

LEAN AND THE ECRS PRINCIPLE: DEVELOPING A FRAMEWORK TO MINIMISE WASTE IN HEALTHCARE SECTORS

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ABSTRACT

Background: The healthcare system is characterised by complexities and fragmentation, which sometimes leads to lower quality of care and increased inefficiencies. Therefore, organisations are expected to invest in the improvement of both the quality and efficiency of their healthcare systems. Lean philosophy offers an improvement method encompassing a wide range of stakeholders, including frontline workers, that aims to redesign healthcare systems by eliminating waste. As Lean begins to be adopted within healthcare systems, various elements of Lean philosophy and principles have been specified and adapted. However, despite the wide interest in Lean methodology within healthcare systems, there has been a distinct lack of emphasis on one of its key principles, ECRS (Eliminate, Combine, Rearrange, and Simplify).

Materials and Methods: This study aims to develop a framework using Lean and the ECRS principle to minimise waste within healthcare sectors. It researched literature from the following databases: Medline, CINAHL, Google Scholar, Embase, and the Cochrane Library, adhering to set guidelines to ensure the search remained within the realms of the study. In addition to the electronic database searches, the review will discuss national publications where relevant, the grey literature, and the official websites of various organisations.

Result: Although the literature highlights the importance of the ECRS principle especially in the industrial and service sectors, there is a dearth in applying and adopting the ECRS approach in healthcare sectors. Consequently, this review developed a framework for facilitating a systematic way of thinking to generate different ideas for minimising waste in the healthcare sector. Further, a worksheet for processes improvement using the ECRS principles was developed and incorporated into the framework.

Conclusion: It can be concluded that the ECRS method could be an essential part of the improvement toolkit and necessary for successful Lean implementation within the healthcare sector. This is the first attempt to properly highlight ECRS as a method recommended to be used in healthcare sector.

Keywords: Lean, ECRS, value stream mapping, hospital, healthcare

1.0 Introduction

The healthcare system is characterised by its complexity and fragmentation, which sometimes leads to poor quality of care and inefficiencies. An inefficient system means more duplicated work, errors, and wasted effort and resources, resulting in poor patient flow which undermines healthcare quality, staff, and patient satisfaction, as well as the effectiveness of asset utilisation. In an era of ongoing change, healthcare organisations are facing tremendous challenges that push them to cope with the effects of these changes. As a result, organisations are expected to invest in the improvement of both the quality and efficiency of their healthcare systems. To do so, a clear framework for continuous improvement is required (Rutman, Stone, Reid, Woodward, & Migita, 2015). Lean philosophy could help by offering a method that involves a wide range of stakeholders, including frontline workers, that, with the support of leaders, redesigns healthcare systems through the elimination of waste (Rutman et al., 2015). The ultimate aim is to provide the right healthcare services for the right patient at the right time with the right personnel and in the right place with minimum waste and delay. Lean promises to improve the efficiency of the services by reducing waste within the system (Womack, Byrne, Fiume, Kaplan, & Toussaint, 2005).

Since Lean has been adopted within healthcare systems, various elements of the Lean philosophy and principles have been identified (Kelendar, 2020). The focus of Lean is to create a culture of continuous improvement (DelliFraine, Langabeer, & Nembhard, 2010; Holden, 2011; Mann, 2014; Poksinska, 2010), employee empowerment (Casey, Brinton, & Gonzalez, 2009; Holden, 2011; Mann, 2014), waste elimination and reduction (DelliFraine et al., 2010; Holden, 2011; Poksinska, 2010), and providing the value that is expected by patients (Mann, 2014; P. Mazzocato, Savage, Brommels, Aronsson, & Thor, 2010; Poksinska, 2010). Focusing on these values, the aim includes cost reduction, improved safety, and enhanced quality of care (Casey et al., 2009; Mann, 2014; P. Mazzocato et al., 2010; Poksinska, 2010).

