



26 EISIC – 2023

## Lean Six Sigma Methodology within the Public Sector

Ronnie Peralta Santana

School of Engineering and Computing, University of the West of Scotland (UK)  
[ronnieperaltasantana@gmail.com](mailto:ronnieperaltasantana@gmail.com)

Evdoxia Viza

School of Engineering and Computing, University of the West of Scotland (UK)  
[Evi.viza@uws.ac.uk](mailto:Evi.viza@uws.ac.uk)

Alex Douglas

School of Engineering and Computing, University of the West of Scotland (UK)  
[Tqmeditor@gmail.com](mailto:Tqmeditor@gmail.com)

### Abstract

**Purpose:** Lean Six Sigma (LSS) has been defined as a methodology that focuses on enhancing customer satisfaction and improving bottom line results by increasing processes performance. Regardless of the many different operations and services provided, the Public Sector remains an important contributor to the economies worldwide while facing different operational restrictions and challenges from the Private Sector. The purpose of this study was to identify what factors affect the implementation of LSS, review how these factors can be addressed in order to for LSS be implemented in the Public Sector, and to propose a framework for a successful LSS implementation.

**Methodology:** A systematic literature review (SLR) was conducted to summarize, critically evaluate, and draw conclusions from previous research done about the selected topic. The focus of this literature review was to identify the key factors of a successful LSS implementation and determine how to translate them to the Public Sector by providing a clear framework.

**Findings:** This study identified the importance of top management commitment as a critical success factor for a successful LSS implementation. In addition, SLR provided the basis for the development of a 3-phase implementation framework.

**Research Limitations/Implications:** As with any SLR, some relevant publications may have been omitted.

**Value:** The findings of the research can be used to shed light into the challenges faced by the public sector when attempting to implement LSS approaches to improve service quality.

**Keywords:** Lean Six Sigma, Public Sector, Service Quality.

**Paper type:** Literature Review

## 1. Introduction

Albliwi et al (2014) define Lean Six Sigma as a methodology and business strategy that focuses on enhancing customer satisfaction and improving bottom line results by increasing the performance of processes. LSS can help the Public Sector to eliminate waste and properly identify what customers value, which translates into money savings and enhanced citizen or customer satisfaction (Psomas et al, 2021). Implementing Lean Six Sigma can help to enhance the level of service quality customers experience without eliminating attributions from the Public Sector (Juliani and Oliveira, 2021). Lean thinking and Six Sigma are the bases for the deployment of LSS within an organization and when both are applied properly, a cultural change is experienced resulting in a more customer focus business operation. Because of the breadth of the Public Sector, it means that there are still some departments, functions, and even services where there is no evidence of Lean Six Sigma implementation which begs the question “Is LSS suitable for the Public Sector?” (Rodgers and Antony, 2018).

The Public Sector is an important contributor for the economy of every country in the world while facing different operational restrictions and challenges. The Public Sector is struggling because of the rise in the state’s management and maintenance costs and is facing financial troubles as well as economic constraints. In addition, as the budget continues to shrink while the Public Sector expands, and because the Public Sector is managed by priorities and political processes that compete for a share of a general budget it is imperative the implementation of continuous improvement methodologies such as Lean Six Sigma (LSS) to maintain or even increase the level of service quality delivered (Psomas et al 2021) since the Public Sector is demanded to provide the same level of quality service while being within this shared budget (Rodgers and Antony, 2018). For this study, the Public Sector is the local government where the government controls and finances part of the economy of a country (Rodgers and Antony, 2018).

Over the years, LSS has expanded from its roots in manufacturing to the Service Sector but there is a lack of studies that show the successful implementation within the latter, more specifically within the Public Sector (Rodgers et al, 2021). A successful implementation of LSS can support the Public Sector in achieving a better utilization and distribution of their employees efficiently and effectively, increase the collaboration between different departments not only within the same institution but across all the public institutions, and to modernize municipalities that share the same gubernatorial operations (Psomas et al 2021). Because all of these, the current study presents the following research questions:

- RQ1 Can Lean Six Sigma be implemented successfully in the Public Sector?
- RQ2 Why does Lean Six Sigma fail?
- RQ3 How does the Critical Success Factors and Failure Factors associated with Lean Six Sigma implementation relate to the Public Sector?

To answer this, this research will conduct a systematic literature review (SLR) to systematically analyse the literature to be able to identify the implications of successfully implementing LSS in the Public Sector by studying its critical success factors and failure factors of its implementation. Furthermore, this SLR will be grouping the literature into themes for a better and easier understanding of the information gathered. The following objectives were established in this study:

- To review the academic literature to identify the critical success factors for Lean Six Sigma implementation and determine their applicability to the Public Sector.
- To identify reasons for Lean Six Sigma failure in various industrial sectors.

## 2. Methodology

A Systematic Literature Review (SLR) will be conducted in this study. Tranfield et al (2003) defines a SLR as a review conducted using a transparent and replicable process. This process involves a detailed methodology that includes exhaustive searches of both published and unpublished studies. The reviewers' decisions, procedures, and conclusions are carefully documented to provide an audit trail for accountability. Overall, a systematic literature review aims to be scientific, thorough, and unbiased.

The SLR will follow the 3 steps proposed by Tranfield et al (2003) which are as follow:

**Step 1 Planning the Review:** Establishing the aim and methodology of the research.

**Step 2 Conducting the Review:** Employing criteria for relevance, conducting a literature search, choosing relevant studies, evaluating their quality, extracting, and analysing data, and synthesizing findings.

**Step 3 Reporting and dissemination:** Delivering the report and translating the evidence into practical implementation.

### 2.1. Planning the Review

Tranfield et al (2003) indicate that within this step it is necessary to formulate a review protocol, identify the need for a review and prepare a review proposal. The protocols encompass all the stages involved in searching for the research questions, establishing inclusion and exclusion criteria, and determining the procedures for analysis.

