

Extended Classification of waste in the hospital system

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Abstract

This paper aims to provide a waste classification model to identify most of the problems encountered in the hospitals system. The problem of identification and classification of waste is one of the major obstacles that encounter the Lean approach in its implementation in hospitals. This paper established a SWOT matrix that is the subject of detailed analysis of the waste classification phase. This analysis allows to criticize the proposed classification that focus only on specified sources of waste which can have a negative impact on the waste elimination operation. We propose an extended classification that takes into account the three forms of waste in Lean approach.

Keywords

Lean healthcare, Lean manufacturing, waste classification, Health services, Lean barriers, SWOT analysis

1. Introduction

Lean is a process improvement approach originally from the Japanese car industry (Liker, 2004). This approach is derived from the Toyota Production System, which is based on two concepts: reducing expenditures by eliminating all forms of waste and maximizing the utilization of the worker's ability (Sugimori et al., 1977). It is based on five principles: (i) identify value from the customer's perspective; (ii) identify the value stream for each product or service and address all wasteful steps; (iii) make the product or service flow continuously and standardize processes around best practice; (iv) introduce pull between all steps where continuous flow is impossible; (v) manage towards perfection. (Womack, 1990).

Lean is increasingly applied in hospitals and its use began in the early 21st century as shown in Figure 1. In many countries, health professionals are trying to improve their processes with Lean methods. This approach seems to be promising to solve the current problem of increasing demand for care with equivalent resources (Curatolo, 2014). However, the complexity of the hospital system's processes and its high variability makes the application of the Lean approach, which is considered as a part of the process improvement, so difficult and even impossible in some cases. Furthermore, the application of this approach in the case of hospitals doesn't seem to achieve policymakers' goals, as it does in the industrial system. In fact it was pointed out by al-Hakim (Al-Hakim, 2005), there are seven main differences between these two fields, namely: the need for human intervention, product uniformity, cycle time, the waiting time, the behavior of the product, the ease of measuring performance and effectiveness of processes.

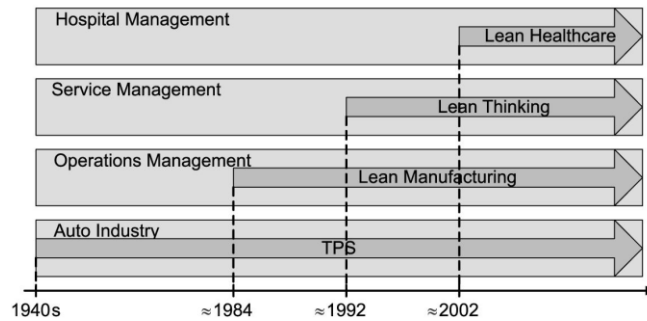


Figure 1 Lean adaptation chronology (Laursen et al., 2003)

For example, having a skilled labor is less required in the industrial system thanks to the involvement of advanced machinery, while it is of an extreme necessity to hire skilled professionals in the healthcare system. Thus, the performance of workers in the industry can be easily measured compared to hospitals due to the huge differences in skills and specialties of the workforce involved. In addition, the high level of complexity and variability of activities in a hospital minimizes the possibility to predict the operation's success degree (Al-Hakim, 2005).

Moreover, production is standardized in the industry which is not the case for the hospital system where each patient needs a different service. For example, a single production process may be used to produce thousands of identical products. However, in the hospital system, the same health problems that appear to be similar may require a single treatment (Gong, 2009). Accordingly, care production process should be modified depending on the circumstances of each patient. So that the implementation of Lean in hospitals has its own problems and its own limitations.

In this paper, we try to reduce the problems associated with the implementation of Lean in hospitals and particularly the problem of identification of waste which is considered one of the pillars of the philosophy of integrating Lean in the waste classification model other forms to identify the majority of problems encountered in hospitals.

