The application of Lean Principles and Six Sigma in the Mexican Health care system

A thesis submitted for the degree of MPhil at the University of Leicester

by

María de los Angeles López Tlahuiz

Department of Engineering
University of Leicester

2011
Para mi Mamá
Statement of originality

The accompanying thesis submitted for the degree of M.Phil. entitled “The application of Lean Principles and Six Sigma in the Mexican health care system” is based on work conducted by the author in the Department of Engineering of the University of Leicester mainly during the period between January 2005 and September 2009.

All the work recorded in this thesis is original unless otherwise acknowledged in the text or by references.

None of the work has been submitted for another degree in this or any other University.

Signed:_________________________ Date:__March 2011.___
Acknowledgments

I would like to thank God, for giving me the opportunity and strength to go through this research.

I would like to thank Dr. Jorge S. Manzanilla Cadenas, for his vital help in making this research at the ISSSTE, Puebla; Q.F.B. Alicia Sanchez Clinical Lab Manager, and Prof. Graham Cherryman, for the opportunity to participate in the “Green Belt Project” at the Imaging Directorate of the UHL.

I also would like to thank my family for the support and confidence in this journey; to my friends Tony, Edgardo (†), Don Antonio (†) and Doña Angeles, Elias, Ing. Joel (†), Esteban, Tio Enrique and Tia, Jorge, Clau, Isa, Alma, and especially to Gareth for his patience, hard work and help.

I wish to thank my Mexican friends in Leicester: Monse, Magda, for their help, support and time during my stay in Leicester, thanks also to Monica and Mark for their hospitality, kindness and help.

Additionally, I would like to thank the “Bobby tour” friends David and Pepe, and especially to Mr. J. Roberto Pulido for cheering me up. Many thanks for being there and making this time enjoyable.

Finally, I would like to express my gratitude to my sponsor CONACYT and to my country Mexico, for giving me the opportunity to pursue my degree in higher education.
The application of Lean Principles and Six Sigma in the Mexican health care system

María de los Angeles López Tlahuiz, Research student, alopezt_99@yahoo.com
University of Leicester, Leicester, LE1 7RH, UK

Abstract

This research addresses the application of Lean principles and Six Sigma in health care.

Lean manufacturing methods were developed in Toyota after World War II and focused on continuous improvement, involvement of personnel, and the elimination of waste. Six Sigma was introduced by Motorola in the late 1980’s as a variation reduction approach. Of the two, Six Sigma is fundamentally statistical. By contrast, Lean’s power comes from its simplicity although underlying this is a process basis that is arguably statistical.

Both approaches started being used in health care, mostly in US Hospitals, having results such as the reduction of mortality rates, improving discharging processes, reduction of surgical site infections, to mention a few. In Europe, the Red Cross Hospital (the Netherlands) applied Six Sigma in at least three different areas; in the UK, places using these approaches include the Royal Gwent Hospital in Cardiff (reducing waiting lists for ultrasound), Bolton Hospital (death rates for patients having operations were reduced by a third); and just recently in Mexico.

The goal of this research is to examine the applicability of Lean principles and Six Sigma in health care (with a focus on the Mexican health care system), as well as to identify the most useful tools/techniques, and what key factors are needed to succeed in the implementation of the approach in health care.

Research was conducted at two different provider organisations in different countries: the University Hospitals of Leicester (UK) and at the ISSSTE Puebla Regional Hospital (Mexico). The research was undertaken using two pilot and two case studies. Interviews with consultants, hospital managers, staff and some patients were also carried out. Thus, qualitative and quantitative information was gathered.
## Glossary

**Andon**  
Visual control

**Adverse Patient Event**  
The term adverse patient event is defined as "any event or circumstance arising during NHS care that could have or did lead to unintended or unexpected harm, loss or damage"

**ASQ**  
American Society for Quality

**CABG**  
Coronary Artery Bypass Graft

**CONAMED**  
Comisión Nacional de Arbitraje Médico (National Commission of Medical Arbitration)

**CONAPO**  
Consejo Nacional de Población (National Council of Population)

**CT**  
Computerised Tomography

**DPMO**  
Defects Per Million Opportunities

**DMAIC**  
Define, Measure, Analysis, Improve, Control.

**FMEA**  
Failure Mode and Effects Analysis

**GDP**  
Gross Domestic Product

**GE**  
General Electric

**GP**  
General Practitioner (family doctor in Mexico)

**Heijunka**  
Randomisation of assembly sequence

**ICU**  
Intensive Care Unit

**ISSSTE**  
Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (Institute of Security and Social Services for the State Employees)

**JIT**  
Just-In-Time

**Jidoka**  
Autonomation

**Kanban**  
Visual system

**Kaizen**  
Continuous Improvement

**Lab**  
Laboratory

**LOS**  
Length of Stay

**MINITAB**  
Statistical software
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muda</td>
<td>Waste</td>
</tr>
<tr>
<td>OR</td>
<td>Operating room</td>
</tr>
<tr>
<td>Poka Yoke</td>
<td>Mistake proofing</td>
</tr>
<tr>
<td>RDA</td>
<td>Radiology Assistant</td>
</tr>
<tr>
<td>SSA</td>
<td>Secretaria de Salubridad y Asistencia (Ministry of Health and Sanitation)</td>
</tr>
<tr>
<td>Stomatology</td>
<td>Field of medicine or dentistry concerned with the structure, functions, and diseases of the mouth.</td>
</tr>
<tr>
<td>TPS</td>
<td>Toyota Production System</td>
</tr>
<tr>
<td>TQC</td>
<td>Total Quality Control</td>
</tr>
<tr>
<td>UHL</td>
<td>University Hospitals of Leicester NHS Trust</td>
</tr>
<tr>
<td>U/s</td>
<td>Ultrasound</td>
</tr>
<tr>
<td>Value</td>
<td>A capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
</tbody>
</table>
# Contents

Title                                  i  
Dedication                             ii 
Statement of originality               iii 
Acknowledgments                        iv 
Abstract                               v  
Glossary                               vi  
Contents                               vii 
List of Figures                        viii 
List of Tables                         ix 

**Chapter 1**                            1  
Introduction                           1 

**Chapter 2**                            7  
Literature review                      7  
2.1 Lean principles development       7  
2.1.1 Lean tools                      11  
2.1.2 Lean applications in industry/services 16  
2.2 Six Sigma                          16  
2.2.1 Six Sigma tools                 19  
2.3 Lean and Six Sigma in health care  22  
2.3.1 Lean cases in health care       24  
2.3.1.1 Benefits of using Lean        32  
2.3.2 Six Sigma in health care        33  
2.4 Applicability of Lean and Six Sigma in health care 39  
2.5 Enquiry                            41  
2.6 Key factors                        43  
2.7 The Mexican context               44  
2.7.1 What is health?                 44  
2.7.2 Economic implications of health care 45  
2.7.3 An opportunity for the Mexican health care system 47  
2.8 Research questions and Aims       47  
Summary                               48
### Chapter 3
Methodology 49
3.1 Introduction 49
3.2 Development of methodology 50
3.3 Pilot studies 52
3.4 Research programme 53
Summary 56

### Chapter 4
Pilot studies in the NHS 57
4.1 University Hospitals of Leicester 57
4.2 Methodology 58
4.3 The Ultrasound pilot study 59
4.3.1 Observation and collection of data 63
4.3.2 Ultrasound map correction 70
4.4 The Plastic Surgery pilot study 73
Summary 77

### Chapter 5
The Mexican health care system 78
5.1 The Mexican health care system and its structure 78
5.2 Health Institutions 79
5.3 The National Crusade for the improvement of the health services 80
5.4 ISSSTE 81
5.4.1 ISSSTE current situation 83
Summary 87

### Chapter 6
The ISSSTE Puebla Regional Hospital 88
6.1 The ISSSTE case study Clinical Laboratory 90
6.1.1 Major customers of the Clinical Laboratory, type and quantity of lab tests ordered 92
6.1.2 Lab test results delivery 93
6.1.3 Queuing problem 96
6.1.4 Reduction of waiting time at the reception desk 100
6.2 ISSSTE Referral and Counter-referral case study 104
6.2.1 Approaches utilised for the case study 104
6.3 ISSSTE Referral and Counter-referral data analysis 106
6.4 Role of unions in Mexico 113
Summary 114

Chapter 7
Discussion 116
7.1 Introduction 116
7.2 Principal findings 118
7.3 Comparison between UK and Mexico 120
7.4 Comparison with other UK studies 121
7.5 Comparison of methods, tools and techniques 123
7.6 Key factors 125

Chapter 8
Conclusions 127

Bibliography 130

Appendices 147
Appendix 1 A typical FMEA form 148
Appendix 2 Sample of questions from interviews 149
Appendix 3 Ultrasound map elaborated by the U/s Staff 150
University Hospitals of Leicester June 2005 General Ultrasound
Appendix 4 Data collected at the UHL U/s 156
Appendix 5 Parts of the U/s map not in accordance with the real 158
Ultrasound path
Appendix 6 Plastic Surgery team goal statement, identification of the 162
problem, and tasks to perform
Appendix 7 ISSSTE Structure 164
Appendix 8 Referral process 165
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Source</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A Kanban card example. Source: Ohno, 1988.</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Example of a Poka-Yoke device.</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>Example of a cell manufacturing layout.</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Icons used for value stream mapping. Source: Rother and Shook, 1999.</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>Example of a map. Source: DeBusk et al., 2004.</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>Sigma levels.</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>7</td>
<td>Similarities between Manufacturing and Health. Graph made by the researcher.</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>8</td>
<td>The virtuous cycle. Source: Frenk J., et al., 1994.</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>9</td>
<td>Expenditure in Health. Source: OECD Health Division, 2007.</td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>11</td>
<td>Means to carry out a U/s at each location. Graphic made by the author.</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>12a</td>
<td>Letter from the UHL Imaging Directorate.</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>12b</td>
<td>Supporting data patient waiting times and size of waiting list. Data provided by the project Co-ordinator.</td>
<td></td>
<td>76</td>
</tr>
<tr>
<td>13</td>
<td>Population covered by IMSS and ISSSTE. Source: Fox, 2005.</td>
<td></td>
<td>80</td>
</tr>
<tr>
<td>16</td>
<td>Population pyramid for the ISSSTE. Source: ISSSTE, 2004.</td>
<td></td>
<td>86</td>
</tr>
<tr>
<td>17</td>
<td>Population pyramid for the ISSSTE. Source: ISSSTE, 2004.</td>
<td></td>
<td>86</td>
</tr>
</tbody>
</table>
Figure 18. Location of Puebla State.

Figure 19. Puebla State Head Municipalities. Source: Papeleriacontable. 2007.

Figure 20. Spaghetti diagram for a patient to pick up lab test results at the ISSSTE Clinic Lab. Made by the author.

Figure 21. Number of patients served by the ISSSTE Clinical Lab during August 2005. Source: ISSSTE database. Graphic made by the author.

Figure 22. Number of patients served by the ISSSTE Clinical Lab during September 2005. Source: ISSSTE database. Graphic made by the author.

Figure 23. Number of patients served by the ISSSTE Clinical Lab during October 2005. Source: ISSSTE database. Graphic made by the author.

Figure 24. Number of patients served by the ISSSTE Clinical Lab during November 2005. Source: ISSSTE database. Graphic made by the author.

Figure 25. Number of patients served by the ISSSTE Clinical Lab during December 2006. Source: ISSSTE database. Graphic made by the author.

Figure 26. Number of patients served by the ISSSTE Clinical Lab during January 2006. Source: ISSSTE database. Graphic made by the author.

Figure 27. Layout of the reception desk. Graph made by the author.

Figure 28. New layout for Lab reception. Graph made by the author.

Figure 29. Distribution of time for getting physical samples at the ISSSTE Clinical Lab sampling rooms. Data collected and graph made by the author. August and September, 2005.

Figure 30. Structure for the Referral Counter-referral project. Graph made by the author.

Figure 31. Information obtained in a brainstorming session.

Figure 32. ISSSTE Cause-effect diagram to identify causes of high costs. Graph made by the author.

Figure 33. Costs generated by medical units. Source: ISSSTE Finance Department database. Graphic made by the author
Figure 34. Pareto Chart for Transport Expenses per medical unit. Source: ISSSTE Finance Department database. Graph made by the author.

Figure 35. Expenses incurred for patients referrals. Source: ISSSTE Finance Department database. Graph made by the author.
List of Tables

Table 1. Companies/public entities applying Lean principles. Sources: Coffman, 2004; Shingo prize.org, 2005; Bourn, 2007; Department of Natural Resources and Environmental Control, 2008. Table made by the author.

Table 2. List of some tools utilised in Six Sigma.

Table 3. Benefits for companies applying Six Sigma. Sources: General Electric, 2005; Bowman, 2000; Rucker, 2005. Table made by the author.

Table 4. Comparison between Lean Thinking and Six Sigma approaches. Source: Pyzdek, 2005

Table 5. The 7 wastes of Health care. Source: www.gemba.com

Table 6. Examples of Hospitals using Lean. Table made by the author.

Table 7. Examples of Hospitals using Six Sigma. Table made by the author.

Table 8. Similarities and differences between Lean and Six Sigma in health care. Table made by the researcher.

Table 9. Answers to the questions sent by the author to experts.


Table 11. Data from the observation at the three hospitals. Made by the author.

Table 12. Parameters to perform U/s at each site. Made by the author

Table 13. Percentage of session time used at each site. Table made by the author

Table 14. Elapsed time (minutes) since a patient left the room and the next one entered into that room. Table made by the author.

Table 15. Outcomes during observation/collection of data at UHL sites. Table made by the author.
Table 16. Classification of the waste found in U/s. Table made by the author 71

Table 17. Main indicators of Social Security. Source: Ochoa León, 2006. 83

Table 18. Rooms and clinics available at the ISSSTE Hospital in Puebla. Source: Clinical Direction, 2006. 89

Table 19. Type of tests ordered and quantity. Source: ISSSTE database. Table made by the author. 92

Table 20. Major Lab customers. Source: ISSSTE database. Table made by the author. 92

Table 21. Number of results per month not picked up by patient/medical unit. 93

Table 22. Parameters of patients served by the Clinical Lab. Table made by the author. 100

Table 23. Performance statistics for chemists to get physical samples. C10 is room 1, C11 is room 2 and C12 is room 3 for getting blood samples. Data collected and table made by the author. 103

Table 24. List of some ISSSTE peripheral medical units in Puebla State. Source: ISSSTE Clinical Direction. 107

Table 25. Type and origin of referrals. Source: ISSSTE Clinical Direction records. Table made by the author. 109

Table 26. Summary of pilot and case studies. Table made by the author. 118

Table 27. Findings from pilot and case studies. Table made by the author. 119
Chapter 1

Introduction

This research addresses the application of Lean and Six Sigma in health care, to examine their suitability in the Mexican health care system, benefits, most used tools/techniques, critical factors and barriers. Both manufacturing and services share common characteristics: existence of processes, human factor, budgets, constraints/lack of resources, and customer expectations (goods in manufacturing, and health/tests/diagnostic/services and so on, in health care).

Health is an important subject in a number of countries, since health, social, and economic development are intimately related (Frenk et al., 1994). Reasons for concerns vary: offering care to an increasingly ageing population and finance problems (Ochoa Leon, 2006); to accomplish specific targets such as access for all citizens, effective care for better health outcomes, efficient use of resources, high-quality services and responsiveness to patient concerns (Saltman et al., 2004); to deliver first-class services and improve health for all citizens (Jones and Mitchell, 2006); to deal with finance issues (Mango and Shapiro, 2001); to improve safety and quality (Institute of Medicine, 2001). It would be relevant, perhaps, to point out that private health providers concerns are quite different from the public ones, given that they also look for profits while offering their services; this can be a reason for them to improve their way of working. In the USA, some hospital managers found that Lean and Six Sigma could help them to solve economic problems and reduce the process errors they were experiencing. According to Schneider (2002) pioneers using both approaches in health care include: Froedtert Memorial Lutheran Hospital (Milwaukee), Northwestern Memorial Hospital (Chicago), Heartland Health (Missouri), and Commonwealth Health (Kentucky).

Lean manufacturing, Lean thinking, TPS (Toyota Production System) or Lean, are synonyms used to refer to the set of principles developed at Toyota by Taiichi Ohno. These concepts were built up to deal with the specific needs of Toyota after World War II to keep the factory active and to reach Ford’s production level in a certain period of time. Regardless of an approach being made to accomplish particular goals, Lean has been applied in different areas of human action and industry/services; for example Boeing (2004), Kodak (2007), Engineering at the city of Los Angeles (Kuprenas, 1998), and Stanford Hospital (George and Rago, 2005).
There are several definitions of Lean, depending on the field of application, e.g. for Toyota, it is a production control system, a way of "making things" (Toyota web site, 2008). Others have described it as: a total organisational change (Koenigsaeker, 2000); a management system (Ballé, 2008); a philosophy that incorporates a collection of tools and techniques into the business processes to optimize time, human resources, assets, and productivity, while improving the quality level of products and services to their customers (Becker, 2008), Lean can be defined as a philosophy that brings into play techniques in the pursuit of the elimination of all activities that do not add value (from the customer’s eye) to a product/service while it is processed, delivering it to time, in the right amount and place, satisfying customer expectations, and without extra expenses (Womack and Jones, 1996; Joyce and Schechter, 2005; Maleyeff, 2007).

Six Sigma was developed in industry (Motorola) in order to lower costs and improve the quality of the items produced, and defining it as a metric, a methodology and a management system (Motorola web site, 2008); General Electric defines the approach as a “highly disciplined process that helps us focus on developing and delivering near-perfect products and services“ (General Electric web site, 2005), and it is also considered as a powerful breakthrough management tool (Harry and Schroeder, 2000). Six Sigma is based in a methodology named DMAIC (Define, Measure, Analyse, Improve, Control), which defines the problem, measures those variables which are considered as a source of variation; next these data are analysed and sources of variability are detected, then are eliminated/reduced, improving the process and setting controls to avoid a return to the previous practices that were the origin of defects. The aim of Six Sigma is the elimination/reduction of variability by following a structured style and by employing statistical techniques. Because of the benefits reported by Motorola, other companies like GE, Citibank (Rucker, 2005), Honeywell, Dow Chemical Co. and Du Pont to cite some, are also utilising this approach.

Lean and Six Sigma are approaches that were created to deal with specific needs of companies, to make them not only competitive but profitable, both using different concepts and methods, but sharing the same objective: a continuous improvement process. Their inclusion (along with their outcomes) in other fields like public services, banking, military and so on, signify an excellent opportunity to bring in a new field: health care. From this, several hospitals across the US have launched their own projects using Lean principles and/ or Six Sigma. Not only have American hospitals applied these techniques, but European countries have also done so, such as the Netherlands, France, Ireland, Sweden and the UK. Van den Heuvel et al. (2004)
reported that the average length of stay (LOS) for patients in the recovery room at the department of Gynaecology at the Red Cross Hospital in Beverwijk (Netherlands) was reduced. In another case, the Royal Gwent Hospital (Wales) reduced the waiting list for an Ultrasound from 18 - 20 weeks to just two weeks, by using Lean principles (Angel, 2005). Westwood et al. (2007) cite Bolton Hospitals (UK) as a place where a 50% reduction in hospital mortality for older patients with a fractured neck of femur was achieved. In addition, there was a 37% reduction in overall mortality for adult trauma patients, and a 32% shorter LOS, among other improvements. At the Mater Misericordiae University Hospital and the Children’s Hospital Temple Street (Ireland), the National Pathology Service (2008) reported batch size reduction. The flow of small batches to analyses highlighted 50% over capacity in analysers, handoffs (the act of passing something or the control of it from one person to another) reduced from seven to six, areas of over staffing, surplus inventory, excess equipment capacity and poor skills mix. The Lidköping Hospital in Sweden (Lifvergren and Bergman, 2008) conducted a project to reduce morbidity and mortality of patients on Warfarin (an anticoagulant) treatment using Lean/Six Sigma. Henderson (2005) revealed that the Adelaide & Meath Hospital in the Republic of Ireland started a Six Sigma project in order to improve the hospital performance.

Health is fundamental in raising both workers’ and companies’ productivity, as well as a nation’s development. Government expenditures in health care can consume high percentages of GDP as Jones (2002) mentions, and these resources can be invested in other areas such as education, agriculture, energy, housing, science to mention some. In both fields (manufacturing and health) customers are the reason for the existence of businesses/services.

The significant changes taking place in Mexico to cover most of its population with medical services, the structure of its health care institutions, budget constraints and a growing ageing population, along with the advent of Lean and Six Sigma offer a significant research challenge. The paucity of research on such approaches in Mexican health care organisations demonstrates the need for investigation in this area.

In the UK, the National Health System (NHS) was created on July 5 1948 by the health secretary Aneurin Bevan, to provide healthcare free at the point of delivery, on the basis of citizenship, rather than payment of fees or insurance premiums. In addition a national system of benefits was also introduced to provide social security (Palmer, 2008). The NHS central principles are: health service available to all and financed
entirely from taxation. In 2007/8 it received a budget of more than £90 billion (NHS website, 2008).

Before the NHS was established, low-paid working men were provided with the services of a ‘panel’ doctor in return for a compulsory fee per week in National Insurance contributions. The employer had to pay in three pence and the state two pence. However, hospital care was not provided. Higher-paid workers and all women and children had to pay to see the GP (Palmer, 2008). Hospitals charged for services although there were some local authorities and voluntary hospitals that did provide free or subsidized care for those who could not afford to pay. They survived only through fundraising, wealthy benefactors, and the goodwill of consultants who gave their services for free or for a minimal charge while making their living from private patients’ fees.

At the beginning, the NHS was separated into three parts: hospitals, general practice and local health authorities. It was launched as a single organisation based on 14 regional hospital boards. It took over control of 2,751 hospitals containing 533,000 beds. For the first time, consultants and senior physicians were paid like other staff and no longer honorary and entirely dependent on private patients for a living. There was a vast surge in demand for medical care from people who had previously been denied access to free treatment. There has been huge development in the NHS since 1948. According to the NHS website (2008), the 1967 Cogwheel Report considered the organisation of doctors in hospitals and the proposal of speciality groupings. It also highlighted the efforts made to reduce the disadvantages of the three-part NHS structure – hospitals, general practice and local health authorities – acknowledging the complexity of the NHS and the importance of change to meet future needs.

In 2001, the Chief Medical Officer recognised health inequalities (Donaldson, 2002). Since then, issues about poor medical performance and poor access to primary care, long waiting times, poor maternity care and the deaths of women giving birth, old buildings, financial deficits, hospital-acquired infections, capacity constraints, accusations of endemic inefficiency, and adverse events, have been brought into public light (Donaldson, 2006; Boseley, 2008). With an annual budget of more than £90 billion the NHS still faces inadequate levels of care, poor quality, staff shortages and constant resource pressures (King’s Fund, 2005; Tomson and Berwick, 2006), as well as a constant shifting of goalposts, imitation of projects from other places with a lack of consciousness (since the circumstances were different among sites; thus, no real
knowledge of reasons for using/applying approaches or procedures for that). Several quality initiatives have been put in place (Stahr, 2001) causing staff confusion and dissatisfaction because no one knows what programme has priority, as Maddock (2002) pointed out.

The NHS is struggling to deliver better health and health care while dealing with public and political concern about these issues, implementing several plans to manage the situation. The NHS currently is under a 10 year programme of transformational change, that was set to provide health and healthcare service that meets the life-long needs of the citizens of England (Bevan et al., 2006).

The Mexican health care system is organised into a National Health System, which involves agencies and entities of the Public administration, local and Federal, and people from the social and private sector who provide health services. It is important to note that, in Mexico, as long as a person has a job, but is not self-employed, medical attention can be accessed by law; however, if a person is unemployed or self-employed, health care will need to be personally financed.

In Mexico there are three main institutions which provide public health services:

1. IMSS (Mexican Institute of Social Services).
2. ISSSTE (Social Security Services Institute for Federal Employees).
3. SSA (Ministry of Health and Assistance).

Mexican health institutions are coping with offering health services to an increasing number of people, an ageing population, and financial difficulties. The research in Mexico is based at the ISSSTE, which is immersed in serious financial problems and is looking for a way to improve its services and cut its costs (without putting at risk patients’ lives). There is an opportunity for a country like Mexico to improve one of its main health care institutions by using industrial approaches (Lean and Six Sigma).

A survey of the applications of Lean and Six Sigma in health care was instigated. From this information the author concluded that it was not possible to pursue the research aim outlined only by studying and evaluating existing applications. It was necessary to carry out applications on real situations as part of the research. A pilot-study approach in an NHS Trust provided a major opportunity to get in-depth experience. This was followed by case studies at the ISSSTE.
At the ISSSTE in Mexico case studies were set up in the Clinical Laboratory (Pathology) and in the Referral Counter-referral process. Lean was used in the Clinical Laboratory first, because the Hospital Director wanted to see quick results, which were achieved through the reduction of service time at the reception desk; at the same time Six Sigma was used in order to reduce variability in the number of patients served per day. Due to the outcomes obtained in the first case study, the ISSSTE Clinical Director and the author set a second case study to be made on the Referral and Counter-referral process in order to reduce costs.

This thesis is structured as follows: chapter two includes a revision of the roots and development, tools/techniques of both Lean and Six Sigma approaches, as well as the Mexican context and the aims of the research. Chapter three contains the methodology utilised in the research. Chapter four is concerned with the pilot studies in the UHL at the UK. Chapter five is about the Mexican Health care system and the ISSSTE situation. Chapter six is about the case studies carried out at the ISSSTE. Chapter seven contains the discussion regarding the research. And finally, Chapter eight comprises the conclusions of this research.
CHAPTER 2

Literature review

A literature survey was conducted firstly to comprehend Lean principles, and Six Sigma methodology. Later, a second and focused review of its application in health care was conducted to identify examples of applications, barriers, tools/techniques, and contact (where possible) people and places, using one or both approaches in health care.

The Mexican context is briefly introduced to discuss the significance of health issues in a developing country and define the research aims in more detail. The Mexican health care system is discussed in more detail in chapter five.

2.1 Lean principles development

In 1934 Kiichiro Toyoda, Toyota’s owner, sent some staff personnel to the USA to learn from their production systems for six months. An engineer named Taiichi Ohno was part of this group. Later on, Toyoda selected the most useful aspects of the American mass-production system, since the whole concept was not applicable to his company (Fujimoto, 1999). Toyoda also faced difficulties in establishing the ideas of the mass-production system due to the traditional Japanese craft-type system in place. A reluctance to change was based on the people’s perception and distrust of a new way of working.

As a consequence of War World II, Toyota was having tremendous problems in the late 1940’s, because of the poor quality of its products and, crucially, the lack of human resources, raw materials, and money available (Japón, 1962). Because of the lack of economic resources any improvement in productivity needed to be without much hardware investment. Taiichi Ohno was a key in the improvement programme (Ohno, 1982). His findings have led to the belief that on a production line, the right parts required should not only be received at the time they are needed, but also by the amount as well. This idea stands by the notion of eliminating all unnecessary resources that do not add value to the process/product.

In 1947 Ohno changed the machine layout according to the production sequence, first into an “L” shape, later changing into a “horseshoe” shape. This is the origin of cell manufacturing. At the same time, he developed the Kanban system (visual system). It was a continuous process of trial and error.
Another important issue is the concept of working in teams. Ohno mentioned that manufacturing is done through teamwork, just like in some team sports, where individuals have a common target. (Ohno, 1988); he discovered that the action of a single individual affected the work of others. He also pointed out that assigning responsibilities is not enough to make things “...run smoothly...” at work.

The Korean War in the 1950’s was an important factor in Toyota’s recovery because the APA (American Army Procurement Agency) ordered motor vehicles from Toyota; it then had to produce more with less by eliminating as much wasted effort as possible. Under these conditions Ohno developed the JIT (Just-In-Time) concept. It happened while he was observing the activities in a North American supermarket that he conceived the idea of a flow. By visualizing how supermarket shelf replenishment was undertaken only when necessary and by an amount determined by demand. In other words, JIT provides goods when the customer needs them and in the amount required. This results in a minimum inventory of items (raw material, final product, and so on) and only produces the amount of goods that can be sold. Ohno comprehended the importance of customer needs and listened to their requirements. He defined JIT as “an extremely rational approach to eliminating waste” (Ohno with Mito, 1988).

Through his visit to some American automobile plants in 1956, Ohno identified and classified seven types of waste arising from:

1. Overproducing (producing more than the customer needs).
2. Waiting (idle time created when material, information, people, or equipment is not ready).
3. Transportation (unnecessary movement of product, material, paperwork).
4. Processing itself (unnecessary steps in the production of goods/services).
5. Unnecessary stock on hand (more materials, parts, or products on hand than the customer needs).
6. Unnecessary motion (unnecessary movement of people).
7. Producing defective goods (work that contains errors, rework, and mistakes or lack of something necessary).

Ohno also recognised the control that certain people had over the process. While workers knew what was wrong in a process and how to solve it, they did not have the “power” to stop the process and correct it. They had to wait for an order from a
supervisor. He noticed that manpower was beyond measurement and those capabilities had no limit once everyone began to think.

By 1955 automated systems were introduced in Toyota leading to the arrival of Autonomation (automation with a human touch). Ohno observed that it was not necessary to have a worker attached to a machine watching how it worked and equipment should be able to stop when an irregularity happened, preventing the production of defective goods (Ohno, 1988). At the same time, Shigeo Shingo was hired to help find a solution in setup and changeover problems. In 1962, he developed Poka-Yoke (prevent inadvertent mistake) or “mistake-proof techniques”.

In the 1950’s Toyota introduced:

a) Susha system or strong project leader and product champion, continuing in learning American scientific management techniques, education of first line supervisors for quality control,

b) Kaizen (continuous improvement).

c) Andon system (visual control), which through lights and visual signs indicated the mode of operation in a process. It encouraged workers to stop the production line if an abnormality was detected. Another part of the Andon system was the standard worksheets, which contained three elements of the standard work procedure: cycle time, work sequence and standard inventory.

This was the beginning of worker empowerment, nevertheless, workers found difficult the change of approach, since they were not used to making decisions on their own. Ohno says that if someone wants a change, first thing is to persuade people, bringing them around to the way of thinking.

In the 1970’s Toyota experienced an era of growth; a key factor was the oil crisis. However, this sudden growth also required then to diversify their range of car production. To cope with this increase, Toyota established the levelisation of production by both volume and product mix (Fujimoto, 1999). Levelisation refers to reducing lot sizes, reducing set-up times and minimising mass production.
Ohno’s concepts of Lean are simple, like the 5W; he suggested that the best way to deal with a problem is by always asking “why?” at least five times, which allows to uncover the root problem and correct it. Below, an example is given: in a finishing area of a clothes manufacturer, inspectors have found needle holes in different parts of a shirt:

1. **Why are these holes appearing?**
   - It is a new type of fabric and workers were not aware of this fact and did not change needles.

2. **Why were the workers not aware?**
   - The supervisor was absent and did not write/give any instructions

3. **Why did the supervisor not leave any indications?**
   - He does not trust anyone else

4. **Why is he the only one who handles this information?**
   - The instructions are written in English

5. **Why are the instructions not translated?**
   - No one in the company is in charge of that.