The academic online databases and search engines that had no costs through the institution were used to identify articles relevant to the objective of this study, more specifically Scopus, and Science Direct. These publishers are widely recognized and trusted for their reliability (Psomas et al, 2021). In addition, peer reviewed journals, articles, and books in the English language were taken into consideration when conducting the SLR, excluding everything that does not fit within this category. Furthermore, the review period selected in the research protocol goes from 2013 to 2023 since the focus of the implementation of Lean Six Sigma within the Public Sector is still relatively new, the study wants to ensure that recent literature from its early implementation within the Public Sector are identified. Hence, it is understood that a 10-year timeframe chosen for this SLR provides an adequate scope to examine the real-world implementations of Lean Six Sigma. The inclusion and exclusion criteria used in this study is presented in table 1.

Inclusion Criteria	Exclusion Criteria
Peer reviewed journals, articles and books published between 2013 and 2023	Articles published before 2013. Non-peer reviewed publications.

Search engines: Science Direct, and Scopus.	Non-academic search engines.
Articles analysing the implementation of LSS, the Critical Success Factors and the Critical Failure Factors.	Articles analysing only Lean or Six Sigma.
Articles studying the Public Sector holistically or the local government specifically.	Articles studying different areas of the Public Sector.
Articles in the English Language.	Articles in a language different than English.

**Table 1. Inclusion and exclusion criteria.**

## 2.2. Conducting the Review

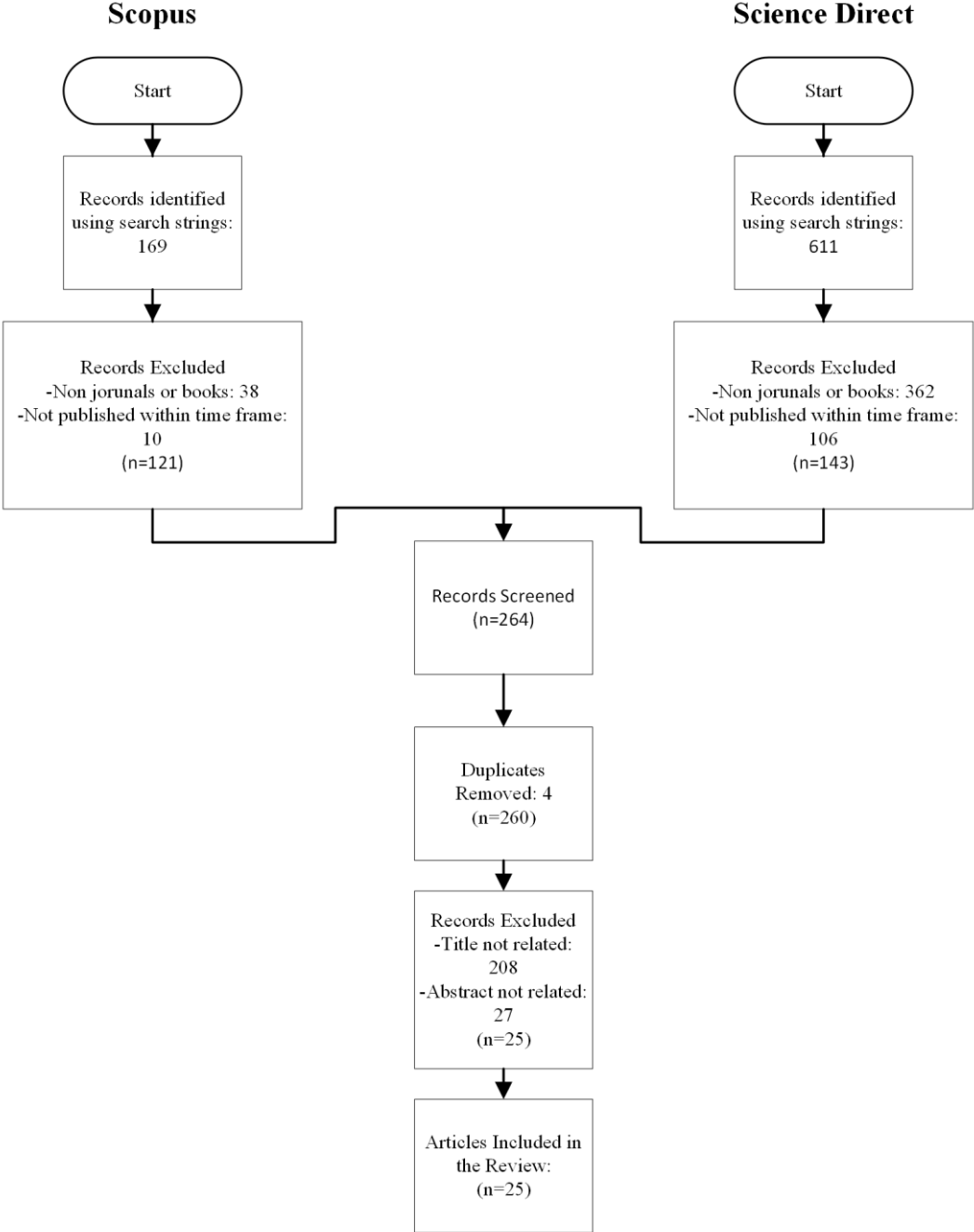
The primary tasks in the second phase of the review process involve identifying relevant research, selecting studies, evaluating the quality of the studies, extracting data, monitoring progress, and synthesizing the collected data. Tranfield et al (2003) explains that a thorough and impartial search constitutes a fundamental distinction between a conventional narrative review and a systematic review. The author continues by stating that a SLR starts with the selection of search terms and keywords, that are taken from the literature, topic of study, and discussions.

