

# Lean Manufacturing and Six Sigma Critical Success Factors: A Case Study of the Moroccan Aeronautic Industry

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**Abstract-**Companies are constantly striving to achieve a highest rate of competitiveness. Thus, they implement either Lean manufacturing or Six sigma approach or both. However, their successful implementation is a real challenge. Hence, one of the proven tools to take up this challenge is a set of critical success factors (CSFs). This study provides a comparative statement of the recommendations suggested by every CSF from the perspective of each approach and examines how far the CSFs determine the successful implementation of Lean manufacturing and Six Sigma in the Moroccan aeronautics industry. Also, based on a qualitative research methodology it assesses the importance assigned to each CSFs for each approach. The results would provide aeronautics managers with indicators and guidelines for a successful simultaneous implementation of Lean principles and Six sigma techniques.

**Keywords:** *Lean, Six Sigma; Critical success factors; chronology; Moroccan aeronautic industry*

## 1. Introduction

Companies are constantly investigating the improvement of their competitiveness. Lean Manufacturing and Six Sigma are among the most popular approaches that help organizations optimize the management system and business processes leading to total supply chain transformation [1] resulting in customer satisfaction, reduced costs and consequently increased revenue [2].

Indeed, the two approaches have different roots but have some common purposes: both methodologies aim to reduce waste and time and to enhance the quality of a product. They also help managers to structure projects and to focus as much as possible

on customer expectations and satisfaction [3].

Therefore, it is the two methodologies integration as Lean Six Sigma that provides a more dramatic impact to the organizational culture and the bottom line [4], and then integrating the two approaches can achieve better results than what either approach could not achieve alone [5].

To further understand each approach and encourage their simultaneous integration, several papers discussed the comparison of Lean manufacturing and Six sigma in terms of their similarities, differences and issues in different context to properly assimilate each of the two methods [3], [5]–[11].

This comparison has taken on a broader scope through significant studies [6], [9], [12]–[17] and has been well expanded by establishing numerous CSFs needed for fruitful implementation of Lean, Six sigma and Lean Six Sigma.

Several critical factors that determine the successful implementation of Lean manufacturing and Six sigma are identified. Management commitment, communication, employee involvement, culture change, skills and expertise, amongst other factors; are classified as the most pertinent issues critical for the successful adoption of Lean manufacturing and Six sigma.

Furthermore, this research paper aims to outline the choice and sequence to implement either Lean manufacturing or Six sigma in Moroccan aeronautics industry. Thus, the main objectives of this research are to:

- Review the literature to identify and consolidate the Lean and Six sigma critical success factors;
- Reveal the Lean and Six sigma implementation strategy in the

- Moroccan aeronautics industry: sequential or separated implementation.
- Compare the identified CSF with those implemented in the Moroccan aeronautics industry.
- Define and draw up a comparative statement of the importance assigned to each CSF for each methodology in the Moroccan aeronautics industry.

## 2. Literature review:

### 2.1. Lean and Six Sigma approaches:

These approaches have been widely used by companies around the world. In the 1940s, Lean manufacturing originated at Toyota in Japan and has been also implemented by many major US firms [7]. Six sigma was founded by Motorola Corporation in the 1980s, and then was adopted by many US companies.

Effective implementation of Lean management generates routine reinforcement of intra and inter-organizational capabilities and improved competitiveness over time through the use of Lean principles, structured processes and tools [18]–[20]. Therefore, the integration of this approach maximizes the product value and reduce losses [21].

While, the additional approach appears and has proven its power to improve processes and quality, to reduce costs and accelerate product cycles. The new approach was based on statistical measures for quality improvement, is known in the business world by the phrase, Six Sigma [22]. And thanks to its proven success in improving the production operations of renowned companies such as Motorola and GE, Six Sigma has been adopted by other sectors such as the health and service sector [20].