Solution: Provide a translation of the customer’s indications, placing them on a board, addressed to the workers involved in the process. This example is taken from the researcher’s personal experience in industry.

Customer demand is the driving force behind these systems (Ohno, 1988). The general idea is to create a flow by linking work centres, generating an even and balanced stream of materials through the entire production process. Toyota did not look for zero inventories, which in practice is not possible, but to level the flows of production and goods (Ohno with Mito, 1988).

In 1977 Anderson Ashburn editor of American Machinist referred to Ohno’s concepts as the “Ohno system”. Later on Ohno called them Toyota Production System or TPS. The term “Lean Manufacturing” was conceived by John Krafcik while he was working as a researcher at the International Motor Vehicles Program in the 1990’s, and it indicates a system that utilises less (in terms of all inputs) to create the same final items/services as those produced by a typical mass-production system. It is also known as “Lean thinking”, “Lean principles”, or “Lean”.

Ohno’s original ideas on Lean have been summarized into five principles by Womack and Jones (2003) as:
1. Value
2. The value stream map
3. Flow
4. Pull
5. Perfection

Tracing the history of Lean is not an easy task. Causes of this are that concepts were developed according to the specific situation that Toyota was facing at that time as Ohno (1988), Majima (1992), and Bodek (2006) cite; the system was different from the ones existing; Majima (1992) mentions that the Toyota Production System was a well-kept secret and the way the system works was not clear for other companies. Another reason is that Lean is based on methods that are considered difficult to evaluate and were perceived as “inelegant, work-floor based” as Majima wrote. Aside from that, the first book written about TPS was not released until 1978 by Ohno, and even then only in Japanese.

2.1.1 Lean tools

The following lines will explain with more detail the most usual tools referenced in literature. It is beyond the scope of this research to describe all the individual tools and techniques that comprise Lean (and Six Sigma).

1. Kanban. (Sign board): this is a card inserted in a vinyl pouch which is used for production control. It notifies workers who are making parts whether those parts are needed or not, thus components in a production line are only produced/delivered at the required moment and in the required quantity. This card is attached to a box/container. An example of this is shown in figure 1.

Information regarding production quantity, time, method, sequence or transfer quantity, transfer time, destination, storage point, etc. can be seen with a quick look. There are other types of Kanban like transport, supplier, withdrawal, to name a few.
2. Andon (Line stop alarm lights): is a board placed above machines, and uses different coloured lights according to the situation. For instance, when operations were normal, a green light was “on”; when an adjustment was needed and the worker needed help, a yellow light came on; if a line stopped to rectify a problem, a red light was on. With this concept, workers were encouraged to stop a line and not to be afraid of doing so. It was always better to correct defects at an early stage, rather than producing defective items.

Standard worksheets are a part of Andon, since they are visual signs. The sheet lists three elements of the standard work procedure:

a) Cycle time. This is the time allocated to make one piece or unit, which is determined by production quantity, e.g. the quantity required and the operating time.

\[
\text{Quantity required per day} = \frac{\text{Quantity required per month}}{\text{Month's number of operating days}}
\]

\[
\text{Cycle time} = \frac{\text{Operating hours}}{\text{Quantity required per day}}
\]

b) Work sequence. This refers to the order of operations in which a worker processes items: transporting, mounting, removing and so on.

c) Standard inventory. The minimum amount of items needed for operations to proceed.
3. Poka-yoke (Defect prevention): this concept is concerned with designing processes/devices in a form that reduces the likelihood of mistakes to zero or as close as possible.

There are two major categories for devices: prevention and detection. A prevention device affects the process by stopping it, not switching on, etc. So that it is impossible to make a mistake; an example of this type of device is shown in figure 2, where the position and shape of the holes avoid an incorrect plug-in.

![Figure 2. Example of a Poka-Yoke device.](image)

A detection device indicates by a sound, light, etc. to the operator when a mistake has been made, allowing the operator to correct the problem.

4. 5W (5 Whys'): asking five times “why?” whenever a problem is found. This is concerned with the nature of the problem as its solution becomes clear. The solution is designed as 1H (How to).

5. Kaizen (Continuous improvement): this concept stands on teamwork and process standardisation. Its goal is to increase productivity by controlling the manufacturing process through a reduction of cycle times, standardisation of quality criteria and work methods. It uses statistical quality control. The kaizen is made in four steps: establishing a plan to change what needs to be improved, carrying out changes on a small scale, observing the results, evaluating both results and the processes, and determining the lesson learnt.

6. Go Esu (5S): this concept is related to five points of organisation and maintenance of the workplace.

   a) Seiri (Classify/organise), means to separate all the useful and necessary things in the workplace from the useless and unnecessary, keeping just the items needed.
b) Seiton (Systematize) makes available/provides a convenient, safe and neat place for all the essential elements, in order to have them on hand when needed.

c) Seiso (Sanitize) keeps the workplace—including machinery—clean and tidy.

d) Seiketsu (Standardise) refers to acquiring the state of tidiness and organization through the application of the first 3S, which leads to a standardization process.

e) Shitsuke (Self-discipline) sustains the procedures already established through the first 4S. It involves a periodic control, worker self-control, respect for oneself and others. It is a continuous improvement process.

7. Cell manufacturing: arranges machines of different types in the correct process sequence, where operators remain within the cell. The materials, parts, information and tooling are stored where they are needed and used. The layout is usually in a “horseshoe” shape or “U” shape, in order to decrease worker’s movement and to keep a minimum quantity of work-in-process (figure 3).

8. Check list: used for specific data collection of any desirable characteristics of the process, product or workplace.

9. Spaghetti diagram: a map of the path taken by a specific product as it travels along the production line.
Another tool used in Lean was developed by Womack and Jones (1996, 2003) called “value stream map”. This is a graphic representation of all actions, value added as well as non-value added, which are required to bring a product or a group of products/services that use the same resources through the main flows, from raw material to the customer. The goal is to identify all the waste and then eliminate it as much as possible. In taking into account the overall picture rather than an isolated part (individual processes) improvement in the whole flow can be achieved.

The benefits of using the value stream map according to Rother and Shook (1999) are:

- it helps to visualize more than just the single process level
- mapping not only helps to see waste but also its source
- it provides a common language for the stakeholders
- it forms the basis for an implementation plan

A useful tool for showing the complete problem is by using a predefined set of icons according to Rother and Shook (1999) to draw a value stream map. Figure 4 illustrates some of them.

![Figure 4. Icons used for value stream mapping. Source: Rother and Shook, 1999.](image)

However, the icons are not essential, as long as people can understand the idea of the flow to identify the waste (see figure 5).
2.1.2 Lean applications in industry/services

Through the literature review, the author found that outside of Japan, early practitioners of Lean in the US are already cited by Womack and Jones (1996, 2003) and Emiliani (2006). It has been widely applied in both industry/services areas; in table 1 there are some examples of companies or public entities, areas of use, and improvements/results reported. Benefits identified are not only in terms of savings (Coffman, 2004) but also in customer satisfaction (Womack and Jones, 2005), less bureaucracy in services and energy reduction (Environmental Protection Agency, 2008). It is not in the scope of the research here to analyse industry or general services application, but rather to focus in health care.

2.2 Six Sigma

Motorola has been cited as the birthplace of Six Sigma, as Breyfogle et al. (2001) and Ramias (2005) mention, but the man who coined the term was the late Bill Smith, an
<table>
<thead>
<tr>
<th>Company/Entity</th>
<th>Area</th>
<th>Improvement/Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lockheed Martin</td>
<td>Design and manufacturing process</td>
<td>More than $5 Billion in net savings across our corporation</td>
</tr>
<tr>
<td></td>
<td>Chemical, Environmental, Safety, and Health Department</td>
<td>Reduction in chemical inventories reduces likelihood of chemical-related spills and accidents; virtually eliminated hazardous waste caused by chemicals expiring on shelf and from excess chemicals mixed in quantities larger than needed; chemical authorization process and chemical challenge program tightened screening of chemical choices and increased attentiveness to chemical use and risk reduction opportunities; and energy savings resulted from the significant reduction in warehouse space required for chemical storage.</td>
</tr>
<tr>
<td>Delphi</td>
<td>Adrian Operations</td>
<td>99.99% on time delivery to all customers; a 90% quality improvement, a 12% improvement in productivity and a 67% scrap rate reduction.</td>
</tr>
<tr>
<td>Grupo Fernando Simão</td>
<td>Car Dealer group</td>
<td>Increased the speed at which customers and vehicles move through the system, and reduced the total cost to the company of the typical repair by 30%; customers’ prices for repairs fallen; repair process cut from two hours to 69 min.</td>
</tr>
<tr>
<td>Fujitsu</td>
<td>Help desk</td>
<td>Reduced total calls to the help desk by 40% within 18 months and improved customer satisfaction.</td>
</tr>
<tr>
<td>Royal Air Force</td>
<td>Logistics</td>
<td>Introduction of pulse lines, significant benefits in both on- and off-aircraft repair, increased throughput but with less man hours, workspace and spares holdings.</td>
</tr>
<tr>
<td>Michigan State</td>
<td>Department of Environmental Quality</td>
<td>Decreased the time needed to process major air construction permits from 422 days to 98 days. Quality improved, with initial application administrative completeness rising from 82 to 95%.</td>
</tr>
<tr>
<td>Delaware State</td>
<td>Department of Natural Resources and Environmental Control (DNREC)</td>
<td>Lowered a backlog of air construction permits from 199 to 25, while reducing the average permit processing time to less than 76 days.</td>
</tr>
<tr>
<td>Iowa State</td>
<td>Department of Natural Resources (DNR)</td>
<td>Reduced the average time to issue standard air quality construction permits from 62 days to 6 days (a 90 percent reduction), elimination of 70% of the process steps (from 23 to 7 steps). A backlog of nearly 600 permits was cut in half in the first three months after the process improvements were implemented</td>
</tr>
<tr>
<td>Department of Homeland Security (USA)</td>
<td>Nation-wide web-accessible case and document management system; giving each employee a scanner; established a new division; improved hiring and training; formed Lean Six Sigma working groups.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Companies/public entities applying Lean principles. Sources: Coffman, 2004; Shingo prize.org; Bourn, 2007; Department of Natural Resources and Environmental Control, 2008. Table made by the author.

engineer at Motorola, who wrote a technical paper on the definition of Six Sigma.

Pande et al. (2000) and Eckes (2003) cite the previous work of Dr Mikel Harry, while he was as an instructor at Motorola in the early 1970’s. Six Sigma was developed in the mid 1980’s as a metric for measuring defects and improving quality, due to the company’s high costs incurred in fixing its own defective products.

Six Sigma refers to having six standard deviations (or sigma) between the mean of the process and the closest tolerance limit (see figure 6); the higher the number of sigma the less likely the occurrence of a defect. The original aim of having no more than 3.4 defects per million opportunities (DPMO) was set for Motorola, based on its existing processes and because of the characteristics of the company (Maleyeff and
Krayenvenger, 2004; Perez-Wilson, 1999); this DPMO is achieved through reduction and/or elimination of variation. As other important figures (like Shewhart and Ishikawa) in the field of Quality Control have stated, variation is an important factor in any process. Therefore, by understanding it, improvements can be made. Consequently, variation is fundamentally the root of excessive costs.

To avoid conflicts in using the terms Six Sigma, Black Belt and so on (registered as a trademark by Motorola), some companies use other terms like “operational excellence”, “agents of change”, “process owner” and “sponsor” to mention some.

The way Six Sigma works is via project-by-project improvement methodology, e.g. defining the opportunity, setting the metrics for measuring current performance through collecting data, and analysing the data. Therefore, based on this data analysis, the process is improved and finally, controls are set to avoid returning to the old working style. This is known as the DMAIC methodology (Define, Measure, Analyse, Improve, Control). Statistical tools are used from the very basic, such as Control charts and Pareto diagrams, to the more complex like Quality Function Deployment, Response Surface and so on (see table 2). Projects are led by “Black Belts” (e.g. managers or engineers) trained on Six Sigma and statistical techniques and dedicating 100% of their time to the project. There are also “Green” Belts, which only dedicate a portion of their time (usually 20%) to the project.

The only way of reducing/eliminating disconformities is by finding the causes of such variation and working in towards its eradication.
2.2.1 Six Sigma tools

1. Statistical Process Control. This is a set of charts on which a phenomenon behaviour/trend, characteristics can be illustrated. Following this, predictions, changes, or problem solving can be made. The choice of charts in use depends on what the person is interested in analysing, such as Mean-Range ($\bar{x} - R$), Mean-Standard deviation ($\bar{x} - S$), cumulative sum (CUSUM), dispersion and bars, to mention a few.

2. Flow chart. This is a diagram where the activities in a process can be visualised and comprehended. It is often used in the measurement stage.

3. Design of Experiments (DOE). This was created by Sir Ronald A. Fisher as a tool to improve yields in agriculture in the UK in the 1920’s. It is based on the examination of factors that can affect a process. These factors are chosen and then modified observing the results. For example, in a metal hardness process, the researcher considers that two factors (temperature, concentration of salts) are affecting the hardness. Then he/she changes these factors to a higher/lower level and observes the result of those changes, determining which one is the real cause of influence in the product. Therefore, the best conditions can be established and the process improved.

4. FMEA (Failure Mode Effect and Analysis). This is a tool in which a potential failure mode can be identified and prevented, before problems can occur. An example can be found in Appendix 1.

| Statistical Process Control |
| Flow chart |
| Process capability index (Cp) |
| Design of experiments |
| Failure Mode Effect and Analysis (FMEA) |
| Regression analysis |
| Analysis of means and variance (ANOVA) |

Table 2. List of some tools utilised in Six Sigma.
5. ANOVA (Analysis of Variance). A statistical tool used to compare differences between two or more means ($\bar{x}$) of samples and to determine if they are a result of randomness or if there are real dissimilarities.

6. Regression. A statistical tool which examines the relationship between two continuous variables: one response (y) and one predictor (x). When the two variables are related, it is possible to predict a response value from a predictor value with better than chance accuracy.

7. Hypothesis test. A statistical tool to decide if a population parameter is or is not equal to a previous determined value. For instance, making sure that an item is between the specification limits.

8. Talking wall. This is a tool used after a brainstorming session, where the ideas are written on post-its, and then placed on a wall in a random manner, in order to elaborate an affinity diagram.

9. Affinity diagram. It is a tool that gathers large amounts of language data (ideas, opinions, issues) and organises them into groups based on their natural relationships.

10. Pareto chart. It is a series of bars whose heights reflect the frequency or impact of problems. The bars are arranged in descending order of height from left to right. This means the categories represented by the tall bars on the left are relatively more significant than those on the right. This bar chart is used to separate the “vital few” from the “trivial many”.

Companies utilising Six Sigma, such as General Electric, Kodak (Bowman, 2000) and Citigroup (Rucker, 2005) to cite some, have demonstrated its benefits (see table 3).

<table>
<thead>
<tr>
<th>Year</th>
<th>Company</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>General Electric</td>
<td>Over $8 billion in productivity and profit gain</td>
</tr>
<tr>
<td>2000</td>
<td>Kodak</td>
<td>Reduction of 90% in product defects</td>
</tr>
<tr>
<td>1997</td>
<td>Citigroup</td>
<td>Reduction from 2 hrs. to 30 min (funds transfer process)</td>
</tr>
</tbody>
</table>

Table 3. Benefits for companies applying Six Sigma. Sources: General Electric, 2005; Bowman, 2000; Rucker, 2005. Table made by the author.
A comparison between the two approaches was made by Pyzdek (2005) and is illustrated in table 4.

<table>
<thead>
<tr>
<th>Focuses on customer value stream</th>
<th>Lean thinking</th>
<th>Six Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focuses on creating a visual workplace</td>
<td>y</td>
<td>x</td>
</tr>
<tr>
<td>Creates standard worksheets</td>
<td>y</td>
<td>x</td>
</tr>
<tr>
<td>Attacks work-in process inventory</td>
<td>y</td>
<td>x</td>
</tr>
<tr>
<td>Focuses on good housekeeping</td>
<td>y</td>
<td>x</td>
</tr>
<tr>
<td>Process control planning and monitoring</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>Focuses on reducing variation and achieving uniform process outputs</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>Focuses heavily on the application of statistical tools and techniques</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>Employs a structured, rigorous and well planned problem solving methodology</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>Attacks waste due to waiting, over processing, motion, etc.</td>
<td>y</td>
<td>x</td>
</tr>
</tbody>
</table>


Based on the table, Lean offers more benefits than Six Sigma. First of all, its focus on customer requirements (real demand) allows the production of specific goods/services eliminating unnecessary production, manpower and inventories of materials and items not “pulled” by the market (Ohno, 1988), while Six Sigma is focused on the elimination of variability and reduction of costs. By creating a visual workplace and practising certain disciplines in the form of 5S’ (creating standardisation) in Lean Thinking, efficiency is accomplished (Ohno, 1988), removing all those activities that do not contribute to add value to the final product/services (control on inventories, which is a way of planning).

From the researcher’s point of view, there are some issues related to Pyzdek’s comparison: it can be said that, through a revision of the history and development of Lean (Ohno, 1988, Hines et al., 2004) variation can be reduced and eliminated by standardisation, which is a consequence of the 5S’. Moreover statistics are employed and Ohno himself encouraged its use (1988). Thus Lean can be as scientific as the DMAIC methodology. The most important asset in Lean is the human being (Ohno, 1988), which has not been always taken into account while applying the approach (Emiliani, 2006), and the involvement of all stakeholders, not just engineers or top management, like in Six Sigma.
2.3 Lean and Six Sigma in health care

According to Lean principles, customers are unique. Therefore, a production line must produce unique items, one by one, because their preferences are diverse, more personalised and more rigid as Ohno mentioned to Mito (Ohno, 1988). If we transpose the automobile industry into health care terms, we should be talking about patients as customers, as they are similarly unique, with differing health needs (George and Rago, 2005). Thus, the health care provided must fulfil those needs. The idea of Lean in health care is to eliminate the “waste” (all unnecessary activities) and in doing so give the patient what they need when they need it for the lowest cost. The product (e.g. laboratory test results) or service (patient care) can make the difference between life and death.

Just like in a manufacturing process, waste is also present in health care (table 5)

<table>
<thead>
<tr>
<th>The 7 wastes—“Muda”</th>
<th>Definition</th>
<th>Health care</th>
<th>Manufacturing</th>
</tr>
</thead>
</table>
| Overproduction      | Producing more than the customer needs right now | • Pills given early to suit staff schedules  
• Testing ahead of time to suit lab schedule  
• Treatments done to balance hospital staff or equipment workload | • Producing items to stock, based on sales forecasts  
• Producing more to avoid set-ups  
• Batch process resulting in extra output |
| Transportation      | Movement of product that does not add value | • Moving samples  
• Moving specimens  
• Moving patients for testing  
• Moving patients for treatment  
• Movement patients to and fro | • Moving parts in and out of storage  
• Moving material from one workstation to another  
• Moving equipment |
| Motion              | Movement of people that does not add value | • Searching for patients  
• Searching for doctors  
• Searching for charts  
• Gathering tools  
• Gathering supplies  
• Handling paperwork | • Searching for parts, tools, prints, etc.  
• Sorting through materials  
• Reaching for tools  
• Lifting boxes of |
<table>
<thead>
<tr>
<th>Waiting</th>
<th>Idle time created when material, information, people, or equipment is not ready</th>
<th>Waiting for:</th>
<th>parts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• Bed assignments</td>
<td>• Waiting for parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Admission to Emergency Dept.</td>
<td>• Waiting for prints</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Testing &amp; Treatment, discharge</td>
<td>• Waiting for inspection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Patient lab test results</td>
<td>• Waiting for information</td>
</tr>
<tr>
<td>Processing</td>
<td>Effort that adds no value from the customer's viewpoint</td>
<td>• Multiple bed movement</td>
<td>• Waiting for machine repair</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Retesting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Excessive paperwork</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unnecessary procedures</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Multiple testing</td>
<td></td>
</tr>
<tr>
<td>Inventory</td>
<td>More materials, parts, or products on hand than the customer needs right now</td>
<td>• Bed assignments</td>
<td>• Multiple cleaning of parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pharmacy stock</td>
<td>• Paperwork</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lab supplies</td>
<td>• Over-tight tolerances</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Samples</td>
<td>• Awkward tool or part design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Specimens waiting for analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Paperwork in process</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Patients in beds</td>
<td></td>
</tr>
<tr>
<td>Defects</td>
<td>Work that contains errors, rework, mistakes or lacks something necessary</td>
<td>• Medication error</td>
<td>• Scrap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Wrong patient</td>
<td>• Rework</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Wrong procedure</td>
<td>• Defects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Missing information</td>
<td>• Correction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Redraws</td>
<td>• Field failure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Poor clinical outcomes</td>
<td>• Variation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Missing parts</td>
</tr>
</tbody>
</table>

| Table 5. The 7 wastes of Health care. Source: www.gemba.com |

Tracking down the very first places where Lean principles were applied in health care and why they were chosen was not an easy task. In table 6 examples of hospitals using Lean are given, with causes or reasons for implementing the approach, goals and results.
2.3.1 Lean cases in health care

A total of 26 sites were reviewed, including hospitals in North America, Europe and Australia. Panchak (2003) recognised that one practical aspect of Lean is to observe the process, to understand it and to identify waste.

An analysis of the information collected in table 6 showed that reasons to improve include:

- reduction of mortality and infection rates
- delays
- lack of training, and standard procedures
- medication errors
- batching
- excess of inventory
- poor layout
- length of stay
- wasted time
- waiting
- rework
- cancellations and no-shows
- poor communication
- capacity
- bureaucracy
- handoffs
- incorrect information

All the issues listed can be classified as waste in the form of transportation, motion, waiting, processing, inventory and defects. The review revealed that the tools most utilised are (ordered in number of mentions): Kaizen, mapping, 5S, visual systems (including observation), Kanban; the next tools are cited just once: fishbone, JIT, root-cause analysis, check list, levelling, cell manufacturing and statistics, (histogram, run charts, time series). Integration of teams including clinical specialists, pharmacists, social workers, case managers, respiratory therapists, nurses and managers was reported in all cases. Reactions against Lean included scepticism among doctors, reluctance to change, and a lack of cooperation (Wysocki, 2004).
<table>
<thead>
<tr>
<th>Place</th>
<th>Area/ Unit</th>
<th>Reason for change</th>
<th>Objective</th>
<th>Specific Tools/Techniques</th>
<th>Improvements/ Solutions/Results/Benefits</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stanford Hospital</td>
<td>Cardiac Surgery</td>
<td>Loss of patient volume due to its inability to be cost competitive</td>
<td>Reduce LOS and direct costs of CABG surgery.</td>
<td>Team-work, value stream map</td>
<td>Reduction in costs over $15 million; mortality rates reduced from 4.3% to 1.4 for elective CABG surgery; and from 7.1% to 3.7% for all CABG procedures; average time in ICU reduced by an average of eight hours; use of pulmonary catheters decreased by 15%.</td>
<td>George and Rago, 2005.</td>
</tr>
<tr>
<td>Community Medical Center</td>
<td>Recovery room</td>
<td>Bottleneck in the recovery room limited the number of operations per week.</td>
<td>Increase the number of operations.</td>
<td>Observation, posting somebody’s beeper number in an obvious place.</td>
<td>Recovery time was reduced from 90 to 62 minutes, freeing up time for extra-surgical procedures to be performed; access to care for the patient improves 20%; the quality of care improved.</td>
<td>Panchak, 2003.</td>
</tr>
<tr>
<td>Virginia Mason Medical Center</td>
<td>Following a period of economic stress and a general malaise in the organizational culture, the Board of Directors issued a broad mandate for change.</td>
<td>Increase the number of operations.</td>
<td>Observation, posting somebody’s beeper number in an obvious place.</td>
<td>Recovery time was reduced from 90 to 62 minutes, freeing up time for extra-surgical procedures to be performed; access to care for the patient improves 20%; the quality of care improved.</td>
<td>Panchak, 2003.</td>
<td></td>
</tr>
<tr>
<td>Allegheny General Hospital</td>
<td>Cardiac Infections</td>
<td>Delay in sending bills to insurers.</td>
<td>Improve quality to “world-class” levels (95th percentile or greater); become the health care employer of choice, making the Fortune 100 list of best employers; lower costs in order to reduce the price paid for services, gaining $10 million a year through cost savings and increased productivity.</td>
<td>Andon, Root-cause analysis.</td>
<td>Reduced accounts receivable from 56 to 44 days equating to about $12 million in cash flow; offering an option for follow-up call to patients; providing summary sheets; $3.3 million in savings in 2004; saved $154,000 in the Catheterization lab supply procurement processes; redeployed staff in several areas; improved physicians phone triage times by 35% and abandonment rates by 48%; reduced by 50% the time it takes to complete clinical paperwork on admission.</td>
<td>Wysocki, 2004.</td>
</tr>
</tbody>
</table>

