Empirical assessment of critical success factor of lean and six sigma in the Moroccan automotive industry

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Abstract. Lean manufacturing (LM) and Six sigma (SS) are two methods of continuous improvement that became essential in several industrial sectors. These approaches interest the researchers and also the business managers. Thus, LM and SS success that can be involved simultaneously and systematically is based on a set of Critical Success Factors (CSF). First, we extracted the CSFs discussed in the literature. Then, these CSFs have been projected to those used in the Moroccan automotive industry. For this purpose, we adopted a qualitative research methodology using structured interviews with 12 experts from the Moroccan automobile industry. Through this study, LM and SS implementing characteristics were revealed. Thus, we performed, based on CSF importance and maturity, a bi-dimensional scan that describe Lean manufacturing (LM) and Six sigma (SS) implementation within Moroccan automotive industry.

1. Introduction:
Companies are constantly investigating the improvement of their competitiveness. LM and SS are among the most effective ways to optimize management systems and business processes.

Actually, hundreds of papers produced trace their origins, techniques and highlight the benefits of their implementation. While little researches has attacked the pre-implementation phase through the necessity of taking into account the CSF, and still few have conducted their importance and rarely tested the integration level required to their success. All these elements have to be assimilated before integrating each of them [1].

The main objective of this study is to explore the status of LM and SS’s critical success factors (CSF) in terms of importance and integrating levels within automotive industry in Moroccan context.

Thus, through this empirical study we will define:

- The difference of importance degree between each CSF for the same approach and for the same CSF relatively to the other approach: To list the top factor for success and help company to switch easily from one approach to the other by simply reinforcing certain CSF
- The maturity level of CSF required to success LM and SS implementing: To highlight from any level the CSF integrated is becoming functional.
- A Comparative matrix of between the two approaches according to the factors

The remainder of this paper is organized as follows: First, we present an overview of the literature to extract the CSF. Next, we describe the data, sample, and measures. Results are analyzed in the after next section.
2. Literature review:
Critical Success Factors can be seen as one of the important methods that aims to achieve effective quality management [2], organizational target and goal [3] [4].

The CSF extraction is based on a literature review of papers and researches that had been collaborated in this topic of continuous improvement methods especially LM and SS.

Indeed, the exploration of the literature consists in examining articles resulting from a wide search and a careful sorting from different sources [5]. This allows discovering the conceptual field of research and contributing thereafter to its theoretical development [6] [7].

A review of the literature revealed that there are a set of attributes that are prerequisites for the successful implementation of both methods: management commitment, culture change in organizations, good communication in the hierarchy, new approaches to production and customer service and a high level of training and education of employees [8].

These axes are more frequently reported in the literature as success factors for Six sigma, and are considered critical for effective and efficient implementation of six sigma [8].

Through the literature also, it has been revealed that there are a number of critical success factors for the implementation of LM and SS: Management commitment and support, Education and Training, Communication, Employee Involvement, Culture Change, Skills and Expertise, Linking the SS Method to Customers, Linking the Six Sigma Methodology to Business Strategy, Linking the Six Sigma Method to Vendors, Linking the SS 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 clerks [9].

Key success factors identified include: communication, culture change, management commitment [10]. The common axes between the two studies are: “Commitment and support of management”, “Training”, “Communication”, “Employee involvement”, “Culture Change”, “Understand the tools and techniques” and “Skills & expertise”. They are judged more critical and will therefore serve to refine our comparison.

Many companies often fail to integrate the above thrusts in their organizational systems and do not identify them well before their continuous improvement initiatives, so they never achieve the desired results [11].

This could be explained by the fact that LM does not include the organizational infrastructure. In contrast, SS understands the organizational infrastructure, and thus facilitates communication between employees, since one of the benefits of a SS program is the creation of a common language [10]. Henderson and Evans [12] also mentioned that the organizational infrastructure of SS is as follows: "Have all members of the organization speaking the same language".

Lean tools are geared towards cultural change. However, some organizations believe that it is possible to implement LM only in a specific culture, such as Japanese [13], while SS is based only on statistical analysis. It has been shown that culture is less important for the implementation of SS than for the implementation of LM.

The literature review also found that education and training are of high importance or weight for both Six Sigma and LM methodology. The results of this study showed that education and training were more important for LM than for SS.

This is explained by the fact that an operator can understand LM easily. Also because LM consists of individual methods that provide quick improvements [14].

Hence, the remainder of this paper will examine the level of achievement of each CSF described below, in the Moroccan companies that succeeded or try to implement LM and SS.

3. Material and Methods
This study undertook a combination of two research approaches. It comprises literature review, and interviews with 12 practitioners of Lean and Six sigma.
Through the literature review conducted at the initial session, we had identified specific CSFs of Lean and Six sigma. 

The data was collected through interviews covering automotive manufacturer industry based in Morocco. We have selected companies that are considered leaders in implementing LM and SS.

The interviewers are top or middle management who have a good overview of LM and SS methodologies. To analyze the collected data, we had used the content analyses approach. Thus we had extracted significant elements. The objective of the data collection was to explore the maturity and importance of the same specific CSF in the implementation of lean manufacturing and six sigma within these companies.

