actual work areas where the benefits of 5s etc are there to be seen. It can also be seen in better layouts in some of our newer and older processes. Story boards, promotional materials etc. are also very visible”*.

Finally respondent E named the 6 main ways in which lean is seen in the plant by stating that “*It can be seen in the following ways:*”

1. *Lean boards posted in the plants*
2. *Value stream maps posted in the manufacturing areas*
3. *Lean website*
4. *Various other communications e.g. articles in local site magazines*
5. *Employee meetings*
6. *Kaizen events”.*

4.7.6 *Main Barriers / Obstacles to the Lean Initiative*

Overall there were some differing views on the main obstacles to the lean initiative from the lean members.

Respondent A said the main barriers were “*implementing improvements and getting operator buy-in has been successful, however, managing the sustaining of changes has proved difficult*”.

Respondent B added that he saw the main barrier to be “*the desire to meet targets for production and the financial constraints caused by these targets also*”.

Respondent C mentioned that another obstacle to the lean initiative “*is how to find the time and resources to facilitate large scale (we have quiet a lot of small scale) operator involvement and contribution to lean*”.

Respondent D meanwhile stated that some other barriers were “*corporate support or possible lack of and fear of change*”. The respondent also added that “*sometimes lean is treated as a ‘flavour of the month’ initiative at a higher corporate level.*”

Fear of change is a very natural human reaction and there is a responsibility on the facilitators of lean to ensure that affected employees fully understand what the changes are, how they will be affected and why we need the changes”.

Respondent E summarised what the others had said and stated that the main barriers in general are:

- *“Lack of key management support*
- *Lack of long -term vision as to where we want to go*
- *Some frustration because it may not be easy assign \$ savings to everything we do*
- *Nothing wrong with the way we are now”.*

4.7.7 Lessons Learned from Lean Experience/Future Hopes

Respondent A noted that the main lesson learned “*is that for lean to be successful, it must be driven from the top level down*”.

Respondent E went on to say that “*I have learned how critical top management support/leadership/involvement is. I have also learned how important training & development in this area is. As regards doing something better – maybe more concentrated focus on one area to make it truly lean to the point that we have pull systems in place throughout*”.

Respondent C added that in future “*the primary focus from day one should be on building a management system, fully integrated to all lean components across the full value stream rather than focussing on individual elements of improvement*”.

All other respondents agreed with the views of their peers.

4.7.8 Future of Lean Across the Value Stream of the Company

Respondent C mentioned that the future is bright for lean and that *“to date lean has been mainly in the plants. I believe it will first spread out to all elements of the supply chain value stream and in time to all sectors of the business”*.

Respondent E added to those sentiments by stating that *“I would like to think our organisation over time would be organised more by value stream than functionally. This would mean significant opportunity to optimise the whole supply chain and would require greater lean focus to remove the waste through the value stream”*.

Respondent D also added that *“lean is essential for the company to ensure competitiveness in a very competitive industry”*.

All other respondents mentioned the same views for the future of lean across the value stream.

4.7.9 Level of Difficulty in Evaluating Financial Figures in Terms of Success or Otherwise of Lean Initiatives

Respondent A mentioned that *“lean is measured on dollars saved in cost improvements projects, this is visible at all levels in the company. These figures are estimated in the last six months of the previous year and are based on fairly sound project plans”*.

Respondent B added that *“we do have financial figures, we guess what they will be at the start of a project and hope we are not far wrong. We also get unbudgeted cost improvement projects”*.

Respondent D added to those sentiments by stating that *“The company does have financial figures and many of these figures are derived from the joint lean/cost improvement programs. It is difficult but very possible to predict such figures however we should not forget the intangible benefits like improved employee morale etc”*.

Respondent E finished by saying *“Yes. We have a Continuous Improvement Program (CIP) report that identifies the savings. Inventory reduction can be measured in terms of working capital. Sometimes it can be difficult to measure every improvement in terms of \$ savings. Ultimately the unit cost and profit/loss account is a good indicator of financial success”*.

4.8 Sampling of Company B

In order to help answer the research problem the author chose five personnel connected with lean and continuous improvement in Company B. Due to the anonymity of this research only the job title of each person are disclosed.