1 For full reference please see the Bibliography.
<table>
<thead>
<tr>
<th>Hospital</th>
<th>Department</th>
<th>Problem</th>
<th>Improvement</th>
<th>Resources</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valley Baptist Medical Center</td>
<td>Discharge</td>
<td>Reduce time for discharging patients</td>
<td>Map, Mood’s Median test, change acceleration process, tracking system.</td>
<td>New standard operating procedure, separation of tasks, review of several areas.</td>
<td>DeBusk and Rangel, 2005.</td>
</tr>
<tr>
<td>Northwestern Memorial Hospital</td>
<td>Diagnostic</td>
<td>Amount of time patients wait to be seen in the Diagnostic Centre</td>
<td>DMAIC, mapping, 5S, histograms, run charts and time series.</td>
<td>Patients seen within 20 minutes increased from 44% to 84%; rerouting of specimens, implementation of electronic call processing, revision of laboratory requisition forms, training staff, new procedures for calling physicians’ offices for patients’ orders that had no diagnosis or ICD-9 code.</td>
<td>DeBusk et al, 2005.</td>
</tr>
<tr>
<td>University of Pittsburgh Medical Center Shadyside</td>
<td>Pathology</td>
<td>Large batches of tissue specimens</td>
<td>Lean concepts, 5S, visual controls, cell manufacturing, Kanban cards.</td>
<td>Better inventory management; reduction in turnaround time on small tissue samples; mistakes are discovered immediately; decrease of staff by 28%.</td>
<td>Lean Enterprise Institute, 2004.</td>
</tr>
<tr>
<td>Dietary</td>
<td></td>
<td>Changing the conventional way patients order meals during hospitalisation into an educational one.</td>
<td>Development of a standard menu, written and printed like a restaurant bill; costs per tray dropped from $1.37 to $1.15</td>
<td></td>
<td>Lean Enterprise Institute, 2004.</td>
</tr>
<tr>
<td>Mayo Clinic (Rochester)</td>
<td>Cardiovascular Health Clinic</td>
<td>No-shows, cancellations, perceived lack of demand, and dissatisfaction among allied staff and physicians with the efficiency of the entire patient journey, especially appointments</td>
<td>Improve the service provided by the Clinic.</td>
<td>Cancellations and no-shows dropped from 30% to 10%; the number of high-yield patients rose from 150 to 200 per month; an appointment could be given 90% of the time on first contact with the Clinic. Process steps went from 16 to six; clinical care time rose from 240 to 285 min.; wait time fell from 33 to three days, a reduction of 91%; first-time quality rose from 5% to 65%.</td>
<td>Taninecz, 2008.</td>
</tr>
<tr>
<td>Hereford Hospitals</td>
<td>Biochemistry</td>
<td>Turnaround time (from receipt to results available) 62 min to up to 2 hours, specimen pick up time 13 minutes up to 50, double handling in labelling 40 min a day.</td>
<td>Visual system,</td>
<td>Manned specimen reception, labelling, centrifuges and booking relocated in specimen reception and synchronised, FIFO batches reduced. Turnaround (from receipt to results available) time 38 min saving two beds a day £365,000; specimen pick up time 1 min up to 4, saving £10,000; double handling zero min a day, saving at least £3,000. Nine days were spent to make improvements.</td>
<td>Westwood, 2007.</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>Hospital Beds</td>
<td>Reducing dispensary turnaround times and errors</td>
<td>Rapid improvement activities, mapping.</td>
<td>Involving staff, understanding processes improving flow, eliminating waste, reducing dispensing times and errors.</td>
<td>Westwood, 2007.</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>---------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Mayday Healthcare NHS Trust</td>
<td>Keep 100 beds, reducing LOS.</td>
<td>Identifying waste, FIFO and small batches; 5S; Kanban, case studies.</td>
<td>LOS reduced to 4.8 days; Elective LOS 5.1 to 4.2 Days; theatre utilisation from 75 to 90%; admission on day of surgery in every specialty</td>
<td>Gowland and Bryant, 2008.</td>
<td></td>
</tr>
<tr>
<td>Sterile services</td>
<td>To meet demand on their services.</td>
<td>5W, fishbone, process mapping.</td>
<td>The flow in sterile services was improved, giving more consistent turnaround times for packs and better availability; less time was lost preparing theatre lists; demand was smoothed throughout the day; theatre lists were carried out the plan, without overtime or further resource.</td>
<td>Westwood, et al., 2007.</td>
<td></td>
</tr>
<tr>
<td>Catering</td>
<td>Meals not taking longer than the core standard of 20 min, trolleys lose temperature waiting for a porter, difficulty to identify patient's name on menu cards on meal trays, complaints from patients, relatives and carers concerning food temperature, wards unprepared for meal time.</td>
<td>Just in Time</td>
<td>Wards designated with staff achieved 100% meals served within 20 min, all wards have a meal distribution schedule, kitchen managing food distribution, identified clinical and managerial champions of change, staff understand how to apply Lean.</td>
<td>Gowland and Bryant, 2008.</td>
<td></td>
</tr>
<tr>
<td>Queen Alexandra Hospital, Histopathology</td>
<td>Rapid Improvement Event</td>
<td>Implementing morning and afternoon cut-up sessions, to enable processing of specimens arriving later in the day; developing standard working in the cut-up areas; implementing a &quot;no interruptions policy at reporting; developing a &quot;first in, first out&quot; principle for reporting; reduced batching at report authorisation; samples arriving late are examined by one pathologist and cut-up by another the next day.</td>
<td>NHS Improvement Programme, 2008.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University Hospital of North Staffordshire NHS Microbiology department</td>
<td>Rapid Improvement event</td>
<td>Introduced a 'pull system' to reduce the time to the bench from 50 to 8 min; reduced batch sizes to &lt;20; introduced data entry on receipt of the specimen.</td>
<td>NHS Improvement Programme, 2008.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Helens &amp; Knowsley NHS Trust</td>
<td>Clinical chemistry and haematology</td>
<td>Value stream map and process techniques; Rapid Improvement Event (Kaizen)</td>
<td>Usage of transport systems within A&amp;E and pathology, and between each department; relocation of pathology office and administrative services to facilitate more appropriate flow of specimens, staff and information through the pathology department; capacity was matched to demand in specimen reception; equipment relocated to ensure optimum usage; smooth and levelled flow of work to analysers; ergonomic and standard workstations developed; retaining of staff; removal of waste from the patient pathway; identification and removal of excess inventory; development and implementation of new protocols; visual management systems introduced; risks of accident and injury reduced.</td>
<td>NHS Improvement Programme, 2008.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Calderdale &amp; Huddersfield NHS Trust</td>
<td>Histology</td>
<td>Batched transportation of samples; inconsistency of sample labelling.</td>
<td>Implementation of standardised work to eliminate the possibility of errors and ensure the waste of rework is minimised.</td>
<td>Kaizen event, Spaghetti diagram.</td>
<td>Reducing batch size (maximum 20); FIFO to minimise variation; introduction of zero tolerance on incomplete request cards; overall reduction of non-value added time of 89% in specimen reception; specimen processing time reduced by 32%.</td>
</tr>
<tr>
<td>Leeds Teaching Hospital NHS Trust</td>
<td>Haematology</td>
<td></td>
<td>Relocating the centrifuge to reduce the number of process steps; adopting a maximum batch size of 10 to improve flow; introducing smaller batch sizes and move samples more frequently; encourage utilisation of the pod system to prevent lab staff from walking around the hospital to collect the samples.</td>
<td>Kaizen, Spaghetti diagram.</td>
<td></td>
</tr>
<tr>
<td>Bolton Hospitals NHS Trust</td>
<td>Trauma and stabilisation.</td>
<td>Improve the non-elective trauma patient pathway</td>
<td>50% reduction in hospital mortality for older patients with a fractured neck of femur; 37% reduction in overall mortality for adult trauma patients; 32% shorter LOS; no patients were transferred to long-term rehabilitation ward after the trauma stabilisation unit opened in August 2006; 30% reduction in time from admission to theatre; the average of 2.5 days fell to 1.7 days for complex adult.</td>
<td></td>
<td>Westwood, et al., 2007.</td>
</tr>
<tr>
<td>Pathology (Blood sciences)</td>
<td>Delay for delivering a correct result for a blood sample</td>
<td>Value stream analysis</td>
<td>Redesigning the lab. Urgent blood samples reduced from 75 steps to a maximum of 57; routine blood samples reduced from 309 to a maximum of 57 steps; reduction of sample processing time from an average of 5 hours to approximately 60 minutes (routine).</td>
<td>Westwood, et al., 2007.</td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>Department</td>
<td>Process</td>
<td>Improvement</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
<td>---------</td>
<td>-------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Heart of England Foundation NHS</td>
<td>Emergency</td>
<td>Clinicians spend a lot of time searching for prescription pads.</td>
<td>Improved flow; reduced waste; designed area for flow stoppers; dedicated pod station.</td>
<td>Westwood, et al., 2007</td>
<td></td>
</tr>
<tr>
<td>Salisbury District Hospital</td>
<td>Ultrasound</td>
<td>Wait of 12 weeks</td>
<td>Waiting list to be between a fortnight and zero, by sorting work into routine &quot;green&quot; streams and complex &quot;red&quot; ones; stopped leaving slots open for emergencies or urgent cases; if someone cancels booking staff has been instructed to call another patient to try to fill the gap.</td>
<td>Mathieson, 2006.</td>
<td></td>
</tr>
<tr>
<td>Gwent Healthcare NHS Trust</td>
<td>Community Rehab</td>
<td>LOS</td>
<td>Reduced LOS (from 38 to 27.5 days)</td>
<td>NHS Institute for Innovation and Improvement, 2008.</td>
<td></td>
</tr>
<tr>
<td>Airedale NHS Trust</td>
<td>Bereavement Services Project</td>
<td>Notification of death copied and posted to 19 different departments.</td>
<td>Saved 11,200 copies and internal mailings; freeing time for the Bereavement officer.</td>
<td>Lean Healthcare Academy, 2008.</td>
<td></td>
</tr>
<tr>
<td>Doncaster Health Community</td>
<td>Orthodontic</td>
<td>22 month waiting list for orthodontic services; there were 264 patients on the waiting list and the list was growing by 10-15 per month</td>
<td>The waiting list is currently 94 weeks; clarify all clock stop/start points and ensure all documentation is clear about this; involving the PCT and the private sector was an effective way of getting the best for the patients.</td>
<td>Lean Healthcare Academy, 2008.</td>
<td></td>
</tr>
<tr>
<td>Airedale NHS Trust</td>
<td>Endoscopy (SOP Project,Standard Operating Procedure)</td>
<td>Complex operating instructions for equipment</td>
<td>All the potential risks with the equipment preparation were clearly identified; producing standardised documents: 1) an operation manual describing all possible uses of the machine, 2) a quick troubleshooting guide for error codes.</td>
<td>Lean Healthcare Academy, 2008.</td>
<td></td>
</tr>
<tr>
<td>Airedale NHS Trust</td>
<td>IUGR</td>
<td>Unacceptable waits for scans.</td>
<td>Over 80% of women seen in under 72 hours; no unnecessary admissions; reduction in costs; 100% customer satisfaction with the service provided.</td>
<td>Lean Healthcare Academy, 2008.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Colorectal Cancer pathway</td>
<td>Patients sent on the wrong diagnostic pathway, fast track office clerk is telling to the patient that cancer is suspected, using incorrect dispensing process of powerful laxatives, medical secretaries not consistently copying the information to</td>
<td>Clinical triage of all referrals, patients sent to correct diagnostic, increase in colonoscopy capacity, same day barium enema for failed colonoscopy (if possible), robust patient information at every stage, typical diagnosis time halved from 81 to 41 days, typical diagnosis time 20 days, number of patient hospital trips cut from 9 to 6.</td>
<td>Lean Healthcare Academy, 2008.</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Issue</td>
<td>Proposed Solution</td>
<td>Result</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------------</td>
<td>------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-----------------------</td>
<td></td>
</tr>
<tr>
<td>Flinders Medical Centre (Australia)</td>
<td>Overcrowded in ED, delays in timely treatment, elective surgery cancelled, ambulance diversion, staff unhappy, clinical outcomes being compromised.</td>
<td>Improving patient journey, Mapping value stream, pull system (Kanban)</td>
<td>Reduction in long waits in ED; serious adverse events reduced from 81 (including 7 deaths) to only 31 (no deaths).</td>
<td>Jones and Mitchell, 2006.</td>
<td></td>
</tr>
<tr>
<td>Flinders Medical Centre (Australia)</td>
<td>Overcrowded in ED, delays in timely treatment, elective surgery cancelled, ambulance diversion, staff unhappy, clinical outcomes being compromised.</td>
<td>Improving patient journey, Mapping value stream, pull system (Kanban)</td>
<td>Reduction in long waits in ED; serious adverse events reduced from 81 (including 7 deaths) to only 31 (no deaths).</td>
<td>Jones and Mitchell, 2006.</td>
<td></td>
</tr>
<tr>
<td>Diagnostic Imaging</td>
<td>Rework of images</td>
<td>Mapping</td>
<td>Clerk and technologist share workspace; levelling the workload of technologists reduced wait times and patient queues; better coordination with other areas within the department, such as portering; radiologists standardize protocols.</td>
<td>Taninecz, 2008.</td>
<td></td>
</tr>
<tr>
<td>Clinical Teaching Unit</td>
<td>On floor moving patients in and out from admission to discharge; handoffs; rounds taking three hours.</td>
<td>Making a teaching environment.</td>
<td>Rounds cut in half; 72% of patients in ER had been seen by residents within a negotiated timeframe.</td>
<td>Taninecz, 2008.</td>
<td></td>
</tr>
<tr>
<td>Central Sterilizing and Reprocessing</td>
<td>Lack of standardization due to surgeons and their staff used different names for identical procedures and/or devices</td>
<td>5S</td>
<td>Standardization of information; installation of new computer system; creation of a pathway to efficiently wheel and load carts; the least-required components are set aside from primary flow; storage area was also improved.</td>
<td>Taninecz, 2008.</td>
<td></td>
</tr>
<tr>
<td>Mental Health</td>
<td>Few decision protocols to access services, lack of formal training for those in contact with mental health patients, lack of standard procedures for discharge decisions, patients seen by multiple physicians, and lack of communication.</td>
<td>Discharge patients safely and in less time.</td>
<td>Wait times for mental health patients in ER fallen from nine hours to two; discharge procedures redesigned; safely moving patients out sooner; basic mental-health education for all staff; working to better measure care and measure improvement in patients; and working at getting more doctors involved in lean.</td>
<td>Taninecz, 2008.</td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>Department</td>
<td>Problem Description</td>
<td>Solution</td>
<td>Source</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------</td>
<td></td>
</tr>
<tr>
<td>Orthopaedics</td>
<td>Reducing the in-hospital LOS</td>
<td>Format of the pathway was changed to make it legal documentation and simplified it; compliance improved dramatically; better utilize white boards in patient rooms and in nursing stations to communicate recovery information.; change the role of social workers, increasing the number of patients that meet discharge date; waste reduction; staff reorganizing a supply room; reports made from shift to shift; verbal report takes an average of 42 min and a high of three hours.</td>
<td>Taninecz, 2008.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Hospital for Sick Children (Canada)</td>
<td>Haematology</td>
<td>To streamline work process; eliminate waste, to gain improved productivity; reduce CBC TAT to 30 min or less; reduce Differential TAT to 60 min or less; reduce STAT request; increase overall customer satisfaction; free up staff for other activities.</td>
<td>Value stream mapping, Kaizen</td>
<td>Sickkids and Department of Paediatric Laboratory Medicine, 2006.</td>
<td></td>
</tr>
<tr>
<td>Mater Misericordiae University Hospitals and the Children's Hospital Temple Street (Dublin)</td>
<td>Haematology laboratory</td>
<td>Arrival of specimens in large batches, evidence of excessive inventory and poor layout contributing to wasted staff time and excessive transport and motion.</td>
<td>5S exercise</td>
<td>NHS Improvement Programme, 2008.</td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Examples of Hospitals using Lean. Table made by the author.
In three cases customer dissatisfaction was reported including patients, staff and physicians; in two cases finance was mentioned as a driver of improvement (George and Rago, 2005; Womack et al., 2005). For public organisations (NHS and the ISSSTE) the need to improve is not caused by making profit, but to accomplish their purpose of delivering health to the population, and at the same time using public funds efficiently.

Some lessons learnt (George and Rago, 2005; Lean Healthcare Academy, 2008) are:

a) CEO engagement is critical.
b) Needs support and time from senior managers.
c) Improvement teams must have credibility with physicians.
d) Data is required.
e) The process should be adapted to the population.
f) When possible, improvements must be made quickly.
g) Understanding the human dynamic is critical.
h) Standard operating procedures can be written.
i) Visual approach makes documents clearer and easier to understand.
j) Small changes can have a big impact.
k) If there is a repeated task try to find an easier way to do it.

2.3.1.1 Benefits of using Lean

Among the benefits Lean principles offered are:

- a low cost approach
- prompt response to customer requests
- listening to the customer’s voice
- ability to directly intervene in the process by shop-floor people
- a culture of continuous improvement
- reliability

One of the key ideas in Lean is to decrease response time, since it is not possible to increase the amount of time available in a 24-hour day as Miller (2004) remarks. By reducing the waste and increasing efficiency, a hospital can provide a health service of quality to a greater number of patients. Small changes can have a big impact (Lean Healthcare Academy, 2008).
2.3.2 Six Sigma in health care

Schneider (2002) and Thomerson (2002) refer to the fact that the contact of some hospitals with different bodies and enterprises like GE, ASQ, CartaNova, and National Patient Safety Foundation has helped in the implementation of Six Sigma. In table 7 there are listed 22 hospitals using Six Sigma. From all these sites, it was found that in comparison with Lean, Six Sigma projects took as long as nine months, while in Lean a project could be made in six days. Areas using both approaches include: Cardiac Surgery, catheterization, hospital general admission/discharge, Radiology, Nursing, bed assignment, supplies, Oncology, Pathology, A & E, medication, Imaging, Central Sterilizing and reprocessing, Orthopaedics, Invoicing, Ward, Haematology and Mental Health.

From all the articles regarding the use of Six Sigma, financial reasons and elimination/reduction of infection rates, mortality or variability in the process, for using the approach are cited, even though the objectives may reflect something different as in Migliazza (2008). DATA Strategies & Benchmarks (2002) mentions the necessity for the human factor to be taken into account when making an improvement, meanwhile, five places cite culture as factor that influences a change; this seems quite contradictory, since human are the ones who create culture.

Other issues related to Six Sigma are the requirement for receiving special training, and the considerable investment (Van Kooy et al., 2002) that must be made in this. However, training is often given selectively to some people who are chosen by top management, and not necessarily connected to the shop floor. Finally, Six Sigma projects can take months before getting a positive outcome, e.g. eliminating/reducing variability, mortality/infection rates.
<table>
<thead>
<tr>
<th>Place</th>
<th>Area/ Unit</th>
<th>Reason for change</th>
<th>Objective</th>
<th>Specific tools/ techniques</th>
<th>Improvements/ Solutions/Results/Benefits</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Froedtert Memorial Lutheran Hospital (Milwaukee)</td>
<td></td>
<td>Missing Lab tests caused a conflict between lab technicians and nurses.</td>
<td>Fixing a facility</td>
<td></td>
<td></td>
<td>Schneider, 2002.</td>
</tr>
<tr>
<td>Commonwealth Health Corporation (Kentucky)</td>
<td>Radiology</td>
<td>Reduce process variability and costs</td>
<td>Commitment from senior management in giving priority to the project</td>
<td>Reduction in costs from $68 to under $50 per procedure; billing cycle times improved producing $276,000 in annual savings; waiting time for patients was reduced, generating faster turnaround times and increasing productivity.</td>
<td>Cherry and Seshadri, 2000.</td>
<td></td>
</tr>
<tr>
<td>MD Anderson Cancer Center (Houston)</td>
<td>Radiology</td>
<td>Bottleneck in the CT</td>
<td></td>
<td>Capacity increased from 207 examinations per day on some 115, to around 300 on some 160.</td>
<td>Elsberry, 2000.</td>
<td></td>
</tr>
<tr>
<td>Film library</td>
<td></td>
<td>Poor performance</td>
<td></td>
<td>Tighten policies, re-emphasise procedures, designation of specific person to a task, develop standard procedures and operations, provide training for employees and supervisors, monitoring, inventory,</td>
<td>Benedetto et al., 2002.</td>
<td></td>
</tr>
<tr>
<td>Institution</td>
<td>Location</td>
<td>Department</td>
<td>Change Implemented</td>
<td>Description</td>
<td>Ref.</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>------------</td>
<td>--------------------</td>
<td>-------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Tufts New England Medical Center (Boston)</td>
<td></td>
<td>In-vitro fertilization</td>
<td>Improve In-Vitro fertilizations</td>
<td>Increase percentage success rate</td>
<td>Make a survey about most critical steps, literature review to identify other factors. Best practice session to share techniques and to set standard procedures.</td>
<td>Standardisation of operating procedure, reduction of variability, optimal location identified, increasing implantation rate to 46%, increase in pregnancy rate by 24%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surgery</td>
<td>Reduction surgical site infections.</td>
<td></td>
<td>Changes in guidelines for the use of antibiotics, generating databases for indicator monitoring report, revision of the pre-operative order, educate stakeholders, make a physician’s report card, have available a physician for an antibiotic order, posting appropriate antibiotics and dose at key locations, employ error-proofing techniques on a physician’s order, posters, signs, and a puzzle were created and placed, annual savings exceeded 1 million.</td>
<td>Pexton and Young, 2004.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Catheterisation Lab</td>
<td>Changes in patient flow and efficiency.</td>
<td>Improve patient throughput and on-time performance.</td>
<td>Workflow improved, staff redeployed, improvements in: cases starting on time, in-room wait, room turnaround time, MD response to page.</td>
<td>Reduction in the use of linens from 20 pounds to between 14 and 16; developing training for employees, educating staff on new procedures, disposition of non-usable linen into a reject bag, savings for fiscal year 2002-2003 calculated as $174,918.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Catheterisation Lab</td>
<td>Improve physician satisfaction by increasing number of cases starting on time, cost savings</td>
<td></td>
<td>Implementing new scheduling format, physician satisfaction increased by 20%; saving more than $450,000 per year</td>
<td>Vieth and Pexton, 2005.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR</td>
<td>Rising demand, costs and competition were all signals that the hospital would need to either invest in expansion or operational efficiency.</td>
<td>Increase on-time first-case starts</td>
<td>Accurate measurement is essential to process improvement. Education also contributes to project success.</td>
<td>New policies communicated, daily dashboards, with team-member (RN, CRNA, surgeon) names, time metrics and delay reasons posted, nursing staff educated on the urgency of using the delay codes for any cases inducing after 7 a.m.,.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR</td>
<td></td>
<td></td>
<td></td>
<td>Parker et al., 2008.</td>
</tr>
<tr>
<td>Hospital</td>
<td>Cost for it $1.5 million a year</td>
<td>Prevention of infrequent but serious injuries from medication errors associated with anticoagulants, chemotherapy and infusion pump.</td>
<td>Pareto, analysis of stakeholders and role definition, threat opportunity matrix, process flow charts, calculation of Z scores, cause &amp; effect diagram,</td>
<td>Nurses pick up directly doses of chemo, use of standardised order sheets, and a dedicated chemo unit.</td>
<td>Ettinger and Slaterbeck, 2002.</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Virtua Health (New Jersey)</td>
<td></td>
<td>To improve the safety and efficacy of acute anticoagulation with heparin</td>
<td>Problems with inconsistency and a lack of clarity were addressed, a medication administration record was developed, infusion pumps restricted the range of infusion rates, another substance to replace heparin was introduced, bed scales purchased, clarification with physicians, all patients on therapeutic heparin included in automated review with manual charts, identification of physician group responsible, programmable pumps with drug personalities.</td>
<td>Van Kooy et al., 2002.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yale New Haven</td>
<td>Hospital-acquired blood stream infection</td>
<td></td>
<td>Standardisation of processes (insertion and changing catheter), videotaping procedure to orientate resident physicians, standardisation of supplies and equipment, reduction of infections in ICU, improved satisfaction in the OR by having all materials and equipment necessary to complete a surgery.</td>
<td>DATA Strategies &amp; Benchmarks, 2002.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td>Improve the quality of the work environment for both surgeons and nurses.</td>
<td></td>
<td>Having all the materials and equipment in the OR necessary to complete a surgery, setting maximum time a nurse should leave the OR about once per hour.</td>
<td>DATA Strategies &amp; Benchmarks, 2002.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiology</td>
<td>Improving ability to field calls for scheduling MRI and other radiological exams.</td>
<td></td>
<td>Call abandonments rates lowered from 60-80% to 30% or less.</td>
<td>DATA Strategies &amp; Benchmarks, 2002.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Cross Hospital (Netherlands)</td>
<td>Increase financial benefits</td>
<td>Reduce LOS</td>
<td>Customisation of the approach, use of green belts</td>
<td>Reduction of LOS from seven to 4.5 days, change of protocol.</td>
<td>Van den Heuvel et al., 2004.</td>
<td></td>
</tr>
<tr>
<td>Organization/Department</td>
<td>Service/Department</td>
<td>Improvement</td>
<td>Improvement Details/Notes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------</td>
<td>-------------</td>
<td>--------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shanghai Jiao Tong University and Fudan University School of Public Health Stomatology</td>
<td>Increase revenue</td>
<td>80% increase in revenue.</td>
<td>Luyun Zhao, 2005.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Shore University Hospital in Forest Hills, N.Y Emergency</td>
<td>Improving the patient experience in its Emergency Department</td>
<td>Improvements decreased cycle times, but also raised patient satisfaction. Patients' charts were &quot;stamped&quot; in a time clock so that the team could track patients from the time they walked in until a physician discharged them. Decrease in wait time by 37 percent, from 187 minutes to 118 minutes.</td>
<td>Tuttle, 2008.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital Group of Skaraborg (Sweden) Lidkoping Hospital</td>
<td>To reach breakthrough improvement</td>
<td>The number of Nationalized Internal Ratio increased from 63 to 71-73%; mortality and morbidity in warfarin treatment is now continuously being monitored.</td>
<td>Lifvergren and Bergman, 2008.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ospedale Santa Croce e Carle (Italy) Nuclear Medicine</td>
<td>Deliver excellent service to patients.</td>
<td>30% reduction in patient waiting time and an increase of the equipment utilization rate, while maintaining staff and patient satisfaction.</td>
<td>Migliazza, 2008.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watson Clinic (Florida) Radiology</td>
<td>A growing backlog of appointments impacting timely access to services</td>
<td>CT backlog reduced to one day, 90% of exams start on time, 40% increase in CT capacity, Dashboard implemented, Increased outpatient volumes to 3.3 patients/hour, Financial potential ~ $674,000 over one year</td>
<td>Bansal et al., 2008.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>Department</td>
<td>Action Taken</td>
<td>Results</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>--------------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memorial Hermann Southwest Hospital in Houston, Texas</td>
<td>Orthopaedic</td>
<td>Expanding the service line and ensuring efficiency in the operating room (OR)</td>
<td>Baseline turnover of 24 minutes is now running at 20 to 21 minutes. More importantly the number of defects (turnovers exceeding 25 minutes) has dropped from 40 percent to 21 percent; level of satisfaction among surgeons is much higher.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simone Veil Hospital (France)</td>
<td>Radiology</td>
<td>Improve the flow of patients</td>
<td>Improving the planning process and decreasing patient cycle time. The result was added capacity for an additional 12 patients a day.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyclinique Vauban (France)</td>
<td>OR</td>
<td>Optimise efficiency in the operating room.</td>
<td>By improving OR procedures and valuing the cost of room utilisation, staff were able to increase the occupation rate by 15 patients a day.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital San Dureta (Spain)</td>
<td>Hospital</td>
<td>Number of reported patient in CT was low</td>
<td>Increase productivity at least 21 up to 40% in number of reported patients.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase Bed Availability</td>
<td>Bed availability increased 33%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduce Out-Patient waiting time</td>
<td>Action plan implemented, more than 8,000 annual working hours saved.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Examples of Hospitals using Six Sigma. Table made by the author.
2.4 Applicability of Lean and Six Sigma in health care

After the author reviewed the application of Lean and Six Sigma in health care, the reasons for improving are not always identified in some cases, but they can be inferred from the description of the case and/or the objectives for such change; hence, almost all of them were driven by economic reasons or public pressure to perform better, except by the Mayo Clinic where its improvement process was led by an objective to perform better (Taninecz, 2008). In all Lean cases stakeholders were involved in the improvement process.

The UK seems to register the largest number of Kaizen events, accounting for a total of eight cases, due to the need of getting “quick results” (Lean Healthcare Academy, 2008), this was after trying several approaches as the Office for Health Management (2003) and Fillingham (2007) mention. However, in all cases, Lean has been reduced to a set of tools, whereas Lean is more than that, as Ballé stated (2008).

Womack et al., (2005) mentions culture as an issue to consider in implementing lean and that it cannot be changed by edict: people must be convinced to behave in a certain way. At Thedacare (Womack et al., 2005) when setting principles for changes, respect for people is first mentioned, followed by teaching through experience, while at Virginia Mason Medical Center (Womack et al., 2005) the value of employees work was pointed out; George and Rago (2005) refer to the need to understand the human dynamic. Therefore, the human being is the first issue to deal with while applying this approach.

All examples reviewed (a total of 48) showed that both Lean principles and Six Sigma can be suitable for health care, not only in clinical cases (those that can cause an adverse event), but also in non-clinical ones (more related to administrative, paper work, and that do not harm patients), in terms of results (benefits) achieved. Some authors support their applicability in health care (Jones and Filochoswki, 2006; Young et al., 2004; Breyfogle and Salvaker, 2004; Jones and Mitchell, 2006; Westwood and Silvester, 2007). Based on the cases reviewed a summary of the similarities and differences between Lean and Six Sigma, is shown in table 8.

Moreover, there are similarities between manufacturing and health (Rich and Essain, 2008) see figure 7; Jones and Filochowski (2006) pointed out that health care is full of processes disrupted by queues; perhaps can be found under the form of
<table>
<thead>
<tr>
<th>Deal with specific needs</th>
<th>Lean</th>
<th>Six Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardisation</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Culture an issue to consider</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>CEO engagement</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Collection of data</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Savings</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Improvement on services, transactions</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Multidisciplinary teams, including stakeholders</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Empowerment</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>People are important in any improvement initiative</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Ability to directly intervene in the process by shop-floor people</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Customers are unique</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Creating a visual workplace</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Giving to the patient what he needs when he requires it</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Short periods of training</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Quick changes</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Improvements made in days/weeks</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Hands</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>on</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Low cost approach</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Decrease response time</td>
<td>√</td>
<td>x</td>
</tr>
<tr>
<td>Focused on data analysis</td>
<td>x</td>
<td>√</td>
</tr>
<tr>
<td>Specialised training only for top management</td>
<td>x</td>
<td>√</td>
</tr>
<tr>
<td>Projects lasted up to 3 months</td>
<td>x</td>
<td>√</td>
</tr>
</tbody>
</table>

Table 8. Similarities and differences between Lean and Six Sigma in health care. Table made by the researcher.

Organisational structure and regulations, In both fields (manufacturing and health) customers are the reason for the existence of businesses/services. In using the approaches it must be borne mind that health systems and hospitals are unique (Ricci, 2006) and customisation may be required (Van den Heuvel et al., 2004); approaches should not be used as “cookbooks”.

The NHS has showed interest in applying Lean as published by the NHS Confederation, after a study at Bolton Hospitals NHS Trust in Manchester, helped by the RAF as cited by Lister (2006); at the same time Sir Gerry Robinson at the Rotherham Hospital made improvements based purely on his experience as a businessman, noticing that changing people’s mindset is more difficult than in a commercial organisation (BBC2, 2007). Until now, some difficulties e.g. scepticism, refusing to accept changes (Wysocki, 2004), poor communication while implementing
one or both approaches have been reported.

If a car maker and a mobile manufacturer are concerned about their products, as well as costs and image, why should not health care systems be equally concerned about the money that governments (or associates) spend in providing health? Why not be concerned about people catching infections when they are supposed to get well? Why spent valuable time and other resources in locating items, patients, records, or figuring out how to handle an equipment? It is time to get rid of “this is the way” working silos, as well as the wrong understanding of “pride” by some medical groups (Berwick, 1998).

![Figure 7. Similarities between Manufacturing and Health. Graph made by the researcher.](image)

### 2.5 Enquiry

The researcher interviewed experts on quality in health care using Lean/Six Sigma; they were chosen based on references from their published work and projects made at that time. Experts included scholars from Sweden, Ireland and the Netherlands, one consultant from Wales, one NHS In-patient placement manager in Gwent, one scholar from Cardiff, and two experts from GE. Interviews were made in two ways: by sending via e-mail a questionnaire or by visiting the sites where approaches were taking place. Only the consultant and the hospital manager were interviewed by the author in person. Just the scholars from the Netherlands and the one in Cardiff did not reply to the e-mail.

Table 9 illustrates the answers to the questions in which the author had an insight into possible issues to face during the research, and figuring out potential means to deal with them. On the other hand, interviewing the Gwent NHS Trust consultant and
<table>
<thead>
<tr>
<th>Question</th>
<th>Scholar A</th>
<th>Scholar B</th>
<th>Scholar C</th>
<th>GE expert 1</th>
<th>GE expert 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you know about the applications of Lean manufacturing in health care?</td>
<td>No.</td>
<td>There is little focus on the business side of medicine.</td>
<td>No answer</td>
<td>Yes, most in the USA.</td>
<td>Do not know.</td>
</tr>
<tr>
<td>Are all the Lean tools/techniques suitable for health care?</td>
<td>Yes, 5S is most usual to apply.</td>
<td>No.</td>
<td>No answer</td>
<td>Yes.</td>
<td>The general ideas should be very helpful and after adaption the most tools are adequate.</td>
</tr>
<tr>
<td>Do you have any academic reference on Six Sigma applications in health care?</td>
<td>No.</td>
<td>Not that I am aware of in universities. Red Cross Hospital outside of Amsterdam is the other hospital in Europe that use the six sigma methodology.</td>
<td>No answer</td>
<td>No</td>
<td>No.</td>
</tr>
<tr>
<td>In your own experience, which tools do not work or can be added when using Six Sigma?</td>
<td>Some tools are great, and important supplements to Six Sigma are change management tools.</td>
<td>Starting project currently</td>
<td>No answer</td>
<td>Design of experiment, you can’t make trials on patients.</td>
<td>Some statistical tools do not work well in healthcare, or other services industries. Tools such as Design of experiment do not have much application because in such people intensive processes we are usually dealing with critical element, not operating parameters.</td>
</tr>
<tr>
<td>What are the most usual problems related to health care which are common in any country?</td>
<td>Those that deal with people</td>
<td>Do not know.</td>
<td>No answer</td>
<td>Changing culture.</td>
<td>Usually the most usual “problems” are people issues more than process issues.</td>
</tr>
</tbody>
</table>

Table 9. Answers to the questions sent by the author to several experts.

The manager provided the researcher with valuable information about the use of Lean, issues to deal with, tools and training received. The manager explained to the researcher that the use of Lean was due to a primary contact with Johnson & Johnson personnel, who started a project at the Ultrasound department to reduce the waiting list and providing training; later the same people from Johnson and Johnson suggested to the manager to get in touch with the Lean Centre at Cardiff University, since then the Hospital and the Centre have been working together.

Regarding the first question, the manager mentioned to the author that there was another trust in Wales utilising Lean, but she did not know the department/area of application. Among the personnel from the Ultrasound department who attended a training session for two consecutive days, there were front radiologists, nurses, doctors, and clerks. Lean concepts and tools were explained to them. The first tool they used was a map, to draw the whole process from patient consultation until the film is delivered to the GP (value stream); this map takes account of activities, steps, distances, times, and people involved. The manager declared that another useful tool
was the 5W while examining the data collected from the map. Issues that the manager had to deal with included some degree of doubt among all the people involved, and freeing up time to make sessions for the project. The manager acknowledged that an important feature for the project was the support of the Hospital manager, and the Lean centre involvement. The manager attended a Six Sigma course as part of the Trust initiative for improvements, and she only knew about cases in the US (at the time of this interview), and Singapore, but not in the UK. She finally pointed out that the most usual problem in health care is related to people’s behaviour, because they have been working in a way that was considered the best, and found some difficulties in accepting the new and better way of working.

On the other hand, the consultant was hired by the Trust to support the ultrasound project, due to his experience in improvements. He was aware of Lean applications in the North West Wales NHS Trust, and in Scotland via GE, while the Adelaide and Meath Hospital (Ireland) was using Six Sigma. In order to deal with the issue of ‘problematic’ people in the project, he and the manager organised them into one team. The consultant stated that this team changed their attitudes once they started to work with the map, becoming the biggest supporters of Lean. The consultant declared that Lean tools were easy to use and to understand. He showed the author the value stream map that was made by the staff with the icons suggested by Rother and Shook (1999). He said that this was done as a way to standardise the mapping process:

“...in this way, we prevent any misunderstanding of the meaning of something in the map...Anyone can see it, and can get the idea”.