To achieve this goal, we present in the second section of our research the methodology and steps to follow. In the third section, we list the problems related to the implementation of Lean in hospitals. The fourth section gives an analysis of the waste identification operation. At last, we propose an extension of the waste classification model; which is the main objective of this work; in the fifth section. Finally we set a conclusion, adding some perspectives for the future.

2. Research methodology

First of all, in this paper, we follow the methodology shown in Figure 2. According to literature review, the first step is to identify the main problems related to the implementation of Lean in hospitals. We note that these problems are mainly due to poor understanding of the principles of Lean.

Secondly, we focus on the waste identification operation since it is considered as a primarily step to eliminate waste; and which is also considered the main mission of Lean. In this regard, and in order to better understand the issue we prepare a SWOT matrix to indicate the strengths, weaknesses, opportunities and threats related to waste identification.

Thirdly, we analyze the solutions proposed in literature for the classification of waste, while focusing on the feasibility of these solutions in hospitals.

Finally, we build a new waste classification model in hospitals, which we refer to as an extensive classification.

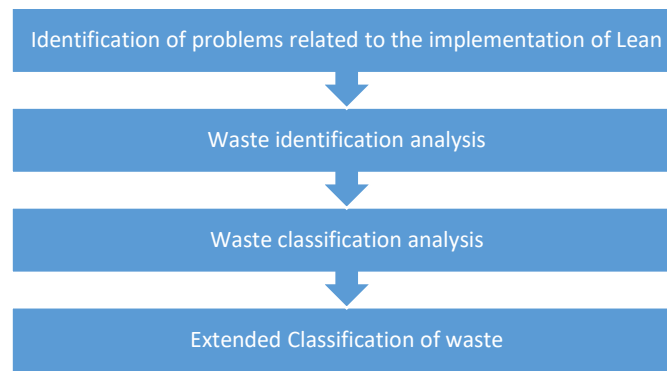


Figure 2. Methodology to apply

3. Problems associated with Lean implementation

The Lean approach like other approaches faces various problems that slow down its integration. In this section, we focus on classifying these problems in hospital and industrial systems. Thus we will emphasis on those related to the implementation of Lean in hospitals.

3.1 Classification of limitations

Obviously the Lean approach has strengths and weaknesses, as it's the case for all process improvement approaches. Therefore de Souza (de Souza and Pidd, 2011) focused on the classification of obstacles through the application of Lean in hospitals and in industry as shown in Table 1. This classification highlighted the peculiarity of the hospital system and demonstrates the difficulty to implement Lean in this system. The hospital field has more obstacles than the industrial system as shown in Table 1.

Table 1. Classification of limitations

<i>Hospital system</i>	<i>Industrial system</i>
Terminology	
Organizational momentum	
Professional and functional silos	
Data collection and performance measurement	
Resistance to change / scepticism	
Hierarchy and management roles	
Personal / professional skills of health care professionals	
Perception	

Terminology: In order to introduce Lean in an organization, it is necessary to incorporate new terms from the Japanese vocabulary as "Muda", "Mura", "Muri" and other non-Japanese words like "takt-time" and "lead-time." This new vocabulary can lead to misunderstanding in the organization.

Organizational momentum: Lean is a long-term process improvement solution, but some organizations tend to implement quick solutions as an attempt to improve their processes. Lean is a continuous improvement approach, which means that its results should be maintained .

Professional and functional silos: The physical and IT flow by different silos cause problems when implementing Lean. In the case of hospitals, professional silo occurs when health care practitioners are divided into professional groups, and a typical hospital may have more than 100 groups (de Souza and Pidd, 2011). In addition, functional silos lead to fragmentation of care (Mann, 2005).

Data collection and performance measurement: Performance measurement is a key element for successful implementation of the Lean approach (Kollberg et al., 2006). To assess the performance of a system, we need to start with collecting data and measuring it. Implementing Lean without pre-evaluation makes it difficult to locate areas for improvement. Also, with no post-assessment we can not know the results of its implementation.