The terms that were searched on the aforementioned search engines and databases were the following: LSS, Lean Six Sigma, Public Sector, Implementation, Critical Success Factors or CSF, Critical Failure Factors or CFF. The term local government was primarily used but is not used consistently and globally so the study focused on the term Public Sector and focused on the literature that involved the local government or papers that holistically studied the Public Sector. Some examples of the search string used within this study are as follows: "lean six sigma" Public AND Sector, critical AND success AND factors AND "lean six sigma" AND implement\* AND public AND sector, critical AND failure AND factors AND "lean six sigma" AND implement\* AND public AND sector, critical AND success AND factors AND "lean six sigma" AND implement\*, critical AND failure AND factors AND "lean six sigma" AND implement\*.

After inputting the search terms into the bibliographic databases, 780 related articles emerged. By applying the inclusion and exclusion criteria, a more manageable volume of literature was discovered, a total of 260 papers that enabled a more focused search on the most pertinent articles. Subsequently, all articles were carefully screened and assessed for their alignment with the study's focus, considering the title, abstract, and keywords of each article. The assurance of article quality was achieved by evaluating the alignment between the research methodology employed and the study's objectives (Tranfield et al, 2003). The whole screening process resulted in the selection of 25 papers published across 13 different academic journals that were found fitting for this study. In table 2 we can see the distribution of papers per journal.

Following the guidelines of the PRISMA Chart, Figure 1 represents the step-by-step screening process followed in this study.

**Identification of articles via Scopus and Science Direct**



**Figure 1. Article identification process.**

<b>Journals</b>	<b>Number of articles</b>
International Journal of Lean Six Sigma	10
International Journal of Quality and Reliability Management	3
Benchmarking	2
International Journal of Productivity and Performance Management	1
Computers and Industrial Engineering	1
International Journal of Mathematical, Engineering and Management Sciences	1
International Journal of Production Research	1
International Journal of Supply Chain Management	1
Journal of Manufacturing Technology Management	1
Journal of Modelling in Management	1
Quality - Access to Success	1
Quality Engineering	1
TQM Journal	1

**Table 2. Quantity of Articles per Journal.**

After the final selection of the 25 published papers, a full and careful reading of each individual document was executed to find common themes between them and categorize them in each theme following an inductive approach for an easier. Tranfield et al (2003) emphasize the importance of systematically reviewing and synthesizing qualitative research findings from multiple empirical studies. This process is vital for achieving higher analytical objectives and improving the generalizability of qualitative research. Psomas et al (2021) suggests that a thematic analysis helps researchers recognize, study and report in an organized manner the qualitative data gathered.

Finally, for summarising the data an inductive approach for analysing the subjects identified in each paper was followed in order to present commonalities and patterns between papers and determine what works best in what scenario. Research synthesis refers to a group of techniques used to summarize, integrate, and, when feasible, combine the findings from various studies on a particular topic or research question (Tranfield et al, 2003). This SLR will build theory based on the common practices and themes found.

### **2.3. Reporting and Dissemination**

In this final phase, the purpose is to prepare and present a report that summarizes the research documents that were utilized (Tranfield et al, 2003). This Systematic Literature Review provided a report that was presented in summary and analytically, meaning that particular cases of critical success/failure factors and instances of the implementation of Lean Six Sigma in the Public Sector were presented.

## **3. Results**

### **3.1. Descriptive Analysis**

#### **3.1.1. Distribution of Articles per Journals**

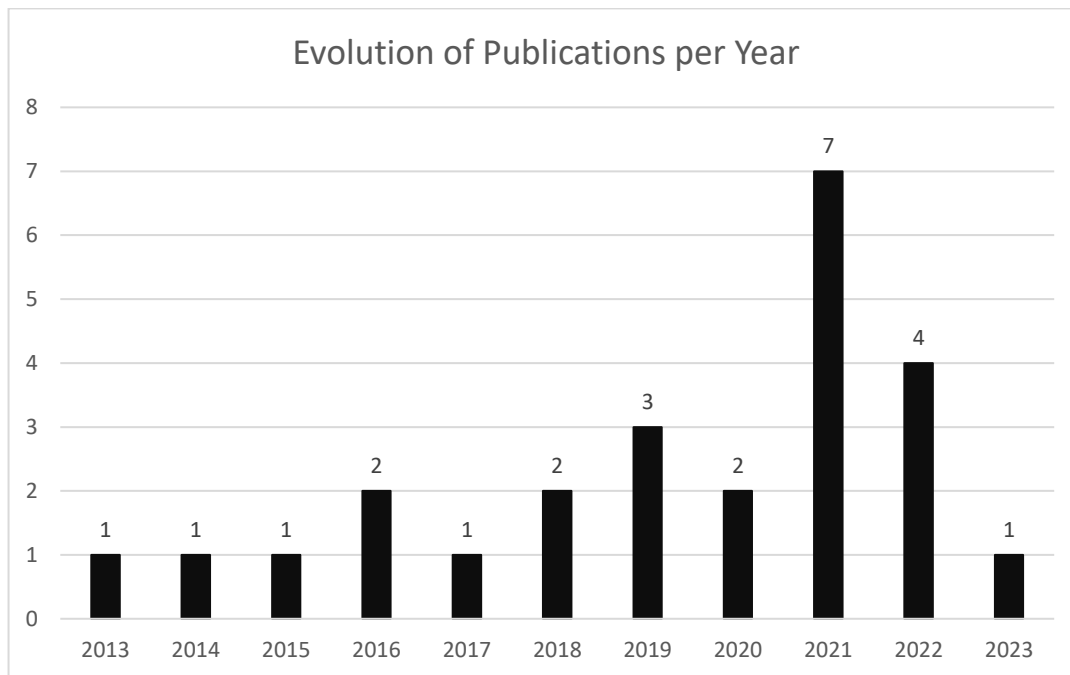
Table 4 below presents the percentage of articles published per journal.

