A Lean Approach for Reducing Downtimes in Healthcare: A Case Study

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Abstract. Lean Management is considered one of the most successful management paradigms for enhancing operational performance in the manufacturing environment. However, it has been applied throughout the years to several sectors and organisational areas, such as service, healthcare, and office departments. After the Covid-19 outbreak, increasing attention has been given to potential performance improvements in healthcare organisations by leveraging Lean. This paper intends to add further knowledge to this field by presenting a case study in a hospital. In this paper, a pilot project is presented carried out in a healthcare organisation. Lean methods were used to improve the operating room performance, particularly by reducing the operating room changeover time. The A3 template was used to drive the project and implement a new procedure using the Single Minute Exchange of Die (SMED) method. With the implementation of the new procedure, the changeover time between two different surgeries in the operating room was significantly reduced, together with a more stable and reliable process.

Keywords: SMED · Lean thinking · Healthcare · Changeover · A3

1 Introduction

With the outbreak of COVID-19, the efficiency of health institutions is under the public spotlight, thus leading to a growing interest towards improving the operational performance of hospitals and clinics. In particular, it has emerged that having a reliable and time-responsive operational process is fundamental, especially for hospitals. This means an increasing need for these organisations in guidance on how time and resources can be managed in an optimal way.

Among the other managerial strategies, Lean management is considered one of the most successful to achieve operational excellence [10]. Throughout the years, this theory's application to other fields has increased thanks to the increased awareness of the benefits given by Lean. In the literature, it is possible to find several examples in which Lean has been applied in other areas of manufacturing firms, such as offices [3]. Also, it is possible to find applications of Lean in sectors different from manufacturing, such as service [18] or healthcare [4, 13].

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In fact, some papers showed how Lean techniques and tools have been applied in healthcare. These examples include the use of seven wastes or SMED and could be beneficial to improving performance and reducing downtimes [1, 2, 4, 7, 13]. Thus, the application of Lean in the healthcare environment has recently been topical due to the strong push that Covid-19 has given to healthcare organisation in improving their performance.

By knowing this, the aim of this paper is adding knowledge on how Lean tools can be implemented in a successful way in the healthcare sector. A case study will showcase how Lean has been introduced in a public hospital to reduce the changeover time of an operating room. This article will be organized into the following paragraphs: literature review, methodology, results, discussion, conclusions and limitations.

2 Literature Review

Lean management is one of the most diffused managerial paradigms in manufacturing environment for improving operational performance [10]. Its wide set of tools [16] has been applied across several areas of the manufacturing industry, ranging from the shop floor [15] to the offices [3]. Furthermore, in recent years, the implementation of Lean tools in other sectors has become common. In fact, thanks to the huge benefits that can be achieved through its implementation, a raising interest is raising in the way in which Lean tools can be implemented in other sectors.

In addition to this, some Lean tools as the A3 template can be easily used for driving improvement projects and as a reference for conducting pilot projects or introducing the Lean culture in a company [18]. Other Lean methods, like SMED, which was usually implemented for set-up optimization in manufacturing [15], have recently turned out to be a relevant method for reducing downtimes in other sectors. SMED could be particularly useful when there is a need to synchronise a set of activities and define a rigorous procedure [15] and healthcare sector is the case in point.

In the literature it is possible several examples of how Lean practices can be applied in the healthcare [1, 4, 7, 8, 12, 13]. Henrique and Godinho Filho 2020 [8] mapped the empirical research done in this field, highlighting the barriers and possible impact on performance. For instance, SMED method has been applied particularly in operating rooms [1, 7, 12] to reduce their set-up time (i.e., changeover time) thus leading to an improved efficiency of the room [11]. Other authors pointed out the factors needed to sustain lean improvements in the long term [9].

Thus, it is evident that there is still a lack of contributions on how Lean can be successfully implemented in healthcare [6]. In fact, some authors have pointed out how the focus is on the results of the Lean implementation rather than in the process [14]. By knowing this, it is interesting understand how Lean can be introduced for the first time to have an improvement replicable and sustainable in the long term [5, 9]. This is particularly relevant not only from the literature perspective, but also from the organisations' perspective which are struggling to find a way to successfully implement methodologies to better manage their time and resources.