Lean acknowledges improving the value for the customer by producing goods or services through appropriately consuming less of everything, including less time, less waste, less effort, fewer human resources, fewer places, fewer steps, and fewer equipment and tools (Anvari, Ismail, & Hojjati, 2011). However, despite the wide interest in Lean methodologies within healthcare systems (Aherne & Whelton, 2010; Bercaw, 2013; Black & Miller, 2008), there has been a lack of emphasis on the Eliminate, Combine, Rearrange, and Simplify (ECSR) principle. The core philosophies of the ECSR process activities are to eliminate unnecessary work, combine operations, rearrange sequences of operations, and simplify the necessary operations. This study aims to develop a framework using Lean and the ECSR principle to minimise waste within healthcare sectors.

2.0 Materials and Methods

The primary research method of this study was the critical review of the retrieved literature. This research followed a structural review approach to ensure that the full range of literature was exposed and analysed. While the literature review was not systematic in the purest sense,

it followed similar principles attempting to minimise bias. The researcher conducted an extensive search of the literature to ensure the inclusion of the most important concepts relating to the research aim. Using advanced techniques such as search criteria and keywords combinations led to a more focused strand of research. Several keywords were used for the search on Lean, ECRS and healthcare. These keywords included: “Health”, “healthcare”, “Health care”, “health system”, “hospital”, “Outpatient Clinic”, “Health Centre”, “Health Centre”, “Health Service”, “acute care”, “primary care”, “secondary care”, “tertiary care”, “rehabilitation”, “home care”, and “community care” accompanied of one of the key terms: “Lean”, “Toyota production system”, “ECRS”, “Just in Time”, “Value stream mapping”, “Process map” “Kaizen” and “Rapid improvement event”. The databases explored were Medline, CINAHL, Google Scholar, Embase, and the Cochrane Library. For Google Scholar searches that provided tens of thousands of pages, the author reviewed the results of the first ten pages.

The retrieved publications were reviewed by examining the title and abstract to identify the articles that were of relevance. Following the snowball method, all the reference lists of the articles found were reviewed. This widened the search area and decreased the chance of missing essential textbooks and articles, especially Lean topics that could be published in other subjects. In addition to the electronic database searches, the review investigated national publications where relevant, as well as grey literature, and the official websites of various organisations. The grey literature was located by searching Google using the same previous terms. These searches concentrated on specific organisation websites (i.e., those where Lean had begun to be implemented and had gained higher attention and interest, mostly in the USA, UK, and other developed countries), including but not limited to:

- Institute for Healthcare Improvement
- Virginia Mason Institute
- NHS Improvement
- Lean Enterprise Institute
- Lean Enterprise Academy
- The King’s Fund
- The Health Foundation
- Department of Health (UK)

3.0 Result and Discussion

Lean contains several tools and techniques. The most common Lean tools used in healthcare for process improvements are a value stream map (VSM), Kaizen, Just in Time (JIT), standardised work, and A3 (Belter et al., 2012; Pamela Mazzocato et al., 2012; Pettersen & Mi Dahlgaard-Park, 2009). A Kaizen event is a tool which allows the organisation to achieve a better system (Kimsey, 2010). *Kaizen* is a Japanese term translated as ‘change for better’, where a rapid improvement event is held between three to five days to improve a specific service through the involvement of frontline workers. The word *Kaizen* is derived from *kai*, which

means to take part and *zen*, which means to make good (Burton & Boeder, 2003). Kaizen stimulates the participation of healthcare workers in the event to improve services as it gives them the opportunity to identify the problem, determine the root causes, propose solutions, and implement changes. The other common and essential Lean tool that aims to uncover and visualise all the activities of the patient journey is VSM (Holden, 2011; Poksinska, 2010). It is most often used by the team responsible for process improvement as a part of the Lean improvement project. It provides an opportunity for all parties to remain familiar with the current state of the entire patient journey. However, despite its popularity within the industrial sector as an instrument of operations improvement (Kasemset, Sasiopars, & Suwiphat, 2013), ECRS remains mostly unused within the healthcare sector as illustrated by its absence from various systematic reviews that mentioned the most common tools used within the healthcare sector (P. Mazzocato et al., 2010; Moraros, Lemstra, & Nwankwo, 2016; Poksinska, 2010).

