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Analyzing the Role of Lean Management (5S) in Driving Sustainability and Efficiency in Malaysian Manufacturing Organizations

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Abstract

The manufacturing industry drives economic growth and societal progress, making sustainability crucial. To ensure effective implementation, it is vital to develop metrics for accurately evaluating and managing sustainability performance in manufacturing firms. The 5S methodology, rooted in the principles of lean management, is a widely adopted tool for improving workplace efficiency, safety, and sustainability. It provides a structured approach to workplace organization and waste reduction. This paper will explore the relationship between Lean management (5S) and overall sustainability, as well as its impact on sustainability outcomes. Additionally, the study will examine employee involvement as a moderating factor affecting the relationship between 5S and sustainability outcomes. Through this analysis, the research aims to provide insights into the role of 5S in promoting sustainable practices within the manufacturing industry. This study will also equip top management with a framework for aligning lean initiatives with corporate sustainability strategies, ensuring a more cohesive and long-term approach. A quantitative research method will be employed, selecting employees from manufacturing organizations in Malaysia as respondents. A set of questionnaires will be distributed to 346 respondents, and PLS-SEM will be used to analyse the data. The expected outcome is to enhance productivity, reduce waste, promote sustainability and align practices with global standards such as ISO14001 and SDGs.

Keywords: 5S, Employee Involvement, Lean Management, Manufacturing, Sustainability

Introduction

The majority of industries in the last century relied on mass manufacturing (Psarommatis et al., 2020). Manufacturing businesses in the af the global market deal with a number of issues that impact production costs, including pollution, material shortages, resource waste, and

environmental impact (Parmar & Desai, 2020). Manufacturing firms are embracing new strategies to compete more effectively in the global market. These strategies aim to consistently enhance the efficiency and effectiveness of manufacturing operation while simultaneously reducing costs and improving quality. This movement is fostering a greater understanding of lean philosophy in manufacturing, leading to the proactive adoption of practices that target as well as remove non-value-added processes in manufacturing organizations, thereby increasing efficiency and effectiveness (Sunmola et al., 2024).

A comprehensive set of method and instruments for reduce waste may be used to characterise and quantify lean manufacturing (Narasimhan et al., 2006). Lean Manufacturing (LM) can be characterised as a strategic philosophy, tactical principles, and operational procedures and tools (Čiarnienė, & Vienažindienė, 2015). Therefore, selecting the right lean tool at the right time to effectively accomplish its intended objectives is the organization's greatest challenge. (Browning & Heath, 2009). To effectively implement lean tools and sustain the transformation process, individuals engaged in the lean transformation are required to have strong expertise and a comprehensive grasp of lean principles (Yadav et al., 2017). Lean thinking impacts operations management by aiming for increased efficiency and ongoing enhancement of products and processes (Ribeiro et al., 2022).

Given the worries regarding the exhaustion of natural resources, economic inequality, and the essential for social responsibility, business sustainability has emerged as an important topic for scholars, industry professionals, and policymakers according to (Siegel et al., 2024). With the triple bottom line (TBL) of sustainability encompassing planet (environment), people (social), and profit (economic) becoming a strategic priority, many organizations view sustainable and environmentally friendly practices as critical for creating value and driving economic growth (Siegel et al., 2019). Nonetheless, companies face significant pressure to enhance the quality of their output and remain flexible in the face of continuous changes, all while keeping operational costs low. Consequently, businesses dedicate considerable effort to balancing their performance concerning economic, social, and environmental aspects due to regulations, fierce competition, and societal expectations (Singh et al., 2021).

Numerous recent studies have explored the integration between lean practices and various aspects of sustainability or the overall concept of sustainability performance (Dey et al., 2020; Dieste et al., 2020; Singh et al., 2020). Therefore, additional empirical research is required to evaluate the relationship between lean manufacturing and the various elements of sustainability (such as environmental, social, and economic sustainability). Finding a balance between the environment and the utilisation of natural resources is the goal of the sustainability process. Natural resources have been damaged by humanity, and in order to assure their continued existence for future generations, it is now essential to seek out and plan their usage. This involves three crucial pillars: social, economic, and environmental (Yip et al., 2021). The integration of these three pillars is often termed the triple bottom line (TBL) in both business and government contexts. While the literature offers numerous publications on the determinants of environmental sustainability, they have mostly been examined in separate research areas. Nevertheless, limited research explores the connection between these elements, especially the influence of Lean Manufacturing (LM) in relation to the other elements and their impacts. Nevertheless, it is essential to broaden the comprehension of

how lean practices influence three aspects of sustainability that have not yet been investigated.

