Chapter 1
Lean Principles for Healthcare

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Abstract Lean thinking, which developed from lean manufacturing or the Toyota Production System, is centred around elimination of waste and preserving value. Lean became especially important, some may go so far to say a fad, in manufacturing in the 1990s. So why in the twenty-first century might the principles of lean be relevant to healthcare? In order to understand this, we need to recognise that healthcare delivery today is facing many pressures much like much of the manufacturing industries in the 1990s. The following serves to introduce key concepts that fall within taking a lean philosophy and explore how/why they might be relevant to healthcare.

Keywords Lean thinking • Kaizen • Total quality management • Six sigma

1.1 Introduction

Healthcare delivery today throughout the world is in a conundrum. Escalating costs, ageing populations, increase in chronic diseases and growth in medical technology solutions are some of the major challenges with which all healthcare systems must contend. Governments, policy makers and clinicians are all in agreement that healthcare reform is necessary and new strategies, protocols and procedures are required if healthcare delivery is to in fact provide appropriate access, quality and value to patients and the community at large. Most are turning to ICT (information communications technologies) as the silver bullet. However, this is only part of the

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solution. The other part of the solution lies in the embracement of leading management principles and techniques which support and enable lean thinking and value creation and generation. The following serves to introduce the key concepts in lean thinking as relevant for healthcare.

1.2 TQM and Kaizen

Integral to lean manufacturing are the concepts of total quality management (TQM) and Kaizen. Both concepts focus on continuous improvements, the importance of process and performance to achieve positive outcomes and the key role of people. TQM is a philosophy (Deming 1986) while Kaizen is a technique. The later tends to focus on quality and customer satisfaction, while the latter takes a top-down approach and focuses on small incremental stages.

1.2.1 TQM

While there are many definitions of TQM, simply stated TQM is a continuous quality improvement approach (Nawar 2008). It has also been described as a total organisation approach (Oakland 1993), an effort to improve the whole organisation's competitiveness, effectiveness and structure (Dale 1999) and requires the mutual co-operation of management, employees, suppliers and customers (Dale 1999). Many scholars and proponents (Deming 1986; Juran 1993; Scholtes 1992) have noted that TQM and more especially a quality focus are important for long-term success.

TQM can be thought of as having a soft side and a hard side or the tools of TQM. Table 1.1 depicts the soft aspects of TQM while Table 1.2 summarises the key tools which make up the hard side.

1.2.2 Kaizen

In contrast to TQM Kaizen is a technique (Imai 1986, 1997). Kaizen means continuous improvement and assumes managers and employees work together to achieve this and such efforts do not require tremendous resources.

The key elements of Kaizen include:

1. Team work
2. Personal discipline
3. Improved morale
4. Quality circles
5. Suggestions for improvement
6. Elimination of wastes and inefficiency

Table 1.1 Soft aspects of TQM

Soft aspects of TQM	Description
Employees	TQM involves all employees at all levels of an organisation
Process	It is a continuous improvement philosophy. Continuous process improvement is a natural evaluation of TQM
Training	Continuous training of employee is necessary for the successful implementation of TQM in an organisation
Top management	Top-management commitment and support is an essential element of successful implementation of all the principles of TQM
Customers	TQM is a customer-focused management approach
Culture	Cultural change is necessary for the successful implementation of TQM in an organisation
Systems	TQM is a system approach through a process management. Processes must be improved to improve the results of an organisation
Decisions	TQM based on actual data is a factual approach to decision-making
Suppliers	TQM develops a mutually beneficial supplier relationship

7. The 5S framework (Saleem et al. 2012): (1) Seiri (sorting out), (2) Seiton (systematic arrangement), (3) Seiso (spic and span), Seiketsu (standardising) and Shitsuke (self-discipline)

These aspects are all captured in Fig. 1.1.

In addition to the elements of Kaizen, Kaizen techniques can be applied at three different levels:

1. Individual vs. team
2. Day to day vs. special events
3. Process level vs. subprocess level

Finally, there exist several tools that can be employed in order to ensure the Kaizen technique ensues. Table 1.3 provides a comprehensive list of these tools.

1.3 Six Sigma and Constraints Management

In addition to the philosophy of lean and the techniques of Kaizen, other complementary management methodologies and theories include six sigma and constraints management. The following briefly looks at each in turn.

1.3.1 Six Sigma

Six sigma has emerged as a primary vehicle for improving both manufacturing and service processes (Inozu et al. 2012). Specifically, "six sigma is a rigorous and

Table 1.2 Hard aspects of TQM (adapted from Saleem et al. 2012)