RESPONDENT	JOB TITLE
A	Continuous Improvement Engineer
B	Continuous Improvement Director
C	Production Supervisor
D	Total Process Management Champion
E	Continuous Improvement Facilitator

Figure 4.2 Respondents List of Company B

4.8.1 *Lean Manufacturing as a Plant or Corporate Strategy*

Respondent A noted that lean manufacturing is currently a plant strategy and also added that *“there is a drive to broaden its application to a corporate level”*. Respondent A also went on to say that as a company they *“implement lean manufacturing but not lean operations”* and that *“improvements are confined to the production floor”*.

Respondent C iterated that *“lean manufacturing is a plant strategy in order for the business to survive”*

The rest of the respondents agreed with the views of A and C in that lean is a plant strategy first and foremost.

4.8.2 *Level of Support for Lean Initiative from Managing Director*

Respondent A commented that the managing director *“is involved frequently and is the main driver in co-operation with the Continuous Improvement (C.I.) Director”*. Respondent A also included that the managing director ultimately decides whether or not a lean initiative is to go ahead or not.

Respondent C noted that the managing director meets with those involved in the lean initiatives *“every three weeks”* to discuss lean issues.

Respondent E added that the managing director *“is very involved and aware of all projects going on in the plant and he receives regular updates in order to provide support/direction where needed”*.

All other respondents concurred that the managing director is very much involved in lean initiatives.

4.8.3 Process Selection for Lean Savings

Respondent A answered that *“if it is a constraint, it gets priority but if there are obvious savings to be made they are pursued”*. Respondent A also went on to say that *“lean initiatives are targeted at cost reduction, anything outside this is currently not pursued”*.

Respondent B had a similar view and mentioned that selecting a process for lean savings is done for mainly three reasons; either:

- 1) *“Change in customer demand”*
- 2) *“To target an area or process that is very labour intensive with potential for big savings”*
- 3) *“If a bottleneck in the process develops”*

Respondent E added that there are some other reasons why a process may be selected for lean savings such as:

- 1) *“Through yearly objectives – agreed/planned improvement projects”*
- 2) *“Suggestions from operators / different opportunities that may arise”*
- 3) *“New learnings / benchmark visits may generate ideas”*

All other respondents concurred with the others on how the company goes about selecting a process for lean savings.

4.8.4 Helpfulness of Team Culture to the Lean Initiative

Respondent A stated that team culture in the company has *“helped collaboration across departments and broken down barriers”*. Respondent A also went on to say that team culture has *“enabled open discussion of issues and collective forming of solutions”*.

Respondent B added to this by saying that *“without the team spirit that exists the lean program would have died”*.

Respondent E added further to the question by stating that the company is “*generally open to new ideas and to try new things and that some people get really involved and interested and contribute great ideas*”.

All others respondents agreed with the others views on team culture in the organisation.

4.8.5 Visual Awareness of Lean within the Company

Respondent A mentioned that visual awareness of lean can be seen “*in some of the communications boards and annual management objectives*”. Further to that respondent A went on to say that lean “*is physically apparent in the labelling, marking and presentation of the manufacturing cells as well as in the production equipment and tooling (shadowboards)*”.

Respondent B added to this by saying that lean improvements that can be visually seen “*in monthly updates issued by C.I director and in bi-monthly briefings*”.

Respondent E extended the view further by stating that the visual awareness of lean is apparent at “*hour by hour progress displays at each cell*”.

All other respondents mentioned the same lean visual awareness systems that are in place throughout the factory.

4.8.6 Main Barriers / Obstacles to the Lean Initiative

Respondent A identified the main barriers of lean as “*lack of understanding of lean from some operators in departments outside the continuous improvement group*”. Added to this respondent A mentioned that sometimes there is “*a narrow view of lean as a cost reduction program focussed on manufacturing while ignoring operations*”.

Respondent B added to those sentiments by stating that the main barriers are “*getting people to understand that lean is all about working smarter, not harder*”.

Respondent C argued that “*people’s attitudes and the increase in headcount can also be obstacles to the lean initiative*”.

Respondent D added that “*sustaining changes after a lean event can be difficult also*” while Respondent E agreed that it can be a “*constant struggle to monitor and sustain any improvements gained*”.