Journals	Number of articles	%
International Journal of Lean Six Sigma	10	40%
International Journal of Quality and Reliability Management	3	12%
Benchmarking	2	8%
International Journal of Productivity and Performance Management	1	4%
Computers and Industrial Engineering	1	4%
International Journal of Mathematical, Engineering and Management Sciences	1	4%
International Journal of Production Research	1	4%
International Journal of Supply Chain Management	1	4%
Journal of Manufacturing Technology Management	1	4%
Journal of Modelling in Management	1	4%
Quality - Access to Success	1	4%
Quality Engineering	1	4%
TQM Journal	1	4%

**Table 3. Proportion of Articles per Journal.**

### 3.1.2. Distribution of Articles per Year

It can be seen the evolution of publications regarding Lean Six Sigma in the Public Sector from 2013 up until 2023 used for this study from figure 2 below.



**Figure 2. Evolution of Publications per Year**

### 3.1.3. Distribution of Articles per Country

The articles selected for this research were classified according to the country of study presented in figure 3. From the figure, it can be seen that the articles used for this study were published across 10 different countries.

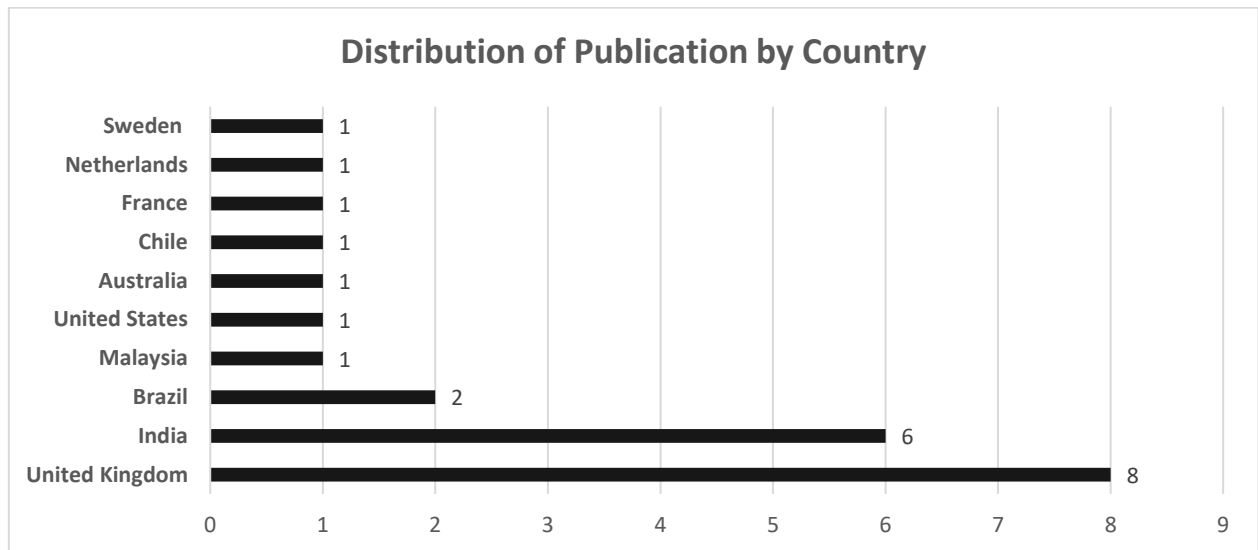


Figure 3. Distribution of Publications by Country.

### 3.1.4. Distribution of Articles per Type

According to figure 4, research papers are the preferred type of for the subject matter.

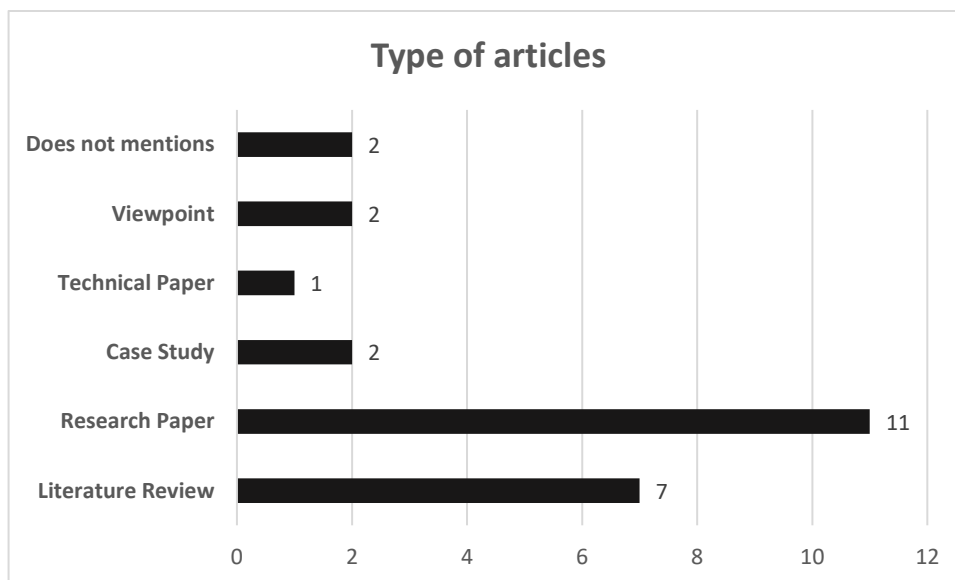


Figure 4. Type of Articles Published

### 3.1.5. Theme Identification

After the sample of 25 articles were reviewed for this study, an inductive approach was used for the identification of themes. 2 common themes appeared within the literature which are shown in table 4 with a provided list of authors that support or focus on these



studies. It is worth noting that some authors may have focused on multiple themes in their research.

