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Lean Six Sigma for Small Enterprises: A Systematic Review and Lite-DMAIC Adaptation Framework for Resource-Constrained Organizations

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Abstract- ***Lean Six Sigma (LSS) has been widely recognized as a powerful methodology for improving process efficiency, reducing waste, and enhancing quality across diverse industries. However, its traditional implementation frameworks are often resource-intensive, making them less accessible to small enterprises operating under financial, technical, and human capital constraints. This systematic review critically examines existing literature on Lean, Six Sigma, and integrated LSS applications within small and medium-sized enterprises (SMEs), with a particular focus on identifying barriers to adoption, success factors, and contextual adaptations. Drawing on peer-reviewed studies, industry reports, and empirical case analyses, the review highlights key challenges faced by small enterprises, including limited expertise, inadequate data infrastructure, resistance to change, and high implementation costs. In response to these limitations, the study proposes a Lite-DMAIC adaptation framework tailored specifically for resource-constrained organizations. The framework simplifies the traditional Define, Measure, Analyze, Improve, and Control (DMAIC) cycle by reducing complexity, minimizing data requirements, and emphasizing practical, low-cost tools that can be easily deployed without extensive training. It integrates agile principles, visual management techniques, and incremental improvement strategies to enhance flexibility and scalability. Furthermore, the framework prioritizes leadership engagement, employee participation, and continuous learning as critical enablers of sustainable process improvement in small enterprise contexts. The findings suggest that when appropriately adapted, LSS can significantly enhance operational performance, customer satisfaction, and competitive advantage for small enterprises. The proposed Lite-DMAIC model offers a pragmatic pathway for SMEs to leverage LSS principles without the burden of extensive resource commitments. This study contributes to both academic discourse and practical implementation by bridging the gap between theory and application in constrained environments. Future research directions include empirical validation of the framework across sectors and the integration of digital tools to further enhance efficiency and data-driven decision-making in small enterprise settings globally.***

Keywords: Lean Six Sigma, Small Enterprises, SMEs, DMAIC, Process Improvement, Resource Constraints, Continuous Improvement, Quality Management

I. INTRODUCTION

Lean Six Sigma (LSS) has emerged as a robust and widely adopted methodology for enhancing organizational performance through the systematic reduction of waste and process variation. Originating from the integration of Lean manufacturing principles, which emphasize value creation and waste elimination, and Six Sigma techniques, which focus on reducing defects and improving process consistency, LSS has evolved into a comprehensive framework applicable across diverse sectors, including manufacturing, healthcare, finance, and services (Ogbete, Aminu-Ibrahim & Ambali, 2018, Okonkwo, Ogunwole & Okeke, 2018). Over time, organizations have leveraged LSS to achieve operational excellence, improve customer satisfaction, and strengthen competitive positioning. Its structured approach, often operationalized through the Define, Measure, Analyze, Improve, and Control (DMAIC) cycle, provides a disciplined pathway for identifying inefficiencies and implementing sustainable improvements (Efobi, Akinleye & Fasawe, 2021, Elebe & Imediegwu, 2021, Oparah, et al., 2021).

In the context of small enterprises, the relevance of process improvement methodologies such as LSS is increasingly significant. Small and medium-sized enterprises (SMEs) operate in highly competitive and dynamic environments where efficiency, cost control, and quality assurance are critical to survival and growth (Moyo, et al., 2021, Ofoedu, et al., 2021, Okafor, et al., 2021). Unlike large organizations, small enterprises often lack the buffer of extensive resources and must therefore optimize their operations to remain viable. The adoption of LSS principles offers these organizations an opportunity to streamline workflows, reduce operational waste, and enhance service delivery, thereby improving overall performance and customer satisfaction (Sanni, Ajiga & Atima, 2020).

Despite its potential benefits, the implementation of LSS in small enterprises is often hindered by substantial resource constraints. SMEs typically face limitations in financial capacity, skilled personnel, data infrastructure, and time, which can make the adoption of traditional LSS frameworks challenging (Ekechi & Fasasi, 2020, Elebe & Imediegwu, 2020, Nduka, 2020). The complexity of standard LSS tools, the cost of training and certification, and the need for extensive data collection and analysis further exacerbate these challenges. Additionally, small enterprises may encounter resistance to change due to informal organizational structures and limited exposure to structured process improvement methodologies (Agbabiaka, et al., 2019, Michael & Ogunsola, 2019, Obogo, Ozobu & Uduokhai, 2019).

These constraints underscore the need for adapting LSS frameworks to better suit the realities of resource-constrained environments. Simplified and flexible approaches that retain the core principles of LSS while reducing implementation complexity are essential for enabling small enterprises to benefit from process improvement initiatives. In response to this need, this study proposes a Lite-DMAIC adaptation framework designed to align with the operational capabilities of SMEs (Adesanya, et al., 2020, Bankole, et al., 2020, Nduka, 2020, Onovo, et al., 2020). The aim of this study is to systematically review existing literature on LSS applications in small enterprises, identify key barriers and success factors, and develop a practical, scalable framework that facilitates effective implementation in resource-constrained settings (Ahmed & Odejobi, 2018, Odejobi & Ahmed, 2018, Okonkwo, Ogunwole & Okeke, 2018).

2.1. Methodology

The methodology for this study adopts a systematic literature review integrated with a conceptual Lite-DMAIC adaptation framework, designed to generate an evidence-based, scalable Lean Six Sigma model suitable for small and resource-constrained enterprises. The approach is grounded in established systematic review protocols and enhanced with data-driven modeling, process optimization logic, and resource-efficiency principles derived from Lean Six Sigma, analytics, and systems engineering literature.

The study begins with a structured evidence identification and retrieval process, guided by systematic review principles similar to those applied in industrial safety, construction risk governance, and Lean Six Sigma reviews (Arumosoye & Obriki, 2019; Tampubolon & Purba, 2021). A comprehensive search strategy is implemented across multidisciplinary databases including Scopus, Web of Science, IEEE Xplore, and Google Scholar. Keywords are constructed around combinations of “Lean Six Sigma,” “SMEs,” “resource-constrained organizations,” “process improvement,” “DMAIC,” “lite frameworks,” and “operational efficiency.” The search is supplemented with backward and forward citation tracking to ensure coverage of foundational works such as Building the Data Warehouse and The Data Warehouse Toolkit, as well as analytics-driven decision frameworks (Chen et al., 2012; Provost & Fawcett, 2013).

Following retrieval, a rigorous screening and selection process is applied using inclusion and exclusion criteria aligned with PRISMA logic. Studies are retained if they address Lean Six Sigma implementation, SME operational contexts, analytics-enabled decision-making, or resource optimization frameworks. Additional relevance is given to conceptual and applied models in risk management (Agbabiaka et al., 2019), infrastructure systems (Aminu-Ibrahim et al., 2019), and enterprise analytics (Mikalef et al., 2020). Duplicates, non-peer-reviewed materials without methodological rigor, and studies lacking applicability to constrained environments are

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excluded. This ensures the final dataset reflects high-quality, context-relevant evidence.