Resistance to change / scepticism: fear of change is a challenge and creates resistance. The resistance handling methods diversify and in this sense (Pardo del Val and Martínez Fuentes, 2003) did workarounds several sources of resistance in a broader context.

Hierarchy and management roles: the need to form a polydisciplinary team is crucial to implement Lean. Alternatively, the team must consist of different professional groups and must operate outside of the hierarchy in order not to favor the views (de Souza and Pidd, 2011). Health care managers consider that their roles are to find a solution as soon as the problem is identified. In opposition to that, Lean emphasizes on the reversed flow to solve the problems that is to say, the bottom-up approach (Homes, 2007).

Personal / professional skills of health care professionals: (Ben-Tovim et al., 2007) highlighted that health care managers usually solve problems like "firefighters" do, they eliminate the problems when they happen. However, Lean consists on finding the root causes of problems.

Perception: the difference between the hospital system and the system where the Lean approach comes from can cause a lack of understanding of Lean principles.

3.2 Problems related to the implementation of Lean in hospitals

In literature, we find a variety of problems encountered in the implementation of Lean in hospitals. (D'Andreomatteo et al., 2015; Grove et al., 2010) cited in their work, based on theoretical and empirical articles, the main problems illustrated in Table 2.

Table 2. Problems related to Lean implementation

<i>UK health visiting: challenges faced during lean implementation</i>	<i>Lean in healthcare: A comprehensive review</i>
High process variability	
lack of Understanding of lean	
problems in defining waste	
poorly defined focus	
Communication and leadership	receptivity of staff
Who is the customer and what they value	the evidence of innovation sharing and the embedding of change
	the complexity of the adoption process
	causes or shifts problems to other parts of the organization
	adaptation of Lean from the private to the public system

According to Table 2, as we can see, we find that there are two main problems related to Lean principles: "Problems in defining waste" which is related to the first principle of lean and "poorly defined focus" related to the identification of the value chain in the second principle. In this paper, we study the problems of waste definition as there are two ways to improve "customer value". The first one is; minimizing waste and, and the second one is improving the added value of activities without increasing spendings. According to (Liker and Morgan, 2006) the elimination of waste is the heart of TPS.

4. Analysis of the waste identification operation

In this section we discuss forms of waste according to the Lean approach and establish an analysis of the waste identification operation.

4.1 Forms of waste

According to the Lean approach, all activities without added value are considered as waste. To facilitate the identification of these wastes, three forms: Muda, Muri and Mura are proposed as part of this approach.

Muda is a Japanese word that means "waste". It refers to a series of non-value-creating activities (Curatolo, 2014). There are seven categories of Muda which have been described by (Womack, 1990) : overproduction, waiting time, unnecessary transport, excessive or incorrect procedures, excess inventory, unnecessary motion, defects / rejects. (Liker, 2004) has added seven categories under-utilization of skills.

Muri corresponds to a work overload (for men or equipment), for example when the workload is excessive given the number of workers (Curatolo, 2014), the elimination of this form of work aims at ensuring the good working conditions that prevent injuries and pressure on the workers (Nicola Burgess and Zoe Radnor, 2013). So if staff feels supported by the organizational structure in which they work, this will positively influence the relationship between staff and patient (Duska et al., 2015) and will help in improving the quality of care.

Mura corresponds to the variability and imbalances in labor. The elimination of this form is to stabilize demand which enables a smooth process flow. The more demand is irregular, the bigger the variation is in the process, which affects its efficiency (Nicola Burgess and Zoe Radnor, 2013).

According to the three forms of waste, Lean can be viewed as a management practice that is centered on continuous improvement by increasing customer value or reducing the Non-Value Added activities (muda), process variation (mura), and poor conditions of work (muri) (Radnor et al., 2012).

