

A Business Process Improvement Method

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Abstract

This paper proposes a Lean method for the improvement of the business processes and a partial implementation of this method in the hospital domain, at the Moulay Ismail hospital in Meknes, Morocco.

This paper analyzes 34 Lean methods from different domains in order to identify the steps to follow, the tools to use as well as the principles to check for successful Lean implementation. A semantic analysis of the steps is used to group them into phases. After that, the principles are associated with these phases and the tools are assigned at each stage of these phases.

The Lean method proposed is a multisectoral method and the hospital domain is the subject of the application of this method. The partial application of this method has ensured the commitment of hospital managers and staff.

Keywords

Business Process Improvement, Lean Approach, Lean Method, Tools, Principles, Objectives, Hospital

1. Introduction

Due to the massive development induced by information and communication technologies in all aspects of life, organizations are subject to rapid changes on technical, organizational and operational levels (Rashid and Ahmad, 2013). These changes require systems, regulations, and procedures in order to increase the efficiency and performance of business processes and ensure that objectives are achieved, thus ensuring the company's competitive position in the marketplace (Rashid and Ahmad, 2013).

Process improvement is the systematic approach to reduce differences in performance of the process or system through streamlining and reducing cycle time, identifying and eliminating the causes of sub-quality, process variation and activities with non-value added (Sutari, 2015).

The Lean approach is widely recognized as effective in improving performance in a broad range of businesses; from the automotive industry and refining aluminum to the administrative and financial services of Aerospace industry (Zhu et al., 2014).

Lean approach is part of continuous improvement and enables organizations to achieve their business goals. In order to implement this approach, we propose a method Lean for the business processes improvement.

In order to do so, we identified the steps, principles and tools used in 34 Lean methods to then group these steps into phases and assign the necessary tools to the appropriate steps, and also to associate the principles that need to be verified to the level of each phase.

We chose the hospital domain to apply our method. The partial application of our Lean method has allowed us to ensure the commitment of managers and staff, which is considered among the problems that limit the implementation of Lean approach. This method has also allowed us to establish the current state of the selected business process in order to make the right decisions to improve it.

This paper is organized into four sections. In section 2, we present our Lean method. In section 3, we present a case study that concerns the partial implementation of our method in the hospital domain. Finally, we present in section 4 a conclusion and some perspectives.

2. The proposed Lean method

(Tiamaz and Souissi, 2018) compiled a literature review of Lean methods and selected 34 articles. These Lean methods come from different domains. We note that there are 29 articles that are presented as a case study and 5 articles that are presented as a research article as shown in Table 1.

Table 1. Selected articles for each article type

Article type	Number
Case study	29
Research	5
Total	34

(Tiamaz and Souissi, 2018) classified Lean methods into four types, namely: tool-oriented Lean methods; that focus on the tools to use, principled-oriented Lean methods that focus on the principles to be satisfied, objective oriented Lean methods that focus on the objectives to be achieved, and finally, hybrid Lean methods that rely on the tools to be used, the principles to be satisfied and the objectives to be achieved. (Tiamaz and Souissi, 2018) also compared these methods based on the objectives achieved by each type of method and found that hybrid methods are the methods that satisfy more objectives. For this reason, we have chosen to propose a hybrid Lean method and implement it in the hospital domain.

To do so, we started by analyzing the Lean methods proposed in the selected articles in order to identify the steps, the tools and the principles used. Regarding the steps, we followed a semantic and syntactical analysis to identify similar steps that have different names. Thus, we grouped the steps that meet a particular objective into phases whose name

bears the designation of that objective. To achieve a step, it is necessary to use at least one Lean tool. Therefore, we assigned the identified tools to the appropriate steps. It should be noted that the tool lists assigned to the steps are non-exhaustive lists. To ensure that Lean principles are implemented by the end of our Lean method, we focused on the verification of principles at the end of each phase. Thus, the success of a phase depends on the verification of the principles associated with it.

Table 2 describes the phases, principles, steps and tools of the proposed method. Every step, tool, or principle mentioned in this method is already used in at least one of the Lean methods selected in our literature review.