Furthermore, integrated implementation of Lean and Six Sigma into Lean Six Sigma increases an organization's potential to achieve high operational and financial optimal results: IBM's consulting team wrote that Lean Six Sigma has included components of the systems-based approach to process improvement cited Goldratt's stress theory. This statement confirms that Lean Six Sigma's continuous improvement methodology continues to change and adapt to the challenges faced in the business community [20]. Indeed, Lean regulates material and information between process steps, while Six sigma has demonstrated its utility in handling deviations in process steps. Many Lean

principles are based on qualitative models developed from years of experience. In contrast, Six Sigma can play a vital role in understanding what is really happening within the process steps [20].

Despite all these miraculous effects on the value chain, many companies were unable to succeed and maintain its integration. Actually, many companies have found it difficult. It is, therefore, very important to identify and understand critical success factors for successfully implementing of Lean manufacturing and/or Six sigma [6].

The paper is structured as follow: First, a literature review of Lean, Six sigma and their common CSFs is outlined. Second, the methodology followed is described. Third, the CSFs comparative implementing guideline is presented. Finally, the study of CSFs assessment in Moroccan aeronautic industry is described and analysed.

### 2.2. Lean & Six Sigma critical success factors:

Defining the CSFs helps companies to achieve a high success rate for Lean and Six Sigma projects [12], it also facilitates the choice between the two approaches and encourages their simultaneous integration [6]. Also, as reported by [13] if any of the critical success factors are missing during the development and implementation stages of a LSS program, it could generate the difference between a successful implementation and a waste of resources, effort, time and money. Then, many companies are employing the CSF methodology to ensure the success and sustain of Lean manufacturing, Six sigma and Lean Six sigma implementation and greatest profitability.

A review of the literature revealed that there are a set of factors that are prerequisites for successful implementation: Management commitment, culture change in organizations, good communication in the hierarchy [23], new approaches to production and customer service and a high level of training and education of employees [19]. These axes are more frequently reported in the literature as success factors for Six

sigma, [19]. It has been also revealed the: Employee Involvement, Skills and Expertise, Linking the Six Sigma Method to Customers, Linking the Six Sigma Methodology to Business Strategy, Linking the Six Sigma Method to Vendors, Linking the Six Sigma method to Human

Resources, Reward System, Competency in project management In 2017, a slight modification was made to these axes by adding the "understanding of tools and techniques" applied to employees [6]. One of the main reflections made is that with only slight variations, the CSFs are similar for all the change methodologies [15]. These factors are more frequently reported as critical success factors for Lean and Six sigma and are set out below (Table1). Although it should be noted that many companies fail to integrate the above factors in their organizational systems and do not identify them well before their continuous improvement initiatives, so they never achieve the desired results [24]. Thus it's crucial to draw up a brief clarification about each factor.

### 2.2.1. Management Commitment

Without commitment, any change program is a wastage of time and energy. Researchers believe that commitment by management is important, which inspires employees and supports the strategic role of the initiative. Management should define vision, strategic direction and develop the culture of the organization, which promotes continuous improvement to improve sustainability performance [14]. Furthermore, three CSFs were discussed in every single article, and "management involvement and commitment is one of the most dominant factors [17] [25]. Not surprisingly, it ranks equally high for the currently popular Lean and Six Sigma [15]. Actually, top management obviously plays a significant role in the adoption and early stages of a Six Sigma program since they set the organizational goals, control the required resources and can solidify the program as a priority for middle management [26]. Also, [27] reports that the top managers need to "directly participate" with the Six Sigma process, "not just offer support."

For Lean implementation to be successful, all members of the organization must be committed to the implementation and practice of Lean tools and techniques [1]. Furthermore, according to [28], to succeed in implementing a Lean program in a factory, managers must commit to and involve themselves in the activities of implementation and develop Lean knowledge and competency by offering continuing education and training to both managers and employees is critical for success. Additionally, top-level managers can make it clear that the firm is committed to the program through the allocation of appropriate resources.