ECRS is a simple method that helps to implement an immediate and rapid improvement action to improve a system's efficiency. Kasemset, Pinmanee, and Umarin (2014) identified ECRS as a motion study technique that is used to improve production lines. The idea of a motion study is to discover maximum effort economy while appreciating both the human workforce and their safety (Pigage & Tucker, 1954). ECRS consists of the following elements:

- Eliminate: In Lean, waste elimination of any form is an essential principle to achieving successful results. Wherever possible, eliminate non-value-adding tasks. Any improvement attempts that fail to consider innate waste(s) and tangible actions to eliminate those wastes will lead to illusory and short-lived results.
- Combine: If it is not possible to eliminate tasks, then combining or co-locating related tasks, services, operations, processes, people, or equipment is suggested. However, before combining to remove the chaff in the process, it is important to avoid combining wasteful actions.
- Rearrange: Jackson (2017, p. 64) explains this element as the “rebalance [of] work by redistributing tasks, resequencing work, or rearranging the physical layout”. It is worth noting that to rearrange is not only the reviewing of the sequence of activities/events, but the rearranging of materials, equipment, resources, suppliers, locations, and people.
- Simplify: The final step should be to study and analyse the processes in-depth, aiming to simplify activities as far as possible. Consider how/where practices and processes could be simplified. In other words, try to simplify everything that can be simplified without compromises.

Mundel (2013) highlighted the necessity of practicing ECRS principles in the process of improving the efficiency of production lines. This recommendation has been followed extensively in the industrial sector (Kasemset et al., 2014). Various researches indicate ECRS as an effective approach for cost and manufacturing cycle time reduction (Kasemset et al., 2013). For example, the ECRS technique was used by Kasemset et al. (2013) in a plastics packaging factory to reduce negative product costs from defects; by Miranda (2011) to increase the efficiency of the clean room assembly process; by Sindhuja, Mohandas, and Madhumathi (2012) to increase the production rate of the horn assembly line; and by the Makprang, Kasemset, and Sopadang (2012) in the canned fruits production line by reducing the total

internal transportation distance and the number of operators. An example from Joo and Park's (2014) study which reviewed the process as a systematic means of investigating cost-cutting ideas is illustrated in Table 1.

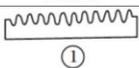
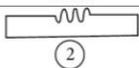
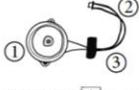
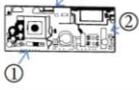
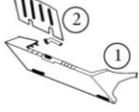
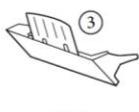
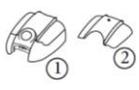
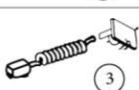
Subcategory	Representative cases	Before	After	Description
Simplification	Belt carrier_whole saw-tooth (to partial saw-tooth)			① Whole saw-tooth ② Partial saw-tooth
Elimination	Wire harness of speaker assembly_EMI core			① Speaker ② Wire harness ③ EMI Core
	Power supply_heat sink			① Power supply PCB ② Frame ground circuit ③ Heat sink
Combination	Guide and Auto Sheet Feeder (to one piece)			① Auto sheet feeder ② Guide ③ One piece ASF
	Cover Dust and Cover Attachment(to one piece)			① Cover dust ② Cover attachment ③ One piece cover dust
Rearrangement	Handset Curl cord_Modular jack (to handset PBA)			① Curl cord ② Modular jack ③ Curl cord and handset PBA are connected

Table 1: Examples of a systematic approach to investigate and review the process of various cases using ECRS to generate cost-cutting ideas.