4.8.7 Lessons Learned from Lean Experience/Future Hopes

Respondent A stated that many lessons were learned about “*work organisation and the failings of traditional thinking. Also about waste economy and value creation and its effect on business generation*”.

Respondent D added that “*lean gives people on the shop floor a forum to improve their process and get rid of the day to day issues that often bring production to a halt*”. As regard to future lean hopes Respondent D maintained that if the company continues to “*involve people from the beginning*” they will have a much better chance of successful lean operations.

Respondent E expressed the view that “*lean improvements arise from simple solutions but implementing and sustaining them is the hard part*”.

The views of the remaining respondents were the views shared above.

4.8.8 *Future of Lean Across the Value Stream of the Company*

Respondent A was of the strong view that in the future it is important “*to improve connectivity between all processes in the stream. To better connect support processes and educate people on the knock-on impact that everyday decisions have on system performance*”.

Respondent D added to those sentiments by saying that the future of lean across the value stream would need to be “*onwards and upwards*”.

Respondent E stated the need to “*generate further awareness of lean and instill as part of ‘the way we do things around here’*”

All others respondents shared the same views as their peers.

4.8.9 *Level of Difficulty in Evaluating Financial Figures in Terms of Success or Otherwise of Lean Initiatives*

Respondent A started by saying that “*we have the financial figures to back up the success sustained following lean initiatives*”. Respondent A also commented that “*if it isn’t clear what the immediate financial return is we don’t pursue it even if the logic is that massive gains will be made. This has locked us into targeting the low level areas where it’s more predictable*”.

Respondent E stated that “*improvements are generally tied to financial savings which is relatively easy to do when making improvements to production. However they are more difficult to predict when implementing standard work, 5S or linking elements of production to create value streams*”.

All other respondents agreed that it is generally easy to predict financial figures to evaluate success of lean initiatives.

4.9 Conclusion

This chapter has examined the issues surrounding the implementation of lean and its effects on both companies involved in the study. The results were based on ten respondents including five from each company. From what was discussed there seems to be a general agreement on the issues between all respondents in each organisation.

This leads on to the next chapter, the discussion chapter that will compare and contrast the views of the respondents in both companies to determine the differences and similarities in how each firm goes about implementing lean. The discussion chapter will also compare the views of the respondents with some of the views of the authors from the literature review chapter.

Chapter 5: Discussion

The discussion chapter discusses in detail the findings from the research in order to compare and contrast the issues discussed with the companies on which the research is based. The analysis and understanding of the data is an essential component of any successful study. It is also important to interpret the data from the interviews undertaken in the most objective method possible.

5.1 Lean Manufacturing as a plant or corporate strategy

From the findings it is evident that in Company A, lean has been adopted as a corporate strategy. Added to this are the company's future hopes to extend their lean strategy onto the commercial and marketing side of things.

Company B on the other hand adopts lean as a plant strategy only but it is evident that in the future the company hope that lean will be extended to the corporate level.

In relation to what was seen from the literature review chapter Womack and Jones (1996) talk about how an organisation implementing lean need to devise a growth strategy in the time frame of six months to two years. They also go on to the mention that when completing the lean implementation process at the end of the fifth year the organisation should be thinking about developing a global lean strategy which is what Company A are hoping to do in the near future.

5.2 Level of support for lean initiative from Managing Director

The level of support for the lean initiatives carried out by both firms from the Managing Director (MD) is very strong. However in terms of Company B the MD is more involved mainly because the plant may not be as far along in their lean journey as Company A or the fact that it is a smaller plant in terms of size and workforce.

The MD in company A gets involved largely when difficult issues arrive. It can be noted that if the MD in company A were to get involved in all initiatives from the start then less problems may arise as a result. However the MD has many roles and it may not be possible for him/her to be involved in the lean initiatives as much as he/she would like.

In the literature review chapter Walton *et al.*, (1987) discuss how a flexible and innovative management structure needs to be in place to ensure a lean and flat organisation. The above paragraphs are also supported by Jordan *et al.*, (2001) when they state “*because of the visibility of a companies executive leadership, the entire workforce consciously or unconsciously respond to its behaviour patterns. Leaderships modelling of lean behaviour is crucial for lean transformation*”.

5.3 Process Selection for lean savings

Both companies have a similar selection process for lean savings. Company A identifies overall potential savings with regard to waste and resources required by mapping the value streams of the processes.