Table 2. The proposed method

N°Phase	Phases	Principles	Steps	Tools
1	Define the goals	- Involve managers (Nguyen and Do, 2016; Skeldon et al., 2014; Zhu et al., 2014)	1.1. Define the target objectives (Atkinson and Mukaetova-Ladinska, 2012; Skeldon et al., 2014)	Project Charter (Simon and Canacari, 2012)
			1.2. Determine and measure the performance indicators (Atkinson and Mukaetova-Ladinska, 2012; Cima et al., 2011; Collar et al., 2012; Mostafa et al., 2013)	
2	Understand the environment	- Go and see for yourself (Gao and Low, 2014)	2.1. Make observations (Collar et al., 2012; Esa et al., 2015; Mostafa et al., 2013; Sutari, 2015; Zhu et al., 2014)	Benchmarking (Banawi and Bilec, 2014; Matt and Rauch, 2013)
				Voice of Customer (Chiarini, 2012)
				Survey (Collar et al., 2012; Esa et al., 2015; Mostafa et al., 2013; Zhu et al., 2014)
			2.2. Select process (Marques et al., 2016; Mostafa et al., 2013; Rohani and Zahraee, 2015; Zhu et al., 2014)	
3	Understand the process	- Go and see yourself (Gao and Low, 2014) - Focus on process (Sutari, 2015) - Employee Empowerment (Gao and Low, 2014; Sundar et al., 2014) - Self-directed work teams (Mostafa et al., 2015) - Cross-functional work force (Chiarini, 2011) - Involve the staff (Nguyen and Do, 2016; Skeldon et al., 2014; Zhu et al., 2014)	3.1. Build a team dedicated to the process (Cima et al., 2011; Collar et al., 2012; Simon and Canacari, 2012; Zhu et al., 2014)	
			3.2. Establish a process mapping [9], [10], [18], [22][8], [9], [17], [21](Andrés-López et al., 2015; Banawi and Bilec, 2014; Belhadi and Touriki, 2016; Bhamu et al., 2013; Chiarini, 2011; Cima et al., 2011; Collar et al., 2012; Duska et al., 2015; Mostafa et al., 2013; Rahani and al-Ashraf, 2012; Rohani and Zahraee, 2015; Simon and Canacari, 2014, 2012; Skeldon et al., 2014; Sultana and Islam, 2013; White et al., 2015; Zhu et al., 2014)	VSM (Andrés-López et al., 2015; Banawi and Bilec, 2014; Belhadi and Touriki, 2016; Bhamu et al., 2013; Chiarini, 2012, 2011; Cima et al., 2011; Duska et al., 2015; Matt and Rauch, 2013; Mostafa et al., 2013; Nguyen and Do, 2016; Rahani and al-Ashraf,

				<p>2012; Rohani and Zahraee, 2015; Simon and Canacari, 2012; Sultana and Islam, 2013; Sundar et al., 2014; Zhu et al., 2014)</p> <p>Gemba (White et al., 2015)</p> <p>Spaghetti diagram (Chiarini, 2011; Gutsche et al., 2014; Lingaratnam et al., 2013; Nguyen and Do, 2016; Rauch et al., 2016; Skeldon et al., 2014)</p> <p>Swim lanes (Collar et al., 2012; Simon and Canacari, 2014)</p>
			3.3. Measure the process (Banawi and Bilec, 2014; Chiarini, 2012; Cima et al., 2011; Sutari, 2015)	<p>Calculte « Takt Time » (Chiarini, 2011; Gao and Low, 2014; Lam et al., 2016; Rohani and Zahraee, 2015; Sundar et al., 2014)</p> <p>Critical to quality flowdown (Chiarini, 2012)</p> <p>Multiple activity chart (Lam et al., 2016)</p>
			3.4. Identify added and non-added values activities (Lam et al., 2016)	
4	Manage wastes	- Go and see yourself (Gao and Low, 2014)	<p>4.1. Identify waste (Banawi and Bilec, 2014; Chiarini, 2012, 2012; Choomlucksana et al., 2015; Collar et al., 2012; Ebeid et al., 2016; Marques et al., 2016; Mostafa et al., 2013; Simon and Canacari, 2012; Sutari, 2015)</p> <p>4.2. Classify waste (Choomlucksana et al., 2015; Ebeid et al., 2016; Esa et al., 2015; Simon and Canacari, 2012)</p>	<p>Brainstorming (Banawi and Bilec, 2014; Chiarini, 2012; Ebeid et al., 2016; Nguyen and Do, 2016; Simon and Canacari, 2012)</p> <p>5 whys / Ishikawa (Banawi and Bilec, 2014; Chiarini, 2012; Choomlucksana et al., 2015; Collar et al., 2012; Gao and Low, 2014, 2014; Gutsche et al., 2014; Lingaratnam</p>