It is worth noting that ECRS can be used in combination with other strategies. It helps by providing a synergistic effect and overcomes the limitations of other techniques. For example, brainstorming and group thinking are common idea generation methods to improve the quantity and quality of suggested opinions for tackling a certain problem (Osborn, 2013). One of the criticisms for brainstorming is that it may inhibit creative thinking (Brightman, 1980). The participants brainstorming tend to not exchange enough ideas and typically, in terms of their thinking and ideas, become stuck inside their own heads. This happens due to blocks in their emotions, professions, perceptions, habits, and culture that may hinder creative ability (Brown, 1992; Parker, 1994). To overcome these constraints, there is a requirement to apply a structural and systematic approach in brainstorming sessions such as the ECRS approach. Many studies have proven that a structural and systematic approach in brainstorming sessions significantly increases team productivity (Kramer, Fleming, & Mannis, 2001; Sosik, Avolio, & Kahai, 1997). Usually, when brainstorming is combined with other idea generation techniques, it becomes more effective (Joo & Park, 2014). Therefore, ECRS is an essential approach to prompt idea generation and stimulate creative thinking. Stimulating the healthcare worker's creativity and curiosity by asking questions is a useful method to generate improvement ideas. Writing a list of brainstorming thoughts can be a practical approach for reminding participants of the improvement possibilities that they may not have considered and may initiate further ideas. ECRS can simplify and organise the way of thinking and help in idea generation for improving the processes and removing the waste in an existing system. It provides an opportunity for

different healthcare workers from a variety of departments to sit together and discover potential changes that could improve the efficiency of the existing system.

Moreover, ECRS is an essential complementary approach with other Lean tools and activities. The activities within any sector can be divided into that which adds value to the customers and that which does not – or waste (Muda). “Any activity that does not ‘add value’ to your customers is considered Muda. Muda is alternatively called waste or a non-value-adding (NVA) activity” (Eaton, 2013, p. 33). All activities that are considered NVA typically add to costs, waste time and effort, and increase the chance of errors. In Lean thinking, seven groups of activities were identified as waste. These seven waste categories were described by (Womack, Jones, & Roos, 1990) as: overproduction, waiting time, unnecessary transport, excessive or incorrect procedures, excess inventory, unnecessary motion, and defects/rejects. The simplicity of ECRS is that it is an easy technique to identify new ideas for improving and removing the various types of waste within the system (Suhardi, Anisa, & Laksono, 2019). Any work or service can be broken down into smaller elements and processes; by appreciating each element and its steps within a certain process, waste can be identified, and optimal workflow can be achieved. This is attained by ensuring the existing steps are being performed in the simplest, easiest, and safest manner possible (Kasemset et al., 2013).

3.1 A framework to apply Lean in the healthcare sector

Based on Lean principles, this paper provides a proposed approach for optimising service efficiency by using a combination of Lean principles and tools to identify the NVA activities and the hidden waste within the target processes. The system activities are analysed by using Kaizen, VSM, ECRS, the pull principle, and JIT production to consider the concept of minimising the waste within the system. Figure 1 shows a practical guide and framework which consists of 17 steps to apply Lean tools and management concepts to the healthcare sector.