Consequently, lean and sustainability are starting to set the standard for the manufacturing industry (Mathiyazhagan et al., 2022). Therefore, it is essential to embrace a strategy that can facilitate the implementation of these sustainability aspects and enhance the competitive edge. That means, use lean as a metrics to achieve sustainability. Lean can also support sustainability efforts by ensuring that products are produced using fewer resources, generating less waste, and enhancing productivity (Farias at al., 2019).

Refer to the study by Qin et al. (2021), by continuously getting removed of non-value-added (NVA) processes, Lean Manufacturing (LM) aims to increase efficiency and performance. LM tools reduce many negative consequences related with manufacturing operations for economic, social and environmental. The number of LM tools available to help companies and their products maintain sustainability is increasing, but the effectiveness of these tools varies, and none is perfect for every business (Maware et al., 2022). The implementation of LM, similar to various other improvement strategies, has not been effectively utilized in all cases (Benkarim et al., 2021). Although numerous recent initiatives have aimed to combine sustainability with lean manufacturing (Souza and Alves, 2018), much of the research on sustainability and lean manufacturing is based on a limited understanding of the three pillars of sustainability (Abualfaraa et al., 2020). Therefore, this study intends to achieve this research objectives:

1) To examine the relationship between 5S and sustainability in the manufacturing organization.
2) To assess the impact of 5S on economic sustainability outcomes.
3) To assess the impact of 5S on environmental sustainability outcomes.
4) To assess the impact of 5S on social sustainability outcomes.
5) To examine the moderating factors that influence the relationship between lean practices and sustainability outcomes.

Literature Review

Definition of Lean Management

Lean management philosophy, also known as lean production or lean manufacturing (Varela et al., 2019), aims to reduce costs by identifying and eliminating unnecessary activities (Rodrigues et al., 2019; Leong et al., 2019; Santos et al., 2019). Many operational and administrative strategies are used lean manufacturing (LM) to increase competitiveness and minimize waste (Faber, 2020). The basis for increasing operational effectiveness and encouraging continuous improvement in a variety of industries is lean methodology. These methods, which have their roots in the Toyota Production System, aim to increase customer value by reducing waste and streamlining processes. Navigating the complexity of lean approaches and guaranteeing their smooth incorporation into current production processes need this fundamental understanding.

Lean focuses on reducing waste and enhancing productivity right from the beginning of manufacturing processes. Research indicates that a significant portion of manufacturing activities (up to 95%) often consists of non-value-added tasks (Yadav et al., 2019). Lean manufacturing emphasizes reducing waste and enhancing efficiency, making it a vital

approach for industries striving to achieve both economic and environmental sustainability. This methodology plays a key role in advancing research on sustainable industrial practices. By targeting inefficiencies such as overproduction, surplus inventory, and redundant processing within the production cycle, lean manufacturing optimizes operations, reduces resource consumption, and contributes to environmental preservation (Thawornsujaritkul & Boonnual, 2024). Lean is praised for its capacity to measure waste, but it is unable to measure potential environmental hot spots or environmental consequences (Cherrafi et al., 2019).

Lean Tools

Numerous LM tools have been utilized to enhance both within and between organization's sustainability performance for achieving competitive advantages in manufacturing performance (Carvajal-Arango et al., 2019). Different organizations have utilized a variety of LM tools to achieve strong performance due to the competitive pressures of the market (Tasdemir and Gazo, 2019). These tools are developed to implement LM principles, emphasizing the removal of NVA activities, boosting productivity, reducing variability, shortening production cycles, and simplifying processes by minimizing components and steps. (Qin and Liu, 2022).