**Table1.** Lean and Six sigma common Critical success factors

Common CSF	References of Lean	References of Six sigma
Management commitment	[1], [14], [15], [17], [23], [28]	[5], [17], [23], [26], [27]
Culture change	[5], [7], [23], [29]–[31]	[6], [23], [28]
Communication	[23], [32]	[13], [23], [33]
Training and education of employees	[1], [16], [19], [32]	[15], [16], [19], [34], [35]
Understanding of tools and techniques	[6], [32]	[6], [26], [32], [36]
Employee involvement	[5], [6], [19], [37]–[40]	[6], [19]
Skills and expertise	[41]–[43]	[5], [15], [44]

### 2.2.2. Culture change:

Changing cultural behavior is a critical success factor for successfully implementing Lean manufacturing [29].

However, changing the behavior of people is an onerous task within Lean manufacturing [30], because as indicated by [29] it's difficult for employees to change habits and then workers require time to become accustomed to the Lean philosophy. while Six sigma is statistical in nature and just requires a work team to understand statistics [6].

Apart from this, the organization should ensure the empowerment of people, inducement and enhancement of creativity. Recognition plays an important role in this context, and in return, employees should work according to the company's strategies for successful implementation [41], [45].

### 2.2.3. Communication:

Significant levels of communication are required for the successful implementation of Lean [46]. This was confirmed by [31] who stated that a lack of organizational communication leads to the failed implementation of Lean manufacturing, while effective communication also ensures the successful implementation of Six sigma within the organizational framework [33]. In contrast, Six

Sigma understands the organizational infrastructure, and thus facilitates communication between employees, since one of the benefits of a Six sigma program is the creation of a common language [23]. Then, resistance to change can be reduced.

#### 2.2.4. *Training and Education of employees*

The literature review found that training is a complex CSF including aspects who, what and when to train [15]. Indeed, it is a complex issue because it combines many components, from an understanding of the change effort in general, impact of the change, the roles of the various employees to more details of specific approaches and tools [15]. Then, similarly, in both Lean and Six Sigma projects, organizations must ensure that employees at all levels are familiar with their role in the process improvement program [16], [35].

Indeed, embracing Lean entails considerable organizational cultural change, which in turn requires training to understand the philosophy. Thus, the training can include anything from general training such as the importance of change method and why it will improve organizational performance to specific tools for the actual method [15].

Similarly, Six Sigma initiatives require investment in education and training to provide the necessary tools, knowledge and methodology that employees need to understand the changes required by the initiative [34].

#### 2.2.5. *Understand tools and techniques*

Understanding techniques provided a platform for communication and new processes of the operation and new tools that are needed to be understood, employees then get ready for the program.

Six Sigma, for example, contains many complex statistical tools, definitions, and acronyms that can cause confusion and reduce efficiency and effectiveness. In this way, issues can arise when Six Sigma teams do not fully understand the tools and try to force tools where they are not practical or needed [26]. One suggested solution to this particular dilemma is to focus training on the most commonly used and needed tools while supplementing training with workshops on the less frequently used tools [26].

Another problem is how the tools are understood as well as applied in projects. Watson and DeYong [36] mean that lack of structure, understanding and training can make all tools seem equally valuable

and applicable. Also, equipping those lower down the organization with an understanding of various tools and techniques is primordial to take ownership for improvements [32].

For Lean implementation, experience indicates that employees can learn basic Lean tools at all levels of employment and can be trained to appreciate and achieve continuous improvement without much difficulty. It's due to the non-complexity of the approach's tool and is, therefore, easily comprehended. Also, the standard work Lean tool produces rapid results. Then, Employees are capable of learning about and understanding Lean manufacturing philosophies without much difficulty [6].

#### 2.2.6. *Employment Involvement*

It is commonly accepted in the literature that employee involvement is a crucial factor in lean manufacturing. Moreover, [19] argue that the organizational change that is necessary during the implementation of lean requires the involvement of all employees [6]. Otherwise, implementation has a higher failure risk [37].

Thus, all employees from the bottom up must be involved in Lean implementation and practice [38], while Six Sigma requires more real involvement from top management to keep it going due to complexities of projects [5]. This was also concluded by [1] that for Lean implementation to be successful, all members of the organization must be committed to the implementation and practice of Lean tools and techniques. For example, for the implementation of Lean manufacturing, working with employees for the resolution of problems is a critical success factor [28].