3 Research Methodology

Coherently with the aim of the research is to demonstrate a successful implementation of Lean tools in the healthcare sector for improving operational performance, a case study will be presented. The methodology used here is the single case study [20], considered the most appropriate one to address the starting research objective. Even though this methodology has some limitations, for instance, [19] argued whatever is derived from a single case study is not statistically relevant and extendable to other contexts; however, others [17] said a single case study could add new knowledge for improving the current literature and for further research.

An improvement project aimed at the reduction of an operating room changeover time will be presented. By using the A3 template, the organisation was able to analyse their processes and address some issues that were causing inefficiencies in their operations. In particular, the operating room changeover process was reshaped using the Single Minute Exchange of Die (SMED) method.

This chapter will present the context related to the case study and the detailed methodology used to conduct it.

3.1 Case Study Context

The case study was conducted in a public hospital. The focus was on the main district of this hospital, in the operating block. In the last period, great emphasis was given to understanding the issues incurred in the management of the operating rooms.

In fact, in this organisation, there were poor operational performances which were causing issues in the management of the operating room. In particular, it was observed that several delays in the planned surgery were caused by a high and unstable timing of the changeover operations. This was directly translated into a low level of the main Key Performance Indicator (KPI) used for the performance monitoring in this hospital, the Overall (Operating) Room Effectiveness (ORE). The ORE is computed as the ratio of Surgical Time to effective opening time. Having this situation clearly in mind, the hospital decided to start a deeper analysis to understand the causes and implement improvements to improve their performance. A detailed description of this process will be depicted in the following section.

3.2 Case Study Deployment

Since the improvement project was driven using the A3 template, the case study will be descripted by using its structure. Thus, the eight sections of the A3 template will be presented. Also, the relationship of the sections with the PDCA (Plan-Do-Check-Act) cycle will be made explicit, as some other authors did [18].

- Step 1 – Plan: Problem Background
- Step 2 – Plan: Problem Breakdown
- Step 3 – Plan: Target Setting
- Step 4 – Plan: Root Causes Analysis
- Step 5 – Plan: Countermeasures Definition

- Step 6 – Do: Countermeasures Implementation
- Step 7 – Check: Results Monitoring
- Step 8 – Act: Standardise and Share Success

Some of these steps will be aggregated to explain the case study better.

Problem Background and Breakdown (Steps 1–2, Plan)

As stated above, the starting point of this study was the quite low level of ORE, which could be improved through changes in the current situation. The value of the ORE was around 50% overall across all the operating rooms. After an evaluation of the goodness of this indicator, it was noted that it includes many aspects and variables, so there was the risk that the results of the projects were not documented. The medical and surgical time, which cannot be analysed and controlled in-depth, strongly influences this wide indicator. Considering the little knowledge in the medical field from the people involved in the project, it was decided to go more in-depth in investigating a particular phase of the process. The part investigated was between the end of an intervention and the start of another one, that is not strongly linked to the medical part of the operation. This period is defined as the changeover time, and it was noted that the time used was too much.

Then, due to the scarce expertise in the organisation in conducting improvement projects, it has been decided to focus only on one room that could be used as a pilot project preparatory for further improvements. The Orthopaedic room was considered as the one to start for the pilot project. Specifically, after data analysis using the hospital's information systems, it was possible to evaluate the changeover time for this room. Historically, it was 27.46 min with a standard deviation of 11.86 min. After a Gemba walk in the operating block, there was clear room for improvement due to an unclear procedure and several lack in the definition of roles and responsibilities.

A process map was created to understand the process better and obtain a clearer overview of the whole process, as in Fig. 1.