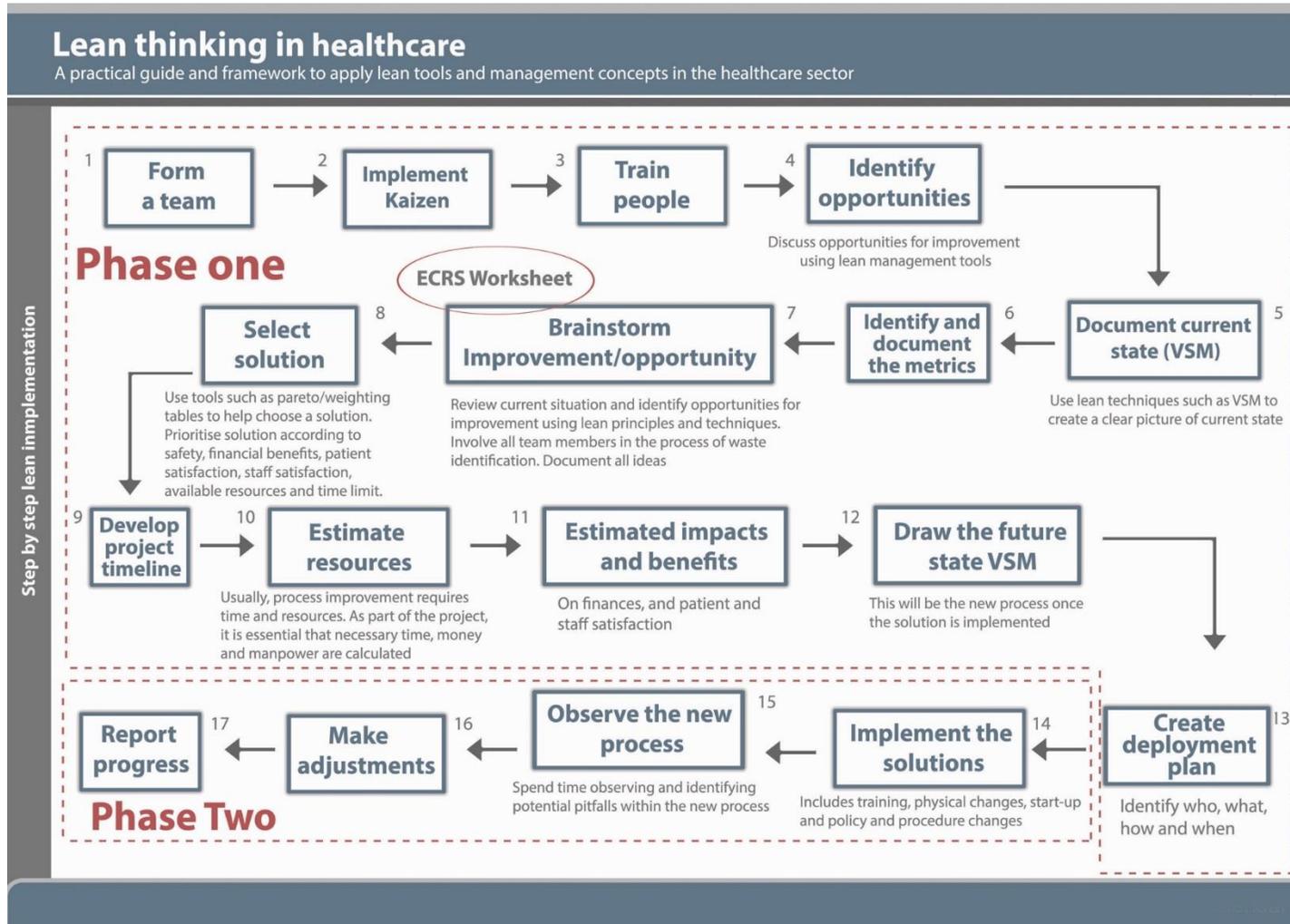


Figure 1: A practical guide and framework to apply Lean tools and management concepts in the healthcare sector

Waste within a system plays a significant role in the delay of services, patient waiting times, service quality, and system efficiency. A VSM tool can be used to draw the current process (Step 5) and organise all work into categories. This will allow for the identification of the source of hidden waste separating value-added activities from NVA activities and explore methods to eliminate the NVA activities. The ECRS principles can be used for the improvement process by adjusting, analysing, and evaluating the current process (Step 7). Based on the results of eliminating waste and the NVA activities, the future VSM (Step 12) will be developed with new and improved processes. The aim is typically to reduce costs, improve healthcare service quality, timely delivery, making processes more effective and efficient, and to practice continuous improvement. The other crucial Lean principle is to continue or establish an ongoing flow of the future VSM. Each activity is connected to another activity as links in a chain and a patient's care will only maintain a timely manner as far as possible without delay or interruption. Therefore, it is not only essential to improve the patient flow within the system but also the flow of information, equipment, samples, and staff. Additionally, service synchronisation, flow balancing, and redesigning layout is an essential part of the JIT principle to keep the flow running smoothly.