On the other hand, Six sigma, does not need the entire organization's involvement. This is because only a select group of professionals who have been trained for the implementation will be involved [19]. Indeed, Six sigma is actioned by designated individuals, while Lean builds talent and, therefore, involves everyone. Six sigma only requires employees to be aware of their own duties and to understand the statistical analyses required. Therefore, each individual could perform the statistical analysis alone [6].

#### 2.2.7. *Skills and Expertise*

Facilitate resources and skills for implementation is one of the most urgent necessities for developing

and maintaining process-change activity, for instance, to construct human capital by working up with the appropriate skill-set for preparing and instructing to representatives [41]–[43]. The representatives should have the ability to comprehend and use the Lean Six Sigma devices and systems into consistent operations while remembering the ultimate objective to improve execution. Coworkers should be given enough time to understand and execute the basic resources to achieve advanced performance. It was noticed that people require a fair amount of specific skills and training to participate in Six Sigma projects [15]. For example, according to [44] Six Sigma project failures are often due to poor project management skills of the person leading the project. Furthermore, the perennial problem still surrounds Six Sigma in that it is seen as a complex analytical methodology that requires many years of statistical training before it can be effectively applied [5].

Differently, for Lean, “skills and expertise” factor includes the recruitment and enhancement of a capable workforce and provision of training and innovation. As confirmed by [5] companies have to assimilate the mutual relationship between these methods, and take into account that the advanced applications of Lean systems in Japan rely on the use of “production engineers”, whose training is an equivalent of the Six Sigma Black Belt, needed when advanced knowledge [5].

In conclusion of this session, we have exposed that each approach proposes a set of elements that are prerequisites for efficient implementation of the respective program. And, through an examination of the cited above, we have concluded a scattered explanations or interpretation of Lean and Six sigma CSFs. Therefore, companies cannot easily assimilate the fundamental elements to be taken into account during the pre-implementation phase of Lean and/or Six sigma and easily decide if they have the necessary means to ensure a successful implementation of one or both approaches.

Then, we aimed to examine the interpretations extracted from different sources studying the CSFs and then combine them into guidance

implementation (Table2) for an unambiguous integration.

### 3. Methodology

A combination of research methodology approaches has been employed in this paper. A comprehensive literature review and interviews with practitioners of Lean and Six sigma

Through the literature review conducted extensively at the initial stages of this research, we identified CSFs of Lean and Six sigma and principally their explanation in aim to develop their understanding. Thus, the literature review demonstrated a dispersion in explaining these CSFs. Then, the first step was to build an implementation guidance. It groups the factors of a successful implementation and distinguishes their interpretations toward each approach (Table2). Furthermore, this guidance was useful to unify the language between the researcher and the interviewees in terms of Lean manufacturing and Six sigma CSFs.

In the second step, the research process was based on an exploratory case study. It focuses on understanding how far the Lean and Six sigma critical success factors are implemented in the Moroccan aeronautics industry. The methodology used in this paper is therefore qualitative. This choice is justified by the orientation of our research to the exploration and qualitative generation of propositions.

To collect data, we adopted a very precise protocol. Thus, the main source of data was structured interviews with 14 quality managers working in different companies in the Moroccan aeronautic industry. The selected respondents were chosen for their knowledge of the issues being researched and are Lean Six Sigma certified. This selection criterion was used to make the study more representative.