Data extraction is conducted using a structured coding framework that captures key variables including implementation strategies, performance metrics, process improvement tools, resource requirements, constraints, and success factors. Analytical abstraction techniques are applied to synthesize findings across domains such as supply chain optimization, cloud resource allocation, safety systems, and healthcare analytics (Ahmed et al., 2018; Adeleke et al., 2021). The synthesis leverages principles from big data analytics and decision intelligence (Gandomi & Haider, 2015; Wamba et al., 2017), enabling cross-contextual generalization of Lean Six Sigma practices.

The next phase involves conceptual model development through integrative synthesis. Drawing from systems thinking and process mining foundations (Process Mining), the study constructs a Lite-DMAIC framework tailored for SMEs. Unlike traditional DMAIC, which is resource-intensive, the adapted model simplifies each phase by embedding lightweight analytics, minimal data requirements, and rapid-cycle improvement loops. The Define phase is streamlined to focus on critical business pain points and stakeholder priorities; the Measure phase incorporates simplified data capture and proxy metrics; the Analyze phase integrates basic statistical and pattern recognition techniques; the Improve phase emphasizes low-cost, high-impact interventions; and the Control phase adopts continuous monitoring through dashboards and feedback loops (Sanni & Atima, 2021).

To ensure robustness, the proposed framework is validated conceptually through cross-domain alignment with existing models in risk governance, safety performance improvement, and enterprise optimization (Obogo et al., 2020; Okonkwo et al., 2021). Logical consistency, scalability, and adaptability are assessed against SME constraints such as limited capital, workforce capacity, and technological infrastructure. The framework also incorporates insights from resource allocation optimization and cloud scalability models (Ahmed et al., 2020), ensuring it aligns with modern digital transformation pathways.

Finally, the methodology integrates an iterative refinement mechanism, where the Lite-DMAIC framework is continuously improved based on synthesized evidence and practical feasibility considerations. This aligns with continuous improvement philosophies inherent in Lean Six Sigma while adapting them to the agility and flexibility required in small enterprises. The outcome is a validated conceptual framework that bridges the gap between theory and practice, enabling SMEs to adopt Lean Six Sigma principles without the traditional cost and complexity barriers.

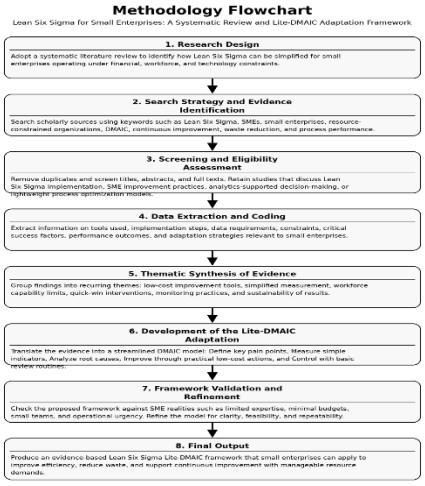

Figure 1: Flowchart of the study methodology

2.2. Conceptual Foundations of Lean and Six Sigma

The conceptual foundations of Lean and Six Sigma are rooted in distinct but complementary philosophies that, when integrated, provide a powerful framework for operational excellence. Lean thinking originates from the Toyota Production System and is fundamentally concerned with maximizing customer value while minimizing waste (Nwankwo, Okeke & Ugwu-Oju, 2020, Okeke, Nwankwo & Ugwu-Oju, 2020, Osuji, Okafor & Dako, 2020). At its core, Lean seeks to create more value for customers with fewer resources by systematically identifying and eliminating non-value-adding activities. Waste, often categorized into forms such as overproduction, waiting, unnecessary transportation, excess inventory, overprocessing, motion, and defects, represents any activity that consumes resources without adding value

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from the customer's perspective (Michael & Ogunsola, 2021, Okonkwo, et al., 2021, Oshoba, Ahmed & Odejobi, 2021). By focusing on value streams and ensuring that every step in a process contributes meaningfully to the end product or service, Lean enables organizations to streamline operations, improve flow, and enhance responsiveness to customer needs. This emphasis on continuous improvement, often operationalized through practices such as Kaizen, empowers employees at all levels to identify inefficiencies and contribute to incremental enhancements (Fasawe, Umoren & Akinola, 2021, Gado, et al., 2021, Imediegwu & Elebe, 2021).

Closely aligned with waste reduction is the Lean principle of value maximization, which requires organizations to clearly define value from the customer's viewpoint and align all processes toward delivering that value efficiently. This involves mapping the value stream to identify bottlenecks and redundancies, creating smooth and uninterrupted process flows, and implementing pull-based systems that respond directly to customer demand rather than forecast-driven production (Sanni, Ajiga & Atima, 2020). In small enterprises, these principles are particularly relevant, as limited resources necessitate efficient utilization and minimal wastage. Lean's focus on simplicity, visual management, and standardization makes it an attractive approach for organizations seeking to improve performance without significant capital investment. Figure 2 shows DMAIC methodology for Six-Sigma quality management presented by Yang, et al., 2020

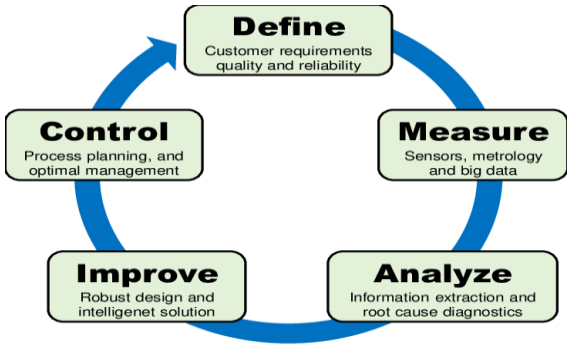

Figure 2: The DMAIC methodology for Six-Sigma quality management (Yang, et al., 2020).

In contrast, Six Sigma is a data-driven methodology that focuses on reducing process variation and minimizing defects to achieve consistent and predictable outcomes. Developed by Motorola and later popularized by General Electric, Six Sigma is grounded in statistical analysis and aims to improve quality by identifying the root causes of variability in processes. The central premise of Six Sigma is that defects and errors are primarily the result of variation, and by controlling and reducing this variation, organizations can enhance process reliability and customer satisfaction (Oshoba, Ahmed & Odejobi, 2021, Patrick, et al., 2021, Sanni & Atima, 2021). The term "Six Sigma" itself refers to a level of process performance where the probability of defects is extremely low, typically no more than 3.4 defects per million opportunities.

