A SOCIO-TECHNICAL FRAMEWORK FOR MEASURING 5S PERFORMANCE IN JAVA ISLAND MANUFACTURING SMEs

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ABSTRACT: Sustainability of 5S Practices remains a major challenge for manufacturing SMEs due to limited integration between technical and social aspects. The current study aims to develop a socio-technical performance measurement framework to evaluate the balance between technical 5S Practices and social enablers in manufacturing SMEs on Java Island. A quantitative survey was conducted among 131 SMEs on Java Island using validated indicators for social (SA5S), technical (TA5S), relational coordination (RC), and sustainability performance (SP). Results indicate unbalanced achievement across variables, particularly weak integration between technical systems and managerial practices. The proposed framework provides a diagnostic tool for SMEs to continuously monitor socio-technical balance in sustaining 5S performance.

KEYWORDS: *5S Practices; Socio-technical System; Performance Measurement; Manufacturing; Small and Medium Enterprises*

1.0 INTRODUCTION

Managing the sustainability of 5S Practices has been challenging for the manufacturing small and medium enterprises (SMEs) on Java Island of Indonesia. Despite the strategic role of the Performance Measurement System (the PMS) in controlling operational performance [1]–[3], many SMEs find it difficult to sustain 5S Practices due to various social barriers. These include low leadership commitment, limited employee involvement, inadequate training, and resistance to cultural transformation [4]–[9].

Previous studies have primarily focused on evaluating 5S Practices from a technical perspective, emphasizing operational outcomes such as efficiency and productivity [4]. However, this narrow approach overlooks the social dimensions that influence long-term sustainability. As a result, the existing PMS framework fails to capture the full complexity of 5S implementation in manufacturing SMEs. [1], [10], [11].

To address this gap, the present study proposes a comprehensive performance measurement framework that integrates the social and technical aspects of 5S Practices. Grounded in socio-technical systems (STS) theory, the framework emphasizes the need to optimize human and technical factors simultaneously to ensure sustainable outcomes [12]. Furthermore, the study incorporates the concept of relational coordination to assess the quality of stakeholder interaction among leaders, employees, and suppliers as a key driver of sustainability performance. [13]–[17].

2.0 LITERATURE REVIEW

The concept of 5S Practices from a Japanese perspective is a systematic approach including Seiri (sort), Seiton (set in order), Seiso (shine), Seiketsu (standardize), and Shitsuke (sustain) [18]. It emphasizes the organization of the workplace to improve safety and efficiency [18]. The goal of the 5S approach is to enhance process quality and productivity in the workplace [19]. Although 5S Practices have been widely adopted globally, the success of these practices needs to be supported through the establishment of the PMS [18], [20]. The current literature review studied the importance of establishing such measurement processes for optimizing and sustaining the excellence of 5S Practices.

2.2 Performance Measurement System for 5S Practices

The PMS provides information both quantitatively and qualitatively to assess the extent to which 5S activities are achieving effectiveness [20]. The capability to assess and examine performance measures is essential to ascertain which areas of 5S activities have been properly implemented and which need to be improved [21]. By establishing an appropriate measurement system, organizational units can ensure efficient allocation and management of resources oriented towards continuous improvement [21].

In addition, the development of the PMS with feedback is an important way to build a culture of continuous improvement [20]. Noteworthy is the difficulty in investigating the root causes of inefficiencies in implementing improvement measures, such as lack of access to accurate performance data and the use of outdated data [22]. A comprehensive measurement system is expected to facilitate companies to control and evaluate progress, set improvement goals, and assess the cause and effect of process change interventions [23]. This is an effort to ensure that 5S Practices are consistently performed and continuously improved [21].

However, in previous studies the assessment of 5S Practices has been oriented towards technical aspects and often does not focus on the importance of mechanisms and the impact of the social performance achieved [19], [24], [25]. The gap of this perspective has resulted in an inadequate evaluation of the effectiveness and long-term sustainability of 5S [18]. Performance measurements that emphasize the balance between technical efficiency and social involvement can provide a comprehensive understanding of the efforts of manufacturing SMEs to maximize effectiveness in the application of 5S Practices [26].