**Table 1.** Key characteristics of Critical success factors for Lean and Six sigma

CSFs	Lean	Six Sigma
Management commitment	<p>Top management:</p> <ul style="list-style-type: none"> <li>Is committed to the program through the allocation of appropriate resources</li> <li>Defines vision, strategic direction and develops the culture of the organization</li> <li>Offers continual education and training to both managers and employees</li> </ul>	<p>Top management:</p> <ul style="list-style-type: none"> <li>Provides proper strategy selection, long-term vision and participation and a strong understanding of the current product and process designs</li> <li>Sets the organizational goals, control the required resources and solidify the program as a priority for middle management</li> <li>Predicts more investment due to project time requirement and complexity of projects</li> </ul>
Education and training	<ul style="list-style-type: none"> <li>Requires everyone in the organization to understand the philosophy</li> <li>Training can include anything from general training such as the importance of change method and why it will improve organizational performance to specific tools for the actual method</li> <li>Lean is easier to understand by senior managers</li> </ul>	<ul style="list-style-type: none"> <li>Requires more intense training</li> <li>Requires investment in education and training to provide the necessary tools, knowledge and methodology that employees need to understand the changes required by the initiative</li> </ul>
Communication	<p>Lean does not include an organizational infrastructure, then it requires to establish a strong communication networks</p>	<ul style="list-style-type: none"> <li>Six sigma projects already imposes a common language among employees</li> <li>Project managers focused on process efficiency within a communication plan in order to describe what should be communicated by whom and how often.</li> <li>Requires to propagate the business strategy, results and customer requirements</li> </ul>
Employee involvement	<ul style="list-style-type: none"> <li>Requires more involvement of all employees because of the organizational changes needed during implementation</li> <li>Based on quick wins to energize and maintain their initiative</li> <li>Individual methods that provide quick improvements</li> <li>Builds talent and, therefore, involves everyone.</li> </ul>	<ul style="list-style-type: none"> <li>Does not necessarily imply all employees: a selected group of professionals, who have been trained for the implementation, will be involved</li> <li>Six sigma project actioned by designated individuals</li> <li>Employees must be aware of their own duties and understand the statistical analyses required</li> </ul>
Understanding of tools and techniques	<ul style="list-style-type: none"> <li>Basic Lean tools at all levels of employment can be learned without much difficulty</li> <li>Employees are capable of learning about and understanding Lean manufacturing philosophies without much difficulty thanks to standard work Lean tools that produce rapid results.</li> </ul>	<ul style="list-style-type: none"> <li>Focus training on the most commonly used and needed tools to avoid confusion or force, not practical ones</li> <li>Provides supplementing training with workshops on the less frequently used tools</li> </ul>
Culture change	<ul style="list-style-type: none"> <li>Requires creating a supportive organizational culture from the ground up</li> <li>Requires to ensure the empowerment of people, inducement and enhancement of creativity</li> </ul>	<ul style="list-style-type: none"> <li>Does not require large cultural change because based on a clear and well-established DMAIC process</li> <li>Requires work team to understand statistics</li> </ul>
Skills and expertise	<ul style="list-style-type: none"> <li>Requires the formalization and codification of the experience</li> <li>Relays on recruitment and enhancement of a capable workforce and provision of training and innovation</li> <li>Relays on use of "production engineers" to assist front line operators when advanced knowledge or capability is required</li> </ul>	<ul style="list-style-type: none"> <li>Requires many years of statistical training and development</li> <li>Requires statistical and non-statistical skills and tools to reduce variation</li> </ul>

In order to analyze the collected data, a content analysis approach was used. This technique helped us to read the transcripts of interviews and allowed us to extract significant elements to understand how far the Lean and Six sigma critical success factors are implemented in the Moroccan aeronautic industry and to compare the importance given of the same specific critical success factors in

the implementation of Lean manufacturing and Six sigma methods.

Thus, to find out the point of view of these companies on those specific factors, a number of questions were asked:

- Whether that company had implemented Lean or Six sigma or Lean Six sigma, and in which sequence both of the approaches were implemented?

- What are the CSFs that are already implemented?
- What are the interpretations of the CSFs for each technique independently?
- What is the importance given by each company to the same specific CSF for Lean manufacturing and six sigma?