Six Sigma emphasizes the use of quantitative tools and techniques, including statistical process control, hypothesis testing, regression analysis, and design of experiments, to analyze data and inform decision-making. It relies on a structured problem-solving approach and a hierarchy of trained professionals, such as Green Belts and Black Belts, who lead improvement projects (Yetunde, Onyelucheya & Dako, 2018). For small enterprises, however, the intensive data requirements and need for specialized expertise can pose significant challenges. Nevertheless, the core principles of variation reduction and defect minimization remain highly relevant, as even small improvements in quality can have substantial impacts on cost, customer satisfaction, and competitiveness. Figure 3 shows figure of Lean Six Sigma framework presented by Rathilall & Singh, 2018.

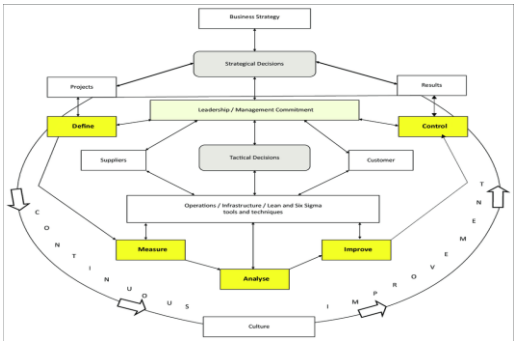

Figure 3: Lean Six Sigma framework (Rathilall & Singh, 2018).

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The integration of Lean and Six Sigma into a unified methodology, commonly referred to as Lean Six Sigma (LSS), combines the strengths of both approaches to deliver comprehensive process improvement. While Lean focuses on improving process speed and eliminating waste, Six Sigma concentrates on enhancing quality and reducing variability. Together, they provide a balanced framework that addresses both efficiency and effectiveness (Ekechi & Fasasi, 2020, Ekechi, 2020, Gado, et al., 2020). This integration allows organizations to not only streamline their operations but also ensure that the outputs of those operations meet stringent quality standards. In practice, Lean tools such as value stream mapping and 5S are often used in conjunction with Six Sigma techniques to identify improvement opportunities and implement sustainable solutions (Ahmed & Odejobi, 2018, Odejobi & Ahmed, 2018).

A central component of the Lean Six Sigma methodology is the DMAIC cycle, which provides a structured approach to problem-solving and process improvement. The Define phase involves clearly articulating the problem, identifying customer requirements, and setting project objectives. This is followed by the Measure phase, where data is collected to establish baseline performance and quantify the extent of the problem. In the Analyze phase, the data is examined to identify root causes of inefficiencies or defects, often using statistical and analytical tools (Ahmed, Odejobi & Oshoba, 2019, Michael & Ogunsola, 2019). The Improve phase focuses on developing and implementing solutions to address the identified root causes, while the Control phase ensures that the improvements are sustained over time through monitoring, standardization, and documentation.

The DMAIC methodology is particularly valuable because it provides a disciplined and repeatable framework that can be applied to a wide range of processes and industries. Its emphasis on data-driven decision-making and continuous improvement aligns well with the objectives of organizations seeking to enhance performance in a systematic manner (Bankole, et al., 2020, Efobi, Akinleye & Fasawe, 2020, Nduka, 2020). However, for small enterprises, the traditional DMAIC approach may need to be simplified to reduce complexity and resource requirements. This has led to the development of adapted models, such as Lite-DMAIC, which retain the core structure of DMAIC while streamlining its implementation to suit the capabilities of resource-constrained organizations. Figure 4 shows the relationship between Six Sigma Models and Lean Principles presented by Tampubolon & Purba, 2021.

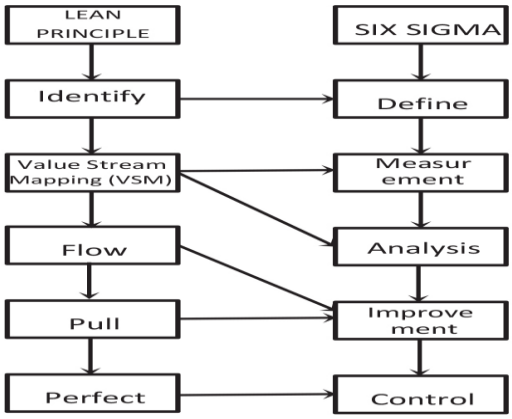

Figure 4: Relationship between Six Sigma Models and Lean Principles (Tampubolon & Purba, 2021).

The applicability of Lean, Six Sigma, and their integrated form extends across a broad spectrum of industries, including manufacturing, healthcare, finance, logistics, and service sectors. In manufacturing, these methodologies have been used to optimize production processes, reduce defects, and improve supply chain efficiency. In healthcare, they have contributed to reducing patient wait times, minimizing medical errors, and enhancing the quality of care (Sanni, Ajiga & Atima, 2020). Service industries have leveraged Lean Six Sigma to improve customer experience, streamline service delivery, and reduce operational costs. For small enterprises operating in these sectors, the adaptability and scalability of Lean Six Sigma make it a valuable tool for achieving operational excellence.

Despite the differences in context and scale, the underlying principles of Lean and Six Sigma remain universally applicable. Their focus on customer value, process efficiency, quality improvement, and continuous learning provides a solid foundation for organizations seeking to navigate the complexities of

modern business environments. For small enterprises, the challenge lies not in the relevance of these principles but in their practical implementation. By understanding the conceptual foundations of Lean and Six Sigma, and by adapting their application to fit organizational realities, small enterprises can harness the benefits of Lean Six Sigma to drive sustainable growth and competitiveness (Obogo, Ozobu & Uduokhai, 2019, Odejobi, Hammed & Ahmed, 2019).

2.3. Characteristics of Small Enterprises and Resource Constraints

Small and medium-sized enterprises (SMEs) represent a critical segment of the global economy, contributing significantly to employment generation, innovation, and economic development. Although definitions of SMEs vary across countries and institutions, they are generally classified based on criteria such as number of employees, annual turnover, and asset base. In many developing economies, small enterprises are often defined as organizations employing fewer than 50 workers, while medium enterprises may employ up to 250 employees (Okonkwo, et al., 2020, Oshoba, Ahmed & Odejobi, 2020, Patrick, et al., 2020). Beyond these quantitative measures, SMEs are typically characterized by their limited scale of operations, localized market focus, and relatively simple organizational structures. Despite their size, SMEs play a vital role in fostering entrepreneurship, supporting supply chains, and driving inclusive economic growth, particularly in emerging markets where they often dominate the business landscape (Anichukwueze, Osuji & Oguntegbe, 2021, Fasawe, Filani & Okpokwu, 2021, Umoren, Sanusi & Bayeroju, 2021).