Theme	Supporting Authors
<p align="center"><b>Critical Success Factors</b></p>	<p>Moya et al (2019), Tsironis et al (2016), Papic et al (2017), Gastellum-Acosta et al (2022), Laureani and Antony (2013), Lande et al (2016), Francescato et al (2023), Swarnakar et al (2020), Raval et al (2021), Mishra (2022), Bakar et al (2015), Sreedharan et al (2018), Stankalla et al (2018), Juliani and Oliveira (2020), Laureani and Antony (2018), Yadav et al (2021), Aljazzazen et al (2022), Ahmad et al (2019), Patel and Patel (2021), Rodgers and Antony (2019), Assarlind et al (2014)</p>
<p align="center"><b>Critical Failure Factors</b></p>	<p>Albliwi et al (2014), Sarnakar et al (2021), Sunder and Prashar (2020), Swarnakar et al (2021)</p>

**Table 4. List of Supporting References.**

**3.2. Findings**

**3.2.1. Theme 1: Critical Success Factors of LSS**

After reviewing the 21 that focused on the Critical Success Factors (CSFs), it was found that authors agree in the common definition of CSFs as those essential characteristics that guide organizations to execute their objectives by providing adequate results (Tsironis and Psychogios, 2016). In addition, Laureani and Antony (2013) define CSF as those factors critical to the accomplishment of any technique or program and if the associated objectives of these factors are not accomplished, then said program or technique may perhaps fail. Furthermore, within the literature it was found a split between authors about the applicability of LSS within the public sector even though that all the authors agree that LSS can provide any organization with an improvement of bottom-line results and

enhanced customer satisfaction (Patel and Patel, 2021). Authors like Rodgers and Antony (2019) proposes that because of the departmental width of the Public Sector, LSS has multiple opportunities of implementation within the Public Sector. Initiatives of continuous improvement like LSS are essential to the Public Sector since it can enhance their competitiveness (Sreedharan et al, 2018). On the other hand, authors like Moya et al (2019) suggest that the implementation of LSS may turn difficult in some instances because of the different context organizations face, and with it, different factors that play in the implementation. Also, factors like the shared budget on which the Public Sector operates play a significant role on the implementation of LSS (Rodgers and Antony, 2019).

Although the differences of though regarding the applicability of LSS in the Public Sector, the literature shows a plethora of CSF identified by the authors between the Public Sector in general, the Manufacturing Sector, and a very small amount of the articles reviewed explored CSF in the local government specifically. Different authors have identified multiple factors that may affect the correct implementation of LSS in different sectors, but the vast majority share the same of those factors with little difference, some ranging from 9 factors up to 40. Most of the authors focused on identifying and ranking said CSF by using different methods such as affinity diagrams, surveys, pareto analysis, and even decision-making trial and evaluation laboratory (DEMATEL). Moya et al (2019) identified 13 CSFs and provided a hierarchy giving different levels of importance to each CSF. Sony et al (2020) identified 12 CSFs by using interviews with employees working with LSS for over 20 years. Patel and Patel (2021) identified in their qualitative study 27 CSFs. Assarlind and Aaboen (2014) identified 15 CSFs within a case study of an organization that implemented LSS. Rodgers and Antony (2019) propose 4 CSF of implementing LSS in the public sector. Tsironis and Psychogios (2016) explain 11 CSFs through qualitative research. Papic et al (2017) selected 45 CSF and ranked them using different statistical tools provided by the software Minitab. Gastellum-Acosta et al (2022) analysed 13 CSFs and validated that only 10 of them are critical for the successful implementation of LSS through a survey. Laureani and Antony (2013) identified 19 CSFs with the use of both qualitative data by doing a literature review, and quantitative data by conducting surveys. Lande et al (2016) identified 22 CSFs and ranked them by taking into consideration their frequency in the literature for a pareto analysis. Swarnakar et al (2020) identified 20 CSFs with the use of questionnaires for different organizations in the Public Sector and categorize them utilizing Fuzzy Theory. Raval et al (2021) identified 40 CSFs, categorized them into 6 groups, and ranked them using the DEMATEL approach. Bakar et al (2015) conducted a literature review and identified 97 CSFs, only selecting the 5 most common CSFs and grouped them using the affinity diagram. Sreedharan et al (2018) identified 16 common CSF across different CI initiatives and ranked them using the pareto analysis. Stankalla et al (2018) identified 29 CSFs of LSS implementation different SMEs manufacturing companies and ranked them by frequency in their literature review. Julianai and Oliveira (2021) propose 46 CSF of implementing LSS in the Public Sector from a management perspective and classified them into 9 dimensions. Yadav et al (2021) reviewed 20 CSFs and found only 18 of them were necessary with the use of questionnaires and t-test analysis. Aljazzazen and Schmuk (2022) selected 10 CSFs and ranked them using questionnaires and t-test. Ahmad et al (2019) selected 3 CSFs and

verified their correlation to operational performance with the use of statistical tools and ranked them.

### **3.2.2. Theme2: Critical Failure Factors of LSS**

Following the articles selected which addressed the Critical Failure Factors (CFFs), it can be concluded that some authors define them as those important points where in order for a methodology to fail its implementation, the process must fall short (Albliwi et al, 2014). In addition, Swarnakar et al (2020) explain that authors tend to confuse the term critical success factors with the term barriers. The authors continue by clarifying that barriers stall processes, prevent them from moving forward while agreeing with the definition of CFFs previously presented by Albliwi et al (2014). On the other hand, authors such as Sunder and Prashar (2020) define CFFs as those aspects that guide continuous improvement initiatives to fail and, as the lack of those aspects that guide continuous improvement initiatives to success, in other words, as the opposite of CSFs. Critical failure factors are those key factors where, if not followed, the application of a program or technique will go wrong (Swarnakar et al, 2020).

Albliwi et al (2014) suggest that not all organisations can feel the profits of a LSS implementations. The authors add that 2 out of 3 of continuous improvement initiatives fail to achieve their objectives since a bad execution can turn a LSS implementation powerless. Continuous improvement initiatives are independent beings from organizations and its applicability depends on different contexts such as the size of an organisation, the country of origin of an organisation, the level of maturity regarding CI in an organisation, etc (Sunder and Prashar, 2020). Same as the CSFs, authors studying CFFs of LSS implementation focus on identifying and ranking them or find those with high frequency of appearance using a diverse range of tools. Also, there is a discrepancy of how many CFFs organisations must consider when implementing LSS but, with some common CFFs like “Lack of Top-Management Commitment” which comes as the most important and most frequent CFF of LSS implementation across all authors selected in this study that focused on CFFs of LSS implementation, being the opposite of the most common and important CSF.