Company B selects a process for lean savings by identifying potential cost reduction, change in customer demand or if a bottleneck in a process occurs.

Both companies have yearly objectives and continuous improvement initiatives in place to deal with lean savings.

5.4 Helpfulness of team culture to the lean initiative

Both companies are in total agreement that a good team culture is very important to the overall lean initiative. Both companies also agree that they are generally open to new ideas and that they encourage the workforce to get involved in lean as much as possible.

According to Liker (2003) in the literature review, one of Toyota's main principles is respect for its workers that has helped to make the Toyota system so successful and a guide for others to follow and this is the case with both organization researched. Also Bicheno (2004) states that without employee contributions it is unlikely that most companies will survive the severe competition facing them today.

5.5 Visual awareness of lean within the company

All respondents from both firms agreed that there is visual awareness of lean throughout each of their plants. Company A however also mention that there may be room for further visual improvements in the future with regard to lower level improvements that are made.

Because Company A is a larger plant it may be more difficult to implement visual awareness of lean throughout the plant and this may be an issue the company can improve on to help the workforce to better understand the lean improvements being made. Overall Company B's continuous improvement team are satisfied that people are visually aware of lean improvements made with the help of communication boards, hour-by-hour progress displays etc.

Bicheno (2004) refers to the 5s program as having a direct effect on safety, cost, quality and equipment performance and as 5s plays a huge part in both companies it can help the overall visual awareness within each plant.

5.6 Main barriers / obstacles to the lean initiative

Overall in both companies there seems to be some barriers to the lean initiative that need to be addressed in the future in order for lean to be a continued success in both organisations. Some of the obstacles to lean are similar in both organisations such as the sustaining of change after a lean event.

Company A's main obstacles are lack of key management support and lack of long-term vision within some levels of the organisation. Company B's main barriers are narrow view of lean as a cost reduction program and workers attitudes towards lean in general.

Some of these concerns were cited by Womack and Jones (1996) when they wrote that "*an organisation should build in financial measures that demand lean success*". Another concern viewed by Velocci (2001) is that some executives view lean as "*a flavour of the month fad*" and can be reluctant to embrace the concepts of lean.

All of the above issues need to be closely looked at by both organisations in order to sustain good levels of success in the lean initiatives particularly in regard to changing people's perspective on lean and educating them accordingly.

5.7 Lessons learned from lean experience/future hopes

On the whole both organisations are in agreement on the main lessons learned from lean initiatives so far and have similar hopes for the future of lean within their plants. One of the main lessons learned by the companies has been the importance of support from top-level management. Another is the training and development of employees involved in lean initiatives in order to understand the techniques used.

Jordan *et al.*, (2001) stress the need to learn from change experiences otherwise ‘*the company may lose the opportunity to build its corporate knowledge base*’. The last thing either company in this study want is for this to happen in the future years ahead.

As regards to future hopes Company A mention that focusing on one process to make it completely lean could be an option while Company B see that involving people from the very beginning may help to improve the lean initiatives.

5.8 Future of lean across the value stream of the company

Both organisations were of the view that the future of lean across the value stream is of the utmost importance in order to improve connectivity between all processes. As well as this it is important for both companies to create an opportunity to optimise the supply chain as a whole in order to remove waste.

Those views expressed are shared by Hines and Taylor (2000) in the literature review when they state that to get your company focused on their lean needs “*you must define the value streams inside your company.... and later the value streams in your wider supply chain as well*”.

5.9 Level of difficulty in evaluating financial figures in terms of success or otherwise of lean initiatives

In general both organisations are of the opinion that there is not much difficulty in evaluating financial figures of lean initiatives. This is mainly because improvements are tied into financial savings and continuous improvement programs.

However both organisations also agree that some savings can be difficult to measure in terms of monetary savings as well as some intangible benefits such as employee satisfaction also.

5.10 Conclusion

Overall it can be seen that both companies have similar attitudes and philosophies when it come to lean implementation. In general both companies tend to agree on what are the most important aspects of the lean initiatives being carried in their plants respective processes. However there are some aspects where both companies have differing views and these are mainly with regard to levels of support from the higher levels of the hierarchy and the visual awareness of lean throughout the plants. As well as this both organisations are aware that standards need to be sustained and improvements made on a continuous basis in order for lean to have continued success.