A defining feature of small enterprises is their exposure to significant resource constraints, which manifest across financial, human, and technological dimensions. Financial limitations are among the most prominent challenges faced by SMEs, as they often operate with restricted access to capital and limited cash flow. This constraint affects their ability to invest in new technologies, training programs, and process improvement initiatives. Unlike large corporations that can allocate substantial budgets to quality management systems and continuous improvement projects, small enterprises must prioritize immediate operational needs, often at the expense of long-term strategic investments (Aminu-Ibrahim, Ogbete & Ambali, 2019, Obogo, Ozobu & Uduokhai, 2019). This financial fragility can also increase vulnerability to market fluctuations and economic shocks, further constraining their capacity to adopt structured improvement methodologies such as Lean Six Sigma.

Human resource limitations further compound the challenges faced by SMEs. Small enterprises typically employ a limited number of staff, many of whom perform multiple roles and responsibilities. This multitasking environment, while fostering flexibility, often results in a lack of specialized expertise in areas such as data analysis, quality management, and process optimization (Obuse, et al., 2020, Okafor, Dako & Osuji, 2020, Onovo, et al., 2020). The absence of trained professionals, such as Six Sigma Black Belts or process improvement specialists, restricts the organization's ability to implement sophisticated methodologies that require technical knowledge and analytical skills (Michael & Ogunsola, 2021, Ogunwole, et al., 2021, Okonkwo, et al., 2021). Additionally, the time constraints faced by employees in small enterprises leave little room for participation in training programs or improvement projects, as daily operational demands take precedence.

Technological limitations also play a significant role in shaping the operational capabilities of SMEs. Many small enterprises rely on basic or outdated technologies, with limited access to advanced data analytics tools, enterprise resource planning systems, and automation solutions. This lack of technological infrastructure hinders the collection, analysis, and utilization of data, which are essential components of evidence-based decision-making in methodologies like Lean Six Sigma (Ahmed, Odejobi & Oshoba, 2020, Odejobi, Hammed & Ahmed, 2020, Oshoba, Ahmed & Odejobi, 2020). Without reliable data systems, SMEs may struggle to measure process performance, identify root causes of inefficiencies, and monitor the impact of improvement initiatives. Consequently, their ability to implement data-driven approaches is often constrained, necessitating the use of simpler and more intuitive tools.

In addition to resource limitations, SMEs are often characterized by informal organizational structures

and decision-making processes. Unlike large organizations with clearly defined hierarchies, standardized procedures, and formal communication channels, small enterprises tend to operate with flexible and less structured systems. Decision-making is frequently centralized, with owners or top managers playing a dominant role in guiding organizational activities (Filani, Okpokwu & Fasawe, 2020, Gado, et al., 2020, Nduka, 2020). While this centralization can enable quick responses and adaptability, it may also limit employee involvement in decision-making and reduce opportunities for collaborative problem-solving. Informal communication practices, though efficient in some contexts, can lead to inconsistencies in information flow and hinder the documentation and standardization of processes (Ahmed, Odejobi & Oshoba, 2021, Michael & Ogunsola, 2021, Sanni & Atima, 2021).

These structural characteristics have important implications for the adoption of process improvement methodologies such as Lean Six Sigma. The lack of formalization in SMEs can make it challenging to implement structured frameworks that require documentation, standard operating procedures, and systematic monitoring (Dako, et al., 2021, Davidor, et al., 2021, Farounbi, et al., 2021). Moreover, resistance to change may arise when employees perceive process improvement initiatives as disruptive or unnecessary, particularly in organizations where existing practices have been in place for extended periods. The absence of a strong culture of continuous improvement can further impede the successful adoption of such methodologies (Aminu-Ibrahim, Ogbete & Ambali, 2020,Ogbete, Aminu-Ibrahim & Ambali, 2020).

The combined effect of financial, human, technological, and structural constraints significantly influences the ability of SMEs to adopt and sustain process improvement initiatives. Traditional Lean Six Sigma frameworks, which often involve extensive data collection, rigorous statistical analysis, and formal training programs, may be perceived as overly complex and resource-intensive for small enterprises (Bankole, et al., 2020, Dako, et al., 2020, Imediegwu & Elebe, 2020). As a result, SMEs may either avoid adopting these methodologies altogether or implement them in a limited and fragmented manner, thereby reducing their potential impact. The mismatch between the requirements of conventional frameworks and the capabilities of small enterprises underscores the need for context-specific adaptations (Mbonu, et al., 2019, Obriki & Arumosoye, 2019, Uduokhai, Obogo & Ozobu, 2019).

In response to these challenges, there is a growing recognition of the need for simplified and flexible frameworks that align with the realities of resource-constrained environments. Such frameworks must retain the core principles of Lean Six Sigma while reducing complexity, minimizing resource requirements, and enhancing ease of implementation. Simplification may involve the use of basic analytical tools, visual management techniques, and intuitive problem-solving methods that do not require advanced statistical expertise (Arumosoye & Obriki, 2021, Mbonu, et al., 2021, Obogo, Uduokhai & Ozobu, 2021). Additionally, adapted frameworks should emphasize practical, incremental improvements rather than large-scale transformation projects, allowing SMEs to achieve tangible results within their limited capacity.

The development of a Lite-DMAIC adaptation framework represents a strategic response to the unique characteristics and constraints of small enterprises. By streamlining the traditional DMAIC process and focusing on essential elements, the Lite-DMAIC approach provides a more accessible pathway for SMEs to engage in continuous improvement (Obuse, et al., 2020, Onovo, et al., 2020, Osuji, Dako & Okafor, 2020). It encourages the use of readily available data, promotes employee participation, and supports iterative learning, thereby fostering a culture of improvement without imposing excessive demands on organizational resources. Furthermore, such frameworks can enhance the scalability of process improvement initiatives, enabling small enterprises to gradually build their capabilities and expand their efforts over time (Mbonu, et al., 2021, Obogo, Arumosoye & Obriki, 2021, Obriki & Arumosoye, 2021).

Ultimately, understanding the characteristics of small enterprises and the nature of their resource constraints is essential for designing effective process improvement strategies. By acknowledging these realities and adapting methodologies accordingly, it

becomes possible to bridge the gap between theoretical frameworks and practical application. This alignment not only increases the likelihood of successful implementation but also ensures that SMEs can fully realize the benefits of Lean Six Sigma in enhancing efficiency, quality, and competitiveness in an increasingly challenging business environment (Aminu-Ibrahim, Ogbete & Ambali, 2021, Sanni & Atima, 2021, Uzoka, et al., 2021).

2.4. Barriers and Critical Success Factors in LSS Adoption

The adoption of Lean Six Sigma (LSS) within small enterprises presents both significant opportunities and persistent challenges, particularly in resource-constrained environments where operational priorities often outweigh strategic process improvement initiatives. While LSS offers a structured and proven approach to enhancing efficiency, quality, and customer satisfaction, its implementation in small and medium-sized enterprises (SMEs) is frequently hindered by a range of barriers that limit its accessibility and effectiveness (Anichukwueze, Osuji & Oguntegbe, 2021, Elebe & Imediegwu, 2021). At the same time, a growing body of literature highlights critical success factors that can enable SMEs to overcome these challenges and achieve sustainable improvements through adapted LSS frameworks (Obriki, Obogo & Arumosoye, 2020).