				et al., 2013; Mostafa et al., 2013; Simon and Canacari, 2014, 2012; Sultana and Islam, 2013; Sutari, 2015; Zhu et al., 2014)[11][10]
			4.3. Prioritize waste (Chiarini, 2012; Ebeid et al., 2016)	Pareto chart (Banawi and Bilec, 2014; Ebeid et al., 2016; Mostafa et al., 2013; Rauch et al., 2016; Sutari, 2015) Impact analysis grid (Simon and Canacari, 2012)
			4.4. Identify root caused of identified waste (Banawi and Bilec, 2014; Chiarini, 2012, 2012; Collar et al., 2012; Ebeid et al., 2016; Mostafa et al., 2013; Sutari, 2015)	Brainstorming (Banawi and Bilec, 2014; Chiarini, 2012; Ebeid et al., 2016; Nguyen and Do, 2016; Simon and Canacari, 2012)
			4.5. Classify root caused of identified waste (Banawi and Bilec, 2014; Chiarini, 2012)	5 whys / Ishikawa (Banawi and Bilec, 2014; Chiarini, 2012; Choomlucksana et al., 2015; Collar et al., 2012; Gao and Low, 2014, 2014; Gutsche et al., 2014; Lam et al., 2016; Mostafa et al., 2013; Sutari, 2015; Zhu et al., 2014)
			4.6. Prioritize root caused of identified waste (Banawi and Bilec, 2014; Chiarini, 2012)	Pareto chart (Banawi and Bilec, 2014; Ebeid et al., 2016; Mostafa et al., 2013; Rauch et al., 2016; Sutari, 2015)
5	Implement	- Quality at the source (Sundar et al., 2014) -Create value for the customer (Gao and Low, 2014) -Build a culture of stopping to fix problems, to get quality right the	5.1. Organize meetings (Collar et al., 2012; Simon and Canacari, 2012) 5.2. Prioritize and develop solutions (Banawi and Bilec, 2014; Chiarini, 2011; Choomlucksana et al., 2015; Ebeid et al., 2016; Lam et al.,	 Brainstorming 5 whys / Ishikawa (Banawi and Bilec, 2014; Chiarini, 2012; Choomlucksana et

		first time (Gao and Low, 2014)	2016; Simon and Canacari, 2014; Sutari, 2015)	al., 2015; Collar et al., 2012; Gao and Low, 2014; Gutsche et al., 2014; Lam et al., 2016; Mostafa et al., 2013; Sutari, 2015; Zhu et al., 2014)
				Pareto chart (Banawi and Bilec, 2014; Ebeid et al., 2016; Mostafa et al., 2013; Rauch et al., 2016; Sutari, 2015)
				Activity scorecard (Simon and Canacari, 2012)
			5.3. Apply the proposed improvements (Atkinson and Mukaetova-Ladinska, 2012; Banawi and Bilec, 2014; Belhadi and Touriki, 2016; Chiarini, 2012; Choomlucksana et al., 2015; Collar et al., 2012; Ebeid et al., 2016; Esa et al., 2015; Lingaratnam et al., 2013; Marques et al., 2016; Mostafa et al., 2013; Nguyen and Do, 2016; Simon and Canacari, 2012; Skeldon et al., 2014)	SMED (Belhadi and Touriki, 2016; Chiarini, 2011; Esa et al., 2015; Sundar et al., 2014)
				Heijunka (Gao and Low, 2014; Sundar et al., 2014)
				Cellular Manufacturing (Belhadi and Touriki, 2016; Matt and Rauch, 2013; Sundar et al., 2014)
				TPM (Belhadi and Touriki, 2016)
				Line balancing (Lam et al., 2016; Sundar et al., 2014)
				5S (Andrés-López et al., 2015; Belhadi and Touriki, 2016; Chiarini, 2011; Gao and Low, 2014; Matt and Rauch, 2013; Nguyen and Do, 2016; Rauch et al., 2016)
				Kanban (Belhadi and Touriki, 2016; Chiarini, 2011; Gao and Low, 2014; Matt and Rauch, 2013; Nguyen and Do, 2016; Sundar et al., 2014)