As a result of applying Lean, the ultrasound department reduced the waiting list from 18-20 weeks to only two weeks.

2.6 Key factors

By understanding the factors (key issues) that affect the implementation of changes in an improvement project, this comprehension permits the elimination of or diminishes the effect of them, leading to an effective execution of the improvement, which avoids wasting time and resources.

According to Pexton (2005), Benedetto et al. (2002), Antony and Banuelas (2002), in order to succeed in improvement projects, the following factors are necessary: a
change in management, leadership, involvement and support; communication, motivation and education; the use of techniques to promote culture change; selecting and scoping projects to achieve financial and quality results; establishing clear roles and responsibilities, just to mention a few. Berwick (1996) stated that clarification of the goals, the method and the expected results are necessary, as well as having effective leadership to succeed. Pexton (2005) identified barriers to healthcare and potential solutions (see table 10) but only for Six Sigma. As Pexton noticed, there is a hesitance from top management to invest efforts in approaches that are unknown for them; also resistance/scepticism in some staff, due to the origins of Lean and Six Sigma, or perhaps for being removed from their comfortable position (status quo). For Karatsu (1988) the key factor for success is through management efficiency.

<table>
<thead>
<tr>
<th>Factors Inhibiting change</th>
<th>Potential Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Leadership Support</td>
<td>Facilitate contact with peers successful in deploying methodologies.</td>
</tr>
<tr>
<td>Resistance or scepticism from Staff</td>
<td>Develop stakeholder analysis and use a team-based problem-solving approach.</td>
</tr>
<tr>
<td>Hesitancy to Invest Time and Money</td>
<td>Create a business case supported by sound data.</td>
</tr>
<tr>
<td>Shortage of Internal Resources to</td>
<td>Enlist outside help to drive initial projects or receive training and mentoring in</td>
</tr>
<tr>
<td>Lead Change Initiatives</td>
<td>conjunction with projects that produce immediate results.</td>
</tr>
<tr>
<td>Waning Commitment or Flavour-of-the-month Syndrome</td>
<td>Implement a solid communication plan that reaches all levels of the organisation, and build momentum through early, visible wins.</td>
</tr>
</tbody>
</table>


A missing point in key factors is the human being; from all the cases reviewed in literature, just Thedacare (Womack et al., 2005) gives importance to it. Most authors focus on tools and techniques, goals, projects, and so on, but the most important character is out of the picture.

As Ohno remarked, to achieve success with any improvement initiative, it is important to adapt the concepts, methods, and approaches from its original frame into a new reality, by taking into account the differences among countries, lifestyles, culture, to mention some.

2.7 The Mexican context

2.7.1 What is health?

“Health is defined as the state of complete physical, mental and social well-being, and not merely the absence of disease and infirmity”, according to the World Health Organisation (1948). It is the most valuable possession that any human being has.
Therefore the absence of any of the above factors can influence an individual’s life. Thus health, social and economic development are intimately related. If a population is healthy, then through its daily performance, the levels of productivity and competitiveness will increase, giving the economy a chance to grow, thereby creating a “virtuous cycle”, as Frenk et al. (1994) states (see figure 8).

![Figure 8. The virtuous cycle. Source: Frenk J., et al., 1994.](image)

On the contrary, a lack of health generates lower levels of productivity, lower economic development, as well as an inability to save. This idea is important for a developing country like Mexico, where around two million families spend more than 30% of their disposable income on health care needs each year, according to the Secretaría de Salud (2004), a situation that definitely does not encourage equal opportunities for all its inhabitants, and where the rate of child mortality is higher than in other Latin American countries, according to Yoriko Yakusawa, representative in Mexico of the United Nations Children’s Fund, as was reported in Cimac (2004).

### 2.7.2 Economic implications of health care

Health is fundamental in raising both workers’ and companies’ productivity, as well as a nation’s development. However, the correlation between a nation’s health improvement and its economy is not entirely equivalent. For example, an increase of 10% in life expectancy can raise the economic growth in a country by as little as 0.4 % according to Bloom et al. (2001). This is an issue which is affected by labour legislation and a country’s rate of development.
Figure 9 illustrates that expenditure in health care can consume high percentages of GDP as Jones (2002) mentions. In the particular case of Mexico, these resources could be invested in other areas such as education, agriculture, energy, housing, science, etc.

As can be seen in this figure, by 2006, the US was the country with the highest rate of GDP expenditure with 15.3%, while France had 11.1%, Germany 10.6%, Canada 10%, UK 8.4%, Japan recorded 8.2% in the previous year. Mexico reported an expenditure of 6.6% for 2006 while in 2000 it was 5.6%.

Costs related to inefficiency affect business, productivity and also families. Economic growth of the UK between 1780 and 1980 is associated with improvements in nutrition and workers’ health as Fogel (1994) found. Illness has a social detriment since:

- it affects the quality of life of its citizens
- there is a cost borne to the country’s economy in days of work lost
- inability permits need to be granted (doctors’ sick note)
- labour-time is wasted in waiting time for medical appointments
- quality of work is poor
there is a failure to realise human potential

As Coleman et al. say (1997), it is almost always more expensive to get people well than to prevent them from getting sick.

2.7.3 An opportunity for the Mexican health care system

If North American hospitals and counterparts in Europe have found a way to improve their health care systems, using Lean principles and/or more sophisticated ones (Six Sigma), why not apply them in other places? How could we translate this idea into a specific improvement project for the Mexican health care system? Mexico is facing a double challenge: how to better invest funds to eliminate the inefficient use of scarce resources and, at the same time, how to invest more in its population’s health.

2.8 Research questions and Aims

As mentioned before, most literature on Lean principles and Six Sigma in health care is from the USA, and some from European countries like France, Ireland, Sweden, the Netherlands and the UK. Therefore, some questions come up:

1. If they achieved improvements in their services via Lean and Six Sigma, why not implement them in the Mexican health care system?

2. Which one is better?

3. Where can they be applied?

4. What are the key factors to take into account?

5. How important is manager support?

6. Is it necessary to train people? If so, to what extent?

7. What will the benefits be?

The aims of the research were to:

- carry out and record implementations of the above approaches in health care,
with particular emphasis on the Mexican context
- identify which one of these two approaches is most suitable for health care, and what the most useful tools/techniques are
- identify critical factors before, during, and after applying the approaches
- identify any specific issues that are important in Mexico. For example, the influence/role of Mexican unions in the improvement process will be shown to be a significant issue.

Summary

Lean and Six Sigma were developed in manufacturing at different points of time, and facing dissimilar scenarios, developing their own tools, techniques and methods. Both have proven benefits in their original environment, and later in other fields like services and most recently in health care. The US is the pioneer in using the approaches in health care, GE being one of the sources of advice to health systems/hospitals, spreading to other countries the benefits achieved through the use of Lean and Six Sigma. Canada, Italy, Spain, France, the Netherlands, Australia, Ireland and the UK also have implemented the approaches. The question of whether both methods are suitable for health has begun to be answered by the cases reported in the countries cited previously. There are however key factors that must be taken into account for implementing these approaches, such as leadership, involvement and support; communication, motivation and education.
CHAPTER 3

Methodology

3.1 Introduction

This chapter discusses some possible approaches to meeting the research aims given in section 2.7 and describes how the research methods were selected and developed. Hence, a survey of the applications of Lean and Six Sigma in health care was instigated. Two observations can be drawn from this survey, which are particularly important in determining how research can be carried out in this area:

1. Lean and Six Sigma are concerned with intervening in a work situation and changing how people work and think. This clearly has implications for staff time, the organisation’s costs and, in the health care situation, potentially for the life and well-being of patients.

2. At the time the research started, there had been few applications of Lean and Six Sigma in the health care sector in the UK and none in Mexico.

It follows from these points that it was not possible to pursue the research aims outlined in section 2.7 only by studying and evaluating existing applications. It was necessary to carry out applications on real situations as part of the research. This meant that the consent and co-operation of hospitals was essential, and hence that the research would be constrained by what they would accept. The work therefore comes under the heading of "real world research" as discussed by Robson (1993). The features he identifies as characterising this, as opposed to laboratory research, such as solving problems, predicting effects, developing and testing programmes, are clearly present in this work.

Robson identifies a number of research methodologies that are suitable for “real world research”. Those that are potentially most applicable to this research are evaluation research, action research and case study. The term action research is commonly, although not exclusively, used when the research is carried out by those who work in the area under investigation and do it as part of their work rather than the work being done by external researchers who come in only for the purposes of doing the research (Robson, 1993). It therefore tends to be used for interventions in a single location or
activity. The aim in this research was to carry out a number of interventions and the researcher was external and only involved in a particular area for as long as required to make and evaluate the intervention. Therefore, the concepts of evaluation and case study are both applicable. According to Eisenhardt (1989), case studies can be applied in order to accomplish various aims, such as providing description, testing or generating a theory.

The practicalities of having only a single researcher and needing to negotiate each application and carry out the work meant that only a limited number of discrete cases could be undertaken in the time available. The overall aim of the research is to evaluate the potential applicability of Lean and Six Sigma in the health care context, particularly in Mexico.

Two other factors also drive the research in the direction of studying a number of cases. One is that Lean and Six Sigma contain a large number of tools and techniques, and it is only practicable to use a limited number of these in any one situation. The second is that the Mexican health care system contains a number of different organisations as well as the inevitable division into different hospitals and departments within those hospitals so again a small sample of the possible range has to be selected.

### 3.2 Development of methodology

Many of the points Robson makes about evaluations are applicable in this research. For instance, they can use “either qualitative or quantitative methods, or some combination of both types”; “the characteristics of real world enquiry discussed … above are present in evaluations in a very clear cut way”; “gatekeepers such as middle management … may be obstructive”.

In order to meet the aims, the criteria against which the evaluation is made should be those in Lean and Six Sigma themselves. Their literature typically lays down a series of steps to follow. The expectation is then that, provided any stated conditions such as management commitment are met, there should be measurable reductions in waste (Lean) or variation (Six Sigma).

Ideally in an evaluation a comparison is made between two groups, one of which has been subject to the innovation, while the other is a control group that has not. Robson
comments, however, that there are often severe problems in finding an appropriate control group, and this was not possible in the situations studied here. Instead, the comparison is made between different groups of patients before and after the intervention. This raises the possibility that the apparent effect of the intervention will be due to other changes taking place at the same time or to differences between the two groups of patients. This sort of problem is difficult to avoid in this type of research, as discussed above, and means that each evaluation can only provide provisional and tentative conclusions. Steps were taken to minimise these effects by keeping the overall timescale short so that there were unlikely to be other significant changes confounding the results. Also, the researcher was able to observe activities before and after the changes and record comments made by the workers involved in the changes. These can potentially provide some qualitative evidence about whether those most involved attributed any observed improvement in performance to the changes or to other factors.

A case study is “an appropriate research method” (Yin, 1993) when a particular object of an investigation and its context need to be covered. Eisenhardt and Graebner (2007) mention the importance of not isolating the phenomena from their context, and case studies “emphasize the rich, real-world context in which the phenomena occur”. Since the UK and Mexico have a completely different background (including health structures, idiosyncrasy, budget, technology, and management support), the case study method seemed to be appropriate for this research.

The case study is fundamentally a research strategy “to be likened to an experiment, a history, or a simulation, which may be considered alternative research strategies” (Yin, 1993). Moreover, in case studies, data from multiple sources of information are employed, thus, information can be qualitative or quantitative. In this particular research, both are brought into play. There is a kind of distrust, from those using only quantitative data, about the application of case studies and qualitative information in a research, since the latter is associated with inadequate evidence (Yin, 1993). Perhaps it is caused by a lack of information on integrating quantitative and qualitative information (Bryman, 2007). Possibly one disadvantage of case study is that, the results might not generalise to other situations.

In each case study, the managers who approve the study will provide more detailed aims that they hope the work will achieve and which provide them with the justification for approving the work. These will be spelt out in the chapters describing the particular
studies. In this way, the case studies replicate the way the process would be carried out if the hospital had been doing it entirely themselves.

Clearly the conclusions that can be drawn from a finite number of case studies are limited. One successful application of Lean (or Six Sigma) would be sufficient to disprove a hypothesis that the method was completely inappropriate in the context of the application. Equally, an unsuccessful attempt to apply the method would appear to be sufficient to invalidate a hypothesis that success was inevitable, although one might be able to argue about details in such a case.

Eisenhardt (1989) discusses the use of case studies to build theory. The examples she discusses were mainly done by teams rather than by an individual researcher, and were also largely conducted by observations and interviews to study an existing situation, rather than requiring an intervention and innovation in that situation. However, in a ‘real world’ setting such as a hospital, and where the research requires an innovation in other people’s work, the intervention will only be allowed by the responsible manager if it appears to have a reasonable chance of succeeding and producing an improvement. It is unlikely to be given the go-ahead if the responsible manager does not already believe that there is room for improvement.

Active case studies such as those carried out in this research will therefore gradually contribute to the accumulation of evidence about the usefulness of techniques such as Lean and Six Sigma and to the development of theory to discriminate between circumstances in which they will be useful in the future and those where they will not be, and about which techniques will be advantageous in which circumstances.

3.3 Pilot studies

The research design is based on two pilot studies at the UHL (from April 2005 to July 2005), and two longitudinal case studies at the ISSSTE (from August 2005 to February 2007).

The pilot studies were aimed at gaining experience in applying the concepts of Lean and Six Sigma in real situations, and to enable the researcher to face possible scenarios that she could experience in subsequent case studies. The pilot studies also bring the possible advantage of enabling the researcher herself to compare from personal experience applications in the UK and Mexico, and to compare the UK
experience with that in the literature. This provides an intermediate step between the Mexican work, which is the main intended focus of the research, and the bulk of the available literature.

3.4 Research programme

This research uses the Lean methodology as suggested by Angel (2005), Robertson (2005), Byrne and Fiume (2005), Jones and Mitchell (2006), to cite some and the DMAIC steps. The same steps were used that these and other authors had applied while carrying out their projects:

1. Specifying the customer requirements
2. Identifying the process
3. Recognising waste in the process
4. Improving the outcomes
5. Setting a continuous improvement process.

At the time the researcher started to study Lean and Six Sigma in health care (January 2005), most of the literature about applications in health care was in the form of website articles, and most of the studies had been performed in the USA. However, there were two hospitals in Wales doing some projects, and the author contacted them in order to gain knowledge about their experiences. Because of constraints on time, budget, and access, the researcher had to instigate two pilot cases implementing the aforementioned approaches in the UK and two case studies in Mexico.

Both primary and secondary methods were used.

1) Primary research methods.

The author interviewed some people using Lean and/or Six Sigma in health care/industry (see section 2.3 page 39). Front line staff in the UK and Mexico was also interviewed in an informal way during the course of the research. Data was collected by observing processes, and recording information; in Mexico computer databases and intern reports (containing confidential information from the ISSSSTE) were accessed. The data obtained would be either quantitative or qualitative. Quantitative analysis is descriptive in nature, summarising data in the form of charts, tables, percentages and averages.
2) Secondary research methods.

A number of journals, newspapers, government sources, conference papers, presentations, research papers and websites were consulted, in order to provide the academic theories, models, and statistics to underpin the author’s findings, and are listed in the bibliography section. The documents are analysed according to their contribution to the research field, and comprehensiveness of the utilised approaches.

The steps followed in this research were:

1. A literature review about Lean and Six Sigma origins, development, tools, techniques and applications in industry and services was made by consulting articles, journals, newspapers, websites, and books. The objective of this primary review was to comprehend both approaches, evaluate them in terms of goals and outcomes, exploring benefits and pitfalls, and obstacles. An analysis of the mentioned approaches suggests that both of them seek to improve processes/services. Lean makes special emphasis about respect for people, empowerment of front-line workers and involvement of stakeholders. On the other hand, Six Sigma is usually addressed to a top management level, where managers and/or engineers are trained as experts in the methodology. The issues with Six Sigma are: it requires an accreditation by a certified body or a consultant; spending quite a large amount of money (in the UK it costs at least £ 4,000 per person attending a four week course) to train people in the approach, and it requires allowing over-time or release duties to those who attend the course (an issue if there are labour/human resources/ restrictions).

2. A focused search of literature for applications in the health care sector was conducted from January 2005 to August 2008. Analysis of reported cases was made, exploring possible trends in areas of application, goals, outcomes, tools/techniques used, and obstacles. It was found that some authors encountered a certain degree of resistance (stakeholders) to the application of any of the approaches, or to make changes, as well as adaptation of the approaches to particular situations. At the beginning of this research in 2005 many examples were found in North American hospitals, in different areas (clinical and non-clinical) and a few in other countries. It has been remarkable the growth that Lean had experienced in a few years. For instance, in 2005 in the UK only three places were reporting using Lean, while at the beginning of
2008 there are 17 sites at least. Analysis of these cases was conducted, and is presented in Chapter two.

3. Collecting first hand data from some experts and researchers applying improvement approaches such as Prof Bo Bergman from Chalmers University (Sweden), Prof Peter Hines from Cardiff University, Jaap Van den Heuvel from the Beverwikj Red Cross Hospital (Netherlands), Caroline Pexton and John Kalb from General Electric (USA), Mary Hickey Process Improvement Manager, Adelaide and Meath Hospital, Dublin, Lesley Angel and Ken Robertson from the Royal Gwent Hospital in Wales, were contacted and some of them interviewed via e-mail and/or personally, about the whole implementation process, tools, barriers, and key factors they faced during the course of action. A set of five open questions (see Appendix 2) to obtain understanding towards the implementation of Lean and Six Sigma, were sent via e-mail to the GE experts, Prof. Bergman, Prof Hines, GP Van den Heuvel, Mrs Hickey, and two personal interviews; a visit to the Royal Gwent Hospital and to the Trust were made. From all, the expert in the Netherlands and the scholar from Cardiff did not reply to the e-mail.

4. Attending a formal Six Sigma course to get the necessary knowledge and gain experience in the methodology.

5. Performing pilot studies in the UK and case studies in Mexico. The selection of areas of opportunity was based on projects reported in literature, and under the assumption that health areas are similar, despite the country, e.g. an X- Ray department in the US performs similar tests to those in the UK or in Mexico. Through a series of interviews and requests across the University Hospitals of Leicester (UHL) to conduct pilot studies using Lean and Six Sigma were done. As a consequence, originally three Directors agreed to participate: Cardiac Surgery, Imaging and Plastic Surgery. The latter has a double goal: as a part of the pilots for this research and to get the Black Belt certification in Six Sigma. From the original three sites, the Cardiac Surgery study was put aside by the Director after a couple of weeks of the first interview, despite the attempts made later by the researcher to carry on. In Mexico, due to facilities and interest of a Clinical Director of a Federal Government institution two cases were put in place: one in the Clinical Laboratory (Pathology) and one in the Referral-Counter referral process of patients (from GP to special medical attention). Data
was collected a) during the observation course at both sites, b) accessing intern databases. In addition, informal conversations with staff took place. Data collected in the UK was obtained by direct observation at three hospitals for two consecutive days at each place. In Mexico observation was conducted in the Clinical Lab between August and October 2005, and January 2006. Databases and classified information were accessed. MINITAB (statistical software) to analyse data collected was used, and Excel to generate some graphs, and in other cases the information was analysed and grouped according to its nature, e.g. tables, figures.

The pilots started as exercises in Six Sigma, but the Definition stage suggested that waste was the real problem and Lean tools appeared to be most useful. The later stages confirmed this. The DMAIC methodology was utilised in the second pilot but only to some extent due to supporter’s retirement.

The case studies represent the first time that industrial approaches have been used in the Mexican health care system. The cases were chosen because both are relevant and exemplary, since they reflect real-life situations.

Summary

A literature survey was conducted on Lean and Six Sigma approaches, its origins and applications in industry/services and health care. Key factors for their application were found; however, the literature survey was not enough to reach the objectives set for this research. Hence, a “real world” investigation must be made; therefore the research is made via pilot and case studies. Primary and secondary research methods are utilised.
Chapter 4

Pilot studies in the NHS

The NHS origins and situation has been already explained in chapter one; consequently, this chapter only deals with pilot studies carried out in the UK.

4.1 University Hospitals of Leicester

The University Hospitals of Leicester NHS Trust (UHL) includes Glenfield Hospital, Leicester General Hospital and Leicester Royal Infirmary, employing over 12,000 people and providing services for nearly two million people across Leicester, Leicestershire and Rutland (UHL web site, 2007). The UHL are organised into corporate and clinical directorates under the leadership of the chief executive. Each corporate directorate is headed by an executive or associate director. Responsibility for the management of each clinical directorate is shared by a clinical director and a general manager. The corporate directors, supported by the clinical directors and general managers, are responsible for the day-to-day management and running of the hospital's services and report to a trust board.

Glenfield Hospital (GH) is about three miles North West of Leicester city centre. The hospital has around 520 beds and provides a range services for patients, including nationally recognised medical care for heart disease, lung cancer and breast care. The hospital has its own helipad to allow rapid access for helicopters carrying emergency patients to the hospital.

Leicester General Hospital (LGH) was opened on 28th September 1905. It was designed to accommodate 512 patients. It is on the outskirts of Leicester in Evington and hosts the headquarters of University Hospitals of Leicester NHS Trust (UHL). It is about three miles east of Leicester city centre and now has around 680 beds. The hospital provides a range of medical services including care at the national centre for renal and urology patients.

Leicester Royal Infirmary (LRI) opened in September 1771. As a voluntary hospital the LRI relied on subscriptions from the city’s rich and good to keep it going. It had no running water but did boast its own brewery. Alcohol was used as a treatment for a whole range of conditions. In the 18th century, nurses and matrons were generally
women who made beds and looked after patients.

4.2 Methodology

This research is based on two pilots studies conducted at the UHL. The areas of application were based on similar topics to the ones found in the cases reported in literature regarding Six Sigma methodology. In a first stage, the DMAIC steps were followed.

1. Definition. The areas of application were set by the managers of the sites (Imaging and Surgical Services, respectively), based on their own needs. Consequently, for the Imaging Directorate and Plastic Surgery the aim was to reducing the waiting lists for a) an ultrasound (u/s), and b) to have surgery.

By the beginning of April 2005 the number of patients waiting for an ultrasound was 4,796 patients, of which 3,269 had to wait between five and 26 weeks for a routine scan (information disclosed by the Project Co-ordinator).

By March 2005, at Plastic Surgery there were 119 patients waiting for surgery.

2. Measurement. For u/s the outcome is mostly quantitative, which is translated as descriptive statistics; a qualitative fragment is also included. The identification of the data source, data collection, validation and analysis of data, and measurement of the current system performance against the one depicted by the u/s and Plastic Surgery staff is made.

The pilot study at Plastic Surgery was halted at this stage because of the retirement of the head of the Surgery department.

3. Analysis. The outcome of this stage is the identification of those factors that drive the process results. The author revised a map made by the u/s staff where they identified all the steps required to make a u/s, once it has been ordered by a referrer and until the result is sent to the origin. A subsequent physical tour was made by the author to verify the steps illustrated by the staff.

4. Improvement. The result of this stage is the implementation and measurement of changes to the process. The u/s pilot study ended at this stage.
4.3 The Ultrasound pilot study

As part of the training as "Black Belt" in Six Sigma (and the research as well) there was the need to look for a place to apply this approach. After an interview with the Clinical Imaging Director of the UHL NHS Trust at that time, an agreement to start a pilot study there was made. The place was the Ultrasound department, because there was already a project initiated by the Clinical Imaging Director as part of his certification as "Green Belt" in Six Sigma; the aim of this project was to reduce waiting lists for patients getting an ultrasound, a well-known problem within the NHS, and the project Coordinator was a person from the Modernisation Agency (currently extinct), who was helped by a Consultant, and one sister at each site, but they only attended official meetings summoned by the Clinical Director, otherwise, contact was established via telephone or e-mail.

As mentioned before, the UHL comprises three hospitals, of which the Leicester Royal Infirmary is the main one. There are different numbers of staff and physical resources at each of the three sites; thus, at the Glenfield Hospital there are just two u/s rooms, at the General four rooms, and at the Royal Infirmary three rooms; the Royal Infirmary and the General Hospital start working at 8:30 a.m. (in theory, since in reality both start between 8:45 and 9 a.m.), and the Glenfield at 9 a.m.

The personnel at the u/s department are: Consultant (Radiologist), Sonographer (technician), Radiology Assistant (RDA), and clerical staff. The Co-ordinator of the programme made a map of the process helped by the staff of u/s, and it is presented in Appendix 3.

Since the health systems are different (UK and Mexico), it was necessary for the researcher to understand the whole process for getting an ultrasound, from the appointment process until the ultrasound result is sent to the referrer. It was made via interviewing the Co-ordinator of the project followed by a physical visit to the site where the process of giving appointments takes place.

In order to clarify the whole process to get a u/s, the author has divided it into three parts as:

I. Pre-process
II. Process, and
III. Post process.
I. Pre-process

The referrals can come from: GPs, Clinics, A & E, Hospital Wards, and from the LGH and GH. Depending on the source, referrals are sent via external, or internal post, and/or fax. In the case where posted referrals are not marked for u/s they are sent to the main X-Ray office, causing a delay. Otherwise, referrals go directly to the booking clerk. Inpatient referrals are collected three times a day by one RDA (just for LGH and LRI); at Glenfield, they are sorted out by RDAs.

After the referrals are received by the booking clerk, they are typed into a waiting list, and are sent for protocoling. This process can take between zero and three days, or in the worst case two weeks. Referrals are protocolled by one senior radiologist every two weeks. The referrals are classified then as “urgent” or “elective”, and assigned to a radiologist/sonographer. After this, the senior radiologist returns all the referrals already classified to the booking staff who sort the referrals out based on the “urgent” or “elective” code. The “urgent” referrals are booked immediately, while the “elective” can wait for an appointment for three weeks. Then an appointment letter is printed and sent to the patient by post service; first class post is used only for urgent referrals.

This pre-process ends when the patient receives the appointment letter.

II. Process

The process for inpatients and for outpatients is quite different in the very first steps. For inpatients, the wards are advised about the u/s time one hour in advance, and a call is logged on the porters’ system. After this, a porter picks an inpatient up, collecting the patient’s file and takes them to the u/s reception; then the porter gives to the clerk the file and the referral, leaving the patient there.

Once outpatients have received the appointment letter, they have the option to change the appointment day in case they cannot attend it on the date pointed out in the letter; it is made through a phone call to the booking clerk. On the contrary, if they agreed the day, outpatients just attend the appointment on the set day.

Outpatients must bring with them the appointment letter to the u/s reception. The next steps are shared by both inpatients and outpatients.
The patient arrives at the reception where he/she hands in the appointment letter, and the receptionist scans a barcode (printed on the letter) in order to print labels for u/s. Then, she or a RDA takes the letter and the labels to the assigned radiologist/sonographer room. The patient then waits until he/she is called by a radiologist/sonographer. Once the patient is called and enters into the room, the RDA helps him to lay down on the couch, and covers the patient with a paper towel; meantime, the radiologist/sonographer enters patient’s details on the u/s machine, checking at the same time the patient’s ID, previous images and reports. After this, the patient is scanned. Once the scan has finished, the RDA removes from the patient the gel used for scanning, and gets the patient off the couch. Outpatients leave the u/s and go home. Inpatients have to wait for the u/s report and are then fetched by a porter.

III. Post-process

The results of the u/s are typed in a report. This report can be made immediately (inpatients usually) or can take some time (12-24 hours) depending on radiologist/sonographer preferences. This procedure can be made in different ways:

   a) The radiologist can dictate the report into a voice recorder.
   b) Writing a provisional report in notes.
   c) Writing the report immediately by the radiologist/RDA.

In the first case, the radiologist or RDA types the report once he/she has some free time, or they can hand the tape in to a RDA to transcribe it, and it is verified by one of them before being printed. In the second case, the radiologist made a revision of the u/s and his/her notes and then the report is typed into the u/s database. If the radiologist did batches he or the RDA checks for unverified reports on the system. Finally, in the third case, the radiologist/sonographer immediately types the report onto the system. At the LRI the RDA puts labels on report and films. If the report belongs to an inpatient, both (report and films) are attached to his file. For outpatients, the verified reports are printed off. If they are “urgent” then a red sticker is put on them. Clerical staff sort, envelope and address “elective” reports, placing them in: internal or external post, pigeon holes. Reports marked as “urgent” are faxed. Finally, the referrer can read the report.

All these three parts above are the description of the u/s staff for getting an ultrasound, and is the base for further questions made by the author on the process.
Direct observation and collection of data from the process for doing a u/s was made, and informal interviews with people involved in the procedure at the three sites took place. Data collected is referred to the time taken for performing a u/s. A review of the process showed that the activities in the map differed from the real process at some points, and this was notified to the Co-ordinator. The author had to modify the diagram in these inconsistent parts; these modifications will be explained later on this chapter.

The author was in charge of collecting information in order to find the capacity and the real usage of the u/s rooms. Visits to the three hospitals were arranged, informing staff and consultants about the presence of the author and the purpose of the visit. A set of templates was provided to verify the usage of each room (see figure 10) at the Royal Infirmary. On the other two sites the templates were not applied, because there was no one in charge there, as stated by the Co-ordinator of the project. The purpose of the template was to identify usage of rooms and assignment of radiologist/sonographer to wards (for inpatients), as an attempt to facilitate the standardisation of all sessions; however in the template those slots assigned to wards are not marked. The length of the slots was established by the Co-ordinator without previous knowledge, just based on her own experience, as she explained to the author:

"Before I worked for the Agency, I worked as a nurse...so, I know how long an ultrasound takes, and that is why I assigned slots of 15 minutes".

After the researcher observed the activity at the LRI u/s department and the template, a question came out: what was the criterion to determine the number of slots assigned to wards? The Co-ordinator was asked about this, and her response was:

"Well, sisters have their own way of working, but I am not sure of the reason for that"

A meeting with the u/s project team took place and the Co-ordinator asked the above question to the site manager directly, and her answer was:

"It has always been like that"

After questioning this issue, the lead sonographer could not explain the reason for having such number of slots booked for inpatients. She and the Co-ordinator agreed to look carefully at the number of slots assigned for inpatients.
One of the problems in the management of health care, in a particular way, is related to "historical reasons". As in the case experienced above, there are processes or activities executed just because it has been that way for years and years, without further questioning, or having some historical data on the use of services or tests requested.