One of the most commonly cited barriers to LSS adoption in small enterprises is the high cost associated with its implementation. Traditional LSS deployment often requires investment in training, certification, consultancy services, and data infrastructure, all of which may be beyond the financial capacity of SMEs (Amatare & Ojo, 2021, Dako, Okafor & Osuji, 2021, Nwankwo, Okeke & Ugwu-Oju, 2021). Unlike large organizations that can allocate dedicated budgets to continuous improvement programs, small enterprises must carefully manage limited financial resources and prioritize immediate operational needs. This cost sensitivity often results in reluctance to adopt methodologies perceived as complex or resource-intensive, even when their long-term benefits are recognized (Ogbete, Aminu-Ibrahim & Ambali, 2021, Ogunsola & Michael, 2021, Sanni & Atima, 2021).

Closely related to financial constraints is the lack of expertise within SMEs. LSS relies heavily on specialized knowledge in statistical analysis, process mapping, and problem-solving techniques, typically facilitated by trained professionals such as Green Belts and Black Belts. However, small enterprises often lack access to such expertise, either due to financial limitations or the absence of internal capacity (Anichukwueze, Osuji & Oguntegbe, 2020, Efobi, Akinleye & Fasawe, 2020). Employees in SMEs are frequently required to perform multiple roles, leaving little time or opportunity to develop the advanced skills necessary for effective LSS implementation. This skills gap can lead to improper application of tools, misinterpretation of data, and ultimately, failure to achieve desired outcomes (Aminu-Ibrahim, Ogbete & Ambali, 2018, Saltz & Shamshurin, 2016, Sculley, et al., 2015).

Resistance to change is another significant barrier that affects the adoption of LSS in small enterprises. Organizational change, particularly when it involves restructuring processes or introducing new practices, can be met with skepticism and reluctance from employees. In SMEs, where informal work practices and established routines are common, the introduction of structured methodologies such as LSS may be perceived as disruptive or unnecessary (Erigha, et al., 2019, Filani, Fasawe & Umoren, 2019, Ugwu-Oju, Okeke & Nwankwo, 2018). This resistance can be exacerbated by a lack of awareness or understanding of the benefits of LSS, as well as fears related to increased workload or job insecurity. Without effective change management strategies, such resistance can undermine the success of improvement initiatives (Mbonu, et al., 2019, Ogbete, Aminu-Ibrahim & Ambali, 2019, Ozobu, Obogo & Uduokhai, 2019).

Organizational culture and leadership play a critical role in shaping the success or failure of LSS adoption in SMEs. A culture that supports continuous improvement, innovation, and employee involvement is essential for the effective implementation of LSS principles. In many small enterprises, however, organizational culture may be reactive rather than proactive, with limited emphasis on systematic problem-solving or long-term improvement. Leadership commitment is particularly important in

this context, as leaders in SMEs often have a direct influence on decision-making and resource allocation (Grover, et al., 2018, Hashem, et al., 2015, Watson, 2017). When leaders actively support LSS initiatives, communicate their importance, and lead by example, they create an environment that encourages participation and fosters a culture of improvement. Conversely, lack of leadership engagement can result in insufficient support, limited resource allocation, and eventual abandonment of improvement efforts (Erigha, et al., 2021, Essien, et al., 2021, Ezeh, et al., 2021).

The role of training and capacity building cannot be overstated in the successful adoption of LSS in small enterprises. Effective training programs help bridge the knowledge gap and equip employees with the skills needed to apply LSS tools and techniques. However, traditional training approaches, which may involve extensive classroom sessions and certification processes, are often impractical for SMEs (Elebe & Imediegwu, 2020, Essien, et al., 2020, Imediegwu & Elebe, 2020). As a result, there is a need for more flexible and context-specific training methods that align with the operational realities of small enterprises. On-the-job training, mentoring, and the use of simplified tools can provide practical learning opportunities without disrupting daily operations (Chen, Mao & Liu, 2014, Delen & Demirkan, 2013, Mbonu, et al., 2018). Capacity building should also focus on developing problem-solving skills, fostering a mindset of continuous improvement, and encouraging employee engagement in improvement initiatives.

Data and performance measurement are fundamental components of LSS, yet they represent a significant challenge for many SMEs. The effectiveness of LSS relies on the ability to collect, analyze, and interpret data to identify inefficiencies and monitor improvements. However, small enterprises often lack the technological infrastructure and data management systems required for comprehensive data analysis. In some cases, data may be incomplete, inconsistent, or entirely unavailable, making it difficult to establish baseline performance or evaluate the impact of improvement initiatives (Zaharia, et al., 2016). This limitation can hinder evidence-based decision-making and reduce confidence in the outcomes of LSS projects. To address this challenge, SMEs must adopt simplified data collection and analysis methods that are both practical and reliable, enabling them to leverage available information for informed decision-making (Onovo, Gado & Atobatele, 2012, Patrick, et al., 2019, Ugwu-Oju, Okeke & Nwankwo, 2018).

Despite these barriers, numerous case examples from the literature demonstrate that successful LSS adoption in SMEs is achievable when appropriate strategies are employed. Studies have shown that small manufacturing firms can achieve significant reductions in defects and production lead times by implementing basic Lean tools such as 5S and value stream mapping, combined with simplified Six Sigma techniques. In the service sector, small businesses have improved customer satisfaction and operational efficiency by applying LSS principles to streamline processes and eliminate bottlenecks (Arumosoye & Obriki, 2020, Mikalef, et al., 2020, Nii-Okai, 2020, Obriki & Arumosoye, 2020). These case examples highlight the importance of tailoring LSS approaches to the specific context of SMEs, focusing on practical and achievable improvements rather than attempting to replicate large-scale implementations.

Furthermore, successful cases often share common characteristics, including strong leadership commitment, employee involvement, and a focus on incremental improvements. Rather than undertaking large and complex projects, SMEs that achieve success with LSS tend to start with small, manageable initiatives that deliver quick wins and build momentum for further improvements. This approach not only reduces the risk associated with implementation but also helps to demonstrate the value of LSS to stakeholders, thereby increasing support and engagement (Ogbete, Aminu-Ibrahim & Ambali, 2018).

In conclusion, while the adoption of Lean Six Sigma in small enterprises is challenged by a range of barriers, including cost, lack of expertise, resistance to change, and data limitations, these challenges are not insurmountable. By fostering supportive organizational cultures, investing in targeted training and capacity building, and adopting simplified and flexible approaches, SMEs can overcome these obstacles and realize the benefits of LSS. The insights

gained from literature and case examples underscore the importance of context-specific adaptations, such as the Lite-DMAIC framework, which align with the unique characteristics and resource constraints of small enterprises (Mbonu, et al., 2020, Michael & Ogunsola, 2020, Obogo, Arumosoye & Obriki, 2020). Through such adaptations, LSS can become a practical and effective tool for driving continuous improvement and enhancing competitiveness in resource-constrained environments.