5S

Refer to study by Samadhiya et al. (2023), 5S is the most effective LM Tool for employee social sustainability. The 5S methodology focuses on standardizing workflows and ensuring workplace cleanliness, serving as a business practice that reduce time and resource consumption during production according to (Díaz-Reza et al., 2024). It has proven effective in facilitating sorting, organizing, cleaning, and minimizing waste associated with transportation, inventory, motion, waiting, overproduction, and overprocessing, alongside addressing other essential requirements (Kumar et al., 2022). 5S is a method designed to eliminate waste, organise or enhance workplace, as well as avoid accidents by using standards and norms (Palange et al., 2021). 5S makes things easier saving by using less time, energy, space, and health hazards, and enhancing the quality of the products, employee morale, and working environment, in addition to security (Shahriar et al., 2022). The five S's are the foundation for working with more structured approaches, as the Single Minute Exchange of Dies (SMED) together with Poka Yoke (Díaz-Reza et al., 2024). Furthermore, a management model linking in between 5S with sustainability in Indian manufacturing firms is proposed by (Setiawan et al., 2021).

The 5S technique is a work philosophy that addresses workplace disarray by giving work dynamics structure and purpose. According to the research of Ribeiro et al. (2019), the five S's are Seiri, Seiton, Seiso, Seiketsu, and Shitsuke (categorization, organization, cleansing, standardization, and improvement). The goal of 5S in industrial practice is to improve worker behaviours and workplace conditions. It becomes a custom or standard, which is the main principle of 5S, if the tools and equipment needed to do a task are consistently categorized, arranged, clean, and ready to use. Consequently, the business gains advantages through operations and production (Veres et al., 2018). According to study García-Alcaraz et al. (2021), implementing cleaning procedures and standardizing tool usage, performing audits to ensure adherence to those standards, and acknowledging employee achievements, and documenting the processes are the five components that make up the 5S implementation level assessment. This study makes the assumption that if there are instruments available to

do all tasks, the productive system will operate more quickly since it will be simple to locate them and operations will take less time. Theoretically, the shitsuke phase (sustain/discipline) ensures that the preceding four stages—seiri (sort), seiton (set in order), seiso (clean/shine), and seiketsu (standardize)—are consistently maintained as an ongoing process. Takashi Osada introduced the 5S principle's conceptual model in the early 1980s (Osada, 1991), as illustrated in the figure 1 below:

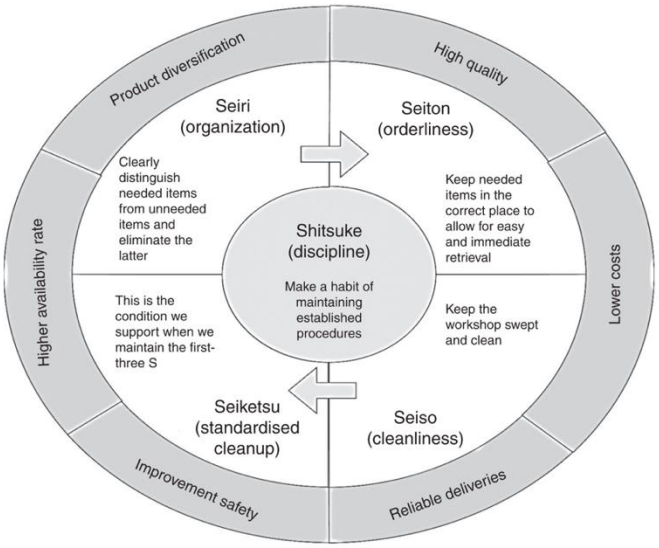

Figure 1. The 5S principle (Osada, 1991)

Seiri emphasizes the efficient use of workplace space by advocating for the strict segregation of goods or items based on their relevance and frequency of use, thereby fostering a more effective work environment (Osada, 1991). Seiton involves prioritizing the necessity and significance of goods or equipment to enhance accessibility and streamline their location (Randhawa & Ahuja, 2017). The third S, Seiso, signifies "cleaning" and emphasizes the significance of self-assessment, ensuring cleanliness, and creating an impeccable work environment (Kobayashi et al., 2008). The fourth S, Seiketsu, represents "standardization," which involves sustaining a productive and comfortable workplace by consistently applying the principles of Seiri, Seiton, and Seiso (Osada, 1991). The fifth S, "Shitsuke," represents the commitment to sustaining and reinforcing all the preceding principles.