**4. Results & Discussion**

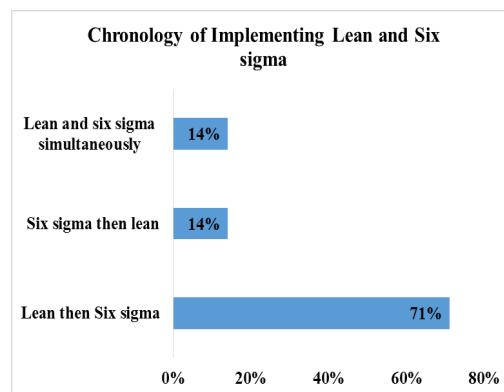
The experts that participated in the confirmation and evaluation of the identified success factors have been a member of the work team that implemented Lean and Six sigma within their aeronautic companies. But, before deepening our analysis with the experts, it was judicious to understand more about the studied companies in terms of their implementation of Lean and Six sigma.

Despite of the chronology chosen; all (100%) of the experts confirm had implemented both Lean manufacturing and Six sigma in their companies. All of the experts state that Lean and Six sigma are non-separable and both are indispensable to achieve customer satisfaction and sustain performance improvements. In other words; the Lean Six sigma concept is more efficient than separate Lean and Six Sigma to address the specific and high exigencies faced by an aeronautic company.

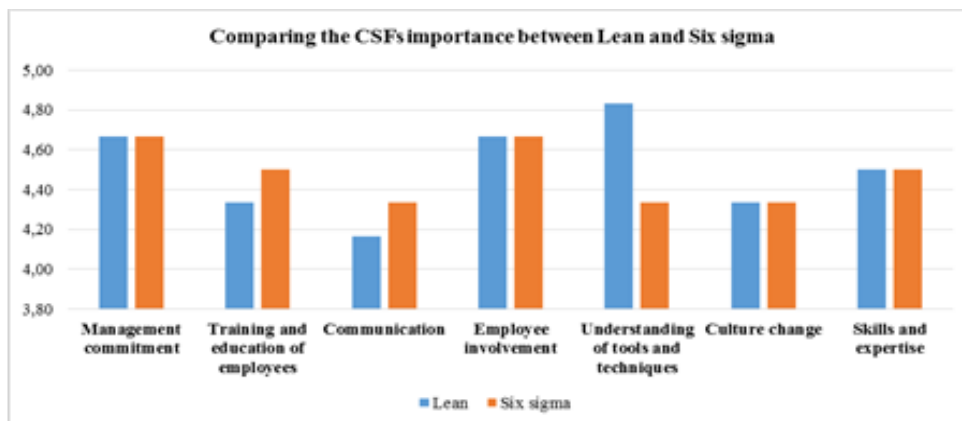
Two experts state that the sequential implementing of Lean then Six sigma help to get organizational success. Furthermore, they report that this chronology is more logical since we are moving from the general and basic techniques of Lean such as 5S, then applying Six sigma tools that are more complex such as analysis of capability.

This is consistent with findings in the literature, which indicate that the evolution of these two methods, the hybrid LSS was formed to act more fully on the entire system of the company, realizing, at the same time, the objectives of these two concepts [12]. Then, the joint application of Lean and Six Sigma allows each of these methods to complement their effectiveness and improve the functioning of the organization [2], [7], [47].

Furthermore, they were asked to answer questions regarding the sequencing of implementing the two methodologies. It was found that 71% companies had implemented Lean manufacturing firstly, 14% companies had implemented Six sigma then Lean and equally 14% had implemented Lean and Six sigma simultaneously (Figure2).



**Figure 1.**The chronology of implementing Lean and Six sigma from interviews



**Figure 2.**Comparing the CSFs importance between Lean and Six sigma

From the same perspective, the experts opined that implementing Lean firstly yielded a rapid improvement in processes through eliminating wastes and non-value added activities with simple actions that help to keep the involvement of the teamwork. Then, they can focus on deeper issues and chronic defects sources that require statistical analysis and integrate Six sigma tools and techniques to offer powerful solutions.

One expert stated that it was necessary to implement Six sigma at the first step, because the approach takes their company, when it was an urgent concern for improving the quality and consumer commitment, to an acceptable level of process capability, then to eliminate waste through joining the techniques of both Lean and Six Sigma.