The survey questionnaire was split into the following categories with several or more questions in each category to determine:
- Integration characteristic of LM and SS: chronology, maturity, due dates
- Importance assigned to each CSF for LM and SS implementing
- Integration level accomplished for each CSF in comparison with LM and SS maturity

4. Results and discussion

By exploring the extracted data, we got a preliminary picture of the company's involvement in the two methodologies. It was revealed that 58% of the companies had implemented Lean Manufacturing methodology only, (0%) none company had implemented six sigma only, while 42% had implemented the combination of the two methodology (figure1). It means that 100% of the companies are implementing LM, of which 42% had implemented LM and Six sigma.

This was explained by the interviews by adopting Toyota strategy in their companies and then the necessity to implement Lean manufacturing to avoid wastes and reduce Lead time. More so, if they tend to take their process to a greater level and meet their customer requirement, then they add Six sigma methodology to which perform their continuous improvement system.

This was consistent with the finding in literature which claim that implementing LM and SS together yield better results [7].

![Figure 1. Repartition of implementing Lean, six sigma.](image1)

![Figure 2. Duration implementing before achieving first improvements.](image2)

The maturity level achieved of implementing LM and SS within these companies is respectively 33% and 25%. It took 10 months for LM and 17 months for Six sigma to mark these levels (Figures 2 & 3). It explains that Six sigma is requiring more time to achieve expected results, while Lean allows quick improvements. According to [1], this deduction is confirmed, claiming that implementing lean guarantee a rapid improvements in processes with simple actions. Then, they can focus on deeper issues that require statistical analysis through Six sigma [1].
Furthermore, the main goal of this paper is to draw by CSF importance and maturity a bi-dimensional sheet-root to companies need to success their process of continuous improvement. As mentioned above, the CSF include: “Commitment and support of management”, “Training”, “Communication”, “Employee involvement”, “Culture change”, “Understand the tools and techniques”, “Skills and expertise”.

Unsurprisingly, for the entire companies investigated, the specific Critical Success Factors had been converted and processed directly or indirectly while implementing within their organizations.

By collecting the importance assigned to each CSF and analyzing the differences between the two approaches. For LM, the results state that the top factors which are slightly rated are “Understanding tools and Techniques” and “Training”. While the most important considered are “Management commitment”, “Employee Involvement” and “Communication”. In contrast, for Six sigma, “Understanding tools and techniques” and “Training” exceed other factors. The lowest ranked for successful implementing is “Culture change” (Figure 5).

Comparatively, “Management commitment” and “Training” are considered as the most important factors for both LM and SS. Whereas, “Skills and Expertise” is the lowest ranked common factor.

**Figure 3.** Maturity level achieved within studied companies.

**Figure 4.** Chronology of implementing Lean & Six sigma.

**Figure 5.** Comparing CSF importance between Lean and Six sigma.
In conclusion, the successful implementation of the two approaches rely on “Management commitment” reinforcement as well as the “Training” of the improvement team, while balancing between “Understanding tools and techniques” and “Communication”.

Equally significant, “Training” can facilitate success when it is provided to both the LM team and the SS staff involved with the implementation. This training can reduce staff hesitation generated from misunderstanding and hence increase their involvement.

Furthermore, if the leaders don’t understand and believe in LM and SS philosophies enough to take the time and remove resistance through employee’s qualification and involvement and strong communication, is less likely to be embraced and the miraculous gains through the two approaches are less likely to be reached.

Conversely, the study depicts a high integration of the majority CSF within these companies development system (65%) (figure 6) while the LM and Six maturity levels, as mentioned before, still modest 25% for SS and 33% for LM. (Figure 2).

By linking the integration level and importance assigned to each CSF we can conclude that: Despite the high importance of “Employee involvement” and “Culture change” as success factor, but it appear they was not properly handled into the improvement program. Also, the “Understanding tools” was considered among of the most important factors, but it wasn’t enough take in account. Thus, it explain the modest LM and SS maturity levels within these companies.

![CSF Integration levels](image)

**Figure 6.** Integration levels accomplished for each CSF.

### 5. Conclusion & Perspectives:

In a dynamic environment, LM and SS are used as a strategic methodologies and has been implemented as a means of achieving a competitiveness by Moroccan automotive industry.

The most implemented approach is LM, while SS is implemented only when it will be combined to LM. This combination is almost starting with LM.

In order to foster these approaches, it is important for companies to develop an implementation roadmap based on CSF. This will enable the organization to achieve quickly and effectively the gains expected. “Management commitment”, “Communication”, “Training” and “Understanding tools” are among the most important factors as assigned by the interviews. Thus, the provision of the necessary resources to properly could enable LM and SS to succeed.

Thus, integrating properly these factors could enable LM and SS to succeed. Otherwise, will delay intended changes and results, and consequently, their low level of integration in the system will stifle the LM and SS maturity.

The above measures are simple and direct tactics that can be undertaken to improve the results of LM and SS further by encouraging a CSF based strategy.

Finally, we have investigated how LM and SS are integrated and what could make LM and SS successful in a Moroccan automotive industry. For further researches, it is recommended to study additional industries to draw up an exhaustive framework in order to ensure success of LM and SS deployment and also to measure their maturity in different industries.
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