4.3.1 Observation and collection of data

A period of general observation was made by the researcher lasting for two months, and specific period of observation was conducted for two separate days at each site to collect data on the u/s area; each observation lasted over six hours, which is the equivalent to a shift. This period of observation was carried out specifically to measure times for making an ultrasound. A sample of the observation data is shown in table 11; time to perform a u/s is inside of a yellow box (starting and finishing times within the box).
### Table 1

<table>
<thead>
<tr>
<th>Room</th>
<th>Time Periods</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LRI</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 1</td>
<td>9:21-9:36</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>9:44-9:48</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>9:51-9:57</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>10:48-10:53</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:32-11:36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12:08-12:12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12:26-12:32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16:34-16:56</td>
<td>10</td>
</tr>
<tr>
<td>Room 2</td>
<td>9:58-10:13</td>
<td>8</td>
</tr>
<tr>
<td>Room 3</td>
<td>9:45-9:55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:06-10:16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:25-10:31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:38-10:47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:05-11:07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:57-12:05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12:21-12:24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12:49-13:02</td>
<td>10</td>
</tr>
<tr>
<td><strong>Glenfield</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 1</td>
<td>9:14-9:18</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>9:22-9:38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9:41-9:57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10-10:22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:27-10:39</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:43-10:57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:04-11:19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:21-11:32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:35-11:45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:50-12:13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12:26-12:35</td>
<td></td>
</tr>
<tr>
<td>Room 2</td>
<td>9:01-9:12</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>9:15-9:24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9:36-9:43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9:47-9:56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10-10:06</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:14-10:18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10:58-11:09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:33-11:41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:46-12:08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12:08-12:21</td>
<td></td>
</tr>
<tr>
<td>Room 3</td>
<td>9:07- 9:14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9:16-9:26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9:34-9:43</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9:46-9:57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.08-10.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.22-10.33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.44-11.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.02-11.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.2-11.28</td>
<td></td>
</tr>
<tr>
<td>Room 4</td>
<td>9.10-9.27</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>10.02-10.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.48-11.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.25-11.46</td>
<td></td>
</tr>
</tbody>
</table>

**General**

<table>
<thead>
<tr>
<th>Room 1</th>
<th>Time Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room 1</td>
<td>9:14-9:18</td>
</tr>
<tr>
<td></td>
<td>9:22-9:38</td>
</tr>
<tr>
<td></td>
<td>9:41-9:57</td>
</tr>
<tr>
<td></td>
<td>10-10:22</td>
</tr>
<tr>
<td></td>
<td>10:27-10:39</td>
</tr>
<tr>
<td></td>
<td>10:43-10:57</td>
</tr>
<tr>
<td></td>
<td>11:04-11:19</td>
</tr>
<tr>
<td></td>
<td>11:21-11:32</td>
</tr>
<tr>
<td></td>
<td>11:35-11:45</td>
</tr>
<tr>
<td></td>
<td>11:50-12:13</td>
</tr>
<tr>
<td></td>
<td>12:26-12:35</td>
</tr>
<tr>
<td>Room 2</td>
<td>9:01-9:12</td>
</tr>
<tr>
<td></td>
<td>9:15-9:24</td>
</tr>
<tr>
<td></td>
<td>9:36-9:43</td>
</tr>
<tr>
<td></td>
<td>9:47-9:56</td>
</tr>
<tr>
<td></td>
<td>10-10:06</td>
</tr>
<tr>
<td></td>
<td>10:14-10:18</td>
</tr>
<tr>
<td></td>
<td>10:58-11:09</td>
</tr>
<tr>
<td></td>
<td>11:33-11:41</td>
</tr>
<tr>
<td></td>
<td>11:46-12:08</td>
</tr>
<tr>
<td></td>
<td>12:08-12:21</td>
</tr>
<tr>
<td>Room 3</td>
<td>9:07- 9:14</td>
</tr>
<tr>
<td></td>
<td>9:16-9:26</td>
</tr>
<tr>
<td></td>
<td>9:34-9:43</td>
</tr>
<tr>
<td></td>
<td>9:46-9:57</td>
</tr>
<tr>
<td></td>
<td>10.08-10.19</td>
</tr>
<tr>
<td></td>
<td>10.22-10.33</td>
</tr>
<tr>
<td></td>
<td>10.44-11.00</td>
</tr>
<tr>
<td></td>
<td>11.02-11.11</td>
</tr>
<tr>
<td></td>
<td>11.2-11.28</td>
</tr>
<tr>
<td>Room 4</td>
<td>9.10-9.27</td>
</tr>
<tr>
<td></td>
<td>10.02-10.30</td>
</tr>
<tr>
<td></td>
<td>10.48-11.16</td>
</tr>
<tr>
<td></td>
<td>11.25-11.46</td>
</tr>
</tbody>
</table>

Table 11. Data from the observation at the three hospitals. Table made by the author.

Other tables containing the data collected at the three sites, each case over two days are in Appendix 4. Considerations about the size of the observation period may be taken, like in any other statistical procedure, a small sample size may not reflect a total picture of the event, but can be considered as a good approximation. Obviously, a large sample of observations is always desirable because it can give a better image of the phenomenon under study, but it is not always possible due to constraints of time, budget, and accessibility. Thus, for cases where there is a small number of observations, the researcher has to consider the degree of reliability and uncertainty. In this particular case, indirect observation of the process was done previously by the author, observing the same performance, e.g. same pace at making ultrasounds. Therefore, the researcher estimates that this number of samples is reasonably representative.

From table 11 it can be seen that sessions to perform u/s started late at the Royal Infirmary and at the General; on the right side hand, there is the total number of u/s performed; the gaps between sessions (blank) represents the time that the radiologist/sonographer is not performing an u/s and the room remains empty, this is called “elapsed time”, and it will be illustrated later on this chapter. It is important to mention that at the Glenfield there is a break if there are no patients at the waiting room, otherwise the radiologists carry on with their schedule. It can also be observed that the Glenfield Hospital with only two rooms performs u/s smoothly in contrast with
the other hospitals. The numbers of u/s performed were: Royal Infirmary (LRI) 34; Glenfield 22, and the General 26; all of them in one day. At the LRI there are one sonographer, one radiologist, and two consultants; at the Glenfield there are two radiologists, and at the General Hospital there are one consultant, and three sonographers. Thus, at all sites there is one specialist per room.

A graphic with the mean time to perform a u/s at these sites is illustrated in figure 11.

Notice that Glenfield has the lowest u/s mean time of the three sites (\(\bar{x} = 5.4\) minutes), followed by LRI (\(\bar{x} = 8.8\)) and finally, the General (\(\bar{x} = 10.2\)). The place with the minimum variation (standard deviation) is again the Glenfield (3.2 and 3 minutes); and the General has the highest variation (10, 4.1, 4 and 13 minutes, respectively). From this information the 15 minutes slots established by the Co-ordinator of the project to perform a u/s seemed to be acceptable. However, in table 12 there is a comparison among the sites, containing means, standard deviation, as well as minimum and maximum time to perform u/s at each site.

Differences about time spent per radiologist or sonographer to make a u/s are noticeable within the hospitals and among them; for instance, at the LRI the radiologist in room three takes almost four minutes more to scan in comparison with the other two rooms; the most significant difference is at the General Hospital. These differences were justified by some consultants arguing complexity, skills, not scanning the same
area, and experience:

“*It is not the same to do an abdo in a pregnant woman, than one for a gall bladder*”

“*New staff are not familiarised with some equipment*”

“*Sonographers are not sure about their diagnosis … they always repeat the ultrasound*”

The time used at room four at the General was justified by the manager of the site, arguing that this was a room dedicated for special screening tests in women. However, this was questioned by the author and by one of the LRI consultants:

“*I did not know about this… (issue)...It is too much time for a pregnant woman, even if you repeat the scanning*”

However, the Clinical Director and one LRI radiologist performed the same type of scans as others radiologists/sonographers, but their times are the lowest. It can suggest that there is something in the process (waste) that is causing such variability on the way of making u/s.

Analysing each room per site, starting with the Royal Infirmary, it was discovered that, the consultant in room one from a session of four and half hours per day (equivalent to 270 minutes), used only 174 minutes or 64.4% of the available time to make u/s. Other percentages are illustrated in table 13. At the Glenfield, sessions lasted for 3.5 hours (per day) or 210 minutes, the same for the General Hospital.

<table>
<thead>
<tr>
<th>Site</th>
<th>Mean</th>
<th>StDev</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>LRI Room 1</td>
<td>7.7</td>
<td>4.9</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>LRI Room 2</td>
<td>7.7</td>
<td>5.6</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>LRI Room 3</td>
<td>11.1</td>
<td>4.7</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Glenfield Room 1</td>
<td>4.9</td>
<td>3.2</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Glenfield Room 2</td>
<td>5.9</td>
<td>3</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>General Room 1</td>
<td>7.6</td>
<td>10</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>General Room 2</td>
<td>6.5</td>
<td>4.1</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>General Room 3</td>
<td>6.1</td>
<td>4.2</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>General Room 4</td>
<td>20.7</td>
<td>13.2</td>
<td>9</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 12. Parameters to perform u/s at each site. Made by the author.
Based on these percentages of occupation, there is no problem related to capacity and the rooms are under-utilised at the three sites, but most critical are the Royal Infirmary and the General Hospital where five rooms are working under 50% of capacity. Elapsed time between u/s was registered and it is shown in table 14.

This time was considered to be that from when a patient left the room and until another entered into it. The total elapsed time is on the column on the right hand side. The Royal Infirmary shows the highest figure; there are irregular gaps of time between u/s performed at the LRI and the General, which are bigger than the Glenfield Hospital.

During the elapsed time, Royal Infirmary Radiologists’ activities varied: one was dedicated to typing reports, another left the room, and the other was sitting waiting for patients. Hence, patients were waiting to be called. A similar situation was happening at the General Hospital; however, at the Glenfield Hospital radiologists used that time to record reports. A “break time” had been established by the Co-ordinator of the project, encouraging staff to pause for about 10 minutes every four u/s, since there is a

<table>
<thead>
<tr>
<th>Site</th>
<th>Usage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rlr1</td>
<td>64.4</td>
</tr>
<tr>
<td>Rlr2</td>
<td>35.9</td>
</tr>
<tr>
<td>Rlr3</td>
<td>34.1</td>
</tr>
<tr>
<td>Gr1</td>
<td>72.4</td>
</tr>
<tr>
<td>Gr2</td>
<td>46.2</td>
</tr>
<tr>
<td>Genr1</td>
<td>51.9</td>
</tr>
<tr>
<td>Genr2</td>
<td>24.3</td>
</tr>
<tr>
<td>Genr3</td>
<td>45.2</td>
</tr>
<tr>
<td>Genr4</td>
<td>44.8</td>
</tr>
</tbody>
</table>

Table 13. Percentage of session time used at each site. Table made by the author.

<table>
<thead>
<tr>
<th>Rlr1</th>
<th>8 3 2 9 5 4 16 9 6 17 14 4 6 4</th>
<th>107</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rlr2</td>
<td>0 5 17 7 4 9 12 * * * * * * *</td>
<td>54</td>
</tr>
<tr>
<td>Rlr3</td>
<td>11 9 7 13 4 17 16 7 16 * * * * *</td>
<td>100</td>
</tr>
<tr>
<td>Gr1</td>
<td>4 3 3 5 4 7 2 3 5 13 * * * * *</td>
<td>49</td>
</tr>
<tr>
<td>Gr2</td>
<td>3 12 4 4 8 3 6 5 8 * * * * * * *</td>
<td>53</td>
</tr>
<tr>
<td>Genr1</td>
<td>4 4 1 3 30 6 5 * * * * * * * * *</td>
<td>53</td>
</tr>
<tr>
<td>Genr2</td>
<td>4 10 10 2 * * * * * * * * * *</td>
<td>26</td>
</tr>
<tr>
<td>Genr3</td>
<td>2 8 3 11 3 11 2 9 * * * * * * *</td>
<td>49</td>
</tr>
<tr>
<td>Genr4</td>
<td>35 18 9 * * * * * * * * * *</td>
<td>62</td>
</tr>
</tbody>
</table>

Table 14. Elapsed time (minutes) between a patient leaving the room and the next one entering into that room. Table made by the author.
human factor involved, and people are not machines. When the data on usage of u/s rooms was presented by the author to the Radiology Improvement team, this information demonstrated that the “break time” was not necessary due to the poor utilisation of the rooms.

Waste was present in the whole process: unclear work role (specifications), paper-work and specialisation, waiting for Radiographer, waiting for in-patients, moving couch in and out of the room. Another issue was reactions to being observed by an external individual, which were different at the three sites. In the first site (LRI), being observed was not a problem for clerical staff, radiology assistants or sonographers. However, consultants (radiologists) rejected the idea of being observed, even when they were informed in advance about this part of the pilot study.

“Why are you observing us? We are professionals and we work in the best way, it has been like that for a long time. Having good results, I do not see the point of change”

The consultants’ reasoning was that they are specialists, know how to do their job and consequently do not need improvement (a reluctance to embrace change), as well as “historical reasons”. A possible explanation for their reluctance to be observed was because there was the perception that everything they did would be reported to the Clinical Director. The sense of being “policed” arose because some consultants were not doing the number of cases they had reported (as the project Co-ordinator noticed when the author showed to her the usage of rooms), starting and/or finishing their sessions late, and a lack of organisation in doing their jobs, consequently affecting RDAs who work beyond schedule due to radiologists’ performance, finishing their shift late.

At the General Hospital, RDAs were not particularly welcoming towards being observed, for the same reasons as consultants at the LRI. In contrast, at the third place (Glenfield) there were no incidents. Furthermore, all the people working there offered their help without restriction, being totally co-operative and asked for feedback to improve; there was a sense of teamwork, and a realisation that the patient comes first. At this stage, issues raised and were noticed by the author and compiled in table 15.
Radiologists session - it was not uncommon for one Radiologist to disappear during the session (to do other things?) which interrupted the flow of the session and extended it beyond the scheduled time.

Target for his Radiologist & Sonographer was: 25 patients between 8:45 and 12:45; 18 patients between 8:45 and 1:30, respectively.

Radiologist kept the RDA over lunch as the work was not finished - but this was his responsibility.

Portering of ward patients was still an issue: arriving late; dumping patients in waiting area without notifying staff on their arrival (if no visible presence at the reception desk).

RDAs - two Ultrasound-trained RDAs were present and another two were sent to help/train. The two training were not clearly instructed by the others so were not much use.

Unused equipment had been shifted to Room 8 to clear the patient scanning area in Room 1. However, when this was collected and used by other staff they left it for RDAs to return to Room 8 instead of taking it back themselves.

Speed of GP reports reaching GPs - approx seven days or more. RDAs batch printed reports daily in a blue box in U/S area. Next day they were taken to post basket in secretary’s office. Postal staff collect (three times daily) and take to Sandrigham Level 0 (LRI) from where GP post is sorted and sent out. Could this process be more efficient? Fewer steps? Less batching? Less waiting?

General point - RDAs do not seem to have a clear picture of what is required of them. Duplication of effort. Unable to deflect inappropriate requests from other staff groups. Clarification of RDAs role in U/S needed? Time out?

Sessions that ran well and efficiently: Dr Campbell (ER), Dr Tyagi (General U/S only), Sonographers sessions. Clear instructions were given to RDAs for scheduling patients. RDAs prefer a quick well-organised session to a slow, confusing one. Can the RDAs and Radiologists be asked to define what makes a session run well/to time i.e. what for both of them is a good way to work?

Dr Hammed - some early training/equipment issues as expected. One problem with CRIS system in typing a report took longer than expected to resolve. RDA could not help; Dr Dux spent 20 minutes of his time trying to help. Was this a good use of everyone’s time when IT staff were available? Does everyone know how to contact Ramanesh from CRIS team?

U/S image printer broke down on one occasion. Technician took over one hour to fix. Had to use other room for printer only.

Report printer not working - 15 minutes spent trying to figure out - technician called and pressed one button to fix. Is unfamiliarity with equipment an issue? Is there some reluctance to call technicians when a problem occurs - whereas Dr Dux can be asked?

Lack of signs at the General Hospital to indicate where the U/S area is located; patients spent about 10 minutes on average to find the U/S desk.

Table 15. Outcomes during observation/collection of data at UHL sites. Table Made by the author.

At Glenfield, concepts of Lean have already been established, e.g. by using colours to make clear which patients belong to the X-Ray department and those from ultrasound; use of small boxes outside the rooms to place the orders that arrive (making a pull system), attaching the printed images of an U/S with a clip to the boxes and sending them immediately to the post room.

Differences at the three sites were detected by the author during the observation, and in separate interviews with the two RDAs at LRI, two at Glenfield, and two at the General. They did not have a clear idea of their own role/activities:

“I am a chaperone during the u/s”
“I have to help patient to get on and off the couch, cleaning the gel off the scanned area”

“I have to look for the patient, explain the procedure to him/her, act as a chaperone, and help the radiographer in placing the patient on the couch”

4.3.2 Ultrasound map correction

A map of the patient flow was made by the LRI staff (Appendix 3), but it was not at all accurate in some parts; therefore, the author had to trace (physically) the stream in order to include those activities not added in before. The omission of details can lead to a misconception of the problem, wrong conclusions and decisions; those parts that were not in accordance with the actual processes are shown in Appendix 5 in red letters. It was in this step that the researcher noticed that using Lean concepts fitted best to deal with the issues at u/s.

As a result of re-mapping the whole process, a summary of problems in the form of waste was elaborated by the author (table 16) and listed on column four. The first three columns are based on “The 7 wastes of Health care” (www.gemba.com) in section 2.3. There was a lack of consistency in standards between the three sites. For instance, Glenfield and LRI have different exam codes for CRIS (which are established by a consultant while sorting out referrals), consultants dictate outpatient reports to tape or digital system, or into CRIS, as they prefer; the General Hospital enters inpatients and outpatients onto the CRIS waiting list, meanwhile LRI and Glenfield only put outpatients.

Among the three sites, it was observed that Glenfield portering is really efficient: finding correct patient, having the right information and being able to get the patient off the ward.

The author visited the LRI on a daily basis (Monday to Friday, from 8 am to 2 pm) during a two month period for meetings and discussions and to carry out the observations referred to previously. From these experiences, the author considers that: there is an excessive amount of movement by staff; there is a lack of standardisation, aimed at adopting best practice, among and within the sites; a lack of communication between hospital staff and managers. One site is already applying Lean principles and working as a team, since they are conscious about the effects and impact of their
<table>
<thead>
<tr>
<th>The 7 wastes- “Muda”</th>
<th>Definition</th>
<th>Health care</th>
</tr>
</thead>
</table>
| Overproduction       | Producing more than the customer needs right now | - Pills given early to suit staff schedules  
- Testing ahead of time to suit lab schedule  
- Treatments done to balance hospital staff or equipment workload - Slots can be reserved or ‘carved out’ especially for urgency. |
| Transportation       | Movement of product that does not add value | - Moving samples  
- Moving specimens  
- Moving patients for testing  
- Moving patients for treatment  
- Movement patients to and fro - Porters need to know patient ID, time required, transport requirements (One or two porters, bed, trolley, chair).  
- Moving couch out to get bed in at LRI.  
- It is quite frequent to see two porters for a patient in a wheelchair, or one for a trolley. |
| Motion               | Movement of people that does not add value | - Searching for patients  
- Searching for doctors  
- Searching for charts  
- Gathering tools  
- Gathering supplies  
- Handling paperwork - General Hospital Consultants & Sonographers have different policies about patients wearing or not a dressing gown.  
- At LRI RDAs and Radiology nurses fetched inpatients |
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Waiting for:</th>
<th>Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting</td>
<td>Idle time created when material, information, people, or equipment is not ready</td>
<td>- Bed assignments&lt;br&gt;- Admission to Emergency Dept.&lt;br&gt;- Testing &amp; Treatment, discharge&lt;br&gt;- Patient lab test results</td>
<td>- LRI referrals are protocolled once a week or every two weeks. Can be left waiting if Radiologist is away.&lt;br&gt;- Postal referrals can be delayed if no-one is available to open post.&lt;br&gt;- Patients often arrive late at General Hospital due to car parking, lack of signs to find the u/s department.&lt;br&gt;- LRI reception is closed at lunchtime. Patients may have to wait.&lt;br&gt;- DNAs (Do Not Attend) is a major problem.&lt;br&gt;- Difficulties when old images not available.&lt;br&gt;- Not enough changing rooms at the General Hospital, patients have to wait.&lt;br&gt;- Old/disabled patients needing assistance.</td>
</tr>
<tr>
<td>Processing</td>
<td>Effort that adds no value from the customer’s viewpoint</td>
<td>- Multiple bed movement&lt;br&gt;- Retesting&lt;br&gt;- Excessive paperwork&lt;br&gt;- Unnecessary procedures&lt;br&gt;- Multiple testing</td>
<td>- GPs often batch their outgoing post, delaying referral.&lt;br&gt;- LRI has a rota for opening post but it does not always work as planned.&lt;br&gt;- Ultrasound scan time depends on radiologist/Sonographer.&lt;br&gt;- Handwrite provisional Inpatient reports directly in notes.</td>
</tr>
<tr>
<td>Inventory</td>
<td>More materials, parts, or products on hand than the customer needs right now</td>
<td>- Bed assignments&lt;br&gt;- Pharmacy stock&lt;br&gt;- Lab supplies&lt;br&gt;- Samples&lt;br&gt;- Specimens waiting analysis&lt;br&gt;- Paperwork in process&lt;br&gt;- Patients in beds</td>
<td>- Some radiologists report whole batch at end of session.&lt;br&gt;- Reports on tape are batched and taken up after the session to the typists.</td>
</tr>
</tbody>
</table>
Defects: Work that contains errors, rework, mistakes or lacks something necessary

- Medication error
- Wrong patient
- Wrong procedure
- Missing information
- Redraws
- Poor clinical outcomes

- Not all post is marked “Ultrasound” and it goes into the General X-ray post.
- Glenfield Hospital urgent referrals are protocolled daily, if not kept separate they may be missed. Other referrals are protocolled twice per week.
- There is a vast list of codes for u/s, making it difficult to understand by other radiologists/Sonographers.
- Appointment letters are sent out differently from each hospital. First class/second-class post, not always based on priority (urgent, routine).
- Time delay in entering referrals onto waiting list if they are difficult to read or incorrect e.g. dates of birth.
- Lists generally do not run to time due to a start late, DNA.
- Patients often phone to cancel or rearrange at any time.
- Re-scanning of the patient.

Table 16. Classification of the waste found in u/s. Table made by the author.

Performance in patients’ life and in waiting lists. The other two hospitals can learn from the small one. But again, the reluctance to change or to try different ways of working is present. Nurses and RDAs expressed disbelief in improvement projects.

“I have suggested something to change, but they (managers) did not listen”

“Glad you are here, you can tell them they need to listen to us”

“How do you expect us to participate in this chaos… they do not know where to start”

The work and results made by the author in this pilot study is given in a letter from the Imaging Directorate (see figures 12a and 12b).

4.4 The Plastic Surgery pilot study

With the support of the Clinical Director and the General Manager for Surgery, Mrs
Julia Spencer the Service Manager for Day Care Services was appointed to take part in a pilot study at the LRI Plastic Surgery Department, using Six Sigma to reduce waiting lists in Plastic Surgery.

The Plastic Surgery mission is to improve the quality of patient’s lives that have suffered disfigurement and functional impairment. There are five main areas of work:

1. Trauma and burns.
2. Cancer (skin, head and neck, breast and sarcoma).
4. Tissue degenerative conditions requiring reconstruction.
5. Normalisation and improvement of appearance.

Therefore, it is vital to reduce the waiting lists for this area.

The day case manager organised a meeting with people involved in that area, where the author explained the Six Sigma approach. In this pilot study, the author had the opportunity to work starting to integrate a team which included: Service Manager Day Care Services ward sisters, waiting list Co-ordinator, and two assistants of the Service Manager. A week later, a second meeting was organised to define the problem using some tools like brainstorming, enlightened thinking, and talking wall; at the end of the session the team came up with a statement of the purpose of the pilot, they also were able to identify the problem, and in doing so, clarify the sort of data needed. Roles of those involved in the pilot were identified, and tasks were assigned (see Appendix 6) as preparation for the second step of the DMAIC.

Data which needed to be collected in a first stage included theatre utilisation, number of surgeons, timing and type of surgeries. Through this initial collection of data the team noticed the following: surgeons usually scheduled more time than required for the surgery; late starting; consultants made more cases on Saturday than those during the week; and programming teaching sessions for auditing every week (with no real reason).

Due to other tasks to be completed by the Service Manager in the other two hospitals, it was not easy to arrange sessions in a regular basis; therefore, by the fourth session just three members of the team could attend it. Unfortunately, the Clinical Director left the hospital just one month after the author’s interview, and the pilot was not a priority.
for the General Manager; therefore, the study was halted at this stage, and it was not possible to conclude it. From this situation in particular, it was elucidated that any improvement initiative must have total support of top level managers, and through this support for freeing up resources, creating a real commitment in conducting such an initiative.

29th Sep 05

Professor Tony Bendell
Centre of Quality & Excellence
University of Leicester

Dear Professor Bendell

Re Maria de Los Angeles Lopez – Ultrasound Project with University Hospitals of Leicester NHS Trust Imaging Directorate (April - August 05)

We would like to thank you for allowing Maria to contribute to our Ultrasound Service Improvement Project. She has been invaluable in observing and baselining our Ultrasound services and providing us with a truly objective viewpoint. To summarise, here are some of the actions/changes, to which Maria has contributed:

- Observation of 1-2 days of normal operations at all 3 UHL hospitals, providing valuable feedback on areas of concern, bottlenecks, staff attitude etc.
- Process-mapping the Ultrasound service at LRI where we have particular problems with coordination of lists, coordination of different staff groups, and accommodation of ward/emergency patients within scheduled lists.
- Standardisation of the LRI Ultrasound Booking templates to avoid ad-hoc changes being made by individual Radiologists (another particular problem)
- Increasing Capacity for Ultrasound using Registrars and an additional Sonographer at LRI. During the period of Maria’s project we were able to establish 6 extra routine scanning sessions for Registrars. Prior to this the Registrars were either observing scans or carrying out their Consultants list for them, so no additional capacity was gained.
- Reduction in overall Ultrasound Waiting list from 4796 patients on 1st April 05 to 3640 patients on 1st Sept 05. This reduction is on going. See Graph below.
- Reduction in General Abdominal, Gynae and Testes Ultrasound Waits (the majority of our work) see Table Below.
- Maria’s initial observations have helped kick start a project about making the best use of our Radiology Dept. Assistants.

Best wishes,

Nicola Leighton Davies
General Manager Imaging Directorate
University Hospitals of Leicester NHS Trust

Figure 12a. Letter from the UHL Imaging Directorate.
The results of these pilots can be catalogued as positive, since both contributed to the experience of the author. Moreover, in the first pilot (u/s) there was a clear result (see figures 12a and b). The lessons learnt included: adaptation of the methodology to specific places and situations, not following steps as a “recipe”; ensure the commitment of top management, involving it in a participative way, guarantees the researcher free course of action, and willingness to change those processes that are clearly the root of errors/mistakes/delays.

Figure 12b. Supporting data patient waiting times and size of waiting list. Data provided by the project Co-ordinator.
Summary

The University Hospitals of Leicester NHS Trust (UHL) includes Glenfield Hospital, Leicester General Hospital and Leicester Royal Infirmary, employing over 12,000 people and providing services for nearly two million people across Leicester, Leicestershire and Rutland (http://www.uhl-tr.nhs.uk/).

At the UHL a pilot study was conducted to reduce the waiting lists for ultrasounds. Observing the whole process was important, for reasons like underuse of facilities, lack of standardisation in processes and policies, unclear roles, lack of communication, and resistance to change became clear. A second pilot in Plastic Surgery was not finished because reasons beyond the researcher’s control, but still gave valuable insight. The DMAIC methodology was used at an early stage of the pilots, and due to the course of action in both cases, this suggested that waste was the real problem and Lean tools seemed the most useful.
CHAPTER 5

The Mexican health care system

5.1 The Mexican health care system and its structure

The Mexican health care system is organised into a National Health System, which involves agencies and entities of the Public administration, local and Federal, and people from the social and private sector who provide health services.

The health system is under the authority of the Secretaría de Salud (Ministry of Health and Assistance), as established in the Mexican Constitution and ruled by the Ley Federal de Salud (1984) as published in the Federation Official Paper, whose main objectives are:

1. To provide health services to the population and improve its quality
2. To contribute to a harmonious demographic development
3. To create social wealth for the population through social assistance services mainly for abandoned children, old people and handicapped people
4. To impel family and community development
5. To improve sanitary conditions that lead towards a satisfactory development of life
6. To implement a rational management system and development of human resources in order to improve health
7. To help in the modification of cultural patterns related to health
8. To promote a system of sanitary practices

Health services are classified into three types as was published in the Ley Federal de Salud (1984):

1. Medical attention
2. Public health
3. Social assistance

Medical attention is divided into three levels according to the type of service required as follows:
1. First level. Medical units that provide external consultation, or first contact of the patient with medical services; can give emergency attention but depending on the seriousness have to send the patient to a higher level of attention. This level includes rural medical units. They have resources for consultation, dentistry rooms and cold room (for vaccine storage).

2. Second level. This refers to hospital units, which have registered beds to undertake surgical procedures or to hospitalise patients. These units have out-patients and emergency services, but at least 4 specialities must exist: gynaecology and obstetrics, paediatrics, internal medicine and surgery.

3. Third level. These are high specialisation units, also called institutes, such as cancer institute, nutrition institute, cardiology institute, etc. They receive patients referred from the first and second levels.

5.2 Health Institutions

It is important to note that, in Mexico, as long as a person has a job, but is not self-employed, medical attention can be accessed by law; however, if a person is unemployed or self-employed, health care will need to be personally financed. Therefore, health services are classified as:

1. Public services for all population
2. Services for members of public institutions of social security
3. Social and private services

There are three main institutions which provide health services:

3. IMSS (Mexican Institute of Social Services)
4. ISSSTE (Social Security Services Institute for Federal Employees)
5. SSA (Ministry of Health and Assistance)

According to the CONAPO (2006) the IMSS and ISSSTE cover nearly 51.54 % of the population in the country. Figure 13 illustrates how these institutions have been increasing their coverage through the years.
A new social security service (named “Popular Security”) was created in 2003 and started operations in 2004; within just one year, it was providing medical attention for approximately 12 million people. The type of people covered by “Popular Security” are independent professionals, small entrepreneurs, farmers and any other person who does not work for a public or private entity. It is not a free service, but the fees for medical attention are minimal in comparison with private ones. In addition, there are other institutions that cover a very specific population, e.g. Army, Navy, petroleum workers, while the first three mentioned previously (IMSS, ISSSTE and SSA), cover most of the population; for instance, the IMSS covers over 41 million people and ISSSTE over 10 million.

The Mexican health system receives funding from Federal and State governments, as well as from workers and employers.

5.3 The National Crusade for the improvement of the health services

Former President Fox (2000-2006), as part of his campaign pledge, launched in 2001 a National Crusade to improve the health service in order to upgrade the health status of the Mexican people (Secretaría de Salud, 2006). To face this challenge, the government established five lines of action:

1. Improve health conditions
2. Address health inequalities
3. Guarantee the responsiveness of public and private services
4. Ensure financing
5. Strengthen the health system, with a particular emphasis on public institutions

As a result, the crusade was expected to allow medical attention to be effective (fulfil expected results by patients), efficient (encourage the optimum use of available resources), ethical (attached to universal values), and secure (offer a service with the minimum risk possible).