Although, many firms have implemented integrated Lean and Six sigma by implementing one method first. Research results have shown that Six sigma is typically implemented effectively only after a Lean manufacturing process is already in place. Moreover, Six sigma can be successful when Lean is implemented ahead of it and this scenario may accelerate the use of Six sigma [19].

However, there is a scarcity of research demonstrating success in the implementation of Six sigma followed by Lean. Also, there are few studies concerning the success of sequential implementation, have indicated that sequential implementation of Lean manufacturing and Six sigma can be successful. [6].

Furthermore, the findings in the literature, indicate that the separate implementation of Lean manufacturing and Six sigma yields weak results, including modest improvements in performance, customer satisfaction, and profits [6].

This was confirmed by the rest of the interviewed experts, who claimed that integrating Lean and Six sigma simultaneously can achieve better results than a separate implementation. Because, deploying the two approaches simultaneously, helps to engage all types of people in improvement activities so that organizations become truly capable and attain competitive advantage [5]. Also, both methodologies simultaneously yielded a rapid improvement in processes [6].

But, some companies found it difficult to implement Six sigma and Lean manufacturing simultaneously in addition to the uncertainty regarding which methodology should be implemented first [5].

Thus, [5] affirms that in this case, it is preferable to start with Lean. Because Lean tools are not as complicated as Six sigma tools, it is more feasible to start with Lean as a means of getting staff members involved early on, while at the same time rapidly yielding results for the company.

As indicated above, there is evidence that enterprises with limited resources such as small and medium-sized do not have the ability to implement Lean manufacturing and Six sigma simultaneously [49], as a result of their limited resources and then choose a sequential implementation as an option. However, this reason of inability in terms of resource, as confirmed by the participating experts, is not the mean limitation for their aeronautic companies. But they still powerless to implement Lean and Six sigma simultaneously. In fact, the challenge is how to establish the appropriate strategy for an integrated form of both methodologies which helps to take account of the resources available within a business.

The results of this study will help companies develop a framework for implementing an integrated form. The key to devise this framework is, firstly, the ability to respect the previously identified critical success factors of each method and take into account differences in interpreting the same specific Lean and Six sigma CSFs while switching between Lean and Six sigma. And secondly, to evaluate and adapt their available resources to meet the critical success factors. Although, it's judicable to evaluate the CSFs cited above or to eventually add others, validate their interpretation, draw the distinction between the more and less important factors within the same approach and assess whether the importance of each success factor was different between Lean manufacturing and Six sigma.

This study has realized seven key main success factors related to Lean manufacturing and Six sigma: Management commitment, Employee involvement, Training and education, understanding the tools and techniques, skills and expertise and culture change. The expert interviewed had confirmed to have to deal with all of them. Additionally, they claimed that is primordial to assign a meaning to the improvements targeted and clarify indicators expected to improve by quantifying them and adapting them to each stage of the project. Also, the targeted improvement must be prioritized and shared with the entire project team.



Furthermore, the timescales of Lean and Six sigma implementation projects have to fit with the company size and complexity of its process.

Also, they have insisted on the management stability and the human resources department's involvement to maintain a good team spirit based on mutual trust within the team project.

After this overview where various CSFs have been described with their interpretation, all of the experts, according to their experiences claimed that they are not all on the same level of importance for the same approaches (table3).

However, in most cases, critical success factors importance was not significantly different between Lean manufacturing and Six sigma. These factors included Management commitment, Employee involvement, Skills and expertise (table3). The results of the survey confirmed the idea of many experts and researchers in the same domain.

**Table 2.** CSFs importance average for Lean and Six sigma

CSFs	Lean	Six sigma
Management commitment	4,67	4,67
Training and education of employees	4,50	4,33
Communication	4	4,17
Employee involvement	4,67	4,67
Understanding of tools and techniques	4,33	4,83
Culture change	4,33	4,33
Skills and expertise	4,50	4,50

Though, the majority of experts claimed that the importance level of top management commitment for the success of both Six sigma and Lean manufacturing was virtually the same. But, eight experts stated that "Training and education of employee" was more important for implementing Lean manufacturing than for implementing Six sigma. Also, ten experts claimed that "Understanding of tools and techniques" was more important than "management commitment" for the implementation of Six sigma.