There are also commonalities between the respondent's point of views and the research carried out in the literature review especially in regards to the importance of team culture to lean initiatives and the main barriers to lean as well. The research undertaken in the previous chapters will enable the author to form conclusions and propose future recommendations in the next chapter.

CHAPTER 6 - Conclusion

6.1 Introduction

This chapter summarises the overall findings, while also identifying the limitations of the study. It finishes with the author outlining details for future research directions. There were a number of findings that can be considered important for any organisation considering implementing lean strategies. Firstly, that lean manufacturing is seen as a strategic tool, to help an organisation to better compete in a competitive marketplace. This is fundamental in an environment where both wages and operating costs are rising.

Next it is important for any organisation to align their key success factors with their lean initiatives. If this is not done then predicting savings can be difficult as production metrics are related to volume. Overall there is still some challenges that remain for both the companies involved in this case study but with the help of lean strategies they can go along way towards achieving their goals.

6.2 Limitations of this Research

There were a number of factors that limited this research study. The main limitation was the imposed time frame meaning it is only possible for the researcher to write a mini-dissertation giving that most time throughout the year was taken up with lectures and exams.

The effects of this were that as the findings in this research were determined mainly from qualitative data, the researcher would have obtained a greater insight into the issues surrounding lean initiatives if the study could have been extended to a broader range of organisations in different areas of manufacturing.

Another limitation of this research is that it is based on case studies. While the use of such studies may produce valid findings for the organisations in question, the ability to draw generalisations for application beyond these organisations is limited.

6.3 Future Research Directions

Based on the research there are a number of recommendations for further study. These include:

- A study of information technology systems to facilitate lean manufacturing. This would be applicable with a longer study involving more organisations.
- A survey on the take up of lean manufacturing in Ireland as most of the surveys found by the author throughout the study were based on figures from Europe as a whole or the US.
- A similar study to this involving a lot more organisations in different areas of manufacturing in order to get a more general analysis of the results of lean initiatives carried out.

6.4 Closing Remarks

This research dissertation was intended to provide valuable insights into large-scale lean manufacturing initiatives upon manufacturing process innovation in Irish companies. It is hoped that the research carried out has shed some light on to a better understanding of the many issues involved in implementing lean in a manufacturing environment. It is also hoped that the theory and research findings presented in this paper will aid others who wish to carry out longer studies involving many different industries in terms of implementing the best practices of lean.

References:

Aaker, D.A. Kumar, V. and Day, G.S. (1998). *'Marketing Research'*, 6th Edition. Canada. Wiley Publications.

Benbasat, I. Goldstein, D. and Mead, M. (1987). *'The Case Research Strategy in Studies of Information Systems'*, MIS Quarterly, 11(3), pp. 369-386.

Bicheno, J. (2004). *'The New Lean Toolbox'*. PISCIE Books.

Bowen, D.E. and Youngdahl, W.E. (1998). *'Lean service: in defense of a production-line approach'*, International Journal of Service Industry Management, 9(3), pp. 207-225, Available from EmeraldInsight.

Brannick, T. and Roche, W. (1997). *'Business Research Methods: Strategies, techniques and sources'*. Dublin, Oak Tree Press.

Burrell, G., and Morgan, G. (1979). *'Sociological Paradigms and Organisational Analysis'*. London, Heinemann Books.

Byrne, D. (1996). *'The needs of the software industry and the content of undergraduate education in Ireland: A survey of the views of practitioners, managers and academics'*, Ph.D. Thesis, Hull University.

Chen, W. and Hirschheim, R. (2004). *'A Paradigmatic and Methodological Examination of Information Systems Research from 1991 to 2001'*, Information Systems Journal, Vol. 14, pp. 197-235.

Chisnall, P.M. (1991). *'The essence of marketing research'*, London. Prentice Hall.

Cooper, D. R. and Schindler, P. S. (1998). *'Business Research Methods'*, Boston: Irwin, McGraw-Hill.

Creswell, J. (2003). *Research Design - Qualitative, Quantitative, and Mixed Methods Approaches*, Sage Publications, London.