Name of tools	Description
7 Basic QC tools	These are basic tools used for data collection, data presentation and data analyses, for the improvement of quality of the products and processes. They include check sheets, Pareto diagram, histogram, control charts, cause and effect diagram, scatter diagram, and graphs (Ishikawa 1985)
Fishbone or Ishikawa diagram	This is a brainstorming method to guess different causes of problems related to each, man, machine, material and method, without using statistical methods
The matrix diagram	This tool is used to grade the relationship among different variables. It encourages them to think in terms of relationships, their strengths and patterns (Besterfield et al. 1999)
Tree diagram	According to Dale (1999), it is a tool which arranges targets, problems or customer's needs in a specific order
Critical path analysis (CPA)	CPA seeks to establish a sequential order of activities including time and their priority for the completion of a project, through the use of a network of arrows or nodes
Statistical process control	This tool is used to reduce both assignable and unassignable variation in the process, e.g., control charts. It helps the managers to control the production process
Pareto analysis	Pareto analysis helps the management teams to identify major 20 % causes which are giving 80 % variation in the production or service processes. Management team should concentrate on these 20 % causes first to improve the quality and performance of the system
ISO 9000 series	ISO series is an international standard written by a worldwide organisation known as the ISO/Technical Committee 176 (Lamprect 1992). This set of standards requirement ensures that a company has a specific quality improvement policy, which makes it more competitive in the market
Benchmarking	It involves selecting a demonstrated standard of product or process, costs or practices that represent the very best performance for processes or activities very similar to the company's own
Just in time (JIT)	It is one of the cost, time and inventory reduction techniques. It is designed to produce products or deliver services just as and when they are needed
Quality lost function (QLF)	It identifies all costs associated with poor quality and shows how these costs increase as the products/services move away from being exactly what the customer wants
Quality function deployment (QFD)	QFD is the process of determining customer's desires/requirements and translating those desires into the target product design. A graphic yet systematic technique for defining the relationship between customer desires and the developed product or service is known as House of Quality

systematic methodology that utilises information (management by facts) and statistical analysis to measure and improve a company's operational performance, practices and systems by identifying and preventing 'defects' in manufacturing and service-related processes in order to anticipate and exceed expectations of all

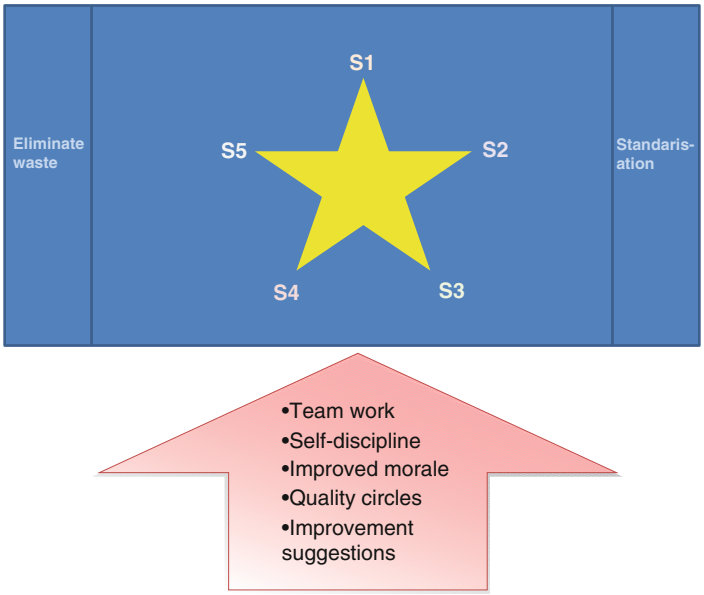

Fig. 1.1 Elements of Kaizen

stakeholders to accomplish effectiveness" (Inozu et al. 2012, p. 20). A five-step define-measure-analyse-improve-control (DMAIC) methodology is used where each step outlines distinct and key activities that must be performed as follows:

1. Define the business issue.
2. Measure the process.
3. Analyse the data and verify root causes of variation.
4. Improve the process.
5. Control the process and sustain improvements.

Six sigma has the power to save healthcare millions of dollars. Usually this is achieved by combining the key components of six sigma with one of the major principles of lean, namely, the seven deadly wastes. Table 1.4 outlines the deadly wastes and how they relate to healthcare.

1.3.2 Constraints Management

The last complementary methodology that will be presented in this chapter is that of constraints management. Constraints management is made up of a suite of techniques used in operations and supply chain management. The key being to enable a systematic approach to manage complex organisations by identifying and