Surprisingly, For Lean, the "Culture change" of employees and team project is the less important for the aeronautic companies, this can be explained by the rigorous recruitment process to hire their ideal team in this type of industry. The most relevant factors were "Management commitment", "Understanding tools and techniques", "Employee involvement" and "Skills and Expertise".

In global, "Management commitment" and "Employee involvement" are running behind by "Understanding tools and techniques", which is seen as the most basic for Six sigma (Figure2).

In addition, as per respondents' consideration, "communication" is not amongst considerable. This result is interesting and difficult to explain. Nevertheless, it is recommended that future researches attempt to determine why this critical success factor is neither significantly important for Lean nor for Six sigma in the aeronautics industry. The highest score of "Management commitment" is indicating that it is very important for the implementation of Lean, while "Understanding of tools and techniques" is the most rated for implementing Six Sigma in the Moroccan aeronautics industry. This results also confirmed the idea of many experts and researchers in the same domain. Also, to implement Lean and/or Six Sigma, "Employee involvement" is widely considered by respondents as second and third most important factors respectively for Six sigma and Lean.

## 5. Conclusion:

There are a lot of studies that had covered the comparison of Lean and Six sigma from the perspective of achieved results, approved efficiency and each approach CSFs ranking, but rarely had proposed recommendation guide, extracted from the given interpretations to each CSFs, respecting the particularity of each approach. And rarer that have examined some literature conclusions in the industry.

For this purpose, the first outcome of this research was to consolidate the CSFs' explanations and draw up a separate and dedicated interpretation of CSFs' for Lean and Six sigma, which will provides a useful insight for the enhancement of their simultaneous implementing. This simultaneous implementing as noticed in the literature is highly recommended because it yields better results than their separate implementation. However, it was revealed, as a second result, that, with the same proportion (14%) of companies had implemented Six sigma then Lean or Lean and Six sigma simultaneously, while the vast majority (71%) of the Moroccan aeronautic companies interviewed had implemented Lean manufacturing firstly. This chronology choice was justified by the necessity of starting with basic techniques of Lean before applying the complex tools of Six sigma. In that respect, As the third result, we had confirmed

the outlined CSFs (“Management commitment”, “Training and education of employees”, “Communication”, “Employee involvement”, “Understanding of tools and techniques”, “Culture change” and “Skills and expertise”) since all the interviewees confirmed to have to deal with all of the dressed CSFs. But they claimed that they don’t have an equal importance for the same approach or from one approach to the other. The highest score of “Management commitment” is indicating that it is very important for the implementation of Lean, while “Understanding of tools and techniques” is the most rated for implementing Six Sigma while “communication” is not amongst considerable. But still revealed that both approaches require “Employee involvement”.

In addition, they claimed that is primordial to allocate meaning to the improvements targeted by quantifying the indicators expected to improve and adapting them to each stage of the project. Also, they suggest to prioritize the targeted improvements and share them with the project team. In addition, they recommend fitting Lean and Six sigma project timescales with the company’s size and process’s complexity and finally to keep the stability of management.

Finally, the understanding from literature with the experience of practitioners help in the elaboration of facts. Then, the results of this study can be used as an input for the optimization of Lean and Six sigma simultaneous implementation framework: In addition to the recommendation of the CSFs comparative statement, Moroccan aeronautic companies should put a stronger focus on the “Training and education of employees”, providing employees with appropriate training and developing “communication” inside and outside the organization.

For future research, and since this don’t hinder Lean in the same way then Six sigma, it’s recommended to explore them in other industries. Thus, it will be possible to devise an exhaustive implementing framework based on CSFs strategy. Also, to streamline the choice between Lean and Six sigma’s separate or simultaneous implementation.

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