Dahlgaard-Park, S.M. (2000). *From ancient philosophies to TQM and modern management theories*, Linköping University. Sweden.

DiCicco-Bloom, B. and Crabtree, B.F. (2006). *The qualitative research interview*, Medical Education, 40(4), 314–321. Available Online from Blackwell-Synergy:

Department of Trade and Industry (dti). (2003). *Review of the Governments strategy 2 years on*.

Egan, T. Clancy, S. and O'Toole, T. (2003). *The Integration of E-Commerce Tools in the Business Processes of SMEs*, Irish Journal of Management. January 2003.

Easterby-Smith, M. Thorpe, R. and Lowe, A. (1997). *Management Research*, An Introduction, Sage Publications. London.

EEF. (2001). *Catching up with Uncle Sam: EEF's final report on UK and US productivity*.

<http://www.eef.org.uk/UK/publications/policy/public/publication21112003.htm>

Fahy, M. (1995). *Management Developed Systems: An empirical study in Irish and UK companies*, Ph.D. Thesis. University College Cork.

Falconer, D. J. and Mackay, D. R. (1999). *The Key to the Mixed Method Dilemma*, Proceedings of the 10th Australasian Conference on Information Systems, Victoria University. Wellington. New Zealand.

Forrester, R. (1995). *Implications of lean manufacturing for human resource strategy*, 44(3), pp. 20-24. Available online from EmeraldInsight.

Galliers, R.D. (1992). *'Choosing Information System Research Approaches,'* Information System Research: Issues Methods and Practical Guidelines, Blackwell Scientific Publications, Oxford. pp. 144-162.

Garrahan, P. and Stewart, P. (1992). *'The Nissan Enigma'*. Mansell.

Guba, E. and Lincoln, Y. (1994). *'Competing Paradigms in Qualitative Research,'* Handbook of Qualitative Research, SAGE Publications, London.

Hammersley, M. (1995). *'A Critique of 'Critical Research',* The Politics of Social Research, Sage Publications, London.

Hines, P. Holweg, M. and Rich, N. (2004). *'Learning to evolve - a review of contemporary lean thinking,'* International Journal of Operations & Production Management, 24(10), pp. 994-1011, Available online from EmeraldInsight :

Hines, P. Silvi, and R. Bartolini, M. (2002). *'Demand chain management: an integrative approach in automotive retailing,'* Journal of Operations Management, 20(3), pp. 707-28.

Hines, P., and Taylor, D. (2000). *'Going Lean – A Guide for Implementation, Lean Enterprise Research Centre,'* Cardiff Business School, Cardiff.

Hopp W.J. and Spearman, M.L. (2004). *'To pull or not to pull: what is the question?,'* Manufacturing and Service Operations Management, 6(2), pp. 133–148.

Hussey, J. Hussey, R. (1997). *'Business Research, a practical guide for undergraduate and postgraduate students'*. New York. NY.

Jones, D.T. Hines, P. and Rich, N. (1997). *'Lean logistics,'* International Journal of Physical Distribution & Logistics Management, 27(3/4), pp. 153-173. Available from EmeraldInsight:

Jordan, A. and Michel, F. (2001). *'The lean company – Making the right choices'*, Society of Manufacturing Engineers. Michigan. US.

Lean Enterprise Institute (LEI) survey (2004).

www.lean.org/WhoWeAre/NewsArticleDocuments/LEI%20state%20of%20lean%20survey%20summary%208%2018%2005.doc

Liker, J. (2003). *'The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer'*, First edition, McGraw-Hill.

Malterud, K. (2001). *'Qualitative research: standards, challenges, and guidelines'*, The Lancet, 358(9280), pp. 483-488. Available online from ScienceDirect.

Mingers, J. (2003). *'The Paucity of Multimethod Research: A Review of the Information Systems Literature'*, Information Systems Journal, Vol. 13, pp. 233-249.

Monden, Y. (1983). *'Toyota Production System: A Practical Approach to Production Management'*, Industrial Engineers and Management Press, Norcross, GA.

Myers, M. D. and Avison, D. E. (2002). *'An Introduction to Qualitative Research in Information Systems'*, Sage Publications, London.

Nagalingam, Sev. V. Lin, and Grier. C. I. (1999). *'Latest Developments in CIM'*, Robotics and Computer-Integrated Manufacturing, 15(6). pp. 423-430. Available online from ScienceDirect.