2.5. Lite-DMAIC Adaptation Framework

The Lite-DMAIC adaptation framework emerges as a pragmatic response to the challenges faced by small enterprises in adopting traditional Lean Six Sigma methodologies. While the conventional Define, Measure, Analyze, Improve, and Control (DMAIC) cycle provides a rigorous and structured approach to process improvement, its implementation often assumes the availability of substantial financial resources, specialized expertise, and robust data infrastructures (Uzondu & Ofoedu, 2011, Yeboah & Enow, 2018). These assumptions rarely hold true in small and medium-sized enterprises (SMEs), where operational realities are shaped by limited budgets, multifunctional roles, and constrained technological capabilities. As a result, there is a clear need to simplify the traditional DMAIC framework in a manner that preserves its core logic while making it accessible, flexible, and practical for resource-constrained environments (Sharma, Mithas & Kankanhalli, 2014, Van der Aalst, 2016).

The justification for simplifying DMAIC lies in the mismatch between the complexity of the traditional model and the operational capacity of SMEs. Standard DMAIC applications often involve extensive data collection, advanced statistical analysis, and formal project governance structures, which can be overwhelming for small enterprises (Bayeroju, 2020, Dako, et al., 2020, Ekechi & Fasasi, 2020). In many cases, the perceived complexity and cost of implementation discourage SMEs from adopting Lean Six Sigma altogether, thereby missing out on its potential benefits. Simplification, therefore, is not about diluting the effectiveness of the methodology but about adapting it to fit the context in which it is to be applied. By reducing unnecessary complexity and focusing on essential elements, the Lite-DMAIC framework enables SMEs to engage in structured problem-solving without incurring prohibitive costs or requiring extensive expertise (Mbonu, et al., 2020, Obogo, Arumosoye & Obriki, 2020, Obriki, Obogo & Arumosoye, 2020).

At the core of the Lite-DMAIC framework are simplified versions of the five traditional phases, each tailored to align with the capabilities and needs of small enterprises. The Define phase in Lite-DMAIC emphasizes clarity and simplicity in problem identification, encouraging organizations to focus on specific, high-impact issues that directly affect customer value or operational efficiency. Instead of developing extensive project charters, SMEs are guided to articulate concise problem statements, define achievable objectives, and identify key stakeholders. This streamlined approach reduces the administrative burden while ensuring that improvement efforts remain focused and relevant (Arumosoye & Obriki, 2018, Côrte-Real, Oliveira & Ruivo, 2017, Provost & Fawcett, 2013).

The Measure phase is adapted to accommodate the limited data capabilities of SMEs. Rather than relying on complex data collection systems and large datasets, Lite-DMAIC encourages the use of readily available data and simple measurement techniques. Organizations are guided to identify a small set of key performance indicators (KPIs) that are easy to track and directly linked to the problem at hand. Basic tools such as check sheets, simple tally charts, and manual logs are employed to gather data in a practical and cost-effective manner. This approach not only reduces the resource burden but also fosters a culture of data awareness and evidence-based decision-making within the organization (Akidau, et al., 2015, Chen, Chiang & Storey, 2012, Obriki & Arumosoye, 2018).

In the Analyze phase, the emphasis shifts from advanced statistical techniques to intuitive and accessible problem-solving tools. SMEs are encouraged to use methods such as root cause analysis, fishbone diagrams, and the “5 Whys” technique to identify underlying causes of inefficiencies or defects. These tools require minimal training and can be effectively applied by employees without specialized expertise. By focusing on simplicity and clarity, the

Lite-DMAIC framework ensures that analysis remains actionable and directly linked to improvement efforts, rather than becoming an abstract or overly technical exercise (Gbadamosi & Obogo, 2013, Jagadish, et al., 2014, Kelleher & Tierney, 2018).

The Improve phase in Lite-DMAIC prioritizes practical and low-cost solutions that can be implemented بسرعة and with minimal disruption to ongoing operations. Instead of large-scale process redesigns, SMEs are encouraged to adopt incremental improvements that deliver quick wins and build momentum for further change. Techniques such as brainstorming, pilot testing, and small-scale experimentation are integrated into this phase, allowing organizations to test solutions in a controlled manner before full implementation. This iterative approach reduces risk and enhances the likelihood of successful outcomes, particularly in environments where resources are limited and tolerance for failure is low (Mbonu, et al., 2021, Obogo, Obriki & Arumosoye, 2021, Obriki, Obogo & Arumosoye, 2021).

The Control phase focuses on sustaining improvements through simple and effective monitoring mechanisms. Rather than implementing complex control systems, SMEs are guided to use visual management tools, standard operating procedures, and routine checks to ensure that gains are maintained over time. The emphasis is on embedding improvements into daily operations and fostering accountability among employees. By keeping control mechanisms straightforward and transparent, the Lite-DMAIC framework supports long-term sustainability without imposing additional burdens on the organization (Adeleke, Ajala & Olugbogi, 2021, Arumosoye, Obogo & Obriki, 2021, Fadayomi, et al., 2021).

A defining feature of the Lite-DMAIC framework is its reduced reliance on extensive data and sophisticated analytical tools. While data remains an important component of decision-making, the framework recognizes that SMEs may not have access to comprehensive data systems or advanced analytics capabilities. As such, it promotes the use of "good enough" data—information that is sufficient to inform decisions without requiring perfection. This pragmatic approach allows organizations to move forward with improvement initiatives even in the absence of ideal data conditions, thereby overcoming a common barrier to LSS adoption in small enterprises (Arumosoye & Obriki, 2019, Batistič & van der Laken, 2019, Dubey, et al., 2019).

The integration of agile and visual management techniques further enhances the adaptability and effectiveness of the Lite-DMAIC framework. Agile principles, such as iterative development, continuous feedback, and flexibility, align well with the dynamic and resource-constrained nature of SMEs. By incorporating short improvement cycles and regular feedback loops, the framework enables organizations to respond quickly to changes and refine solutions in real time (Anichukwueze, Osuji & Oguntegbe, 2019, Dako, et al., 2019, Ugwu-Oju, Okeke & Nwankwo, 2018). Visual management techniques, including process maps, dashboards, and visual performance boards, provide clear and accessible representations of information, facilitating communication and engagement across the organization. These tools are particularly valuable in SMEs, where formal communication structures may be limited and quick understanding is essential (Mbonu, et al., 2020, Obogo, Arumosoye & Obriki, 2020, Obriki, Obogo & Arumosoye, 2020).