5.4 ISSSTE

There is little information available about organised and formal attempts to protect workers before the Mexican Revolution in 1910. However, in Mexico City in 1904 and Nuevo Leon in 1906, laws were passed concerning labour accidents, indicating employers as responsible for compensation. It was not until 1911 that former President Francisco I. Madero included in his programme an initiative to issue laws officially concerning pensions and compensations for labour accidents (ISSSTE, 2007). In addition, only in 1917, with the proclamation of the Constitution, were workers’ rights acknowledged and protected. The Constitution granted social security in article 123, obligating the employer to provide pensions, comfortable and hygienic rooms, schools, infirmaries and other services to the workers.

Because of the rapid economic and social growth during the 1920’s, it was necessary to proclaim laws as well as create institutions to sustain the diversity of society. Also, by law there were some employees that already had security like the Mexican Foreign Service and the Postal services. In 1924, the District Law of Common Tribunal Organisation and Federal Territories pronounced that magistrates, judges and officials that were not wealthy were allowed to receive a pension. However, there was a large group of public employees that were outside of this law (ISSSTE, 2007). As a result, in 1925, the General Law of Civil Pensions and Retirement was proclaimed, creating a General Direction.

In 1938, the Workers Trade Federation for the State (FSTSE in Spanish) was born, giving a legal personality to the workers and to guarantee employment and freedom of association.
In 1959, former President Adolfo López Mateos proposed a law to create the ISSSTE, which was approved and published on 30th December 1959. By 1960, the ISSSTE protected 129,512 workers; 11,912 pensioners and 346,318 workers relatives. The structure of the ISSSTE is shown in appendix 7.

The management is presided over by a Board, which is the main body and is composed of five Federal Government representatives, five members of the Workers Trade Federation and a General Director. The President of the Republic names the President of the Board and the General Director. The ISSSTE is funded by the Federal Government and workers’ fees. In each state there is one Delegation, and four in the city of Mexico; at each one there is a Delegate and a Clinical Medical Director (who is under the authority of the Delegate) who represent the ISSSTE and are responsible for granting and promoting insurance, rights, and services to the Institute members, in order to solve the correspondent requests, procedures and actions within its jurisdiction in good time.

The ISSSTE’s main function is to provide social security; therefore, it protects and defends its members, by granting 20 forms of insurance (ISSSTE, 2007) and services which are the following:

- preventive medicine
- insurance for illness and motherhood
- services for physical and mental rehabilitation
- insurance for labour risks
- insurance for retirement based on time served in employment
- insurance for age retirement and service time
- insurance for invalidity
- insurance for cause of death
- insurance for advanced age retirement
- global compensation
- services and development of children
- services to the retired and pensioners
- housing and renting
- medium term loans
- short term loans
- shops and pharmacies
- tourist services
- cultural and sports activities
- funeral services
- savings for retirement services.

The ISSSTE now covers a population of about 10.31 million people in the whole country, which comprises 22.8% of members, 4.5% pensioners, 58.7% members’ relatives and 3.9% pensioner’s families as Gonzalez Roaro (2004) reported to the Mexican Congress.

5.4.1 ISSSTE Current situation

The ISSSTE is facing a financial crisis due to an increasing number of pensioners (see Table 17). When a worker retires the payment (pension) he/she receives is the equivalent to a 100% of his/her salary.

<table>
<thead>
<tr>
<th>Year</th>
<th>Expenditure per member (Mexican pesos)</th>
<th>Number of workers per pensioner</th>
<th>Pensioners per each 1000 workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>19</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>13.8</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>3,486</td>
<td>9.3</td>
<td>107</td>
</tr>
<tr>
<td>1991</td>
<td>4,047</td>
<td>8.8</td>
<td>114</td>
</tr>
<tr>
<td>1992</td>
<td>4,002</td>
<td>8.1</td>
<td>124</td>
</tr>
<tr>
<td>1993</td>
<td>4,198</td>
<td>7.6</td>
<td>132</td>
</tr>
<tr>
<td>1994</td>
<td>4,718</td>
<td>7.2</td>
<td>139</td>
</tr>
<tr>
<td>1995</td>
<td>3,764</td>
<td>6.8</td>
<td>146</td>
</tr>
<tr>
<td>1996</td>
<td>4,092</td>
<td>6.5</td>
<td>155</td>
</tr>
<tr>
<td>1997</td>
<td>4,391</td>
<td>6.2</td>
<td>162</td>
</tr>
<tr>
<td>1998</td>
<td>4,703</td>
<td>5.9</td>
<td>169</td>
</tr>
<tr>
<td>1999</td>
<td>5,127</td>
<td>5.6</td>
<td>180</td>
</tr>
<tr>
<td>2000</td>
<td>5,318</td>
<td>5.3</td>
<td>187</td>
</tr>
<tr>
<td>2001</td>
<td>5,763</td>
<td>5</td>
<td>199</td>
</tr>
<tr>
<td>2002</td>
<td>5,540</td>
<td>4.7</td>
<td>213</td>
</tr>
<tr>
<td>2003</td>
<td>6,163</td>
<td>4.3</td>
<td>231</td>
</tr>
<tr>
<td>2004</td>
<td>6,082</td>
<td>4</td>
<td>247</td>
</tr>
<tr>
<td>2005</td>
<td>6,440</td>
<td>3.7</td>
<td>269</td>
</tr>
</tbody>
</table>

From this table, it can be seen that the expenditure per member (providing medical attention) has dramatically increased 184.73% in 15 years, while the percentage of pensioners has risen 517.3% in the last 20 years; conversely, the number of workers has decreased considerably to only 3.7 per each pensioner. Basically, the population is retiring at an earlier age and living longer.

Payments for pensioners represented 52.8% of the total budget for the ISSSTE in 2005. This level of payment means that the government has to assign yet more money to the ISSSTE; money whose origins come from taxes paid by the general population. The irony here is that most of this population does not have access to the Institute or to other public medical services.

To show the inequity of the system, Gonzalez Roaro (2004) gives the following example: if a worker earns monthly a salary of $5,000 (Mexican pesos), after 30 years of paying a low percentage fee of his wages fees to the Institute, he and his work centre can accumulate a total of $216,000 during that period of time. However, when this worker retires, he can enjoy a full 100% pension of his salary of $5,000 for 22 years on average (according to life expectancy figures) until he dies, which is a cost to the ISSSTE of $1,320,000. The difference between the worker's contribution and the money received as a pension is enormous.

Why is the ISSSTE spending more money in pensions? Gonzalez Roaro (2004) found two causes for this:

1. **Demographic changes**

   In Mexico, like in other countries, social security is affected by the ageing process of its population. Mexico experienced an accelerated process of demographic change; it started in the 1930's with a decrease in the mortality rate. This coupled with an increasing birth rate, brought about a period of demographic growth.

   By 1960, the birth rate was at 46 births per 1,000 inhabitants; but by the year 2000, this indicator was down to 21 births. During the second half of the 20th century, the average life expectancy for Mexicans doubled from 36 years in 1950 to 74 years in 2000. Therefore, although the population in 1903 was about 18 million, it has now risen considerably to some 100 million in 2000.
The distribution of the population by age and sex is shown in figure 14. It reflects the growth in the number of young people of working age. In figure 15, a change at the base of the pyramid is clearly noticed: the change in the demographic distribution, of those who were born between 1960-1980 will start to enlarge the upper part of the pyramid as they reach the age of 60. This change will modify the structure of the pyramid, which will be wider at its peak and narrow at its base; thereby, illustrating that the life expectancy is increasing and the birth rate is decreasing.


In the case of the ISSSTE the phenomenon is serious: among public health institutions, it has the highest cost of medical attention for an adult population (see population pyramid figures 16 and 17), where 36% of the members are 40 years old or more, and 25% are 50 years old or more.


Figure 17. Population pyramid for the ISSSTE. Source: ISSSTE, 2004.
2. Rights

The second cause of the financial problems of the ISSSTE is related to all the benefits its union has accomplished through the years. The pension for length of service, and the pension for reaching pensionable age (depending on the institution people are registered with) did not exist, and both were created in the 1980's.

There was a lack of foresight, from the union leaders and from the people in the government of the financial consequences of the benefits achieved by the union over the years.

The concern regarding the points cited before is that the institution has to provide its services to an ageing population that will require a different type of medical attention, and at the same time dealing with a financial problem. Thus, another way of using current resources is imperative.

Summary

The Mexican health care system comprises three main institutions: IMSS, ISSSTE and SSA, each one covering a specific sector of population. The ISSSTE provides medical attention to all federal employees and their families. Currently, it is facing a financial problem caused by a change in demographic conditions and for the benefits achieved by the Union. In every state of the Mexican Republic, the ISSSTE has a delegation that has a Clinical Director, in charge of the administration of the resources and medical attention.
Chapter 6

The ISSSTE Puebla Regional Hospital

The state of Puebla is one of the 31 states of Mexico, and is placed in the centre of the Mexican Republic (see figure 18), it has a surface area of 33,995 km$^2$ and is divided into 217 municipalities. The capital city is Puebla, with a population over 1.8 million inhabitants.

![Figure 18. Location of Puebla State](image)

The Regional Hospital is in the city of Puebla and provides services to the states of Puebla, Veracruz, Oaxaca and Tlaxcala. It was opened in 1980. The ISSSTE Hospital provides second and third level medical attention, and is under the authority of the General Director, while the Clinical Direction is under the authority of the Delegate in the state of Puebla.

Population of the ISSSTE in Puebla counts for a total of 296,773 members. In this total, 64,940 are workers; 206,989 are relatives; 13,900 pensioners and 10,944 relatives of the pensioners, as registered by the ISSSTE (2007). Some Federal offices located in Puebla are: Ministry of Foreign Relationships; Ministry of Taxes and Public Credit; Ministry of Agriculture, Forest and Fishing; Social Development Secretary; Ministry of Health and Assistance; Ministry of Transport and Communications; General Attorney of the Republic; Ministry of the Economy; Ministry of Government; Ministry of Education; Ministry of Public Function; Ministry of Public Security; Ministry of Labour and Social
Security; and Ministry of Energy. Figure 19 shows Puebla State head municipalities.

![Map of Puebla State Head Municipalities](image)

Figure 19. Puebla State Head Municipalities. Source: Papeleriacontable. 2007.

The services available at the Hospital are shown in table 18.

<table>
<thead>
<tr>
<th>Rooms for</th>
<th>No. of clinics</th>
<th>Rooms for</th>
<th>No. of clinics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family medicine</td>
<td>9</td>
<td>Physical Rehabilitation</td>
<td>1</td>
</tr>
<tr>
<td>Specialised medicine</td>
<td>31</td>
<td>Expulsion</td>
<td>1</td>
</tr>
<tr>
<td>Emergency</td>
<td>4</td>
<td>Haemodialysis</td>
<td>1</td>
</tr>
<tr>
<td>Dentistry</td>
<td>5</td>
<td>X Ray</td>
<td>3</td>
</tr>
<tr>
<td>Preventive medicine</td>
<td>2</td>
<td>Electroencephalography</td>
<td>1</td>
</tr>
<tr>
<td>Family planning</td>
<td>2</td>
<td>Electro and echocardiography</td>
<td>1</td>
</tr>
<tr>
<td>Injections and minor injuries</td>
<td>2</td>
<td>CAT (scan)</td>
<td>1</td>
</tr>
<tr>
<td>Social work</td>
<td>1</td>
<td>Central for Sterilisation and equipment</td>
<td>1</td>
</tr>
<tr>
<td>Intensive care</td>
<td>2</td>
<td>Ultrasound</td>
<td>2</td>
</tr>
<tr>
<td>Emergency</td>
<td>1</td>
<td>Endoscope</td>
<td>1</td>
</tr>
<tr>
<td>Surgery (Theatres)</td>
<td>5</td>
<td>A blood bank and a pharmacy</td>
<td></td>
</tr>
<tr>
<td>Recovery</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 18. Rooms and clinics available at the ISSSTE Hospital in Puebla. Source: Clinical Direction, 2005.

During the initial six months of 2005, the Hospital provided 122,460 appointments,
while the clinical laboratory processed 231,372 tests from January to September the same year.

The Mexican Institute of Social Security and Services for Federal Employees (ISSSTE) Clinical Laboratory is responsible for tests of: serology, microbiology, special tests (e.g. testosterone), haematology, biochemistry, functional tests, others like organic liquids, sodium, potassium; calcium; arterial gases, general urine test, immunology, just to mention some. Patients visit the Lab for the following reasons: to get an appointment for tests; to collect results of the tests in order to attend a consultation, and to deliver samples.

In the following couple of cases there the author and the ISSSTE Clinical Director were both involved. The Lab Manager was also involved to a minor degree but just for the case study at the clinical lab. Both cases are longitudinal; the first one lasted for six months from August 2005 to January 2006, and the second one from November 2005 to February 2007.

6.1 The ISSSTE case study Clinical Laboratory

In an interview with the Clinical Director of the Puebla ISSSTE Delegation, areas of opportunity to apply Lean and Six Sigma were discussed; the Clinical Laboratory was suggested by him based on his internal reports of the performance of the Lab, such as number of tests ordered by some specialists, number of patients´ served, and costs for conducting those tests. A meeting with the Clinical Director, Hospital Director, Manager of the Lab, and the Manager of Services was arranged to explain the purpose of making a case study there. The Hospital Director indicated two problems:

a) a large queue in a main corridor of the hospital, causing bottlenecks at one access to the hospital, and to the X-Ray archive,

b) patients´ dissatisfaction because of a lengthy process of being served at the Lab.

The author carried out a case study (helped by the Lab Manager to be acquainted with some terms and official procedures) to solve the aforementioned problems and with some issues cited by the Clinical Director; therefore the objectives of this case study were to:
- find out the quantity and type of lab tests ordered
- find out which area was ordering the most lab tests
- improve the results delivery service
- reduce the number of outpatients waiting in queue
- reduce waiting time at the reception desk

The author used Lean principles based on the previous experience at the UK. The DMAIC steps were used as a way to structure the application of Lean.

The case study was carried out by the author between August and October 2005 (from Monday to Friday, starting at 6.30 am, finishing at 2 pm), with monthly assessments the same year and until January 2006. In the assessments the author presented to the Clinical Director the Lab performance through graphs and statistics (mean and standard deviation), suggesting changes, evaluating effectiveness and sustainability of the agreed modifications as a result of applying the approach. The assessments from August to October 2005 and the second week of January 2006 were made in person, while November and December were through e-mail.

Historical data existed in different databases and was confuse regarding number of patients served per day, types and quantity of tests performed; therefore, the author had to select and organise them. On the other hand, data required for the research like time a patient spent waiting, time being served at the desk, time to get blood samples, to mention some did not exist. Consequently, it was collected and analysed by the researcher.

The author conducted a walk through the Hospital and the Clinical Lab to discern the areas and to observe front line staff performing their jobs. After this, the researcher started the specific period of observation for Clinical Lab performance, personnel and patients arriving there. The researcher spent a total of nine weeks at sampling rooms studying each one of the chemists while they were taking samples, and at the same time interviewing them informally. During these informal conversations, topics like ways of working, improvement initiatives, management support, union, assignment of activities, quality concepts, and internal policies to mention some were discussed.
6.1.1 Major customers of the Clinical Laboratory, type and quantity of lab tests ordered

The following data comes from the Clinical Lab database, and it is typed from patient’s lab orders daily. The researcher compiled the information regarding referrers and type of tests most usually ordered (in a month), and are presented in table 19, and the lab major “customers” in table 20.

It is worth to mentioning that lab orders enclose data such as: patient’s name and ID, age, referrer’s name and specialty, medical unit, type of tests to run, and date, to cite some.

<table>
<thead>
<tr>
<th>Type of Lab test</th>
<th>Quantity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Chemistry</td>
<td>22063</td>
<td>69.8</td>
</tr>
<tr>
<td>Haematology</td>
<td>5532</td>
<td>17.5</td>
</tr>
<tr>
<td>Urine</td>
<td>2292</td>
<td>7.2</td>
</tr>
<tr>
<td>Serology</td>
<td>1043</td>
<td>3.3</td>
</tr>
<tr>
<td>Bacteriology</td>
<td>673</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Table 19. Type of tests ordered and quantity. Source: ISSSTE database. Table made by the author.

<table>
<thead>
<tr>
<th>Lab ordered by (Customers):</th>
<th>No. of tests ordered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialists</td>
<td>16,836</td>
</tr>
<tr>
<td>Puebla medical unit</td>
<td>7,527</td>
</tr>
<tr>
<td>Hospital</td>
<td>5,590</td>
</tr>
<tr>
<td>Medical units outside the city</td>
<td>4,529</td>
</tr>
</tbody>
</table>

Table 20. Major Lab customers. Source: ISSSTE database. Table made by the author.

The information illustrated on tables 19 and 20 was discussed in a brainstorming session with the Clinical Director and Managers of Lab and Services, allowing them to: give chemists the authority to refuse to do tests that do not comply with the Institute policies; send a Memo to the peripheral units to remind them about the Lab tests authorised for its corresponding level, as well as the costs incurred through not picking up the results on time; and finally to implement a new program to deliver test results directly to the peripheral units.

While the author was collecting data, another problem was detected and that was also a cause for incurring in expenses: lab results were not picked up, even those marked as “urgent”. This was noticed through the information gathered about the Lab’s major customer and unapproved lab tests ordered by GPs. The data for results not being
collected is presented on the following table.

<table>
<thead>
<tr>
<th>Month</th>
<th>No. of Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>26</td>
</tr>
<tr>
<td>September</td>
<td>35</td>
</tr>
<tr>
<td>October</td>
<td>39</td>
</tr>
</tbody>
</table>

Table 21. Number of lab results per month not picked up by patient/medical unit. Source: Clinical Laboratory files. Table made by the author

The root of this problem was basically: a) patients within the city not picking up results on the day indicated by the receptionist, or b) the specialist’s intern forgetting to collect the results for inpatients. The clarification of this problem was made by the author (with previous guidance of the Lab Manager) by reviewing each one of the results, searching for a code indicating if it was an outpatient or an inpatient, and address. After discussing the issue between the Manager and the author a solution to diminish/eliminate this problem came up in the form of sending a Memo to the Chief of Medicine resident students to remind them to collect the results on time. From January to March 2006, the lab results which were not picked up were in total three (all for outpatients), which is a major improvement. By this improvement there was no need to repeat lab tests for inpatients, and consequently a benefit for the lab saving resources. Unfortunately, the information regarding savings could not be obtained, because it is confidential.

6.1.2 Lab test results delivery

Lean tools like the spaghetti diagram (see figure 20) and direct observation were used to “see” which parts in the process were causing delays. Through this diagram, it was possible to identify non-value added activities.

The process in figure 20 is:

I. Arrival. A patient arrives (red line) at the Hospital for his/her consultation, he/she goes straight to the “specialties reception Desk”. There, the receptionist confirms the availability of the clinic file, then asks the patient if a lab test was ordered and verifies that the results are attached to the file. If the results are not attached, the patient has to look for them. It can be by going directly to the Clinical lab reception desk and waiting his/her turn to
Figure 20. Spaghetti diagram for a patient to pick up lab test results at the ISSSTE Clinic Lab. Made by the author.
ask the receptionist for the results, or going to the “temporary desk” to look for the results.

II. The patient visits the “temporary desk” and asks for his/hers lab results; if they are located there, the receptionist gives them to the patient and the patient returns to the “specialist desk reception” and hands them to the receptionist and waits for consultation.

If the results are not at the “temporary desk” then he/she is sent to the “Clinic Archive” to look for them. Again, there are two possibilities: if the results are there, the person responsible for the area delivers them to the patient; otherwise, the patient is sent to meet the Manager of the clinical lab to order a copy of the results. The temporary desk works between 8 am and 9:30 am, after that it moves to the “clinic lab reception desk”. This change of place is because the reception desk area is not large enough to deal with the volume of customers, as there are only two customer service windows.

All the test results are printed out in the Lab Manager’s office, and one secretary puts them all together, attaching a list containing patient’s name, ID, and specialities. These documents are then delivered directly to the Clinic Archive, where one person there checks in a list (along with the secretary) each one of the results received. If there is not a missing report, he signs in a copy as proof that all the results were in accordance with the list. After that, personnel of the Archive append each report to the patient file. The researcher made a visit to the Archive, finding that workers there were not appending lab results to patients’ files, mixing lab results or, even worse, losing results. Results were piling up on a desk. Here, the most affected person is the patient, since he/she can spend more than 30 minutes looking for the results, or even worse, waiting for a copy of them.

As a solution (applying the concept of Just-in-Time) to avoid dissatisfaction among patients caused by not finding results attached to their clinic files, and to eliminate a lack of privacy, an agreement between the Clinical Director and the Lab Manager established that all the results of patients from medical units outside of the city, would be collected at the Lab Manager’s office once a week by personnel from the Clinical Direction, and delivered directly to the corresponding medical unit to attach the results to the patient’s file, with the exception of those marked as urgent, which are collected by the patient at the reception desk on a specific day given by the receptionist.
6.1.3 Queuing problem

The author conducted a period of observation for the queuing problem at the reception desk, for a period of two weeks beginning at 6:45 a.m. and finishing at 10.15 a.m. from Monday to Friday at the waiting area. A great variability in daily numbers of patients served (see figures 21 and 22) was a cause of distress to the lab personnel, who had to cope with an unpredictable number of tests on any one day; outpatients also experienced distress because of the time spent at the laboratory ((waiting for being served at the reception desk plus waiting time to being served by the chemists). The researcher observed and analysed the process and the movements made by the receptionist and patients, perceiving that the problem was directly related to: a) the appointments system, where one person is responsible for assigning the number of patients per day; and b) by the time that the receptionists spent on serving patients.

![Patients served by the Clinical Lab](image)

Figure 21. Number of patients served by the ISSSTE Clinical Lab during August 2005. Source: ISSSTE database. Graphic made by the author.

The DMAIC steps were followed:

- Defining. To reduce/eliminate variability in number of patients served per day.
- Measure. To collect data on the number of patients attending lab per day, number of chemists, the time to get blood samples, and the receptionist time to serve a patient.
Thus, in this step data was collected, starting with the number of patients served by the laboratory. The standard deviation is a measure of variability and was calculated for each month. Therefore, in August there were on average 194 patients served per day, with a standard deviation of 29, while in September the figures were 152 and 41, respectively. As can be seen, variability is greater in September than in August, even though there were fewer patients served at the clinical lab.

Through a data analysis and observing the appointment process a severe problem was highlighted: the person giving the appointments did not care about the limit established by the computer program when it displayed that the day chosen was fully booked, adding more patients; the Lab manager explained to the author that the software utilised had a pre-established number of appointments per day:

“The software utilised to register appointments automatically limits to 180 appointments per day, but the receptionist can add more people if necessary... just in case of emergency, or if the Hospital Director asks for. The secretary should follow indications regarding when adding more patients”

A meeting with the Clinical Director, the Hospital Director, Services Manager and the Lab Manager was held in the third week of September. The first results of the case study were shown by the author and after discussion a limit was set on the number of patients seen per day to 195, with a possible increase of 10, in case of emergencies.
After this, the Lab Manager reminded the secretary to follow Lab policies. After these actions were taken, the variation in the number of patients served by the laboratory was reduced significantly, from a maximum registered of 250 in August 2005 to 173 in October 2005. For more evidence see figures 23 to 26.

Figure 23. Number of patients served by the ISSSTE Clinical Lab during October 2005. Source: ISSSTE database. Graphic made by the author.

Figure 24. Number of patients served by the ISSSTE Clinical Lab during November 2005. Source: ISSSTE database. Graphic made by the author.
Table 22 summarises the information contained in figures 21 to 26. Observe that October registered the minimum number of patients served by the lab. In January 2006 standard deviation increased, without affecting the target of serving the threshold level of 206 patients. This parameter (standard deviation) must be minimized because it measures the process of levelling the number of patients served per day. The increase of this parameter is caused by peaks in the number of patients in certain days, as can be observed in the figures above. All this data supports the changes made.
Table 22. Parameters of patients served by the Clinical Lab. Table made by the author.

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean</th>
<th>St Dev</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2005</td>
<td>194</td>
<td>29</td>
<td>250</td>
</tr>
<tr>
<td>September 2005</td>
<td>152</td>
<td>41</td>
<td>226</td>
</tr>
<tr>
<td>October 2005</td>
<td>155</td>
<td>12</td>
<td>173</td>
</tr>
<tr>
<td>November 2005</td>
<td>170</td>
<td>13</td>
<td>196</td>
</tr>
<tr>
<td>December 2005</td>
<td>168</td>
<td>13</td>
<td>188</td>
</tr>
<tr>
<td>January 2006</td>
<td>124</td>
<td>23</td>
<td>187</td>
</tr>
</tbody>
</table>

6.1.4 Reduction of waiting time at the reception desk

The process at the Lab is: the receptionist receives a lab order, and verifies on the ISSSTE computer database:

a) the date of the appointment,
b) the patient’s data,
c) type of test to run.

After that, the receptionist then prints out and places the labels for the corresponding containers; she then gives a number to the patient, and places the lab order over the printer. The researcher made a visual examination of the reception, as a result a layout was pictured (see figure 27). After the visual inspection a period of observation of the processes taking place there (movements made by the receptionists within the lab reception) for three days from 7 am to 10 am. The author registered the time between when the patient arrived at the desk and when he left it, and this was 2.2 minutes on average. The author noticed an inefficient use of space meant that the printer had to be placed on an inappropriately small desk. Subsequently, the orders became mixed up and the receptionist had to turn them over all the time, in order to identify the addressee wasting a lot of time in the process. Therefore, a change was suggested in the position of the printer (see figure 28).

At the beginning there was reluctance and scepticism towards changing the layout, since people working in that area had been working in that way for many years:

“It is not going to work”

“I have made many suggestions, with no result. How this time do you expect to make
something different?"

Fig. 27. Layout of the reception desk. Diagram made by the author.

“I do not think it is a good idea"

“…until I see I will believe”

However, within two days of the changes being made, the workers realised that it was now easier for them to identify and assign lab orders, because the unnecessary movements had been eliminated:

“I believe"

“It is a good start”

Other changes included placing signs, and introducing some degree of accountability
through obtaining an attendance certificate from reception. These were the first results using Lean principles at this location. As a consequence there was a reduction in the average time spent being served by the two receptionists, from 2.2 to 1.1 minutes, and from a total time spent at the lab of two hours to just one, increasing patient’s satisfaction through being served quickly. To assess patient satisfaction informal interviews were conducted with 15 patients, randomly, for three days (Monday, Wednesday and Friday), and just one question was made: “What is your opinion of the service of the lab?” Some responses were:

“I am quite happy for not being here the whole morning”

“…this is faster…”

“I see a small change; it is good”

“…now someone has listened to us”

“It is better than in the past”

After changing the layout, it was possible to close approximately 30 minutes earlier the desk; therefore, having completed all necessary tasks, the lab is able to close at around 9:20 am. Hence, the two receptionists have more time to perform their other activities at the lab main office e.g. printing reports, preparing attendance certificates, to cite some.

There was a problem related to lab operating hours, which is not easy to solve, since labour policies are involved; e.g. if the employee shift starts at 7 am, he can check in at 7.10 am, but it does not necessary imply that the worker actually starts working, it can take another 10 or 15 minutes. Thus, the worker is causing a delay that can affect him, the patient and the efficient operation of the lab.

The data collected on the chemist’s performance (the time taken to get physical samples) demonstrated that they are doing their job faster than the Institute recommended times of a minimum of five minutes to a maximum of 15. This five minute minimum was explained by the Lab Manager as a precaution so as not to cause harm by taking a blood sample under pressure. With regards to this issue, the Clinical Director considered that the National Institute indicators in this specific case were
obsolete, and he was weighing up the pros and cons of undertaking a National project on this.

Data for getting blood samples was collected between August and September 2005, for three weeks in each month at three different sampling rooms. The distribution of time (in minutes over the “X” axis) for getting blood samples, and the patients (black dots) served during that time is illustrated in figure 29. Observe that the time width for chemist in room 1 (C10) is wider than the other chemists because this chemist has a physical disability; the chemist in room 3 (C12) performed the activity in a maximum range of 3.3 minutes. The difference among those chemists was attributed by the Lab Manager to personal ability. However, the chemist working in room 2 (C11) performed within the range of 0.5 and 1.5 minutes for 65.9% of the time, a more efficient performance. Interestingly, this chemist has been contracted for a limited period of time, whereas the other two work with a “lifetime” contract.

![Distribution of Time for getting physical samples at 3 sampling rooms](image)

Figure 29. Distribution of time (in minutes) for getting physical samples at the ISSSTE Clinical Lab sampling rooms. Source: Data collected and graph made by the author. August and September 2005.

In table 23, the mean, standard deviation and minimum and maximum time (in minutes) for the chemists are shown.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>StDev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10</td>
<td>1.9</td>
<td>0.8</td>
<td>0.5</td>
<td>4.3</td>
</tr>
<tr>
<td>C11</td>
<td>1.4</td>
<td>0.7</td>
<td>0.5</td>
<td>3.8</td>
</tr>
<tr>
<td>C12</td>
<td>1.8</td>
<td>0.6</td>
<td>1</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Table 23. Performance statistics for chemists to get physical samples. C10 is room 1, C11 is room 2 and C12 is room 3 for getting blood samples. Data collected and table made by the author.
6.2 ISSSTE Referral and Counter-referral case study

The ISSSTE is the only institution in Mexico that pays its health care members’ travel expenses from the patient’s home to the Hospital; these travel expenses within the ISSSTE are covered by the Clinical Delegation at local government level. The Clinical Direction receives an annual budget from the Federal government from which the expenses caused by referrals are paid. Consequently, if payments for this are reduced, then the Clinical Director can apply that fund in other areas, e.g. buying new equipment, maintenance of ambulances, equipment, to mention some. A small team was created to carry out a case study to reduce costs by controlling the way a patient is sent by a GP to a higher level of medical attention, and after he/she has received treatment, is referred back to his/her GP (Referral and Counter-referral process). The team comprised the Clinical Director, a Doctor in charge of the area of Verification, and the author. This study started in November 2005 and finished in August 2006.

6.2.1 Approaches utilised for the case study

The structure followed for this case is based on the DMAIC methodology (figure 30), and some tools of Lean (5W, observation) were applied. For instance, to understand the problem, a brainstorming session (see figure 31) was held, arising two issues: the first one related to the unclear process of Referral and Counter-referral, and the second one with high costs caused by the patient’s travel expenses to the hospital to receive medical treatment. Both are intimately related, because if there is no accountability and order in the referral process, then payments made by the Clinical Direction to cover patient’s travel expenses are out of control, according to the Clinical Director. Therefore, the Referral and Counter-referral process is a key issue in reducing costs. This is the “Define” stage.

Figure 30. Structure for the Referral Counter-referral case study. Graph made by the author.
It is important to get know and understand the whole process. A detailed diagram of the referral process is in Appendix 8, and is briefly explained next.