2.2 Socio-technical Model of 5S Performance Measurement

From a conceptual perspective, the STS was created to emphasize the mutual relationship between people and machines and to forward the initiative to change the social and technical aspects of work environments in order to balance efficiency and humanity [27]. The most substantial conceptual and empirical foundation for work design and employee involvement is found in STS theory. In accordance with STS theory, performance can be improved by optimizing the firm's social and technical systems simultaneously [28], [29].

In the context of 5S Practices, the STS-based measurement model incorporates concepts from a variety of performance measurement and management models, including the Balanced Scorecard, which emphasizes the interplay between financial and non-financial perspectives [21], [30], [31], and the input-process-output model, which has been employed in numerous management studies to assess the effectiveness of systems [22].

This model implies that the success of 5S Practices is contingent upon both technical aspects (TA5S) (such as 5S technical steps (Sort, Set in order, Shine, Standardize, Sustain), 5S technical guidelines, and 5S integrated management system) [18] and social aspects (SA5S) (including leadership commitment, employee involvement, attitude, training, working culture, policy, organizational structure, and stakeholder involvement) [5], [8], [18]. This is achieved by incorporating both aspects as inputs (Figure 1).

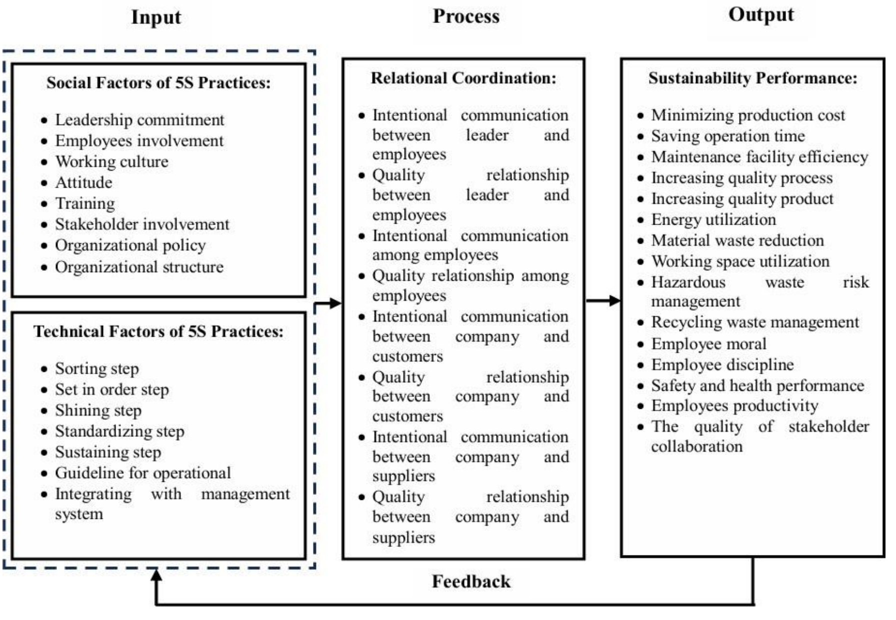


Figure 1: A socio-technical framework for 5S performance measurement

The literature review in this study seeks to examine and propose performance measurement indicators for 5S Practices that are grounded in the input-process-output model (Figure 1). This measurement concept incorporates relational coordination (RC) as a mechanism to optimize output and identify the impact of 5S on sustainable performance.

3.0 METHODOLOGY

This study was conducted through survey research. The instrument questionnaire was designed and validated by six experts, including two academicians and four practitioners in Indonesia. The performance measurement instrument consists of 38 indicators that evaluate the social aspect of 5S Practices (SA5S) and technical aspects of 5S Practices (TA5S), the relational coordination (RC), and the sustainability performance (SP). This study employed a purposive sampling technique using specific criteria, including SMEs facilitated by the Indonesian government facilitator, and the participants have implemented 5S Practices in the workplace. From a population of 500 SMEs, this research obtained 131 valid responses that met the criteria for further analysis.