The overall structure and workflow of the Lite-DMAIC framework are designed to be intuitive and easy to follow, ensuring that it can be implemented without extensive training or external support. The framework maintains the sequential logic of the traditional DMAIC cycle while allowing for flexibility and iteration as needed. Each phase is clearly defined, with a focus on practical actions and outcomes rather than theoretical rigor. The workflow encourages collaboration among employees, leveraging their knowledge and experience to identify problems and develop solutions (Gandomi & Haider, 2015, Inmon, 2005, Kimball & Ross, 2013). By promoting a participatory approach, the framework not only enhances the quality of outcomes but also fosters a sense of ownership and commitment to continuous improvement.

In practice, the Lite-DMAIC framework can be implemented as a series of short, focused

improvement projects that address specific operational challenges. This modular approach allows SMEs to gradually build their capabilities and expand their use of Lean Six Sigma over time. As organizations gain confidence and experience, they may choose to incorporate more advanced tools and techniques, thereby evolving their approach in line with their growing capacity. This scalability is a key strength of the Lite-DMAIC framework, as it provides a pathway for continuous development without overwhelming the organization at the outset (Awe, Akpan & Adekoya, 2017, Osabuohien, 2017).

Ultimately, the Lite-DMAIC adaptation framework represents a balanced and context-sensitive approach to Lean Six Sigma implementation in small enterprises. By simplifying traditional processes, reducing resource requirements, and integrating agile and visual management techniques, it offers a practical solution to the challenges faced by resource-constrained organizations. In doing so, it enables SMEs to harness the benefits of structured process improvement, enhance operational efficiency, and strengthen their competitiveness in an increasingly demanding business environment (Akpan, Awe & Idowu, 2019, Ogundipe, et al., 2019).

2.6. Implementation Strategies for Resource-Constrained Organizations

Effective implementation of Lean Six Sigma (LSS) in resource-constrained organizations requires a pragmatic, structured, and context-sensitive approach that aligns with the realities of small enterprises. The Lite-DMAIC framework provides a simplified pathway for applying LSS principles without overwhelming limited financial, human, and technological capacities. Its successful deployment depends not only on following a clear sequence of steps but also on fostering leadership commitment, encouraging employee participation, leveraging low-cost tools, and embedding mechanisms for monitoring and continuous improvement. When carefully executed, these strategies enable small enterprises to achieve meaningful operational gains while building a sustainable culture of improvement (Awe & Akpan, 2017, Isa, 2019, Udechukwu, 2018).

The step-by-step application of Lite-DMAIC begins with a focused and practical Define phase, where the organization identifies a specific problem that has a clear impact on performance, cost, or customer satisfaction. Rather than attempting to address multiple issues simultaneously, resource-constrained organizations benefit from narrowing their scope to manageable, high-priority challenges. This involves articulating a simple problem statement, defining measurable objectives, and identifying key stakeholders who will be involved in the improvement effort. The emphasis at this stage is on clarity and alignment, ensuring that all participants understand the purpose and expected outcomes of the initiative (Ajayi & Akanji, 2021, Ejibenam, et al., 2021, Osabuohien, Omotara & Watti, 2021).

The Measure phase follows, with a strong emphasis on practicality and accessibility. Small enterprises are encouraged to rely on readily available data and simple data collection methods, such as manual logs, checklists, and basic performance tracking sheets. Instead of striving for perfect or comprehensive datasets, the focus is on gathering sufficient information to understand current performance levels and identify patterns. Selecting a limited number of key performance indicators (KPIs) that directly relate to the problem ensures that measurement efforts remain manageable and relevant. This approach reduces the burden on staff while still enabling evidence-based decision-making (Awe, 2021, Halliday, 2021, Isa, 2021, Jimoh & Owolabi, 2021).

In the Analyze phase, the organization seeks to uncover the root causes of the identified problem using straightforward and intuitive tools. Techniques such as the “5 Whys,” cause-and-effect diagrams, and simple process mapping are particularly effective in this context, as they require minimal training and can be applied collaboratively. Engaging employees in this phase is critical, as their firsthand knowledge of processes provides valuable insights into underlying issues. By focusing on practical analysis rather than complex statistical methods, resource-constrained organizations can quickly identify actionable causes and avoid unnecessary delays (Adeshina, 2021, Isa, Johnbull & Ovenseri, 2021, Wegner, Omine & Vincent, 2021).

The Improve phase centers on developing and implementing solutions that are both effective and

feasible within existing constraints. Emphasis is placed on low-cost, high-impact interventions that can be tested and refined through small-scale experimentation. Pilot testing allows organizations to assess the effectiveness of proposed changes before committing significant resources to full implementation. This iterative approach aligns with the principles of agility, enabling rapid adjustments based on feedback and observed outcomes. By prioritizing quick wins, organizations can build momentum and demonstrate the value of improvement efforts, thereby increasing stakeholder support (Akpan, et al., 2017, Oni, et al., 2018, Isa, 2020).

The Control phase ensures that improvements are sustained over time through simple and practical mechanisms. Standard operating procedures, visual controls, and routine performance checks are used to maintain consistency and prevent regression. Assigning clear responsibilities for monitoring performance helps to reinforce accountability, while regular reviews provide opportunities to identify deviations and implement corrective actions. The goal is to integrate improved practices into daily operations, making them part of the organizational routine rather than one-time interventions (Akomea-Agyin & Asante, 2019, Awe, 2017, Osabuohien, 2019).

Leadership plays a pivotal role throughout the implementation process, particularly in small enterprises where decision-making is often centralized. Leaders set the tone for change by demonstrating commitment, allocating resources, and actively participating in improvement initiatives. Their support is essential for overcoming resistance, motivating employees, and ensuring alignment with organizational goals. In resource-constrained environments, leadership involvement also helps to prioritize improvement efforts and ensure that limited resources are used effectively. When leaders champion LSS initiatives and communicate their importance, they create an enabling environment that fosters engagement and accountability (Ayanbode, et al., 2019, Bamgboye, et al., 2019, Ogbole, et al., 2019).

Employee engagement is equally critical to the success of Lite-DMAIC implementation. In small enterprises, employees often possess deep operational knowledge and are well-positioned to identify inefficiencies and propose practical solutions. Encouraging their participation not only enhances the quality of outcomes but also fosters a sense of ownership and commitment to change. Engagement can be promoted through inclusive problem-solving sessions, recognition of contributions, and opportunities for skill development (Aransi, et al., 2019, Bankole, et al., 2019, Okeke, Ugwu-Oju & Nwankwo, 2019). By involving employees at every stage of the process, organizations can build a collaborative culture that supports continuous improvement.