Table 1.3 Kaizen tools and techniques

Name of tools	Description
Single-Minute Exchange of Die (SMED)	Technique which refers to significant reductions in set-up times. In this technique main emphasis is given on reduction in set-up time, like "changeover of die, clamping and unclamping of work piece/die on the machine"
Total productive maintenance (TPM)	TPM enhances equipment efficiency through establishment of a preventive maintenance system of equipment throughout its working life. It involves and empowers every employee, from shop floor worker to top management to initiate preventive and corrective maintenance activities
Kanban	Kanban is a specially designed box/container having a kanban card in it, which moves from workstation to store on requirement bases. This Kanban card is a green signal for store to forward material to workstation for processing. Toyota motor used Kanban system to reduce the work in process inventory
5 S practice	The 5S framework (1) Seiri (sorting out), (2) Seiton (systematic arrangement), (3) Seiso (spic and span), Seiketsu (standardising) and Shitsuke (self-discipline)
Poka-Yoke/Jidoka	It is mechanisms used to make mistake-proof an entire process; Poka-Yokes ensure that proper conditions exist before actually executing a process step. This prevents defects from occurring in the first place. Where this is not possible, Poka-Yokes detect and eliminate defects in the process. Stop the machine whenever problem occurred. This ensures the reliability of the process
Standardised work	A work in which the successive activities have been properly structured so that it can be done efficiently is called standardised work. The aim of standardised work is to bring the process under control by reducing variation. This in turn eradicates wastages and increases the productivity
Value stream mapping	A value stream mapping is a flow diagram of all the activities required to bring a product from raw materials to delivery to the customer. The objective is to identify and get rid of the waste in the process
Takt time	Takt time is time taken from the receipt of order from customer till the product is handed over to him or her. It should be minimised through reduction of waste in the processes
Standard operating procedure	Means standardise all operating procedures for comparison and further improvement purpose
Kaizen blitz/Kaizen event	Kaizen event or kaizen blitz is a focused small incremental improvement project completed by cross-functional team in a limited time frame (Doolean et al. 2008)
7 W (waste)	Seven Ws are 7 commonly accepted wastes out of the manufacturing operations. They include waste from overproduction, waste of waiting time, transportation waste, inventory waste, overprocessing waste, waste of motion and waste from production defects

Source: Singh and Singh (2009)

controlling key leverage points within the system. Some of the basic constraint types include:

1. Market
2. Resources

Table 1.4 The seven deadly wastes of lean

Wastes	Examples
Transport	1. Moving patients from room to room 2. Charts not centrally located 3. Poor layouts, lab located a long distance from the ED
Inventory	1. Overstocked medications on units/floors 2. Multiple locations for consumable goods 3. Multiple suppliers of surgical supplies 4. Any work in progress
Motion	1. Heavy items on top shelf, light items on bottom 2. Excessive bending, reaching, walking to complete a progress step
Waiting	1. Specimens waiting analysis 2. Patients waiting to make appointments 3. Patients waiting to be seen for an appointment 4. Time lag with physician's orders 5. Patients on hold for admission
Overproduction	1. Duplicate charting 2. Copies of reports sent automatically 3. Multiple forms with same information
Overprocessing	1. Clarifying orders 2. Increased size of patient records 3. Multiple blood specimen collections
Defects requiring rework or scrap	1. Label on the wrong tube 2. Over-/under-coding 3. Decrease in revenue based on insurance claims 4. Decree in patient satisfaction scores

3. Materials
4. Supplier/vendor
5. Financial
6. Knowledge/competence
7. Policy

For healthcare this involves looking at the five focussing steps. These steps are presented in Table 1.5.

1.4 Discussion and Conclusions

Healthcare delivery today is under pressure to deliver high-quality outcomes, contain costs as well as contend with other challenges such as increase in chronic diseases and the impact of technology advances on healthcare delivery. All are agreed that healthcare reform is necessary, and we are witnessing in all OECD

Table 1.5 Focusing steps of constraints management (adapted from Inozu et al. 2012)

Five focusing steps	Translation for healthcare
1. Identify the system's constraint(s)	Identify the constraint at the system level: what most impedes the delivery of care? • Resource: lack of nurses • Policy: payer-network participation • Artificial: nurses transporting patients • Market: lack of patients • Supplier: flu vaccine unavailability
2. Decide how to exploit the system constraint(s)	Determine how to get the most out of the constraint: • Decrease the time it takes to prepare patients • Shift portions of treatment to other resources with available capacity or where capacity could be added easily • Modify treatment procedures to reveal hidden capacity • Reduce the idle time of the constrained resource • Operating rooms and other similar nonhuman resources do not need to take lunch breaks and can be scheduled to remain in use during such times • A transporter does not abandon his or her post before a porter replacement arrives
3. Subordinate/synchronise everything else to the above decision	All elements of the system support the constraint via coordination and synchronisation so that the bottleneck is never starved (assuming that the system constraint is a resource): • Purchase drugs and supplies based on demand and consumption • Schedule patients based on doctors' capacity • Stagger lunch breaks so that the phones of the call centre are always answered
4. Elevate the system's constraint(s)	Having completed exploit and subordinate, if the revealed/exposed capacity is insufficient, then additional capacity may be added, usually at some expense: • Buy an additional MRI scanner • Hire more nurses • Increase hours of operation • Hire temporary workers for morning registration
5. Warning! If in the previous steps a constraint has been broken, go back to step 1 and do not allow inertia to become the system constraint!	Be alert to adapt to change in the operational, regulatory and competitive environments, as well as changes to patient population, because constraints can shift: • Healthcare reform • Accountable care organisation • Group purchasing organisations • If the system constraint changed, go back to step 1

countries a focus on healthcare reform with a key enabler being e-health. The preceding has introduced the principle of lean thinking and other complementary concepts all aimed at effecting more efficient and effective operations to ensue. These tools and techniques have proved their value in the manufacturing sector. It is the thesis of this book that they are as important for and can facilitate the attainment of superior healthcare delivery. It is therefore essential that practitioners and researchers alike try to embrace lean principle and related concepts as they set about designing and developing new healthcare initiatives.

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