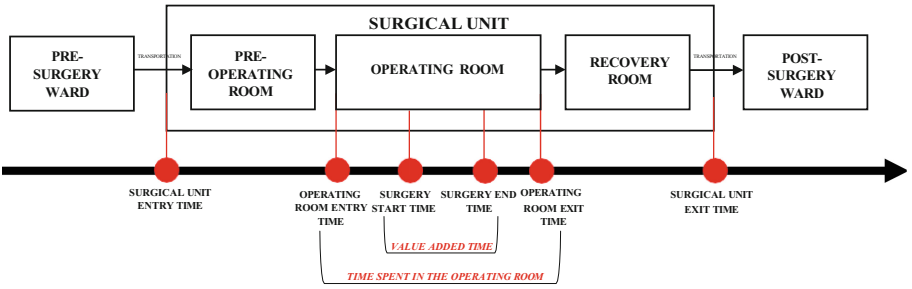


Fig. 1. AS-IS process

Target Setting (Step 3, Plan)

After all the analysis presented above, the hospital could identify a set of targets strongly related to the problem. As explained in the above section, the changeover time was the indicator to be monitored and improved, particularly in the Orthopaedic surgery room, which is considered the standard room to carry out the improvement project.

A decrease in the average changeover time was needed since by reducing this time, it is possible to save some precious minutes that could be employed in a valuable way. A reduction of 20%, going from 27.46 min to around 22 min, was set.

It was also important to reduce the standard deviation of the changeover time. This indicator also has a strong meaning since a low value tells us that the process is more reliable and repeatable. Here, the starting point was 11.86 min, and the target was 10.65, which is around a 10% reduction.

Root Causes Analysis (Step 4, Plan)

It has been decided to use the Ishikawa diagram to analyse the problem and identify the root causes. This tool has been used according to the original 4M (Men-Method-Machine-Material) classification. Several interviews and brainstorming with different stakeholders at all levels and direct observation have been conducted to obtain a clear and complete overview of the possible causes. Through its use, it has been possible to uncover several root causes directly linked to the problem under analysis, as represented in Fig. 2.

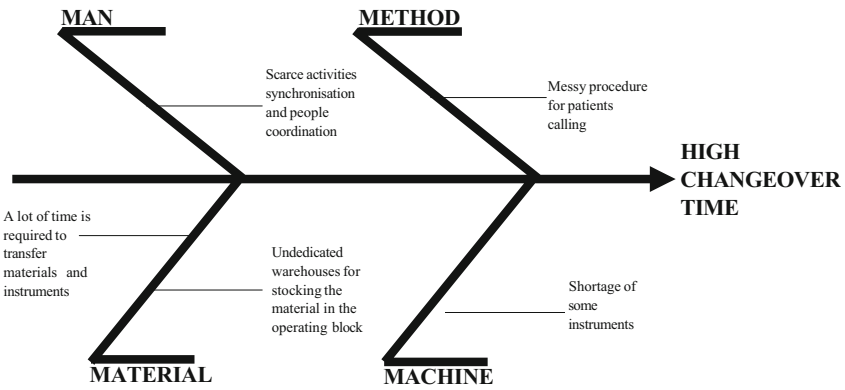


Fig. 2. Ishikawa diagram

Countermeasures Definition and Implementation (Step 5–6, Plan/Do)

After depicting the current situation and the causes of the higher changeover time, it has been possible to move to the definition and implementation of the countermeasures. With the identification of the root causes, it was evident that the main problem was related to a confusing and unstandardised process. Thus, it has been decided to go for a SMED application to define a new procedure for the change between two different surgical operations.

The new procedure has been developed, validated by all the medical staff, and approved by the hospital's management team. This double validation was needed to satisfy both the management of the hospital and the staff working on the operating room. In fact, on the one hand, the management wanted a simple, effective, and easily implementable procedure that could rapidly be understood and applied by all the actors involved in the changeover operations. On the other hand, medical validation was needed to know if the new procedure was feasible: a check was made on the constraints

of timing and competencies of the activities. After this phase, the final procedure was developed and was ready to be implemented as in Fig. 3. The most relevant changes that impacted the changeover time have been some parallelisation of activities and anticipation of some others (e.g., the second patient preparation was done in parallel with the changeover time, thus leading to a longer operating room occupation in case of any delay or issue).

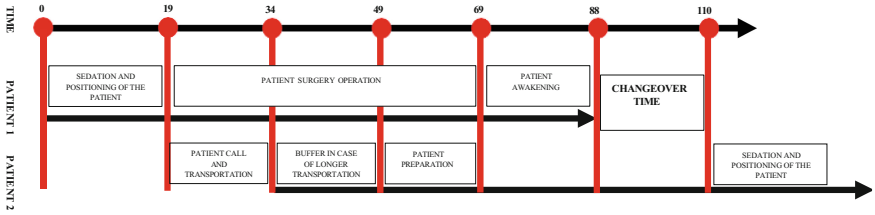


Fig. 3. New changeover procedure

Once the new procedure was developed, all the medical staff of the Orthopaedic surgery room (doctor, nurses, anesthetists) were informed and trained about the new procedure to get acknowledgement from them and minimise the risk of resistance to change.