4.2 SWOT analysis

(SUGIMORI et al., 1977) states that TPS works on the assumption that "anything other than the minimum amount of equipment, materials, parts, and workers (working time) which are absolutely essential to production are merely surplus that only raises the cost". Before reaching this stage, we have to identify waste in the organization so that we can take the most appropriate actions.

For this reason, we are interested in establishing a SWOT analysis to show the importance of the stage of identification of waste.

This analysis is a commonly used method for analyzing and positioning an organization's resources and environment in four regions: Strengths, Weaknesses, Opportunities and Threats (Samejima et al., 2006). Strengths and Weaknesses are internal (controllable) factors that support and obstruct organizations to achieve their mission respectively. Whereas Opportunities and Threats are the external (uncontrollable) factors that enable and disable organizations from accomplishing their mission (Dyson, 2004).

Table 3 illustrates our waste identification analysis while showing the internal and external factors.

Table 3. SWOT matrix

Forces	Weaknesses
Define tasks with non-value added	- Lack of tools to define waste managers - Identifying one form of waste "Muda". - The concept of waste is different from one area to another. - The complexity of the operation increases with the type of system to be studied (eg. Hospital system)
Opportunities	Threats
- Eliminate activities that carry no added value - Reduce the cost of service delivery. - Define a more appropriate action plan	Failing to identify des activités NVA activities to eliminate can generate other sources of waste

Strengths

- Define tasks with non-value added

The diagnosis of the company's allows the identification of the activities that carry no value added to the company. These activities generally influence the product cost and the manufacturing time negatively.

Opportunities

- Eliminate activities that carry no added value

The main objective of the waste identification even in Lean is the elimination of waste.

- Reduce the cost of service delivery.

An evaluation of expenditure which the Lean approach has eliminated and improvement of the quality work are presented in Table 4. The identification of waste allows the company to properly locate money for leaks then remove it. This process typically involves reducing product manufacturing costs. Table 4 shows some experiences of hospitals that have successfully implemented Lean.

Table 4. Lean impact on hospitals

Hospital	Impact
Royal Bolton Hospital (Royaume-Uni)	Direct savings of £3.1m Death rate for patients fell by a third. The time taken to process important categories of blood fell from 2 day to 2 hours. Average turnaround time in pathology from over 24 hours to 2-3 hours
Nebraska Medical Center (Etats-Unis)	Reduced staff walking by 167 miles a year. Reduce lab space by 825 sq ft and specimen processing turn around time by 20% Reduced manpower by 11 FTEs, who were redirected to other critical work. Average length of stay decreased from 6.29 days to 5.72 days
Virginia Mason Medical center (Etats-Unis)	\$ 6,000,000 saved on expected investments, 1200 m2 of freed space , 55 km a day walked by employees eliminated

Theda Care (Etats-Unis)	\$ 7,000,000 saved, 80 full-time equivalent redirected towards new activities
Flinders Medical Center (Australie)	15-20% more work, fewer safety incidents, same budget, same infrastructure, staff, and technology.
The Pittsburgh General Hospital	Change to the procedure for intravenous line insertion giving a 90% drop in the number of infections after just 90 days. The new procedures saved almost \$500,000 a year in intensive-care-unit costs.
Scotland Cancer Treatment	Customer waiting times for first appointment from an average 23 to 12 days and improvement of customer flow time for patients of 48%

- Define a more appropriate action plan

Lean has different tools to solve the identified problems. Each one of these tools is created for a specific purpose. Before establishing an action plan while precisising the tools involved, it is necessary to identify the sources of waste to eliminate. For example, the SMED method is applied to reduce the number of change times. The kanban method consists to eliminate the in-progress and produce just what is required.

Weaknesses

- Lack of tools to define waste managers

Policymakers want to immediately identify the causes and solutions of waste as they arise (Holden, 2011). Yet these wastes are generally the consequences of other sources of waste. So eliminating waste generators usually involves the removal of other types of waste. Implementing tools to define this waste like (Henrique et al., 2015), will help optimize and improve the effectiveness of this operation.