				Poka Yoke (Chiarini, 2011; Matt and Rauch, 2013)
6	Revise	- Self-directed work teams (Mostafa et al., 2015) - Go and see for yourself (Gao and Low, 2014)	6.1. Evaluate the progress (Chiarini, 2012; Collar et al., 2012; Lingaratnam et al., 2013; Nguyen and Do, 2016)	
			6.2. Evaluate the indicators selected (Chiarini, 2012, 2011; Cima et al., 2011; Nguyen and Do, 2016)	2-tailed t-test (Collar et al., 2012)
7	Sustain the results	- Continuous improvement culture (Gao and Low, 2014; Simon and Canacari, 2012; Sundar et al., 2014) -Pursue Perfection (Mostafa et al., 2015)	7.1. Promote a culture of continuous improvement (Andrés-López et al., 2015; Banawi and Bilec, 2014; Belhadi and Touriki, 2016; Mostafa et al., 2013; Simon and Canacari, 2012; Sundar et al., 2014)	Standardization (Andrés-López et al., 2015; Belhadi and Touriki, 2016; Matt and Rauch, 2013; Sundar et al., 2014)
				Control plan (Banawi and Bilec, 2014)
				Kaizen (Simon and Canacari, 2012)
			7.2. Update procedures (Ebeid et al., 2016; Mostafa et al., 2013)	
		7.3. Expand Lean practices (Mostafa et al., 2015, 2013)		

After identifying the elements that build our method and assigning the principles to the phases and the tools to the steps as well as establishing the necessary sequencing in order to apply our Lean method in a way that guarantees the success of its implementation, we synthesize our research below, explaining each phase further.

Phase 1 - Define the goals: Clearly define the objectives to be achieved based on the company's own needs and the commitment of managers in order to avoid any reluctance from their side, and mobilize financial, human and material resources for common goals in order to achieve significant changes. Lack of commitment from managers is considered as an obstacle to implementing Lean approach (Turesky and Connell, 2010). Ensuring this commitment is an essential step in the implementation of the Lean approach. This commitment must remain along the implementation of Lean approach and not only at the beginning because the Lean team can not implement this approach without the continuous support of managers (Berlec et al., 2017).

Phase 2 - Prepare the environment: Build a project team that helps implement Lean approach at the selected process scale. This team must have the required knowledge to implement Lean approach and be able to share this knowledge with the employees and convince them to accept the eventual changes and subsequently embrace Lean approach as part of the corporate culture, because it is not easy to implement changes without disrupting employees' habits. The team is supposed to know how to neutralize negative reactions. It is important to use lean tools that aim to better organize the workspace in order to eliminate waste and to spot employees who are not yet motivated and are not ready to make changes. It is also important to listen to this type of employees and include them in the process of change by empowering them and encouraging their autonomy.

Phase 3 - Understand the process: Visualize how the chosen process works to understand its physical and information flows in order to map them through identifying and writing all the steps necessary to carry out the operations that build this process. However, this mapping should not be too general so it doesn't show little operational interest and shouldn't be too detailed so that it doesn't become inoperable. Then, analyze and measure process parameters in order

to identify process improvement opportunities through the identification of added-value activities that report and activities that consume time and resources without added value in the process.

Phase 4 - Identify the waste: Identify the waste: Collect identified process waste through information on the whole process provided by the mapping. Then, classifying waste gives an overview that makes it easier to analyze it. Generally, tracking all identified waste is a tedious job that consumes a lot of time and requires mobilizing human, financial, and material resources that are not always available to intervene. So, it is best to focus on the most important waste to eliminate. While the identification of wastes is only a starting point for the elimination of waste, the identification of the root causes of identified waste is the most guaranteed way to avoid its reappearance.

Phase 5 - Implement: Propose effective corrective actions to eliminate the root causes of waste. To do this, organize meetings in order to propose possible solutions that could be put in place to eradicate this waste. But implementing all the proposed solutions is still not feasible and not a wise decision. It is better to analyze and examine the proposed solutions in order to decide later which are the most adequate ones. These solutions require applying a series of tools that lead to an improvement in the chosen process.

Phase 6 - Revise: Evaluate the effectiveness of applied solutions at the process level by checking the targeted metrics that have been targeted by the project team, and at the company level, by checking the indicators that have been selected by the managers. However, the selected solutions do not necessarily bring improvements at this level. Gathering information regarding different the advancement status of the project team helps to evaluate the added value of these solutions and to make informed decisions.

Phase 7 - Sustain the results: Sustain the results: Save the solutions that provide desirable results as a set of procedures in the operating mode. Formalizing the tasks performed to improve a process is necessary to fluidize and simplify the improvement of other processes.