Results Monitoring (Step 7, Check)

Two ways of monitoring were done simultaneously to be both time consistent and efficient in the analysis, focusing more in-depth on two aspects. A first check was done through direct observation in the operating block to verify if the procedure was understood and applied. A second check was on the time results, which were monitored with the data stored in the IT system of the hospitals, to understand if the performance was improved in terms of time.

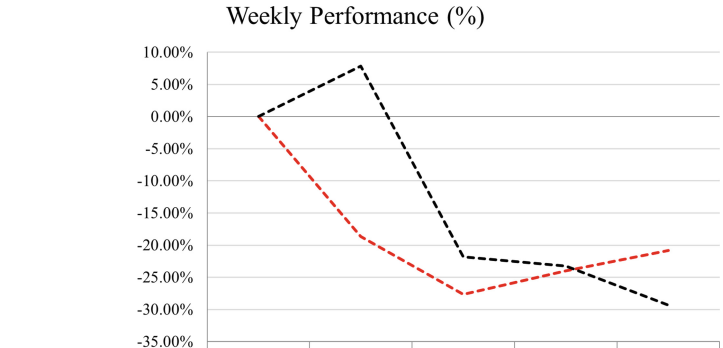
The decision was to analyse the data four weeks after the implementation to have all the necessary data to spot problems and propose improvements to cope with them. Also, four weeks of analysis were considered sufficient for a reliable overview of the project's progress. The outcome of this phase will be presented accurately in the results section.

Standardise and Share Success (Step 8, Act)

After the four-week monitoring phase, a closing meeting was held to recap the improvements and formalise what was done. Thanks to this, it has been possible for the organisation to share with the management the success of the process and discuss the results, highlighting pitfalls and possible improvements that could be made, especially for the possible extension of this pilot project.

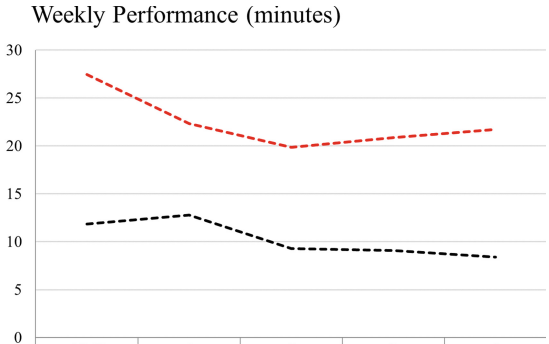
4 Results

Regarding the results, after the four-week monitoring phase, it has been possible to observe the weekly performance of the average changeover time and its standard deviation. The weekly fluctuation in terms of changeover time and its standard deviation is depicted in Figs. 4 and 5.



	AS-IS	1	2	3	4
Average	0.00%	-18.65%	-27.68%	-24.00%	-20.87%
Standard Deviation	0.00%	7.84%	-21.84%	-23.27%	-29.34%

Fig. 4. Weekly performance after the new procedure implementation (%)



	AS-IS	1	2	3	4
Average	27.46	22.34	19.86	20.87	21.73
Standard Deviation	11.86	12.79	9.27	9.1	8.38

Fig. 5. Weekly performance after the new procedure implementation (minutes)

From the figures, it is possible to notice that the targets were achieved for all the weeks apart from the first one due to the newness of the countermeasure, which also worsened the standard deviation. Thanks to the intensive training and some corrective actions, it was then possible to reach the targets as shown in the figures. At first glance, it could seem that the improvement is of slight importance, but the effect of these upgrades must be considered from a larger perspective.

Considering the several changeovers during the day and the possible extension to the other operating rooms of this pilot project, this will lead not only to a mere improvement the changeover time. In fact, by taking as a reference a full day, when the operating time is around 8 h, a saving of about 8 min in a single changeover time could result in about 60 min saved, so the time needed for one more surgery. An improvement that could be even higher if extended to the whole set of operating rooms: in this way, it will be possible

to enhance the daily surgery capacity of the operating block significantly, especially if combined with a change in the surgery planning logic.