Sustainability

To meet sustainability objectives, businesses are shifting towards LM practices (Jum'a et al., 2022). The objective of LM is to enhance productivity and lower operating expenses, but concerns regarding the three dimensions of sustainability: economic, social, and environmental have been brought up (Hao et al., 2021). Sustainability encompasses three aspects: environmental, economic, and social (Jum'a et al., 2022). The concept of sustainability encompasses multiple facets that depend on the context of the study. For instance, Carvajal-Arango et al. (2019) carried out research demonstrating that 27 topics or aspects can be utilized during construction projects within the framework of sustainability.

Sustainability is a process that incorporates actions aimed at achieving equilibrium between the economy, society, and environment through effective utilization of resources (García-

Alcaraz et al., 2022). To satisfy the social, economic, and environmental demands of both current and future generations, sustainability aims to create and maintain a harmonious environment where humans and nature can exist together (Poudyal and Adhikari, 2021). To prevent harm to the planet that could negatively affect quality of life, limit future economic opportunities, and create adverse social and environmental impacts, sustainability seeks to structure human and industrial systems so that they do not adversely influence one another (Birkin et al., 2021).

In general, a collection of actions that include meeting stakeholders' short and long term needs, guaranteeing economic growth, sustaining resources, and minimizing negative effects on the environment and society, as well as concurrently taking into account economic, environmental, and social factors when creating goods and services, constitute industrial sustainability (Mengistu and Panizzolo, 2021). Sustainability can be attained through the adoption of sustainable practices within organizations (Jafarzadeh et al., 2022).

Critical Factor for Sustainability

Critical factors were identified based on past review to determine the key elements influencing the sustainability of the 5S methodology in industrial workplaces. Previous research has highlighted the significance of factors such as commitment, involvement, and communication in ensuring the sustainability of 5S practices. Additionally, human-centric elements like leadership, organizational culture, socio-psychological factors, and individual abilities, skills, and knowledge are critical determinants of 5S sustainability. These parameters are interrelated; for instance, leadership plays a pivotal role in fostering motivation, commitment, and effective communication among team members (Attri et al., 2017). However, limited attention has been given to contextually reviewing optimization strategies for addressing these factors. For instance, there is a lack of exploration into effective methods for developing communication strategies and fostering employee engagement in the 5S program.

Employee Involvement

For this study will focus on employee involvement in an organization because for the 5S principles are not merely organizational technique but a mindset aimed at fostering employee involvement and a commitment to excellence. Employee participation in sustainability efforts is essential, as it is key to their success such as in enabling a company to successfully implement effective sustainability measures. Employees demonstrate a high level of commitment to lean thinking when they actively participate and engage in lean management practices within the organization. This dedication is cultivated when employees have a clear understanding of the objectives and methods behind the adoption of lean principles. Therefore, the theoretical framework presented as below:

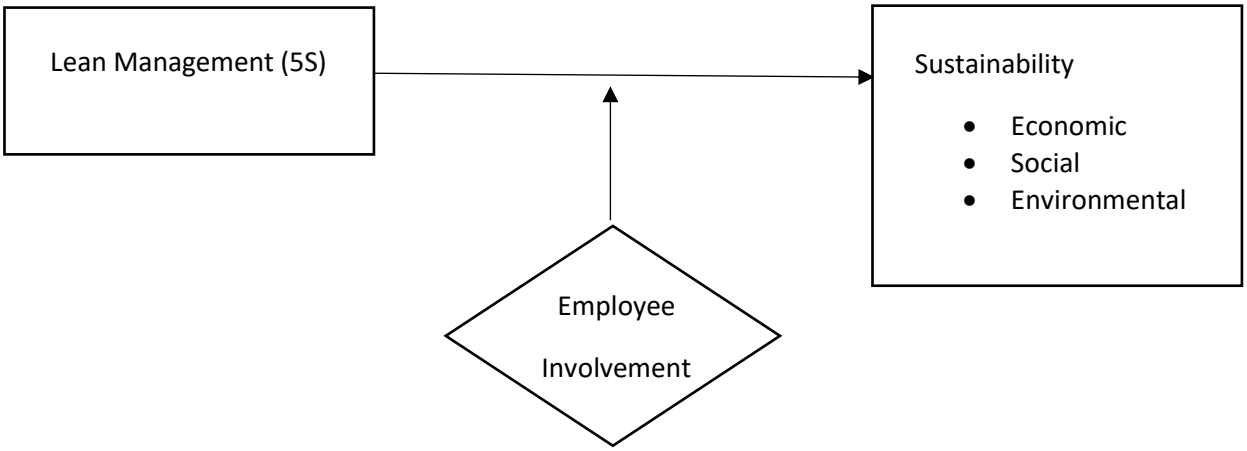

Figure 2. Theoretical Framework

As a result, this study empirically explores the relationships between Lean management(5S), employee involvement, and sustainability. Two relationships have been identified, as outlined below:

i. The relationship between Lean management (5S) and sustainability in the manufacturing organization.
ii. Employee involvement influence the relationship between Lean management (5S) and sustainability outcomes.

Research Methodology

The target sample frame will be drawn from the 53rd edition of the Malaysia Federation of Manufacturing directory. The total population size for this study comprised 3229 organizations in Malaysia. However, based on Krejcie and Morgan's (1970) sample size determination table, a sample size of 346 will be deemed sufficient. Quantitative research entails gathering and analyzing numerical data, making it well-suited for detecting patterns and averages, generating hypotheses, assessing correlations, and extrapolating results to larger populations. In this study, quantitative research will be employed by gathering data from potential and existing respondents using a sampling technique and distributing the questionnaire through Google Forms. Researchers will ask multiple survey questions, collect data from respondents, and analyze the data to produce numerical results in order to draw conclusions regarding the role of Lean management (5S) in driving sustainability. Quantitative research designs enable researchers to systematically and objectively evaluate hypothesized relationships among study constructs, facilitating the extrapolation of findings from the sample to a broader population or context (Hair et al., 2018).

This study will utilizes empirical data from manufacturing organizations that have adopted LM practices in their production processes, gathered through structured questionnaires. The data for this study will be collected through a survey method, focusing on capturing the perceptions of respondents working within manufacturing organizations. These questionnaires will be meticulously designed to collect the necessary data for analyzing the variables outlined in the research framework. Prior to deployment, the questionnaires will undergo pre-testing to ensure their validity, clarity, completeness, and comprehensibility for the respondents. The data analysis process will be carried out in multiple stages. Initially, a preliminary analysis will be performed, focusing on data screening and cleaning using SPSS to

identify any abnormalities, including missing or outlier data. Descriptive analysis will then be conducted with SPSS to examine the demographic characteristics of the study sample, such as the percentage of firms involved. Subsequently, inferential statistical analysis will be carried out using SmartPLS.

Conclusion

The findings of this study underscore significant improvements in workplace productivity, efficiency, and sustainability. The study demonstrates that enhanced workflow, material, and tool organization contribute to increased productivity, while optimized office layouts help reduce cycle times and delays. Additionally, improved inventory management and waste reduction lead to notable financial savings, including lower maintenance costs and reduced downtime through proactive equipment management.

From an environmental perspective, the study highlights reductions in resource waste such as energy and raw materials alongside improved waste management practices that minimize pollution and landfill contributions. These efforts collectively foster a more sustainable operational environment. Furthermore, the study emphasizes the development of a safer and more comfortable workplace, positively impacting employee morale and job satisfaction.

Beyond operational benefits, the study promotes a culture of responsibility, collaboration, and continuous improvement among staff members. Establishing standardized procedures aligned with global sustainability frameworks such as ISO 14001 and the Sustainable Development Goals (SDGs) to ensures long-term adherence to best practices. Ultimately, this study contributes to fostering a cultural shift towards workplace stability, cleanliness, and efficiency, reinforcing the organization's commitment to sustainability and operational excellence.

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