The literature also shows a high number of CFFs identified in different sectors such as the Manufacturing Sector, the Public Sector in general, but lacks studies regarding CFFs of LSS implementation in the local government. Albliwi et al (2014) conducted a SLR where the authors identified 34 common CFFs and discussed the top 5. Swarnakar, et al (2020) applied both qualitative with the application of a literature review and a quantitative study to identify 26 CFFs and ranked them using a total interpretive structural modelling (TISM) approach. Sunder and Prashar (2020) identified in their study 39 CFFs through a literature review and ranked them developing a survey instrument which used the Likert scale. Aljazzazen and Schmuk (2022) conducted a literature review to identify the 10 most common CFFs and developed a questionnaire in order to ranked them. Swarnakar et al (2021) identified through a literature review 14 CFFs where they used TISM and MIMAC in order to classify and rank them.

Equal to the CSFs, the authors agree on a common CFF being the lack of top management commitment. Some CFFs such a lack of top management commitment can promote the

development of other CFFs, and if these are not deal with on the early stages of the LSS implementation it can lead to the loss of resources (Swarnakar et al, 2021).

#### **4. Discussion**

A common practice found in the literature is the ranking of the different CSFs and CFFs since this contradicts the thought that every factor is critical and proposes the idea that some factors are more critical than others. Following the definition of CSF explained earlier, if one of the objectives related to the CSF is not achieved the methodology may fail which means that every factor is equally important for the successful implementation of LSS (Lande et al, 2016). The literature shows that different authors have different opinions regarding the number of CSFs and CFFs necessary to address to implement LSS within any organization or sector. Furthermore, a lack of CSFs and CFFs of the implementation of LSS within the Public Sector is present in the literature, even though that authors propose that LSS has been implemented successfully in the Public Sector. On the other hand, there is a common CSF present in all the articles reviewed being top management involvement, the same happens with the CFFs. Tsironis and Psychogios (2016) explain that the involvement and commitment of top management has a great influence on facilitating the implementation of LSS.

However, the research does not show how the CSF previously identified aligns with the operations of the Public Sector and what barriers may come since most of these factors come from implementing LSS in the Private Sector. Furthermore, there is a lack of studies regarding if the critical success factors previously identified would be the same factors when implementing LSS in the Public Sector.

Several initiatives have been put in place in order to implement LSS in the Public Sector, but there is a lack of evidence of the success of these initiatives (Rodgers et al, 2021). The literature shows many case studies of how the Public Sector over relies on Lean over SS and even LSS because of the common thinking that Lean is easier to implement since it does not require any statistical knowledge (Rodgers and Antony, 2019).

##### **4.1. Lean Six Sigma Within the Public Sector**

Rodgers et al (2021) refers to the book “Out of Crisis” by Deming (1982) and expresses the idea that the same management problems that flourish when implementing a CI methodology in Manufacturing are the same problems to be addressed in service organisations. This is because CI methodologies like LSS are beyond of applying technical skills like statistics, but more about a cultural change. They continue by adding that the similarities of the Manufacturing Sector and the Service Sector is that mistakes increase costs, and the costliest of all costs are those which a defect reaches the customers. As expressed in the previous chapter, the articles selected for this research followed the pattern of selecting a couple of CSFs or CFFs and ranking them which brings the idea of separating and creating a hierarchy of factors in order to implement LSS but never gave recommendations on how to address them. Knowing and understanding the aspects that affect the implementation of LSS can bring benefits to organisations that have little to no experience in the methodology (Francescato et al, 2023).

## 5. Conclusion

Organizations from different sectors can implement LSS for them to improve processes, enhance customer satisfaction, reduce costs, and increase profits taking into consideration the key success factors mentioned before (Antony et al, 2016,).The public sector would benefit from a continuous improvement methodology such as LSS because it drives an organisational culture change and it helps to discover new ways of maintaining and even enhancing service levels with the same or fewer resources while also increasing customer satisfaction, improving performance, and reducing operational costs (Psomas et al, 2021). Since LSS is a methodology that is more focused on cultural change and not acquiring technology, its implementation can be achieved with little investment and, while the Public Sector expands and the budget shrinks, it is imperative to adopt methodologies like LSS to guarantee a reliable, quality and on time delivery service (Antony et al, 2016).

The literature demonstrates that LSS can provide the Public Sector with a plethora of benefits such as increased customer satisfaction, stakeholder value, quality, speed, and reduced costs (Tsironis and Psychogios, 2016). While there are several case studies regarding the implementation of LSS within the Public Sector, the literature exposes the need for more quantitative studies that analyses the success or failure of a LSS implementation initiative within the Public Sector.

Within the literature several gaps were identified such as a clear disconnection between authors on how many and which CSFs and CFFs needs to be addressed for the successful implementation of LSS. Also, authors identified or selected different numbers of CSFs and CFFs to further assign a grade or give them different levels of criticality using different statistical tools. This process creates a gap and minimises the importance of some factors over the others which does not help to the implementation of LSS and promotes the overreliance of some specific factors.

The findings of this study can bring benefits for academics and practitioners within the Public Sector that wish to follow review the implementation of LSS within the Public Sector. Managers from the Public Sector can benefit from the CSFs and CFFs identified within the literature to serve as a good practices guideline to successfully implement LSS or other CI initiatives, drive the initiation of a cultural change and the improvement of inefficient processes. In addition, the current study can promote the education of professionals within organisations of the Public Sector regarding LSS offering valuable perspectives and highlighting pertinent matters that needs to be considered during the implementation of LSS and to enable public managers to increase the satisfaction of citizens by making better decisions.