The patient attends an appointment with the GP, and he/she evaluates the patients by a diagnostic test determining if the patient requires medical attention in another medical unit, in which case a form must be filled in by the GP which goes through several steps until it is received by the patient. These steps are:

a) Filling in a form and two copies, and sending it to the immediate manager.
b) The manager verifies that the form has been filled in properly and accurately.
c) If the form is correct the manager signs it and sends it to the Referral-Counter referral intern area.
d) The Referral-Counter referral area receives the form and elaborates a cost-benefit study to determine if the patient is referred or sent to a private provider.
e) If the patient is referred, then a request for an appointment is sent to the receiving medical unit.
f) The receiving medical unit receives the form, scheduling the appointment, confirms it with the emitting unit, and sends the form to the referring medical unit for authorization.
g) The manager of the emitting unit receives confirmation of the appointment and sends the form to the medical unit Director, who authorises it and determine if the patient needs to travel with an escort and the type of transport.
h) The manager of the emitting unit verifies that the form is authorised and patient’s requirements for attending the appointment; he fills in a transfer form with two copies, and sends this to the manager responsible for the expenses area; he plans the expenses, and gives a copy of the transfer order to the patient.

Through the understanding of the process a comparison between the processes as it should be and the real one was done. To perform this comparison, visits to the medical units were necessary where possible, as well as accessing a limited number of patient files to examine if the form SM-1-17 was filled in according to the official procedures.

6.3 ISSSTE Referral and Counter-referral data analysis

The author conducted a revision with the Clinical Director of the procedures manual. A fishbone diagram or Cause-Effect diagram (see figure 32) was utilised to identify the causes of costs. The Clinical Director was able to detect transport as a main cause for generating high costs to the Clinical Direction, followed by personnel, which is more complex to deal with, because there are other factors involved like contracts, federal policies, union policies, location and training, to cite some.

The process to pay patient’s transport is: patient pays the bus ticket or petrol bill (if he uses his own car); after receiving medical attention, he fills in a special form to ask for a refund, submitting it along with the respective bills to his medical unit. Then, the medical unit sends all these documents to the Clinical Director in order to be authorised; next, after the Medical Director authorises them, these documents are sent to the Finance Department, where a cheque is produced and sent to the medical unit, where the patient gets it.

The collection of data (costs) was made from January to July 2006. The first thing to take into account was costs generated per month per medical unit. As explained before, there are medical units across the State. A list of some medical units outside of the city is presented in table 24.

Medical units located in the city and around are not included due to proximity; the Clinical Direction does not cover any of the travel expenses for these units.
Through the use of the information obtained from the ISSSTE database, a graph to show the expenses was first made (figure 33), as well as a Pareto diagram (figure 34).

In the Pareto chart (figure 34), the “Y” axis (left-hand side) scale represents the amount in Mexican Pesos spent, and on the opposite side (right), in percentage terms. On the “X” axis, the boxes represent medical units; and the red line indicates cumulative percentage.

This Pareto chart classifies medical units according to their expenses, from the largest to the smallest contributor, which helps to separate the “vital few” problems from the “trivial many.” Thus, on the left hand side the medical unit in Teziutlán represents 27.9% of the total cost incurred for referral; this is followed by Acatlán, (21.4%) and Tehuacan (21.3%). As is noticed, the cumulative percentage of Teziutlán and Acatlán...
represents nearly 50% of the total costs for patients transport. The last group in the Pareto chart is labelled “Other,” and contains a count of all defects (other medical units) in various categories of so few counts as to represent less than 5% of the total defect count.

Through this chart, it was clear that the first place which needed detailed analysis was Teziutlan medical unit. A comparison (in expenses) was made for the years 2005 and 2006, looking for possible trends in diseases, which might explain high costs. However, the data did not show a trend. As a consequence, a detailed revision on the costs
generated by this unit was conducted; the 5W tool was applied to find out the reasons for these costs. The tool enabled the author to look carefully at the number and type of referrals, as well as the type of transport utilised. However, while the author was using the database, some inconsistencies were found, and e.g. number of patients referred did not match to number of patients seen at specialties and treatment. Because of this, it was necessary to collect data from the original source. The type of referrals and transport utilised is illustrated in table 24. It is important to say that, information regarding expenses is under the authority of the Finance Department, and referrals to the Administrative Department; due to this division, the data showed in table 25 was only available up to July 2006.

The data in table 25 is explained as follows: in the first column is the month, the second column contains the number of patients who travelled by bus (the ones the ISSSTE pays transportation to); the third column comprises the number of patients referred to specialists; and finally the fourth column shows the number of patients who were referred to receive treatment at the Hospital e.g. chemotherapy, dialysis, physical rehabilitation, to cite some. In March and April there were no reports of any patients referred for treatment.

<table>
<thead>
<tr>
<th>Type of transport Bus</th>
<th>Specialist appointments</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>12</td>
<td>59</td>
</tr>
<tr>
<td>February</td>
<td>46</td>
<td>2</td>
</tr>
<tr>
<td>March</td>
<td>122</td>
<td>122</td>
</tr>
<tr>
<td>April</td>
<td>92</td>
<td>93</td>
</tr>
<tr>
<td>May</td>
<td>139</td>
<td>141</td>
</tr>
<tr>
<td>June</td>
<td>184</td>
<td>184</td>
</tr>
<tr>
<td>July</td>
<td>182</td>
<td>192</td>
</tr>
</tbody>
</table>

Table 25. Type and origin of referrals. Source: ISSSTE Clinical Direction records. Table made by the author.

Analysis of the data highlighted some issues:

- Are there enough personnel in the medical unit? (e.g. X-ray technician, gynaecologist, etc.)?
- If so, why are they not paid them over-time, rather than referring to an external service?
- Did the Director of the medical unit make a cost-benefit analysis?
- Was it necessary to refer those patients for special medical attention?
- Does the patient actually need to travel accompanied?

These issues were asked in an interview with the Clinical Director, who answered:

“Directors of medical units have to do several tasks, aside from the management of the unit; they have to fill in reports, dealing with requests…and do not have enough time to check GPs procedures. It is not an excuse, may be they need to organise themselves better.”

He and the researcher searched into the files, and noticed that most of the time:

- Policies were not followed by the doctors, director and other people involved in the process.
- Peripheral medical units have not got an area of Referral and Counter-referral, because of the population size (too small). Consequently, the doctor or the nurse should do the paperwork, apart from working as pharmacists.
- Not all the forms SM1-17 were correctly filled in, there were blots, amendments, incomplete data, illegible handwriting, just to mention a few.
- Lack of rules to impartially decide if a patient’s travel expenses had to be paid by the Institute; currently, the decision is made by the doctor’s personal opinion.
- There is no accountability to register the number of referrals, number of times that a patient is sent for the same illness and case. According to the policies there is a limit of five consultations. Any subsequent consultation should be notified to the medical unit Director. However, this situation is not communicated to the Director, who was unaware about the actual time that a patient stays in the system. The patient can be under medical treatment for different illnesses from the original one. For example, a patient can be referred to a neurology consultant and after the consultation he/she is referred to another speciality like orthopaedics, cardiology, etc., losing control on money, which has to be covered by the Institute. This is a waste of resources not only economic, but also in time and personnel.
- The cost-benefit study was not made: thus, in some cases the Institute pays more for a substitute provider service (because the most expensive was chosen) rather than paying overtime to a radiologist, doctor, technician, nurse or chemist.

- Finally, inconsistencies in the procedures policies were found as discussed with the Clinical Director. This could be because the Referral and Counter referral manual was written at different points of time and for different people.

Because the manual is used in the whole country, corrections have to be made through consensus of the Clinical Directors in the country. A unique document must then be produced and sent to the respective authorities for its consideration. However, the Clinical Director was able to order (at the end of March 2006) that some basic procedures should be followed like:

a) registering the number and type of referrals made by each GP

b) GPs with unusual number of referrals require the medical unit Manager’s authorisation, prior to giving the patient a referral

c) selecting referrals randomly (at least two per month), to assess diagnosis and proper form filling

d) analysing the payment of overtime before referring the patient to a substitute provider; if it was not possible to get specialists available by paying overtime, then to choose a substitute provider (not an expensive one) without compromising patient’s life

As mentioned before, due to inconsistencies in data, a second comparison in expenses for 2005, 2006 and the first two months of 2007 was made (see figure 35). This information was obtained through the Clinical Direction. Reduction in expenses can be noticed in May, June, July, August, and November in 2006 (with a small increment in September, which was caused by a rise in the bus fare tickets as the author examined and compared each ticket to previous months); for October and November, less patients were reported sent to the hospital; yet, there was a high amount that was paid in December caused by extemporaneous bills presented by patients’ to their medical unit, which is authorised by the Finance Department; in order to eliminate this
extemporaneous payments, the Clinical Director has established a deadline (starting in February 2007) to submit bills from patients´ to medical units.

In order to evaluate the efficiency of the procedures set by the Clinical Director in March 2006, the author obtained a partial balance (due to fiscal taxes reasons in Mexico the expenses are registered up to this month and the information for the following months is recorded for the next fiscal period) of the expenses during January and 15 days of February 2007, reporting expenditures for $32,359.00, which seems to be lower than the other two previous years in the same period. However, it would be too risky to make such an assumption without further data. Thus, this diminution must be considered with caution, but at least represents a good start in reducing costs.

Another possible solution suggested by the author to cut costs, is to programme the visit of specific specialists to the medical unit (Teziutlan), providing medical attention on a certain day, previously agreed with the medical unit Manager and the specialists. Thus, rather than paying for transportation of many people, the Institute would pay for the transport of three people (one specialist, one intern and one nurse). This solution was considered feasible by the Clinical Director; unfortunately, it was not possible to implement it, due to changes in the Clinical Direction.
6.4 Role of unions in Mexico

Maleyeff (2007) recognised unions as a barrier in the public sector, and Mexican public institutions are not an exception; they are so powerful that they can change Presidential or Congress initiatives, through strike action or public demonstrations, as was seen recently in the southern state of Oaxaca, when teachers protested about their salaries. Over the last 70 years and due to agreements with a political party (PRI or Revolutionary Institutional Party), they have achieved exaggerated power and “benefits” as Gomez Mena (2005) indicates. It is not a secret that in public Mexican health institutions, a large number of staff workers do not have the skills required for those positions (e.g. secretaries, receptionists). It is always a kind of reward for political favours, current employees “agreed” with the Union to get a place for a relative, or even worse, workers give their job positions to a son or a daughter, which makes it almost impossible to offer a place for people not related to the system even when they are properly qualified for the job (Santana, 2007; Ruíz and Ruíz, 2008). The “lifetime contract” catalogued by Mexican unions as a “labour right” gives workers a job security, creating a sense of “it does not matter how hard or well one person works”, the employee still will earn the same salary. The opposite attitude can be seen in the Japanese culture, where lifetime contract encourages loyalty to the company, workers do not look for overtime payment (Karatsu, 1988).

It was due to the industrial revolution in England that production systems changed, and in doing so, work organisation was modified too, creating the trade-unions. In Mexico these changes took place in the late XIX century. In their origins, they were organised to protect workers from unfair labour policies at the beginning of the XX century. A wide variety of trade unions were created to represent workers of the different sectors, e.g. mining, steel, milkmen, etc. Unfortunately, after the Revolution (1910), there was a kind of alliance between the political party of the time (PRI), and the worker’s leaders that supported the Revolution. This association reinforced the position of this political party in power until 2000, receiving in reciprocity “carte blanche” to act as they wanted. As a result, their leaders became rich, and remained in their positions for years (more than 40 in one case), or as a property of a family, like the mining Union. Therefore, the original principles of protecting workers disappeared through time due to the voracity of the “leaders” of the numerous unions grouped in an entity called Work Congress (CT in Spanish). The way the Union leaders compel workers to support them, is made via the same company or by using coercive methods, especially in the public sector, where they can promote or relegate people. Because of this, unions are quite powerful, even
when a new party is ruling the country.

Any changes in public health institutions usually have to be approved by the Union, once no risk is found for the workers, and are then put in place. Usually, things like changing a workers´ schedule, reducing/eliminating permits, allowing late starting, etc. are subject to the Union approval. As Sarmiento says (2003), only in Mexico can a Union declare a strike without its members´ consensus or force new “rights” or benefits.

In the mid 1990´s there was a leaders´ movement inside some public and private institutions to break the domination of the official one, and to eliminate all the pressure imposed on the workers by the official leaders, creating a new group of unions in 1997 called Workers National Unity (UNT in Spanish). At the beginning this new group tried to eliminate the vicious practices of the CT, but after some time they became a copy of the old unions (Gomez Mena, 2007; Contreras and Busca, 2008), the only difference being that they did not support the government.

With the change of political party in the Presidency since 2000, union leaders were aware of proposed changes (Rocha, et al., 2007). These changes represent a challenge for the current President Felipe Calderon Hinojosa, as transformations for the benefit of the country are not always welcomed by unions just because they will be affected directly, not necessarily the workers (Martínez González, 2008). This situation is similar to the new ISSSTE scheme, whose economic situation has already been shown in section 5.4.1.

The Union role in Mexico is an important contributor to the success of making changes that lead to improvements. As a consequence, studies can take up more time than expected if workers feel that their jobs are threatened, or if they are not doing duties that they are supposed to do, and are protected by the Union. This situation was experienced by the author during the case studies at the ISSSTE, and also reported by the Clinical Director:

“I know what things must be change, but it is not easy when you try to eliminate vicious practices… the Union is always there to protest if its members are involved."

Summary

At the city of Puebla is located a regional hospital that offers medical attention not only
to the state but to other states in close proximity to it. It was at this place where two case studies took place: Clinical Laboratory and Referral-Counter referral process. Both Lean and Six Sigma DMAIC were used. Some Lean tools used were direct observation, spaghetti diagram, brainstorming, cause-effect diagram, 5W, Kaizen and basic statistics, Pareto chart and diagrams. Benefits at the clinical lab were: establishing a number of patients to be served by the clinical lab, reduction of the waiting time to be served by lab desk from 2.2 minutes to 1.1, reduction of the total time that an outpatient spent at the lab, from two hours to one. For the Referral-Counter referral process, the research permitted to detect medical units and periods where they incurred high costs and it was noticed that the Referral process was not being followed, allowing to the Clinical Director to set some policies regarding this issue. The Union plays an important role in improvement processes at public institutions if workers´ rights are involved in major changes to be done.
Chapter 7

Discussion

7.1 Introduction

The main goals of this research were to: a) carry out and record implementations of Lean and/or Six Sigma approaches in healthcare, with a focus on the Mexican health system, b) gain experience with pilots in Ultrasound and Plastic Surgery at UHL, c) investigate which one of these approaches fits best into health care, and what the most useful tools/techniques are, d) identify critical factors before, during, and after applying the approaches to achieve a successful implementation, and e) identify any specific issues that are important in Mexico.

The first task was to investigate places applying these approaches in Health care and in which areas, which of them were used more frequently and what sort of tools/techniques were used. Through a literature review, it was shown that both methods have been widely applied in American hospitals and in countries like the Netherlands, the Republic of Ireland, Sweden, France, Australia, and some trusts in the UK (Hereford. Salisbury, Bolton, Airedale, Gwent to mention some). A rapid growth of Lean in British health care has been experienced recently; Radnor et al. (2006) suggested that it was originated by the dispersion of Lean facilitators who worked in the extinct Modernisation Agency. Areas of application include clinical and administrative areas. The use of these tools/techniques seemed to be based on each particular situation, e.g. the NHS used Kaizen events, perhaps as a way to demonstrate immediate results, and to exclude possible negative responses from stakeholders due to past initiatives.

In the course of the pilots at the UHL and the case studies at the ISSSTE, the author could appreciate both applicability and factors to use, while implementing both approaches. The first pilot was about the reduction of waiting lists at the Imaging department in the UHL, specifically at the Ultrasound area. From this experience, the author noticed the importance of the necessary factors for success in improvement projects, such as: management support, organisation, teamwork, communication, seeing problems as a whole, not just parts, and involving “front-line” people, since they know the processes and possible solutions. However, throughout this pilot at the U/s, the researcher observed that even when management supported an initiative for
making changes/ improvements, every person in charge of different areas (e.g. consultants, sisters, clerical staff.) worked separately, not as part of the same team; perhaps this is a reason for failures in other initiatives (Moran and Brightman, 1998). Also, historical reasons are still an important issue in the NHS: resistance to change and to the adaptation of ways of working to the current needs of health care is a characteristic of the UHL. However, among the three sites, at least in one of them, the situation was completely different. Their attitude toward changes/improvements is positive, they even asked for feedback about their performance. It was strange for the author to experience this attitude after minor incidents with some radiologists and RDAs at the other sites. The question was unavoidable: why can this hospital work in a better way than the others? The only possible answer for the author is: they work as a team, and are aware of their job and that the patient comes first; there is no such division between radiologists, sonographers, RDAs; all of them are part of a whole.

The second pilot at the UHL was finished in an early stage due to the retirement of the supporter of this initiative. The DMAIC methodology was applied and helped the site manager and her team to identify the actual problem of large waiting lists, setting a goal and the metrics for the pilot, as well as assigning tasks for the Measurement step; all of this was made in sessions and using tools such as brainstorming, 5W, and the “talking wall”. When they were working as a team issues related to the way of booking theatres, surgeons’ morning meetings, and differences in number of operations performed during weekdays and those on Saturdays were revealed. Working as a team allows seeing the whole and not just a part of the picture. After the supporter left his position, the site manager showed interest in the project, but due to her job and tasks to perform at the three hospitals it was not possible to carry on.

The two case studies at the ISSSTE also prove the applicability of Lean and DMAIC steps; one of those ventures by March 2006 was still applying the techniques learnt. Lean tools (spaghetti diagram, 5 W), basic statistics to obtain parameters of the process (mean and standard deviation), and charts to illustrate the trend of data, were utilised. Factors that influence implementation of improvements are quite similar to the ones in the UHL; but in the Mexican case, the Union plays an important part if changes involved or affected the workers’ comfort, e.g. changing their shift or working hours, assignment of new tasks to perform, to cite some. Conversely, in the UK the author did not notice an issue like that, but a series of labour regulations and/or rights that ruled working conditions. For instance, despite the late start at the u/s RDAs remained working there until the sessions programmed finished, after finishing their shifts. In
Mexico, this situation would not be tolerated by the employees and reported immediately to the Union, whereas in the u/s department was occasionally informed by the RDAs to the sister in charge of them, as observed and declared to the author by the RDAs. Management support is decisive to launch and to conduct an improvement initiative, since it represents the maximum authority; therefore, no one would challenge the authority. To ensure that changes in the Clinical Lab were effective, an assessment was made in January and February 2007, the author found that the number of patients served remained into the limits established in 2006. It confirmed the sustainability of the changes made. Table 26 summarizes the pilot and cases studies made by the author.

<table>
<thead>
<tr>
<th>Place</th>
<th>Area</th>
<th>Reasons for change</th>
<th>Objective</th>
<th>Approach/Specific tools</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHL Imaging Directorate</td>
<td>Ultrasound</td>
<td>Large numbers of patients waiting for u/s</td>
<td>Reduction of waiting lists for getting an U/s.</td>
<td>Six Sigma* and Lean Map, bar charts, basic statistics, identification of waste,</td>
<td>Providing feedback on areas of concern, bottlenecks, staff attitude etc.; standardisation of the LRI Ultrasound Booking templates; increasing capacity to establish six extra routine scanning sessions for Registrars; reduction in overall Ultrasound Waiting list from 4796 patients on 1st April 05 to 3640 patients on 1st Sept 05; reduction in General Abdominal, Gynae and Testes Ultrasound waits; start a project about making the best use of Radiology Dept Assistants; process-mapping the Ultrasound service at LRI where there is particular problems with coordination of lists, coordination of different staff groups, and accommodation of ward/emergency patients within scheduled lists.</td>
</tr>
<tr>
<td>ISSSTE Regional Hospital Puebla</td>
<td>Clinical lab</td>
<td>Large queues at the clinical lab, patient’s dissatisfaction for time spent at the lab, patient’s with appointments did not find the lab results attached to their files, personnel distress,</td>
<td>Improve the results delivery service, reduce the number of people waiting in queue, reduce waiting time at the reception desk, find out which area was ordering the most lab tests, find out the quantity and type of lab tests ordered.</td>
<td>Lean Observation, Spaghetti diagram, graphics, basic statistics, scatter diagram,</td>
<td>Agreement between the Clinical Director and the Lab Manager to collect once a week all the results by personnel from the Clinical Direction, and delivered directly to the corresponding medical unit, with the exception of those marked as urgent; setting a threshold limit of patients served by the lab; reduction of time to serve patients at desk from 2.2 to 1.1 minutes; reduction of overall time that a patient spent at the lab from two hours to one.</td>
</tr>
<tr>
<td>ISSSTE Puebla Delegation</td>
<td>Referral-Couter referral</td>
<td>High costs for referrals.</td>
<td>Reduce the cost for referrals.</td>
<td>Lean plus DMAIC structure. Observation, 5W, Pareto diagram, Cause-effect diagram, brainstorming, basic statistics,</td>
<td>Setting basic procedures to be followed by medical units for referring patients; establishing a deadline for submitting bills from patients’ to medical units.</td>
</tr>
</tbody>
</table>

Table 26. Summary of pilot and case studies. Table made by the author.

7.2 Principal findings

In chapters four and six the pilot and case studies conducted in the UK and Mexico were discussed individually. In the next paragraphs common conclusions are
disclosed. Findings from the pilots and case studies at the two sites are in the next table.

<table>
<thead>
<tr>
<th>Observation</th>
<th>Supporting evidence</th>
<th>Applicable tool</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Top management must be involved</strong> in the work providing total support and commitment for changes.</td>
<td>Virginia Mason Medical Center; Middletown Medical Center; MD Anderson Cancer Center; Robins, D., Womack, J.P., Byrne, A.P., Nume, D.J., Kaplan, G.S., Fossaeint, J.</td>
<td>The Clinical Director (ISGSE) gave all the permissions to access territories, classrooms, manuals, arranging meetings with other authorities, being available, and making changes suggested by the researcher.</td>
</tr>
<tr>
<td><strong>Site management must have time to listen to the workforce.</strong></td>
<td>French hospital; Good Samaritan Hospital; Doss, R.,彻, C.</td>
<td>Imaging managers and clinical lab manager were too busy, and did not support worker's suggestions.</td>
</tr>
<tr>
<td><strong>Top management must come round to the idea of empowerment</strong></td>
<td>Hôpital Dieu Grace Hospital; Antony, J. and Baumeau, R.; Robins, D., McIward, L.J. and Bryan &amp; Ken, Berwick, D.</td>
<td>Traditional management style is hierarchical, and is resistant to employee empowerment. Site managers (NHS, and Clinical lab) were in charge of the whole department, changes can only be made by them, or by a higher authority. Managers should spend more time on the work-floor to observe directly how things work.</td>
</tr>
<tr>
<td><strong>Top management must ensure communication at all levels.</strong></td>
<td>Northwestern Memorial Hospital; Hôpital Dieu Grace Hospital; Middletown Medical Center; Jones, D., and Mitchell, A.</td>
<td>Ineffective rels or tasks were evident at the VA/U lab with NDA, generating confusion and misunderstanding, incorrect procedures were found at the reception desk of the lab and in the referral-counter referral process. Managers must be available for workers, recognizing their contributions.</td>
</tr>
<tr>
<td><strong>People involved directly in the improvement project must work as a team.</strong></td>
<td>Stanford Hospital (University of Pennsylvania Medical Center); Good Samaritan Hospital; Robins, G. Socoley, S.</td>
<td>Even though there was a team at the Directorate, it did not work like that; each member pulled on different directions, the ward sister was interested in specific problems of her area e.g. lack of RDA’s, consultants’ representatives were trying to get more as radiographers, or radiologists, and even some workers, establishing a culture of “me-first”, permits the objectives of the organization to be reached.</td>
</tr>
<tr>
<td><strong>Avoid bureaucracy.</strong></td>
<td>ThedaCare Inc., Allegehi General Hospital.</td>
<td>The whole process for an ultrasound at the UH seemed too bureaucratic. Many steps that did not add value in place; see Appendix 4. RDA’s were at the clinical level in collecting lab orders and lab rejection was a problem. At the ISGSE there are many steps for the referral process, as well as the authorization form for referring patient.</td>
</tr>
<tr>
<td><strong>Make tasks and responsibilities clear; assign a role for each person.</strong></td>
<td>Community Medical Center, Heart of England Foundation Trust, Hôpital Dieu Grace Hospital; Middletown Medical Center; Valley Regional Medical Center.</td>
<td>RDAs at UH did not have a clear idea of what their duties were, causing duplication of work, wrong standards, overload of work. Performance issues were related to establishing communications, as the management wanted clear duties and responsibilities, RDA’s were less likely that duplication of work will occur along with miscommunication and poor utilization of human resources.</td>
</tr>
<tr>
<td><strong>Avoid specialisation, promote multi-skilled jobs.</strong></td>
<td>There were any reports on this issue on cases reviewed.</td>
<td>Over-specialisation in the ultrasound area was found (NHS); there are consultants or radiographers who only do fingers, necks, thyroid, abdomen, to mention some. Could they learn to conduct ultrasounds over any part of the body? Is there any practical reason for restricting their field of action? The response to these questions was personnel comfort, and preventing any workers with whom an male patient being seen by someone off his appointing sex.</td>
</tr>
<tr>
<td><strong>Frustration is a reason for not participating on projects.</strong></td>
<td>MD Anderson Cancer Center; Womack, J.P., Byrne, A.P., Nume, D.J., Kaplan, G.S., Fossaeint, J.; Fillingham, D., Jones, D. and Mitchell, A.</td>
<td>Nurses and RDA’s gave their suggestions to the site manager, but nothing happened, and there was an imbalance situation with the Clinical Lab Manager. No particular reasons from both managers were given as an explanation. Managers must create the time for training frontline people or to work in their proposal. The Office for Health Management (2003) mentioned that key factors for change in the NHS reside in human resources.</td>
</tr>
<tr>
<td><strong>Projects can fail because everything is on paper.</strong></td>
<td>Finders Medical Center; Beavon, H.; Westwood, B., Crown, R., O’Connor, M.</td>
<td>After workers of the Clinical Lab perceived benefits of changes, they were more creative, and acceptance vested.</td>
</tr>
<tr>
<td><strong>Always question the “obvious” reasons”.</strong></td>
<td>Finders Medical Center; Allegehi General Hospital; Berwick, D., Jones, D. and Mitchell, A., Rock C., Hospital San Durante.</td>
<td>It may seem odd that before the researcher questioned the way of working at both sites (UK and Mexico), no one noticed that there were non-value added activities, and that there were better ways of doing their jobs.</td>
</tr>
<tr>
<td><strong>Projects do not really need large investments.</strong></td>
<td>Virginia Mason Medical Center; MD Anderson Cancer Center; Robins, D., Womack, J.P., Byrne, A.P., Nume, D. and others have mentioned before, there is no need of large investments, lean appears to be effective. Since it does not require large investments perks like Six Sigma, it is learning by doing. Also, removal of waste is free of cost. Ishikawa pointed out that instead of overloading people, it was enough to provide them with only basic tools and the desire to continuously improve, providing guidance and support as cited by Polani and Morgan (2008).</td>
<td>At the ISGSE, changes were fairly rapid due to the willingness and support of the Clinical Director, but in the NHS there was no possibility of doing something similar, since the author had not a total support of Directors of Imaging and Surgery for trying to making changes, because the researcher actions were limited, Ohio’s idea was a continuous process of trial and error for several years in some cases, before he could see improvements.</td>
</tr>
</tbody>
</table>

Table 27. Findings from pilot and case studies. Table made by the author.
7.3 Comparison between UK and Mexico

Carrying out pilot studies in the UHL allowed the author to compare: a) studies in the UK against the cases in Mexico; b) evaluate the studies in the UHL against those conducted in other sites within the UK.

There is a difference of resources and facilities between the NHS and the institutions in Mexico; expenditure per capita is $794 in Mexico against $2,760 in the UK (in US dollars); there are 1.9 practising physicians in Mexico against 2.5 in the UK, and 1.7 hospital beds in Mexico versus 3.6 in the UK (per 1,000 population the last two figures), according to the OECD (2007).

In Mexico, there is a population of over 100 million of which more than 60 million are covered by the IMSS, the ISSSTE and the SSA. The NHS with greater resources and a smaller population has large waiting lists and poor utilisation of facilities and resources (Moore, 2007). At any public medical unit in Mexico a patient can ask for a GP appointment the same day; a GP can serve up to 27 patients in a shift of four hours (including physical examination); U/s departments can see as many patients as possible (including A&E, in-patients and out-patients) sometimes with only one radiologist per shift; while at the U/s in one of the UHL there is one “finger” specialist who sees only four patients per week.2

The fear for change is present and perhaps is the most problematic issue. Hence, the human factor or cultural issues are very important in any improvement program (Millward and Bryan, 2005; Westwood 2008; Westwood and Silvester, 2007; Antony and Banuelas, 2002) as was experienced at the UHL and at the ISSSTE Clinical Lab. A variety of causes include: uncertainty, inconvenience, work environment, lack of information, inadequate resources, fear of an increased workload, economical threat, self-interest, group pressure, inertia, to cite some.

Even though management support is a key for making changes, the unions in Mexico play a key role in public and private institutions/entities when workers perceive a possible effect on their rights. Thus, the person who is the driver of the improvement must inform union representatives of the goals, people and areas involved, and if necessary set agreements between them. If the union and stakeholders understand the purpose and benefits of improvements, and that jobs and positions are not threatened,

2 For someone from a country in development, this experience was a real shock.
then a positive outcome can be obtained. Workers need to feel that their work is valuable, and that they can contribute to the Institute (Womack et al., 2005). However, in the case studies conducted at the ISSSTE the author was fully aware that these cases would be possible affected or restricted by the Union. Because of this, during the whole process for making changes or suggesting them, the author was able to deal with this by means of establishing clear communication with the lab employees about the researcher’s presence and objective. The author considers that, it would have been possibly to carry out other cases having large improvements in other fields, where unfortunately the labour contract is involved.

Other factors that should be borne in mind in order to make changes include labour policies, regional and national health programs from federal and state government.

Another important issue is related to have top management support, which In Mexico was granted by an ISSSTE high level authority (Clinical Director), while in the UHL was consent with different directives of the departments. In Mexico the ‘top management’ has to be higher up in the organisation, because it has to be high enough to have the institutional and political power to: a) overcome the authority of the union, and b) implement changes. Improvements made can work better if those changes are driven by a high level of authority, as was proved through the cases carried out.

Some similarities between the NHS and the ISSSTE reside in: over regulation, unions, labour policies and rights, and frustration among front line employees.