3. Case study: Moulay Ismail Hospital in Meknes, Morocco

The institution that is the subject of our case study is Moulay Ismail Hospital in Meknes, Morocco. A functional map of the hospital information system is shown in Figure 1 to clearly understand the institution studied.

A meeting with the Hospital Information System (HIS) Manager helped us identify the system to be transformed, which is the Surgical Diagnostic Service. The manager of HIS generated a personalized roadmap where he removed "Provide Training" phase. For a month and a half, we followed the first four phases: "Define the goals", "Understand the environment", "Prepare the environment" and "Understand the process".

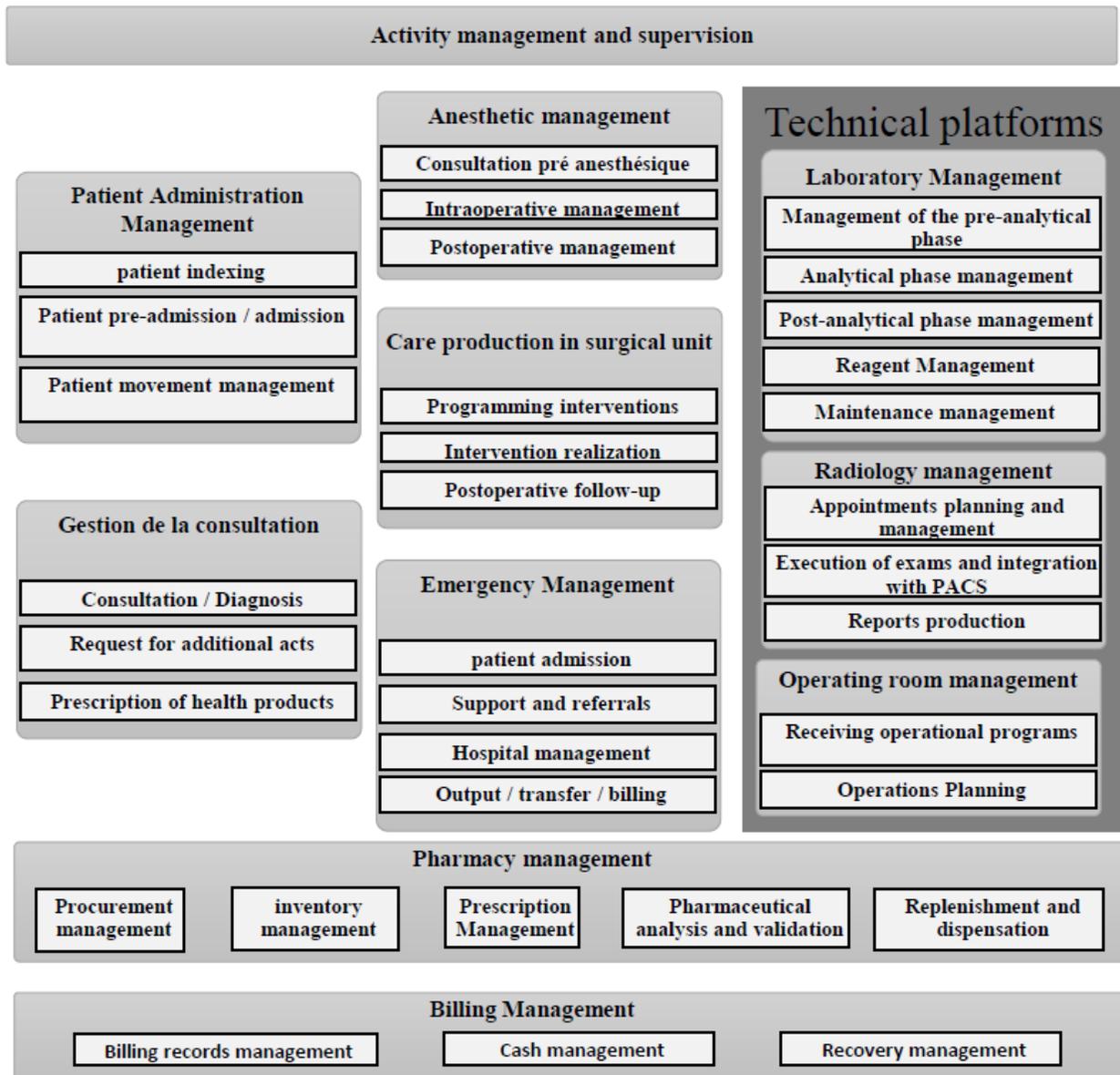


Figure 1. Functional mapping of Moulay Ismail Hospital in Meknes

A meeting with the Hospital Information System (HIS) Manager helped us identify the system to be transformed, which is the Surgical Diagnostic Service. For a month and a half, we followed the first three phases: “Define the goals”, “Understand the environment”, and “Understand the process”.