This study also provides a broad insight into the challenges faced during the deployment of LSS and how to avoid them. This understanding enables managers to adopt preventive and change management strategies needed to evade the failure of its implementation. Additionally, it is imperative for managers within the Public Sector to acknowledge the reasons behind LSS implementation failures. Equally important is the practical significance of interpreting CSFs and CFFs that arise at different stages of the deployment of LSS. This knowledge gives power managers to take appropriate actions in response to these challenges.

The main finding of this study is the identification of top management commitment as a critical factor for a successful LSS implementation, as authors such as Tsironis et al, (2016); Laureani and Antony, (2013); Swarnakar et al, (2020); Raval et al, (2021); Mishra, (2022); Juliani and Oliveira, (2020); Patel and Patel, (2021) previously found in their studies. But rather than ranking this as the most important factor with the use of statistical or quantitative tools creating a gap between the other factors and diminishing their value, is selecting it as the driver and enabler for the rest of the critical factors. With a fully committed management, a cultural change within the Public Sector will happen more smoothly with the selection of prepared leaders that can further drive the cultural change with proper communication, training, and coaching. In addition, with a fully committed management financial and human resources will always be provided because there is already a sense of awareness about the importance of both for the implementation and sustainability of LSS. Furthermore, with a fully committed management team, change leaders selected, trained personnel and enough resources available, LSS projects can be successfully executed without any limitations. Top management commitment as a critical success factor can be compared to the overproduction waste that lies within the Lean Thinking methodology. As overproduction is the generator of other wastes such as inventory, waiting, transport, etc., top management commitment will drive other critical success factors such as cultural change, human and financial resource management, communication, etc.

## **6. Limitations**

This study suffered from the following limitations:

First, only using 2 search engines which, even though are two well-known search engines, exists the possibility that some relevant articles may be excluded from this study. Second, the exclusion criteria may be another reason of the exclusion of relevant articles with only a 10-year period used for this study with articles published only in English. Third, this study is based entirely on qualitative data and previous work, so assumptions were made based on the data gathered. A quantitative approach with a field study to evaluate the effectiveness of the framework proposed may be more suitable. Finally, the low number of published papers that addressed LSS within the Public Sector.

## **7. Recommendations**

Several gaps and opportunities were identified in this study which can make up for a future investigation agenda, these are as follow:

It is unclear from the literature how organizations, more specifically from the Public Sector, should approach the implementation of the Lean Six Sigma methodology. In addition, it is also unclear how the different critical success factors relate to the reality of the Public Sector services. There is a need for more publications regarding LSS within the Public Sector and more case studies that not only explain the benefits of post-implementing LSS but also during the implementation and pre-implementation of it. In addition, the use of case studies would clarify how a Lean Six Sigma initiative behaves within the public sector. Furthermore, there is a lack of literature regarding the failures of implementing LSS in general, it is recommended that future researchers focus on failed attempts of implementing LSS without compromising the studied institution since it can

provide a new perspective on implementing LSS. In addition, there is a vast number of CSFs and CFFs with authors assigning different rankings. It is suggested that for further research authors identify and summarise those essential CSFs and CFFs and instead of ranking them focus on providing suggestions on how to reach those CSFs and how to avoid those CFFs.

On the other hand, it is recommended for practitioners such as managers within the Public Sector to adopt the CSFs preciously identified for a successful LSS implementation, and to use frameworks such as the developed in this study to guide them throughout the different phases of the implementation. In addition, it is recommended that public managers switch the mentality of quick wins and focus on the short- and long-term benefits of LSS for its successful implementation. Furthermore, it is recommended that managers of the Public Sector encourage the top managers from their institutions to implement LSS, by fully involving them into the benefits that this methodology may bring. Finally a framework was proposed in this study, for future research it is recommended to test this framework to evaluate its efficiency, efficacy, and determine if future adjustments are needed.

## REFERENCES

- Albliwi, S., Antony, J., Lim, S., and Wiele, t. (2014) 'Critical failure factors of lean Six Sigma: A systematic literature review', *International Journal of Quality and Reliability Management*, 31(9), pp. 1012–1030. Available at: <https://doi.org/10.1108/IJQRM-09-2013-0147>.
- Aljazzazen, S. and Schmuck, R. (2022) 'Critical Success Factors for Successful Lean Six Sigma Implementation in the Service Organizations.', *Quality - Access to Success*, 23(188), pp. 76–85. Available at: <https://doi.org/10.47750/QAS/23.188.11>.
- Alnadi, M. and McLaughlin, P. (2021) 'Critical success factors of Lean Six Sigma from leaders' perspective', *International Journal of Lean Six Sigma*. Emerald Group Holdings Ltd., pp. 1073–1088. Available at: <https://doi.org/10.1108/IJLSS-06-2020-0079>.
- Antony, J., Rodgers, B. and Cudney, E.A. (2017) 'Lean Six Sigma for public sector organizations: is it a myth or reality?', *International Journal of Quality and Reliability Management*, 34(9), pp. 1402–1411. Available at: <https://doi.org/10.1108/IJQRM-08-2016-0127>.
- Antony, J., Rodgers, B. and Gijo, E. V. (2016) 'Can Lean Six Sigma make UK public sector organisations more efficient and effective?', *International Journal of Productivity and Performance Management*, 65(7), pp. 995–1002. Available at: <https://doi.org/10.1108/IJPPM-03-2016-0069>.
- Assarlind, M. and Aaboen, L. (2014) 'Forces affecting one lean six sigma adoption process', *International Journal of Lean Six Sigma*, 5(3), pp. 324–340. Available at: <https://doi.org/10.1108/IJLSS-07-2013-0039>.
- Francescato, M., Junior, A., Kubota, F., Guimarae, G., and Oliveira, B. (2023) 'Lean Six Sigma case studies literature overview: critical success factors and difficulties', *International Journal of Productivity and Performance Management*. Emerald Publishing, pp. 1–23. Available at: <https://doi.org/10.1108/IJPPM-12-2021-0681>.
- Gastelum-Acosta, C., Limon-Romero, J., Tiapa, D., and Baez-Lopez, Y. (2022) 'Assessing the adoption of critical success factors for lean six sigma implementation', *Journal of Manufacturing Technology Management*, 33(1), pp. 124–145. Available at: <https://doi.org/10.1108/JMTM-12-2020-0488>.
- Juliani, F. and de Oliveira, O.J. (2020) 'Lean Six Sigma principles and practices under a management perspective', *Production Planning and Control*, 31(15), pp. 1223–1244. Available at: <https://doi.org/10.1080/09537287.2019.1702225>.
- Lande, M., Shrivastava, R.L. and Seth, D. (2016) 'Critical success factors for Lean Six Sigma in SMEs (small and medium enterprises)', *TQM Journal*, 28(4), pp. 613–635. Available at: <https://doi.org/10.1108/TQM-12-2014-0107>.