7.4 Comparisons with other UK studies

At the UHL, nurses at one site experienced a sense of frustration, inhibiting to a certain degree their participation in improvement projects. Previous suggestions had been made for changes but were not taken into account by the authorities of the Directorate. Similar situations happened at the Clinical Lab, where one of the chemists did not participate in institutional efforts of improvement, because in the past the Manager accepted her proposals, but then these were stored away. In the literature, physicians have been reported to show unsympathetic reactions to improvement (Blumental and Edwards, 1995; Wysocki, 2004), but also the author experienced something similar with some Consultants at the UHL. Wysocki (2004) found that doctors were the most sceptical among stakeholders, arguing “historical reasons”. “Why change if things are working well?” Traditional management must change (Doss and Orr, 2007).
In agreement with the experiences of Sir Gerry Robinson, the NHS is, definitely, suffering due to poor management; it has the financial, human and technical resources to provide a better health service; Robinson remarks that “quite small sums of money properly and sensibly spent could have produced very large results in terms of reduced waiting lists, and actually very large sums of money had been thrown at the NHS and produced very little...” as cited by Mount (2007). Tomson and Berwick (2006) said that investing more on health does not mean that a better or safer service is provided. It is about using in an efficient way all the resources. The researcher observed in the NHS: there is a protective attitude towards employees and staff (overregulated); several bodies such as NICE, Institute for Improvement and Innovation, National Patient Safety Agency, working towards a better health service, but until the end of 2007 there were some progress in improvements by using one or both approaches, just after several attempts of the extinct Modernisation Agency. Possible failure of the latter was caused by asking hospitals to examine the procedures that work in other sites (Maddock, 2002) but not considering each particular situation (Lim and Tang, 2000); a focus on demand and capacity; hence, they could not observe the entire operation of the site. There is no communication among NHS hospitals across the country, with a notorious regionalism, as confirmed by Angel (2005), losing opportunities to learn from each site.

Changing ways of working is quite difficult, particularly when talking about specialists or managers, those who had some degree of “power” (sometimes arrogance or pride), as the author discovered while carrying out this research. Berwick (1998), Moran and Brightman (1998) reinforce this thought: people feel comfortable living in a status quo, having a certain degree of control, and which has been reached because of a number of opposing forces e.g. people, habits, emotions, and attitudes, to mention some. Sir Gerry Robinson found that changing people’s attitude was difficult, in comparison to any commercial organisation where “… you need to make things happen and you need to make it happen now, otherwise in business you run the risk of dying on the vine. The Health Service, you’re protected, so you can take your time, you don’t have to change...” (BBC2, 2007); Ennis and Harrington (1999) found in a survey of hospitals’ that 47% of them indicated organisational resistance to change as a barrier. But also the health care structure is itself a barrier, because it is “fragmented” (Merry and Brown, 2002). Stock (2002) indicates that to get a hospital or health system performing at a high level a cultural transformation is necessary.
7.5 Comparison of methods, tools and techniques

From the two approaches, Lean can be easier to apply due to its simplicity and active involvement of stakeholders in changes/improvements, and the fact that it is based on listening to those people who know best the processes/services; on the other hand, failures associated to Six sigma have been reported: development of cynicism and disinterest, focusing on demonstrating savings rather than how to transfer process knowledge and sustain gains over time (Sanders and Hild, 2000). Its goal of 3.4 DPMO might be too demanding, since final outcomes (patients/services) cannot be directly compared to those in industry. Another difference is, Lean is “learning by doing” in a team integrated by people from different areas and layers of the organisation, conferring front-line workers with authority to make changes; empowerment originally was intended to integrate workers, in a “humane atmosphere”, according to Ohno. It means providing employees with knowledge and skills, with a consciousness about the importance of making decisions towards implementing changes. While in Six Sigma just a selected group of the organisation is trained; apparently this level of management is required due to the nature of the methodology, decisions and techniques that need to be learned. On the contrary, Lean does not require special training or financial investment, or sophisticated tools. From all the examples reviewed of applications in health care, just in the case of ThedaCare, is the respect for people emphasised (Womack et al., 2005). The human being is the most valuable asset, without it no activity or service could be done and/or provided, and its performance affects the whole organisation. This is one reason that may explain why many other attempts have failed, people must be the primary factor to take into account when an improvement initiative is about to start.

Most usual tools for both approaches were: Pareto charts, $\bar{x}$-R charts, scatter diagrams, value stream maps, Kaizen, Andon, 5W, 5S, spaghetti diagram, cause-effect diagrams, Kanban, and cell manufacturing. The concept of empowerment should not be misunderstood as an allowance to workers to act thoughtlessly, without having in mind the consequences of their actions. A flaw in Six Sigma is that it does not consider human factors (Bevan et al., 2006). Note that Lean concepts work because respect for people is present, valuing each worker, and encouraging communication.

These approaches must be adapted to each particular situation (Tanner and Gadd, 2007; Radnor et al. 2006) to prevent any pitfalls and attribute them for not being
“culturally transferable” (Folaron and Morgan, 2003). The approaches must be considered as a whole and not only as individual tools/techniques. Van den Heuvel et al. (2004) customised Six Sigma, because hospitals do not have the same quantity of resources (human, financial). Also the reality for the American health care system is different from the British one or the Mexican.

Some authors pointed to negative consequences on people working with Lean, suffering of stress and psychological pressure. The author does not consider this issue as something that is exclusive to Lean: pressure and stress are present in every day, working in an office or in a factory, or in a hospital. Barriers reported while using Lean and Six Sigma have been reported as: lack of/or inconsistency in leadership, poor management, lack of communication, existence of unions, policies and regulations, lack of training and education, to cite some (Maleyeff, 2007). In all of them the human factor is involved in some degree; Radnor et al. (2006) gave some reasons for resistance to change. For Lean and Six Sigma the human factor is decisive in making improvements; the first approach involves people from all levels despite their position in the company. That is, all workers have the chance to participate in the improvement practice. They are seen as able to learn, to create, in a word people capable of thought (Ohno, 1988), relying on their own decisions (empowerment); it does not encourage “subcultures” (e.g. operators, engineers and executives). Robinson mentioned that chief executives should get down on the shop floor more often. Øvretveit (2001) says that manager’s role must change from the “controller” to one of empowerment. Changing culture is not made by an edict (Womack et al., 2005), having present that perhaps that culture has been existing for a long time (Koenigsaecker, 2000); managers or leaders must propitiate conditions to make a shift, and must be gradual (Maleyeff, 2007), each person has its own pace and its own behaviours, values and beliefs.

While conducting the pilots, the author found that management were prone to organising committees, set agendas, and so on. On a certain degree it is comprehensible that management looks carefully for using something completely new and unfamiliar as the approaches mentioned in this work. Thus, a proper introduction and explanation about what the approaches are is required, involving not just managers but also front line staff. In these sort of organisations if they are not able to see figures through collection of data, no opportunity of making any suggestions for improvements exists. Unfortunately, the people who are cooperative and eager to put in place the lessons learnt do not have the sufficient power over the process to make
changes. Therefore, Six Sigma would be the best way to make improvements when situations like the ones described above happen. On the contrary, in the case studies the engagement of top management to make improvements allowed the use of Lean, and after a first period of observation of two weeks and collection of data – only as a support, preliminary results demonstrated that small and inexpensive changes resulted in services improvement, as well as employees and patient satisfaction. Involvement of front line staff was important, even though when they did not receive any type of training. This first result was a driver for setting another project in a more critical area. Lean principles are agile and scalable, leading to rapid improvements.

From the experiences of the pilot and case studies, the author suggests that Six Sigma can be too demanding for health care as well as expensive and lengthy, but the collection and analysis of data as supporting evidence for cases where human life is directly involved (such as application of medication) is necessary and must not be ignored. On the other hand, before empowering frontline staff, it is necessary that everyone fully understands their responsibility in the processes, otherwise making decisions by themselves without having in mind this issue will cause more problems than the existing ones. The appreciation of cultural issues is important and must be taken into account. Hence, Lean needs of Six Sigma, but to just use it as a reference and framework, not as cooking recipe; both concepts as well as tools and techniques must be adapted for each particular situation.

Reduction/elimination of waste does not need to cost money; this is a very important issue, especially for hose health care systems that are under government’s responsibility, and Lean fits very well, since it is inexpensive, as demonstrated on the literature review.

### 7.6 Key factors

According to Pexton (2005), Benedetto et al. (2002), Antony and Banuelas (2002), in order to succeed in improvement projects, the following factors are necessary: a change in management, leadership, involvement and support; communication, motivation and education; the use of techniques to promote culture change; selecting and scoping projects to achieve financial and quality results; establishing clear roles and responsibilities, just to mention a few. For Karatsu (1988) the key factor for success is through management efficiency. Berwick (1996) stated that clarification of the goals, the method and the expected results are necessary, as well as having
effective leadership to succeed. Pexton (2005) identified barriers to healthcare and potential solutions but only for Six Sigma. Results are important if people have invested time and effort, and must be communicated immediately to the stakeholders. This avoids a low morale for those who have worked hard. Another key issue that has an important influence is the support of top management, as already cited. This is confirmed by the fact that the studies at the UHL were stopped in an early stage, because the sponsors of both pilots left the UHL, with no one else at top management level committed to the studies.

As Ohno remarked, to achieve success with any improvement initiative, it is important to adapt the concepts, methods, and approaches from its original frame into a new reality, by taking into account the differences among countries, lifestyles, culture, to cite some. Radnor et. al. (2006) found that concepts and notions of Lean were adapted in the public sector. By understanding the factors (key issues) that affect the implementation of changes in an improvement project, this understanding permits the elimination of or diminishes the effect of them, leading to an effective execution of the improvement, which avoids wasting time and resources.

By focusing in the elimination of waste improvements were made and results obtained. In response to the question about if Lean and Six Sigma are suitable for healthcare: both of them can be applied in any healthcare system; this is also supported by the existent literature. Besides, where there are processes, it is possible to use industrial methods, as was the case of the pilot studies.

“In health care, improvement is not just about building more beds or hiring more staff it is about efficiently utilising all the resources” (Horton, 2005), keeping the processes or services as simple as possible; in addition, miraculous, instant results cannot be expected.
Chapter 8

Conclusions

In this research the use of Lean and Six Sigma in health care are addressed, with a special focus on the Mexican health care system, by means of pilot and case studies conducted in the UHL (UK) and the ISSSTE (Mexico).

In order to achieve the aims of showing the feasibility of Lean and Six Sigma in health care with a focus in the Mexican health system, including which one of the approaches fits best, tools/and techniques most useful, and the key factors for the implementation of such approaches, that the research should be made on the field. This was achieved by means of pilot and case studies in two health care organisations: the University Hospitals of Leicester in the UK, and the ISSSTE Regional Hospital in Puebla (Mexico). From the two pilots made at the UHL the author considers that even though when the pilot at Plastic Surgery was stopped in an early stage, this situation gave some insight into key factors to take into account for implementing an improvement initiative. Benefits obtained at the Ultrasound department include: a feedback about the way of working, standardisation of booking templates, increasing capacity to performing U/s, start a project about making the best use of RDAs.

Another benefit of the pilots is that, they allowed the researcher to identify which one of the approaches is most suitable, which in this case is Lean due to the simplicity of the concepts and tools. This is confirmed through the case studies. Lean empowers the workforce, and acknowledges employees’ experience, making each participant an owner of the process. At the same time, it recognises that team work is essential in any organisation. Its focus on removing waste is more relevant to the needs of the sector. Furthermore, it does not require large periods of training and investment; benefits can be seen in a relatively short period of time, especially if Kaizen events are promoted.

In case studies performed at the ISSSTE Regional Hospital in Puebla, in the Clinical and Referral-Counter referral process, the outcomes include an improvement in the service provided to the patients, and avoiding the distress among the chemists by determining a limit on the number of patients served by them every day. As a result of the second case study, the Clinical Director was able to set up basic procedures that medical units must follow in order to reduce the costs of referring patients from medical units to specialties.
The studies concur with the key factors found in other studies, such as management support, communication, teamwork and empowerment, sense of commitment, clear assignment of tasks, responsibility, effective communication at all levels, fear of change, specialisation, bureaucracy, historical reasons, frustration and attitudes. In the Mexican case, another factor was discerned: unions. From the pilot studies, the researcher confirmed that top management support is vital for an improvement initiative, and moreover, in the Mexican case, the support must come from a high level of management. The author found that a way to avoid any sort of conflict with the Union was through the communication with the employees as well as having the support from a prominent authority in order to have a balance with the union. The research in Mexico was sponsored by the Clinical Director (top management); his commitment to the case studies, getting involved in the research and granting access to all sort of information related to the cases, allowed the author to complete them. Unfortunately, it was not the case in the two pilots, since the persons that agreed to start the pilots left their respective positions at the UHL. Consequently, in the first pilot there was not a total support to carry on with the original project; a similar situation happened with the second pilot which was stopped at an early stage.

Through the observation performed during the pilot and case studies, the author realised that the processes in the UHL are guided by “historical reasons”, and there are a few people that question the way of doing things. The pride in following the methods established through the time is present; there is reluctance to questioning the current way of working.

This research represents the very first time –at the time the author started it- that an attempt to apply Lean and the DMAIC methodology are applied to health care in a developing country, with outcomes that were of great value for the ISSSTE.

It is worth mentioning that limitations in research exist since a few cases cannot prove that Lean or Six Sigma will always work, as each case is a distinct experiment\(^3\). Particularly since applications will usually only be approved if it seems likely that they will be beneficial. Hence, this research is only a contribution to growing evidence. The case studies contribute to the growing body of evidence that Lean and Six Sigma (DMAIC methodology) can be applied in the health care field.

\(^3\) Eisenhardt and Graebner, 2007.
The differences between the UK and Mexico are patent. Mexico is a developing country, with notorious inequalities among its population, and health care is not an exception. Other differences between both countries in health care include expenditure per capita, number of practising physicians per inhabitants, number of beds available, and number of scanners (3.5 in Mexico compared with 7.5 in the UK per million population by 2005). Despite this, the similarity is that health care systems in each country are dealing with patients, and in doing so, processes exist. In this way, a comparison of both systems can be made.

Finally, further research on the applications of Lean in other areas like surgical ones can be of great benefit to health care, given that it not only has such an important impact on costs, but at a most important asset: human life.
Bibliography


Blaha, J. *Outpatient imaging reports TAT cut from 64 to 9 hours*. Available on line from: http://healthcare.isixsigma.com/library/content/c060927a.asp. [Accessed March 1st, 2008].


Coleman, W.P., Gaynicotche, A., Mejía Mendoza, S., *Healthcare systems process*
reengineering for developing countries: A Report to IMIA working Group 9. WPCMath.

CONAPO. Available on line from: www.conapo.gob.mx/00cifras/Proy/RM.xls [Accessed
June 12th 2006].

nandez__reeleccion__perpetua/281468. [Accessed July 10th, 2008].

London: Department of Health.


DeBusk, C. and Rangel, A. Jr, *Creating a Lean Six Sigma hospital discharge process.*

DeBusk C., Pexton C., Cogswell N. *Streamlining diagnostic testing at Northwestern

Department of Natural Resources and Environmental Control. Available on line from: http://www.epa.gov/lean/toolkit/LeanGovtPrimer.pdf [Accessed June 1st, 2008]

Department of Environmental Quality. ttp://www.epa.gov/lean/toolkit/LeanGovtPrimer.
pdf [Accessed June 1st, 2008].

Donaldson, L., 2002. Annual report of the Chief Medical Officer. Available on line from:
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/AnnualReports

Officer. Available on line from http://www.library.nhs.uk/healthmanagement/View


Gonzalez Roaro, B., Appearance of the ISSSTE Director before the Senate. 2004.


Confederation.


Office for Health Management. 2003. Learning from the NHS in change a study on the management of major structural change in the NHS. Prepared by OPM.


Robertson, K., Personal Conversation at the Royal Gwent Health Care Trust, March 2005.


Rocha Larrainzar, F., Hernández Juárez, F.; Rodríguez Fuentes, A., 2007. *Propuesta...

Rother, M. and Shook, J., 1999. Learning to see. The Lean Enterprise Institute, USA: Brookline.


The Times Online. 2006. NHS Waiting lists on the increase. March 4th.


Westwood, N., 2008. Learning by doing. *Institute for Innovation and Improvement*.


[Accessed on January 17th 2008].
APPENDICES
<table>
<thead>
<tr>
<th>Process Description</th>
<th>Current controls</th>
<th>Action taken</th>
<th>Area/Individual responsible &amp; Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deliver precise dose of medication to patient.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does not deliver desired dose to patient.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospitalisation required.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inappropriate battery contact(s).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical trials.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Cycle Laboratory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmacological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine availability of battery performance information from supplier.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J. Bigg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/21/06</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.1. Reconfigured the battery to relieve stress on wires that are weld to the battery.

A typical FMEA form

Appendix 1
Appendix 2
Sample of questions from interviews

1. Do you know about the applications of Lean manufacturing in health care?
2. Are all the Lean tools/techniques suitable for health care?
3. Do you have any academic reference on Six Sigma application in health care?
4. In your own experience, which tools do not work or can be added when using Six Sigma?
5. What are the most usual problems related to health care which are common in any country?

Answers
Person A:
1. I do not.
2. The general ideas should be very helpful and after adaption the most tools are adequate.
3. No.
4. Some statistical tools do not work well in healthcare, or other services industries. Tools such as Design of experiment do not have much application because in such people intensive processes we are usually dealing with critical element, not operating parameters.
5. Usually the most usual "problems" are people issues more than process issues.

Person B:
1. No
2. Yes, 5S is most usual to apply.
3. No.
4. Some tools are great, and important supplements to Six Sigma are change management tools.
5. Those that deal with people.
General Ultrasound

8th October 2003

University Hospitals of Leicester

Ultrasound Map Elaborated by the U/S Staff

Appendix 3
Referrals can come from:
- GPs – large referrers can batch
- OPD clinics – large referrers
  E.g. Walk in clinics
  One stop clinics
  Urgent clinics (Fracture)
- Wards / ITU – large referrers
- A&E
- Tertiary referrals
- Some post-natal hips, paeds & renal protocols batched and sent from LGH to LRI (every 4 weeks)

Internal post personal/non-personal
1-3 days

External post personal/non-personal
2-5 days

Fax
Ordercoms (LGH & GH)
Emails (LGH)
Immediate arrival

Delivered to:
LRI
Inpatients to Windsor reception
(RDA collects 3xdaily)
Paediatrics go to RDAs in rooms or Booking clerk

Glenfield
X-ray reception
Inpatients to Ultrasound Rooms (RDAs deal with)

Post delivered to:
Main X-ray office if not marked for “ultrasound”

General Post opened
0-24 hours

Personal letters go to Radsts desk/ in-tray
Internal post personal/ non-personal
1-3 days
External post personal/ non-personal
2-5 days
Fax
Ordercoms (LGH & GH)
Emails (LGH)
Immediate arrival

Delivered to:
LRI
Inpatients to Windsor reception
(RDA collects 3xdaily)
Paediatrics go to RDAs in rooms or Booking clerk

Glenfield
X-ray reception
Inpatients to Ultrasound Rooms (RDAs deal with)

All Outpatients + LGH Inpatients
Reach Ultrasound/Paediatrics Booking Clerk

LRI Inpat Paediatrics
Reach the RDA in Paediatrics U/S

LRI and GH Inpatients
Reach the Ultrasound Rooms. RDA deals with. Not entered on
Get patient onto couch – may need help

Sonog/Radst scan patient. 2-23mins

Get patient off couch – may need help

Outpatient leaves & goes home

Similar delays as for fetching patient

Inpatient waits for report and porter 0-1hr?

REPORTING TIME 1. After each scan dictate, hot report or type report on CRIS or write provisional report in notes 2mins?

12-24 hrs

REPORTING TIME 3. Small no of pats wait till next day

PREVIOUS IMAGES & REPORTS
LRI & GH reports & films already there CRIS3
Fax takes 2 mins to arrive
Report now available to internal users of eCris/HIS!!

Self typed & verified
Sonographer or Radiologist types report self
2-5 mins?

Sonographer or Radiologist types into CRIS3
0 - 1 weeks
Sonographer or Radiologist checks on CRIS for Unverified reports
2 mins?

Sonographer or Radiologist checks & verifies batch of reports

Report read by the referrer!!
Referrers dept. may have their own delays in post distribution
?hours - ?days

Internal post takes 1-4 days
Glenfield pigeonholes take 0-1 day
Fax takes 2 mins to arrive
External post takes 1-5 days

Reports sorted enveloped & addressed
? mins

Verified reports printed off CRIS3
1 min
LGH Urgent reports have a RED sticker to highlight this

LRI RDA puts letter/films /labels 1 min
In Patient
10 secs
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Room 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glenfield</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of patients "served"
<table>
<thead>
<tr>
<th>Time</th>
<th>Room 1</th>
<th>Room 2</th>
<th>Room 3</th>
<th>Room 4</th>
<th>Room 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>08:45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>34</strong></td>
</tr>
</tbody>
</table>

**LRI**

<table>
<thead>
<tr>
<th>Time</th>
<th>Room 1</th>
<th>Room 2</th>
<th>Room 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>8</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Glenfield**

<table>
<thead>
<tr>
<th>Time</th>
<th>Room 1</th>
<th>Room 2</th>
<th>Room 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>11</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**General**

<table>
<thead>
<tr>
<th>Time</th>
<th>Room 1</th>
<th>Room 2</th>
<th>Room 3</th>
<th>Room 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>8</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*It is supposed they start at 8:30 am.*

Service starts at 9 am.
Appendix 5  
Parts of the U/s map not in accordance with the real Ultrasound path

<table>
<thead>
<tr>
<th>Code:</th>
<th>Radiologist</th>
<th>Sonoographe</th>
<th>RDA</th>
<th>Clerical staff</th>
<th>Porters</th>
<th>Patient</th>
</tr>
</thead>
</table>

- Bookings Clerk enters patient on CRIS3 waiting list immediately 1 min. LRI Outpatients only. Assume exam code.
- Referrals sent for protocolling: LRI put referrals in box.
- General Referrals protocolled & urgency / scanner decided by Sonographer or Radiologist: LRI Radiologist classifies them, four hrs.
- All referrals return to Booking Staff.
- Once a week, or once 2 weeks!

- Patient receives letter.
- Appt Letter sent to patient: LRI 2nd class; Urgents 1st class.
- Appt Letter printed: 30 secs.
- Appt booked on CRIS: 2 min.
- LRI Paeds Routines can wait.

URGENT ROUTE 0-4 hrs.
- Urgent and Elective Routine are the same.
REPORTING TIME 1. After each scan dictate or type report on CRIS or write provisional report in notes 10-15mins

PREVIOUS IMAGES & REPORTS
LRI & GH-RDA pulls reports & films already there

CRIS3
Get patient onto couch – may need help 0-10mins

Sonog/Radst scan patient. 2-23mins

Get patient off couch – may need help 0-3mins

Outpatient leaves & goes home Inpatient waits 0-1hr?

Inpatient waits 30-45 min for porter

REPORTING TIME 2. After a batch of patients or in a gap/end of session 0-3 hrs

Small no of reports wait till next day or taped

REPORTING TIME 3. Inpatient waits 30-45 min for porter

Inpatient walls Impatient walls

REPORTING TIME 1. After each scan dictate or type report on CRIS or write provisional report in notes. Each radiologist reports in a different way. Sonographers do immediately on CRIS

It is not made

At LRI room one, the coach has to be placed out of the room if patient is in wheelchair/trolley 2-4 min

Inpatient leaves & goes home
Self typed & verified

Sonographer or Radiologist types report self
2-4 min

Sonographer or Radiologist checks on CRIS for Unverified reports
2mins?

Sonographer or Radiologist checks & verifies batch of reports

It is made once a week by a Radiologist
It is made by each Sonographer/Radiologist on their own cases

LRI RDA puts letter/films/labels 1 min

Report now available to internal users of eCris/HIS!!

Typists check or are told reports Ok for printing
0.5 – 1 min

Report read by the referrer!!

Reports typed into CRIS3

Three hours-two days for typist to transcribe report

Verified reports printed off CRIS3
1 min

Typists check or are told reports Ok for printing
0.5 – 1 min

Report arrives after two weeks

Referrer’s dept. may have their own delays in post distribution
?hours - ?days

Reports placed in:
Internal post
Glenfield pigeonholes take 0-1 day
Fax takes 2mins to arrive
External post takes 1-5days

Reports sorted enveloped & addressed ?mins

LGH Urgent reports have a RED sticker to highlight this

Faxed
Glenfield pigeonholes take 0-1 day
Fax (Urgents)

External post

Reports placed in:
Internal post
Glenfield pigeonholes take 0-1 day
Fax (Urgents)

External post

Internal post takes 1-4days

Fax takes 2mins to arrive

External post takes 1-5days

Verified reports printed off CRIS3
1 min

LGH Urgent reports have a RED sticker to highlight this

Report now available to internal users of eCris/HIS!!

Sonographer or Radiologist types report self
2-4 min

Sonographer or Radiologist verifies Report
2-4 min

Sonographer or Radiologist prints Report
5 sec

Sonographer or Radiologist checks on CRIS for Unverified reports
2mins?
Through the engagement of the medical staff to standardise waiting list processes will achieve a reduction in overall waiting times and result in a high quality, efficient service.

| Engage Medical Staff – Why?          | • To agree standardisation of process.  
|                                      | • To agree clinical priorities and standardise grading of patients.  
|                                      | • To analyse their own data of working practices to improve efficiency.  
| Why do we cancel?                    | • Rolling audit programme which takes no account of clinical commitments.  
|                                      | • Why the team not use Tuesday am teaching session once a month for Audit?  
|                                      | • Annual leave/study leave - not built into timetables to cover these lists.  
|                                      | • CRFS  
| Why poor theatre utilisation?        | • Late start times/early finish.  
|                                      | • Inappropriate timings for procedures – (Procedures normally take less time than indicated).  
|                                      | • Lost lists.  
| Timing of patients procedures – why? | • Listing clinician is not always the operator  
|                                      | • Are they using standard timings and therefore not looking at individual procedures.  
|                                      | • Are the timings based on historical data?  
| Appropriateness of referrals – Why?  | • Are we offering the right service at the right time?  
|                                      | • Links with PCT’s re referral guidelines (include dermatology/General Surgery).  

<table>
<thead>
<tr>
<th>ACTIONS</th>
<th>TIMESCALE</th>
<th>BY WHOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurements to present.</td>
<td>Average time to undertake set procedures. (To include all day case procedures by grade of staff.)</td>
<td>Timings on waiting list slip</td>
</tr>
<tr>
<td>Back up information broken down to individual levels.</td>
<td>June &amp; July</td>
<td>Julia</td>
</tr>
<tr>
<td>Weekly timings vs. Saturday operating</td>
<td>June &amp; July</td>
<td>Julia</td>
</tr>
<tr>
<td>Number of lists lost due to annual leave and study leave and Audit – will reflect the impact of Mr Rauf.</td>
<td>Last rolling 12 months.</td>
<td>Julia</td>
</tr>
<tr>
<td>Start and finishing times overall, and broken down to individuals.</td>
<td>June &amp; July</td>
<td>Julia</td>
</tr>
<tr>
<td>Grading patients by procedure.</td>
<td>June &amp; July</td>
<td>Julia</td>
</tr>
<tr>
<td>Cancer wait times information – down to patient level.</td>
<td>June &amp; July</td>
<td>Angharad.</td>
</tr>
<tr>
<td>Activity through the day ward – Plastic Surgery.</td>
<td>Last rolling 12 months.</td>
<td>Angharad.</td>
</tr>
</tbody>
</table>
Appendix 8 Diagram of the referral process.

Source: ISSSTE Clinical Direction Procedures Manual. 2005

This symbol represents a point of reference where the process is continued. The figure within the circle is referring to the process stage used in the previous part of a diagram. (2 relates to 2, etc.)

1. Patient/ Relative
2. Doctor/GP
3. Immediate boss/ Service Manager
4. Area of referral and counter referral (Emitting medical unit)
5. Area of referral and counter referral (Receiving medical unit)
6. Director (Emitting medical unit)

Beginning

Gives attention to the patient, evaluation by integrating diagnostic according to the illness and determines evolution and complexity

Verifies Therapeutic Diagnosis Guide, determines if patient requires service in another medical unit and the maximum time allowed

Does he/she require service in other medical unit?

NO

Provides medical attention and corresponding treatment, grants appointment or discharges the patient, which is registered in clinic file and sent to Clinical archive

YES

Fills in original and 2 copies at the back of the form SM-1-17, and asks for immediate chief manager authorisation

Clinical file

Clinical file
Receives the form SM-1-17, verifies that all the information and gaps are complete and correct, legible, without amendments or changes made by typex, which should include doctor’s data and his/her signature

Is the form correctly filled in?

Authorises with his/her signature the form SM-1-17 and sends it to the area of Referral and counter referral

Verifies existence of communication systems to confirm patient’s appointment

Is it possible to confirm the appointment?

The Receiving medical unit deals with the form SM-1-17 to confirm the appointment

Registers in the system, indicates to the patient to ask for an appointment and sends him/her to the Director of the referring Medical Unit

Continues with the “Substitute provider Procedural”

The Receiving medical unit deals with the form SM-1-17 to confirm the appointment

Referrals

Is the referral more suitable?

Cost-Benefit Study

Receives form SM-1-17, elaborates cost-benefit study, and determines which one is more convenient and better priced: decides to refer or to send to a substitute provider

Is it possible to confirm the appointment?

Is the form correctly filled in?

NO

NO

YES

YES

YES

NO

NOTES: 3

166
Receives the form SM-1-17 f, via telephone/fax, e-mail or Telemedicine, determines capacity and maximum allowed time for transference

Does it have capacity?

NO

Notifies to the referring Medical Unit

Receives negative confirmation. Look up for the next option in the “Catalogue of Services” via telephone and/or fax, e-mail or Telemedicine, the SM-1-17 form to confirm the appointment

NO

Are there any other options?

YES

Manages the SM-1-17 form to confirm the appointment with the receiving medical unit

YES

Confirms to the referring medical unit the appointment and registers it in the service record

Appointment confirmed

Receives confirmation and sends the SM-1-17 form to the Director of the referring Medical Unit for his authorization

Referrals

Record of Services

Catalogue of Services

Continues with the “Substitute provider procedure”
Receives the form SM-1-17, verifies if it was filled in correctly

Is the format filled correctly?

- Yes
  - Authorises with his/her signature and determines if it is necessary to travel with an escort and the type of transport
  - SM-1-17

- No
  - Form is sent to the immediate superior, who explains the reason to the doctor
  - 5

Appointment confirmed

Receives confirmation of appointment and sends it to the Director of the referring medical unit for his/her authorisation

- SM-1-17

- 7
SM-1-17

Verifies the form SM-1-17, authorised by the Director of the referring medical unit, requires transaction for transport payment, with or without escort

Does it require transaction for transport expenses?

NO

Informs the patient, indicating the need to travel on his/her own means

YES

Fills in form and 2 copies of the "Transfer Order", sends it to the person responsible in the area of expenses

Registers the "Transfer order", programs the expenses, keeps the 1st copy and returns the original and the 2nd copy to the Referral Counter- referral area

Receives the "Transfer order", registers and delivers to the patient 1 original and a 2nd copy, indicates that the patient should collect the stamp from the receiving medical unit

8
Requests the patient to sign the form SM-1-17, keeps the 2nd copy in the patient’s file and gives it to the patient in a sealed envelope, he/she also gives the original and 1st copy, which must be delivered in the Referral Counter-referral area.

Receives original and copy of the “Transfer order” and he/she presents themselves at the Referral Counter-referral area of the receiving Medical Unit on the day the appointment is established.

Signs in the SM-1-17, receives the sealed slip that contains original and first copy.