1.1 Define the goals

In order to define the desired objectives, we decided to provide the HIS manager with the ones mentioned by CXP (Muriel, 2015), which specified 12 objectives to be achieved following the implementation of business process improvement approaches. These objectives are: 1. Customer satisfaction improvement; 2. Reduce costs; 3. Operations Traceability; 4. Operations Reliability; 5. Improved operating performance; 6. Improving team productivity; 7. Membership of employees / proposal of new services; 8. Reduced treatment time; 9. Break the functional and IT silos; 10. Extension of the process to the outside of the company; 11. Improvement of Information System; 12. Better integration of Information System. These goals can also be achieved through Lean approach (Tiamaz and Souissi,

2016). The HIS manager has chosen three objectives: Customer satisfaction, Reduce costs and Reduced treatment time.

After the identification of the objectives, we defined the performance indicators for verification after the implementation of Lean approach. La Table 3 illustrates the selected performance indicators.

Table 3. Performance indicators

Indicator	Description
Average waiting time of the patient	Calculates the average time a patient has to wait between registration and consultation.
Number of visitors (patients) leaving without seeing a doctor	Indicates the number of people who come to the hospital and fail to see the doctor.
Level of patient satisfaction	Indicated if patients are satisfied with the level of care they received.
Number of hours of patient contact	Indicates the time that health care staff spend directly with patients
Average processing load	Indicates the average cost to treat a patient.
Equipment utilization rate "By type"	Counts for the number of days the equipment was actually available compared to the number of days the equipment was needed.
Number of patients served per month	Counts the number of people receiving care each month
Readmission rate «With the pattern (typing)»	Calculates the number of patients the service receives.
Admission rate	Calculates the number of patients the service receives.
Percentage of canceled or missed appointments	Calculates the percentage of canceled or missed appointments

1.2 Understand the environment

A meeting with the manager of the Surgical Diagnostic System helped us identify the processes to be improved, which are the trauma, pre-anesthetic consultation and urology processes. In this phase, the manager preferred to choose only the step of process selection. He chose the trauma consultation process as the first process to improve.

1.3 Understand the process

The manager selected only the step of building a team dedicated to this process. Therefore, the selected team consisted of: Head of surgical pole "Manager", Senior nurse, Trauma surgeon, Medical secretary

The first step is to establish process mapping. In our case, we chose BPMN to build trauma process mapping. Figure 2 illustrates this mapping.

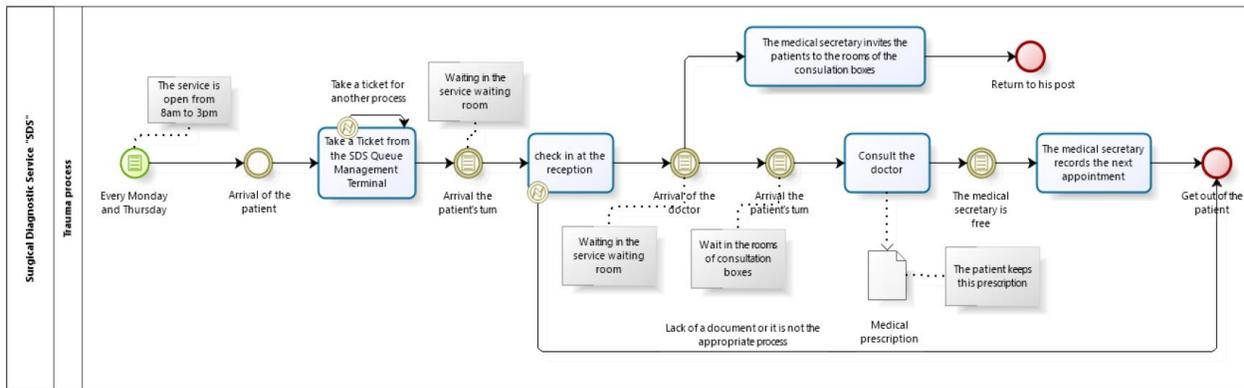


Figure 2. Mapping the trauma process

After the trauma process mapping, we moved to the "Measure the process" step. We measured the length of stay of the patient starting from the entrance to the process until the process exit, for a day. In this process, there is no computer system that records the number of patients arriving or a clocking-in and out system to record the time of entry and exit of the process doctors. But there is an electronic queue management system to streamline the registration and consultation phase. So, we observed the patients and the doctors and we recorded this information in a manual way. Figure 3 illustrates the indicators that we have been able to derive from our observations in the field.