3.2 ECRS Worksheet

Focus on the method and approach of the development of improvement ideas or corrective action is essential. To aid workers of different organisations generate improvement suggestions by encouraging the questioning of everything from every conceivable angle, a variety of simple guidelines have been developed (Kyōkai, 1988). Based on the literature review, the author has developed a worksheet for processes improvement in the healthcare sector using ECRS principles, as can be seen in Table 2.

ECRS Element		The Process (Representative)	Before	After	Description
Questions to Identify Improvement Opportunities	Eliminate (unnecessary tasks)				
	1				
		What is the purpose of the step and is it needed?			
		How much value-added work results from this step/action?			
		How can searching, placing, arranging, and selecting be reduced?			
		How can tools and parts be arranged to make motion more natural?			
		How much work area is needed for the process?			
		Combine (tasks)			
		2			
		What are the step's inputs and outputs?			
		Who performs the step?			
		How can this step/process perform effectively?			
		How can both hands work in smooth and natural motions without interference?			
		What operations could be done on the return path of this process?			
		How could a lever mechanism be used to perform multiple tasks simultaneously?			
		Rearrange (tasks)			
		3			
		When and where is the step performed?			
		What is the proper sequence of steps/process for better safety, efficiency, and flow?			
		What changes in work sequence would improve the process?			
		What elements of steps/process could be rearranged to simplify them?			
		What are some other ways to perform the same process?			
		How could steps/process be reduced by rearranging the workplace?			
		What is the proper sequence of motions for better safety, efficiency, and flow?			
	Can we do the current step before the following step?				
	Can we rearrange the sequence of steps to create a better sequence?				
	Simplify (tasks)				
	4				
	How the step is performed?				
	What adjustments are needed to improve the steps/process performance?				
	How can steps/process be simplified?				
	Is there any task that can be simplified to make the whole process faster and better?				

Table 2: Worksheet for processes improvement using ECRS principles.

Adapted from: (Resource Systems Consulting, 2018)

This worksheet can be used in Step 7 of the framework, as shown in Figure 2. Asking a series of questions can stimulate new ways of thinking and promote the development of creative ideas to minimise the existing waste and perform the current processes more efficiently. ECRS facilitates discussion, analysis, and evaluation of proposed ideas. Usually, two factors affect the selection of the solution. One is the feasibility of implementation, and the second is the impact of the solution on the proposed improvement. Therefore, together the team will decide which solutions are required for minimum resources and which have a higher impact. Sometimes it is valuable to start with straightforward and quick-fixing actions to gain fast results, even if such action does not have a high impact on solving long-term problems.

4.0 Conclusion and recommendation

Even with the wide interest from healthcare sectors to adopt and utilise various Lean tools and techniques, there is a dearth in the application and adoption of an ECRS approach. The result of this review is to develop a framework for the facilitation of a systematic method of thinking to generate different ideas for minimising waste in the healthcare sector. ECRS is a simple process that helps to implement immediate and rapid improvement action. The improvement ideas may be achieved by eliminating immediately, where possible, the NAV steps or by combining steps, particularly when individual steps cannot be eliminated. Additionally, the process should also be rearranged and simplified where time, effort, and finances may be saved. It can be concluded that the ECRS method is an essential part of the Lean approach toolkit and is necessary for successful Lean implementation within the healthcare sector.

Declaration

The author declares no conflict of interest.

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