OECD (1999). *'The Knowledge-based Economy'*, Meeting of the Committee for Scientific and Technological Policy at Ministerial Level, OECD, Paris, June 1999.

Ohno, T. (1988). *'Toyota Production System: Beyond Large Scale Production'*, Productivity Press, Cambridge, MA

Orlikowski, W. and Baroudi, J. (1991). '*Studying Information Technology in Organisations: Research Approaches and Assumptions*', Information Systems Research, 2(1). pp. 1-28.

Patton, M. Q. (2002). '*How to Use Qualitative Methods in Evaluation*', Sage Publications.

Pickler, R.H. (2007). '*Evaluating Qualitative Research Studies*', Journal of Pediatric Health Care, 21(3), pp. 195-197. Available online from ScienceDirect.

Rother, M., and Shook, J. (1998), '*Learning To See: Value Stream Mapping to Add Value and Eliminate Muda*', The Lean Enterprise Institute, Brookline, MA.

Saunders, M., Lewis, P. and Thornhill, A. (2003). '*Research Methods for Business Students*'. London, Pitman.

Sheehan, L. (2002). '*A Contingent Approach to Lean in the Medical Device and Pharmaceutical Industry*', Cardiff University Business School.

Silverman, D. (1998). '*Qualitative Research: Meanings or Practices?*', Information Systems Journal, 8(1), pp. 3-20.

Silverman, D. (2000). '*Doing Qualitative Research, a practical handbook*', London. Sage Publications.

Snape, D. and Spencer, L. (2003). '*The Foundations of Qualitative Research in Qualitative Research Practice*', Sage Publications. London.

Spear, S., and Bowen, H.K. (1999). '*Decoding the DNA of the Toyota Production System*', Harvard Business Review, 77 (9/10), pp. 97–106.

Standard, C. and Davies, D. (1999). '*Running today's factories – A proven strategy for lean implementation*', Cincinnati, OH. Hanser Gardner Productions.

Stapleton, L. (2001). *'Information Systems Development: An Empirical Study in Irish Manufacturing Companies'*, Ph.D. Thesis, University College Cork.

Trochim, William. M.K. (2006). *'Research Methods Knowledge Base'*, Web Centre for Social Research Methods. Available Online from :
<http://www.socialresearchmethods.net/kb/index.php>

Velocci, A. (2001). *'Effective Application of Lean Remains Disappointing'*, Aviation Week and Space Technology, New York, 154(4), pp. 60.

Vogt, W.P. (1993). *'Doing Qualitative Analysis Research – a practical handbook'*, London, Sage Publications.

Wall, P. (2003). *'The extent to which Irish information technology firms outsource information technology and support services: An empirical study of micro businesses versus larger firms'*, M.Sc. Thesis, Waterford Institute of Technology.

Walton, R.E. and Susman. (1987). *'People policies for the new machines'*, Harvard Business Review, No.2, pp.98-106.

Williams, K. Harlam, C. Williams, J. Cutler, T. Adcroft, A. and Johal, S. (1992). *'Against lean production'*, Economy and Society, 21(3), pp. 321-54.

Womack, J.P. and Jones, D.T. (1996). *'Lean Thinking: Banish Waste and Create Wealth in Your Corporation'*, Simon & Schuster, New York, NY.

Womack, J.P. Jones, D.T. and Roos, D. (1990). *'The Machine that Changed the World'*, Maxwell Macmillan International, New York. NY.

Yin, R. (1994). *'Case Study Research, Design and Methods'*, Sage Publications, London.

Appendix A – Interview Questions

Company role/Job title:

1. Is Lean manufacturing a plant/or corporate strategy?
2. How often does the managing director become involved or be asked for support?
3. How does the company go about selecting a process for lean savings?
4. How has the team culture been helpful to the lean initiative?
5. Do you think there is a visual awareness of lean within the company, and in what ways is it seen?
6. What do you think are the main barriers/obstacles to the lean initiative?
7. What have you learned so far from the lean experience and is there anything you feel could have been done better?
8. What is the future for lean across the value stream of the company?
9. Does the company have financial figures to evaluate the success or otherwise of the lean initiative and how difficult is it to predict such figures?