- Using one form of waste types "Muda"

As we mentioned, Lean classified waste into three categories namely: Muda, Mura and Muri. But in practical cases, we notice that they focus only on "Muda".

- The concept of waste is different from one area to another.

Nobody can deny that the work environment differs from one area to another. Tasks that can therefore be considered as an added value in one area can be considered as waste in another. Setting waiting time to zero could be targeted in the industry, while the waiting time is not always a waste in hospital systems. Sometimes it can even be considered a value-added activity. In an operating room of the hospital, an anesthesiologist makes the work especially at the beginning of the operation and the waiting time is not considered as waste while the other surgical team is involved in monitoring activities. However, in an industrial production line, if an operator is pending or is monitoring a process, it is considered a waste that must be eliminated to improve efficiency (Gong, 2009).

- Healthcare is a complex system

Several authors have tried to explain the origin of this complexity. (Ben-Tovim et al., 2007) described the hospital as an organization characterized by functional silos where the vision of a process stops at the doors of service (Curatolo, 2014) and professionals are very inclined to problem solving "firefighters". (Houchens and Kim, 2014; Kim et al., 2006) highlighted the diversity of hospital customers and they have divided them into two categories namely internal customers and external customers. In addition, (Kollberg et al., 2006; Young and McClean, 2008) have emphasized the dual reporting line that often characterizes hospitals: the medical department on the one hand and the administrative department on the other.

Threats

- Misidentification of activities to eliminate can generate other sources of waste

Any activity that does not add value is not necessarily a waste. There are two types of activities with non-value added: activities that have non-value added but are essential activities and non-value added activities that can be eliminated (Monden, 2011). In addition, an activity may be regarded as waste in one area but a necessary activity in another area. We believe that the elimination of a non-value added activity that is essential can lead to other sources of waste.

5. Analyze of waste classification

In the literature, there are solutions to classify waste managers. For example, (Bauch, 2004) classified the waste into two types as shown in Figure 3: "waste type" which refers to a type of waste and "waste drivers" that represent the causes responsible for the generation of waste.

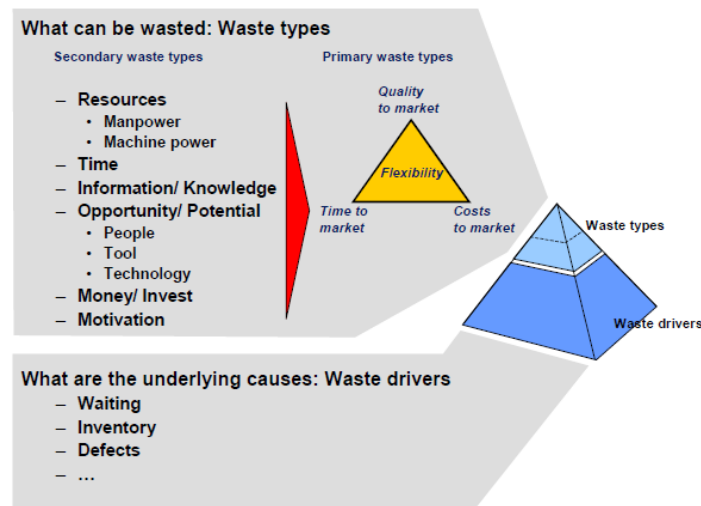


Figure 3. Bauch Classification (Bauch, 2004)

We believe that identifying only the "waste-type" in the system will consume efforts without achieving the desired result because the appearance of this form of waste is likely as the responsible source is not eradicated. In addition, Figure 4 established by (Bauch, 2004) illustrates the relationship between waste through the "cause-effect" diagram by stating that the relationship between wastes is not always linear and it can take other forms.