The use of low-cost tools and digital solutions further enhances the feasibility of LSS implementation in resource-constrained organizations. Basic tools such as spreadsheets, checklists, and visual boards can be highly effective in tracking performance and supporting decision-making. In addition, affordable digital solutions, including cloud-based applications and open-source software, provide opportunities to improve data management and communication without significant investment. For example, simple dashboards can be created using spreadsheet software to visualize key metrics, while messaging platforms can facilitate real-time communication among team members (Pamela, et al., 2021, Ugwu-Oju, Nwankwo & Okeke, 2021, Yeboah & Nnabueze, 2021). These tools enable organizations to leverage technology in a cost-effective manner, enhancing efficiency and transparency.

Monitoring and evaluation are integral components of the implementation process, ensuring that improvements are both effective and sustainable. Regular tracking of key performance indicators allows organizations to assess progress and identify areas requiring further attention. Evaluation should be continuous rather than periodic, enabling timely detection of issues and prompt corrective action. Feedback loops are particularly valuable in this context, as they provide opportunities to refine processes and incorporate lessons learned. By embedding monitoring and evaluation into routine operations, organizations can maintain momentum and ensure that improvement efforts deliver lasting benefits (Uzondu & Ofoedu, 2014, Yeboah & Ike, 2020).

Continuous improvement is a central principle of Lean Six Sigma and must be embedded within the organizational culture to achieve long-term success. Rather than viewing Lite-DMAIC as a one-time project, resource-constrained organizations should adopt it as an ongoing approach to problem-solving and performance enhancement. This involves regularly identifying new opportunities for improvement, applying the framework iteratively, and building on previous successes. Over time, this approach fosters a culture of learning and adaptability, enabling organizations to respond effectively to changing conditions (Elebe & Imediegwu, 2020, Essien, et al., 2020, Imediegwu & Elebe, 2020).

Scalability and sustainability are key considerations in the implementation of Lite-DMAIC within small enterprises. The framework is designed to be flexible and modular, allowing organizations to start with small initiatives and gradually expand their efforts as capacity increases. This incremental approach reduces risk and ensures that improvements are manageable within existing constraints. As organizations gain experience and confidence, they can incorporate more advanced tools and techniques, thereby enhancing the sophistication of their improvement efforts. Sustainability, on the other hand, depends on the integration of improved practices into daily operations and the continued commitment of leadership and employees (Efobi, Akinleye & Fasawe, 2017, Ekechi, 2019, Ugwu-Oju, Okeke & Nwankwo, 2018). By institutionalizing continuous improvement and aligning it with organizational goals, SMEs can ensure that the benefits of LSS are maintained over time.

In conclusion, the successful implementation of Lean Six Sigma in resource-constrained organizations requires a thoughtful combination of structured methodology, leadership commitment, employee engagement, and practical tools. The Lite-DMAIC framework provides a viable pathway for achieving this balance, enabling small enterprises to overcome resource limitations and realize the benefits of process improvement. Through careful application, ongoing monitoring, and a commitment to continuous learning, SMEs can build sustainable capabilities that enhance efficiency, quality, and competitiveness in an increasingly demanding business environment (Anthony, et al., 2019, Bankole, et al., 2019, Okeke, Ugwu-Oju & Nwankwo, 2019).

2.7. Conclusion and Future Research Directions

This study has examined the applicability of Lean Six Sigma (LSS) within small enterprises through a systematic review and the development of a Lite-DMAIC adaptation framework tailored to resource-constrained environments. The findings highlight that while LSS remains a powerful methodology for improving efficiency, quality, and customer value, its traditional implementation models are often misaligned with the realities of small and medium-sized enterprises (SMEs). Key challenges identified include financial constraints, limited access to skilled personnel, inadequate data infrastructure, and resistance to change driven by informal organizational structures. Despite these barriers, the review also reveals that SMEs can achieve meaningful performance improvements when LSS principles are simplified and adapted to their operational context. The Lite-DMAIC framework emerges as a practical solution, offering a streamlined, flexible, and scalable approach that retains the core strengths of LSS while reducing complexity and resource demands.

The study contributes to both theory and practice by bridging the gap between established process improvement methodologies and the unique needs of small enterprises. From a theoretical perspective, it extends the discourse on LSS by demonstrating the importance of contextual adaptation, particularly in environments where traditional assumptions of resource availability do not hold. The integration of simplicity, agility, and practicality into the Lite-DMAIC framework provides a conceptual advancement that aligns LSS with contemporary challenges faced by SMEs. From a practical standpoint, the study offers a usable roadmap for small enterprises seeking to implement structured improvement initiatives without incurring prohibitive costs or requiring extensive expertise. It emphasizes that effective process improvement is not solely dependent on sophisticated tools, but rather on the disciplined application of fundamental principles tailored to organizational capacity.

The implications for small enterprise development are significant. By adopting the Lite-DMAIC framework,

SMEs can enhance operational efficiency, reduce waste, and improve product and service quality, thereby strengthening their competitiveness in increasingly dynamic markets. The framework also supports the development of a culture of continuous improvement, where employees are actively engaged in identifying problems and implementing solutions. This cultural shift is particularly important for SMEs, as it fosters innovation, adaptability, and resilience in the face of external pressures. Furthermore, the ability to achieve incremental improvements with limited resources provides SMEs with a sustainable pathway for growth and long-term performance enhancement.

For policymakers and practitioners, the findings underscore the need to promote accessible and context-appropriate process improvement initiatives. Policymakers should consider developing support mechanisms, such as subsidized training programs, knowledge-sharing platforms, and technical assistance tailored to SMEs. Encouraging collaboration between academic institutions, industry bodies, and small enterprises can also facilitate the transfer of knowledge and best practices. Practitioners, including consultants and industry experts, should focus on delivering simplified and flexible solutions that align with the operational realities of SMEs, rather than promoting one-size-fits-all approaches. Emphasis should be placed on practical tools, hands-on training, and incremental implementation strategies that deliver immediate value.

Despite its contributions, this study also highlights the need for further empirical validation and research. Future studies should focus on testing the effectiveness of the Lite-DMAIC framework across different industries, geographic regions, and organizational contexts to establish its generalizability and robustness. Longitudinal studies would be particularly valuable in assessing the sustainability of improvements and the long-term impact on organizational performance. Additionally, research exploring the integration of digital technologies, such as data analytics and automation, into simplified LSS frameworks could provide insights into enhancing their effectiveness in modern business environments. Investigating the role of organizational culture, leadership styles, and employee engagement in the successful adoption of Lite-DMAIC would further enrich the understanding of critical success factors.

In conclusion, the adaptation of Lean Six Sigma through the Lite-DMAIC framework represents a meaningful step toward making structured process improvement accessible to small enterprises. By aligning methodological rigor with practical feasibility, this approach enables SMEs to overcome resource constraints and unlock the benefits of continuous improvement. Continued research and collaborative efforts will be essential in refining and validating this framework, ensuring that it remains relevant and impactful in supporting the growth and sustainability of small enterprises globally.

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