Laureani, A. and Antony, J. (2018) 'Leadership—a critical success factor for the effective implementation of Lean Six Sigma', *Total Quality Management and Business Excellence*, 29(5–6), pp. 502–523. Available at: <https://doi.org/10.1080/14783363.2016.1211480>.

Moya, C.A., Galvez, D., Muller, Laurent., and Camargo, M. (2019) 'A new framework to support Lean Six Sigma deployment in SMEs', *International Journal of Lean Six Sigma*, 10(1), pp. 58–80. Available at: <https://doi.org/10.1108/IJLSS-01-2018-0001>.

Papic, L., Mladjenovic, M., Garcia, A., and Aggrawal, D. (2017) 'Significant factors of the successful lean six-sigma implementation', *International Journal of Mathematical, Engineering and Management Sciences*, 2(2), pp. 85–109. Available at: <https://doi.org/10.33889/ijmems.2017.2.2-009>.

Patel, A.S. and Patel, K.M. (2020) 'Critical review of literature on Lean Six Sigma methodology', *International Journal of Lean Six Sigma*. Emerald Group Holdings Ltd., pp. 627–674. Available at: <https://doi.org/10.1108/IJLSS-04-2020-0043>.

Raval, S.J., Kant, R. and Shankar, R. (2021) 'Analyzing the critical success factors influencing Lean Six Sigma implementation: fuzzy DEMATEL approach', *Journal of Modelling in Management*, 16(2), pp. 728–764. Available at: <https://doi.org/10.1108/JM2-07-2019-0155>.

Rodgers, B. and Antony, J. (2019) 'Lean and Six Sigma practices in the public sector: a review', *International Journal of Quality and Reliability Management*. Emerald Group Holdings Ltd., pp. 437–455. Available at: <https://doi.org/10.1108/IJQRM-02-2018-0057>.

Setijono, D., Laureani, A. and Antony, J. (2012) 'Critical success factors for the effective implementation of Lean Sigma: Results from an empirical study and agenda for future research', *International Journal of Lean Six Sigma*, 3(4), pp. 274–283. Available at: <https://doi.org/10.1108/20401461211284743>.

Sreedharan, R. V., Sunder, V.M. and Raju, R. (2018) 'Critical success factors of TQM, Six Sigma, Lean and Lean Six Sigma: A literature review and key findings', *Benchmarking*. Emerald Group Publishing Ltd., pp. 3479–3504. Available at: <https://doi.org/10.1108/BIJ-08-2017-0223>.

Stankalla, R., Koval, O. and Chromjakova, F. (2018) 'A review of critical success factors for the successful implementation of Lean Six Sigma and Six Sigma in manufacturing small and medium sized enterprises', *Quality Engineering*, 30(3), pp. 453–468. Available at: <https://doi.org/10.1080/08982112.2018.1448933>.

Sunder M, V. and Prashar, A. (2020) 'Empirical examination of critical failure factors of continuous improvement deployments: stage-wise results and a contingency theory perspective', *International Journal of Production Research*, 58(16), pp. 4894–4915. Available at: <https://doi.org/10.1080/00207543.2020.1727044>.

Swarnakar, V., Sing, A., Tiwari, A., Antony, J., Cudney, E., and Furterer, S. (2020) 'A multiple integrated approach for modelling critical success factors in sustainable LSS implementation', *Computers and Industrial Engineering*, 150. Available at: <https://doi.org/10.1016/j.cie.2020.106865>.

Swarnakar, V., Singh, A.R. and Tiwari, A.K. (2021) 'Evaluating the effect of critical failure factors associated with sustainable Lean Six Sigma framework implementation in healthcare organization', *International Journal of Quality and Reliability Management*, 38(5), pp. 1149–1177. Available at: <https://doi.org/10.1108/IJQRM-07-2020-0243>.

Swarnakar, V., Tiwari, A.K. and Singh, A.R. (2020) 'Evaluating critical failure factors for implementing sustainable lean six sigma framework in manufacturing organization: A case experience', *International Journal of Lean Six Sigma*, 11(6), pp. 1083–1118. Available at: <https://doi.org/10.1108/IJLSS-05-2019-0050>.

Tranfield, D., Denyer, D. and Smart, P. (2003) 'Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review', *British Journal of Management*, pp. 207–222. Available at: <https://doi.org/10.1111/1467-8551.00375>.

Tsironis, L.K. and Psychogios, A.G. (2016) 'Road towards Lean Six Sigma in service industry: a multi-factor integrated framework', *Business Process Management Journal*, 22(4), pp. 812–834. Available at: <https://doi.org/10.1108/BPMJ-08-2015-0118>.

Yadav, N., Shankar, R. and Singh, S.P. (2021) 'Critical success factors for lean six sigma in quality 4.0', *International Journal of Quality and Service Sciences*, 13(1), pp. 123–156. Available at: <https://doi.org/10.1108/IJQSS-06-2020-0099>.