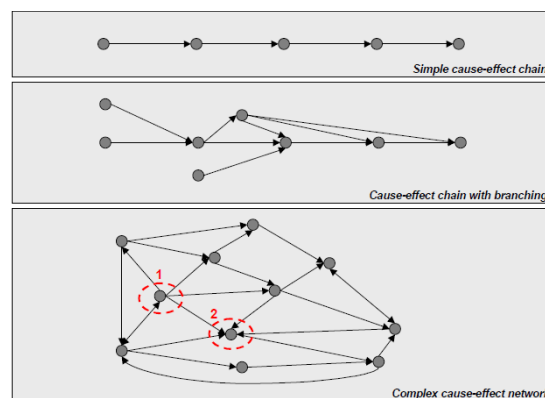


Figure 4. « Cause-Effet » Diagram (Bauch, 2004)

Moreover, other studies consider that Muda is the only form of waste as (Collar et al., 2012; de Souza and Pidd, 2011). We consider the Muda form is not sufficient and that focusing solely on this form may result in the emergence of other forms. For example, the elimination of unnecessary transportation can generate a work overload. In addition

to that, these two kinds of waste can be the origin of the Muda (and vice versa). Also, if the patient waits many hours for a consultation with the doctor, we generally classify this waste in "Waiting". But the cause of this waste may be due to the Mura, which means creating an overload of work of the doctor. In addition, a form of waste can itself be its own original cause. For example, Unnecessary moves of the staff looking for materials and equipment may be due to excessive non-used stocks.

6. Extended classification of waste

The SWOT analysis indicates that the waste identification operation has problems at the level of its classification. (Bauch, 2004) classified the waste into two types, the "waste-type" refers to things that could be wasted and they are divided into two categories: "primary waste types" which appear in the triangle "Quality to market" "Costs to market", "times to market" and "secondary waste types" that result in "Resources", "time", "Information / Knowledge," "Opportunity / Potential", "Money / Invest", "motivation". The second type is "waste drivers" and they are the reasons why things are wasted, or rather why there are problems in achieving the project objectives. This category according to the philosophy of Lean is the Muda type of waste. Figure 2 shows the classification of BAUCHE through which we notice that the author represented the waste in a waste of pyramid. The top of the pyramid represents "waste types" and they are the visible part in a process against "waste drivers" that are invisible and located at the bottom of pyramid.

Since the classification (Bauch, 2004) was established in the field of construction, he focused mainly on the waste type "Muda" as "waste drive" contrarily to "Mura" and "Muri" that are contained implicitly in the "waste type". In opposition to this system, we have indicated in the SWOT analysis that 3M may be responsible sources. We consider not only Muda as "waste drive" but "Muri" and "Mura" as well. So the first waste is not necessarily the responsible waste. We established an Ishikawa diagram that helps us structure the sources of waste to finally locate the responsible source. This diagram is not limited only to the "Muda" but can also include the waste type "Mura" and "Mura" as shown in Figure 5.

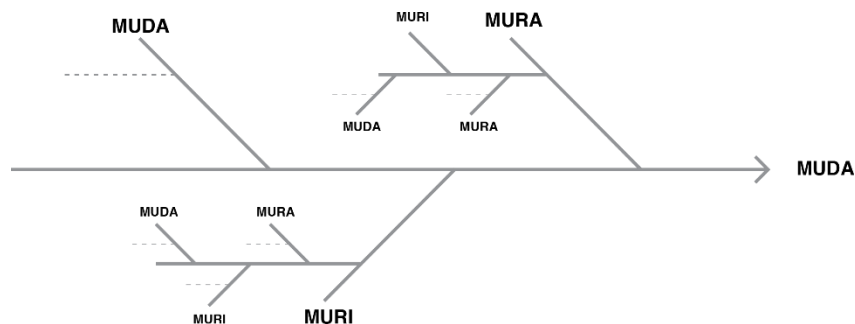


Figure 5. The "cause-effect" diagram of 3M

In addition, waste type "Muda" is the type that we identify first. In this sense, we decided to better classify "waste driver" into two categories namely direct waste attached to Muda and indirect waste which includes "Mura" and "Muri" as shown in Figure 6.