We noticed that only 52% of the patients were registered at the entrance as well as at the exit. It was very difficult to record the timing of exit of each patient, but the timing of entrance was easier to record since it is mentioned in the ticket that patients take via the electronic system. The average waiting time of a patient in this process is high. Also, the number indicated in the patient's ticket and that is used for patient queue management, is not always respected during the consultation phase.

An in-depth analysis of these indicators will be performed to identify problems in this process as well as the root causes, in the fifth phase of the personalized roadmap, which is not the focus of this paper.

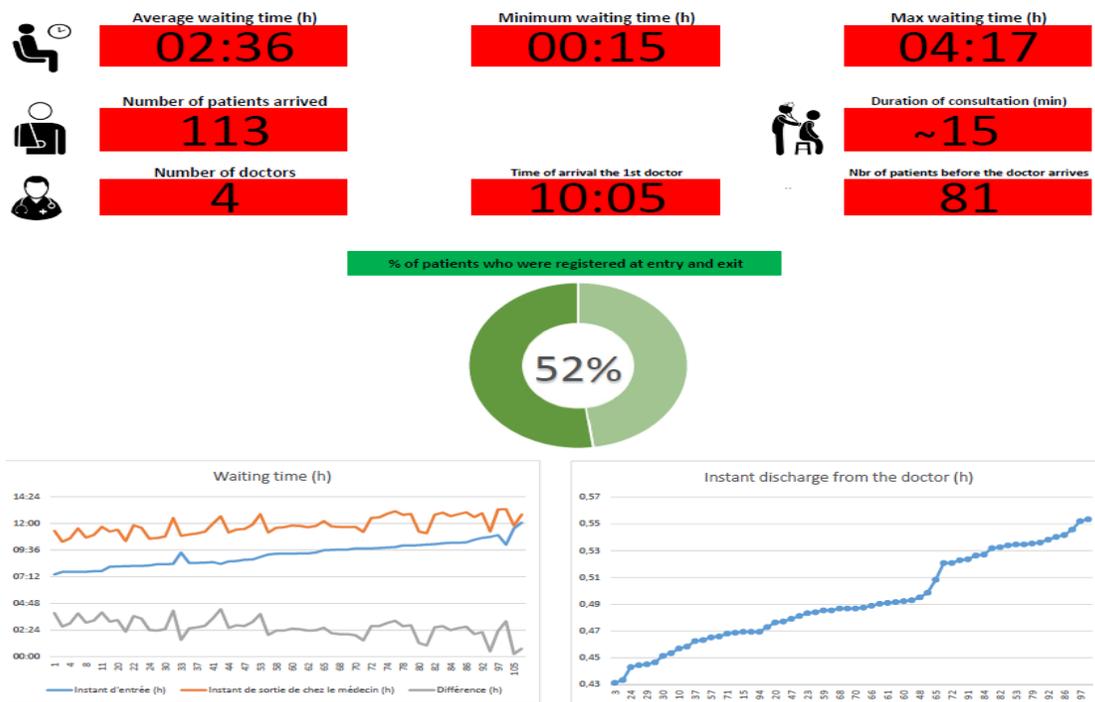


Figure 3. The indicators collected

4. Conclusion and future work

This paper introduced our Lean method for business process improvement based on 34 Lean methods. This method is a hybrid Lean method that involves using tools as part of steps to meet objectives while verifying principles. This paper also presented our progress of the implementation of Lean approach in the hospital of Meknes in Morocco. This case study focused on the application of our method to improve the trauma consultation process. We applied three phases among seven phases of this method namely: "Define the goals", "Understand the environment", and "Understand the process". Afterwards, we plan to identify added and non-added values and analyze the waste in this process to identify its root causes and then propose and apply innovative solutions to address these issues in order to maintain and sustain our improvement.

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