Furthermore, other possible side effects of this project are a much more standardised way of working and a defined procedure, thus leading to less stressful working conditions for the doctors and nurses. Considering all these factors, it is possible to state that the new process certainly has higher reliability and stability.

5 Discussion

This case study shows a successful use of the SMED methodology in the healthcare sector. After the pilot project has finished, it was possible to highlight how the problem was solved, and the performance have improved significantly compared to the limited area of the project. It is also important to underline how using a Lean tool (SMED) driven by another Lean thinking tool (A3 template) was fundamental to address the problem, solve the issues and implement the right countermeasures to enhance the organisation's performance. Some possible hidden pitfalls and troubles were avoided thanks to the robust methodologies employed, and some examples are presented in the following lines.

The structured way in which the project has been carried out, i.e., using the A3 template, was fundamental to correctly spot the area to focus on and address the problem in a robust way. Furthermore, it has been fundamental to identifying the boundaries of the problem and setting the right targets to address it. Also, in a more advanced phase of the project, using tools such as the Ishikawa and the impact effort matrix, it has been possible to highlight the only causes causing the problem and link them with the possible countermeasures.

After seeing the results, it is necessary to stress the importance of a structured and prolonged monitoring phase characteristic of any project using the A3 template. During this step, the results are, at first glance, evaluated. The following are compared to the expected results. In case of any significant fluctuation or difference with the targets, corrective actions are deployed to improve performance in the following periods.

Also, if some possible hidden issues are discovered in the monitoring phase (e.g., in this case, potential interferences among medical staff or nurses), something in the countermeasures can be adapted, which could lead to a slight reduction in the performance.

Furthermore, this phase is fundamental to highlight all the possible failures, pitfalls and corrective actions that could be deployed in the following periods (i.e., after the monitoring) to sustain the change, thus preventing a worsening of the performance. This is particularly important in pilot projects such as the one under analysis, which with a high probability will be extended to similar but different operating rooms in the same organisation. Thus, these actions could be replied to and easily adapted to slightly identical situations.

6 Conclusions and Limitations

Firstly, knowing all these things, this paper confirms the results and adds further knowledge to the article dealing with the same topic, using Lean in healthcare to improve

operating room changeover time [1, 7, 11]. This paper stressed the importance of using a standardised method (A3 template) to introduce Lean in environments where it was scarcely applied. By using this method, it is possible to successfully introduce Lean and its tools in a simple and replicable way. Through the use of this template, thanks to its robust structure, it is possible to set the basement for further improvement projects and could be used to address other improvement projects across the organisation.

Thus, this paper could be helpful for all the firms, managers, stakeholders, and practitioners working in the healthcare field who would like to improve their operational performance successfully using Lean methodologies. It could be useful also to other stakeholders not belonging to the healthcare sector who would like to see a unique way to redesign the SMED methodology (i.e., applying SMED in sectors where Lean is less applied). Lastly, this paper will enrich the existing literature dealing with the topics of Lean Management in the Healthcare sector, bringing a successful case study in which the implementation of the Lean techniques is addressed through the use of the A3 methodology.

This paper also has some limitations that need to be remarked on and explained here. The first limitation is related to the methodology chosen; being this a single case study, the results are difficult to generalise and can be influenced by the environment and the embedded characteristics of the organisation under analysis. Different effects can be expected in other organisations with different levels of Lean culture. This could have influenced the results of the project both in the negative (e.g., higher resistance compared to other organisations) and positive way (e.g., the increased commitment of some actors due to the innovativeness of the project); thus, is difficult to predict and extend the results in other similar organisations. Then, even if the monitoring has been done for four weeks, a long-term vision (e.g., one year or more) is missing. With the presence of a long-term perspective, it will be possible to also analyse the potential issues that arise in the long-term as well as how the Lean culture and methodologies can help in addressing them.

Thus, for future research, it will be interesting to proceed, for instance, by extending the size of analysis to other organisations, having a different Lean maturity grade or analysing the same topics from a long-term perspective, also using different methodologies.

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