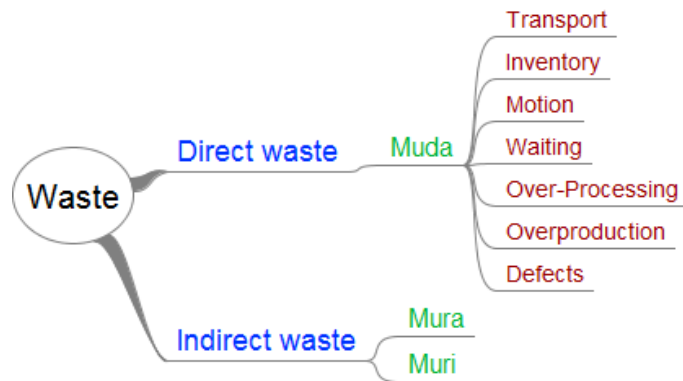


Figure 6. Waste driver classification

We note as well that the philosophy of Lean did not classify Mura and Muri as it was done with Muda. The fact that these 2M are left without any specification can justify their neglect by the entire scientific community. So, in this paper we do not limit ourselves to that level of classification but we try to make an extension of the other "M" that will allow the decision makers to consider the other two forms of waste and allow the elimination of variability in labor and overload. In this regard, we propose two categories for Muri: Lack of staff and lack of equipment.

- **Lack of staff:** human resources available can not achieve the tasks assigned to them in the desired or required time. Reduce the number of staff to minimize costs is not always true and can lead to additional expenses. It is an equation that is not always true because it can be a main cause of the overload.
- **Lack of equipment:** the equipment available can not support the working capacity or there is not a dedicated machine for a desired task when the human operator is unable to do so.

We offer two categories for Mura: Poor planning and irregular demand.

- **Poor planning:** inefficient use of human resources and available equipments.
- **irregular demand:** there is no stable demand

According to the changes we made to the proposal (Bauch, 2004) and in order to adapt to the hospital system, we proposed a model that is illustrated in Figure 7.

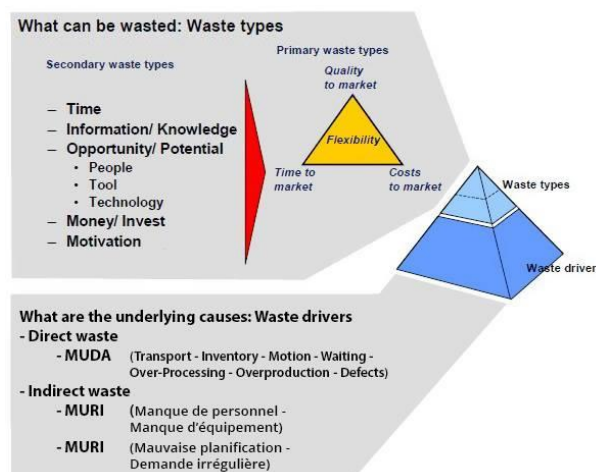


Figure 7. Extended classification of waste in hospitals

Conclusion

For hospital systems, Lean is a strategic approach that allows hospitals to improve the quality of patient care through a process of continuous improvement and employees' engagement. Despite its success in hospitals, its implementation faces many problems. The sources of these obstacles are diverse and their existence is due to the incorrect application of the five principles of Lean. This paper has focused mainly on the second principle of Lean and particularly the waste identification operation for which we have established an analysis using the SWOT matrix. This is seen as a strategic tool for decision making. This analysis allowed us both to criticize the proposals for the classification of waste and thus propose a model that encompasses the majority of problems encountered in the hospital setting. We plan for the next step to apply our model at a care production process of the Military Hospital in Rabat, Morocco.

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