The performance measurement was conducted using descriptive analysis to determine the mean ($\overline{x}$) in Equation 1, standard deviation (SD) in Equation 2, and coefficient of variation (CV) in Equation 3. The ordinal data collected from the survey is within each subset of SA5S, TA5S, RC, and SP variables. The mean, also referred to as the average, is the most used measure of central tendency that can be calculated with equation 1[32]. Referring to Equation (1), ΣX represents the total sum of the scores, while n represents the total number of points in the distribution. To calculate the mean value, sum up all the scores in the distribution and then divide by the entire number of scores (n).

$$\bar{x} = \frac{\sum X}{n} \tag{1}$$

According to [32], the standard deviation (SD) is commonly employed as the primary measure of dispersion. The square root of the variance is calculated by taking the square root of each individual score in the distribution (represented by X_i), subtracting the mean of the distribution (represented by $\overline{x}$), and dividing by the total number of scores (represented by n). The process of taking the square root ensures that the units are consistent with the original values (Equation 2).

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}} \quad (2)$$

In addition to assessing the distribution of data with SD, this study also explores the diversity of data using the coefficient of variation. The objective of the coefficient of variation (CV) is to quantify and compare the degree to which a sample score deviates from the average value ($\bar{x}$) (Equation 3). It provides a measure of how much the percentage of each scale value is similar to or close to the average value.

$$CV = \left(\frac{s}{\bar{x}}\right) X\ 100\% \quad (3)$$

4.0 RESULTS AND DISCUSSION

Descriptive statistical analysis was conducted to evaluate the performance of 5S Practices across four key dimensions: SA5S, TA5S, RC, and SP. The results show that most indicators achieved mean values above 5.0, indicating a generally positive implementation level among manufacturing SMEs located on Java Island. However, coefficient of variation (CV) values ranging from 0.20 to 0.31 suggest notable disparities across individual indicators, warranting deeper analysis.

4.1 Results

This research examined the achievement level of 5S performance using statistical descriptive methods for all variables, including SA5S (Table 1), TA5S (Table 2), RC (Table 3), and SP (Table 4). The descriptive analysis was performed with mean values, SD values, and CV values. Overall, the mean scores indicate good performance levels, averaging around five.

The accuracy of the results is also supported by the SD and CV values (around 20%), which are confirmed around the mean values. However, although in general the average value shows a fairly high achievement, the comparison of the indicator values of each variable shows a significant difference.

Table 1: Statistical descriptive of the social aspect of 5S Practices

Variable/Indicators/Items	Values		Mean	SD	CV
Social Aspects in 5S Practices (SA5S)	Min	Max			
Leadership commitment (5S-S1)	2.00	7.00	5.710	1.163	0.204
Employee involvement (5S-S2)	2.00	7.00	5.198	1.201	0.231
Working culture (5S-S3)	2.00	7.00	5.206	1.208	0.232
Attitude (5S-S4)	1.00	7.00	5.023	1.173	0.234
Training (5S-S5)	2.00	7.00	5.038	1.141	0.227
Stakeholder involvement (5S-S6)	1.00	7.00	5.038	1.221	0.242
Policy (5S-S7)	1.00	7.00	5.214	1.226	0.235
Organizational structure (5S-S8)	1.00	7.00	5.137	1.179	0.230

Table 2: Statistical descriptive of technical aspects of 5S Practices

Variable/Indicators/Items	Values		Mean	SD	CV
Technical Aspect of 5S Practices (TA5S)	Min	Max			
Sorting Activities (5S-T1)	2.00	7.00	5.191	1.259	0.243
Set In Order Activities (5S-T2)	3.00	7.00	5.511	1.268	0.230
Shining Activities (5S-T3)	2.00	7.00	5.344	1.379	0.258
Standardizing activities (5S-T4)	2.00	7.00	5.534	1.126	0.203
Sustaining Activities (5S-T5)	1.00	7.00	5.351	1.166	0.218
5S Guideline for operational activities (5S-T6)	2.00	7.00	5.275	1.140	0.216
Integrated Management System (5S-T7)	1.00	7.00	5.015	1.428	0.285

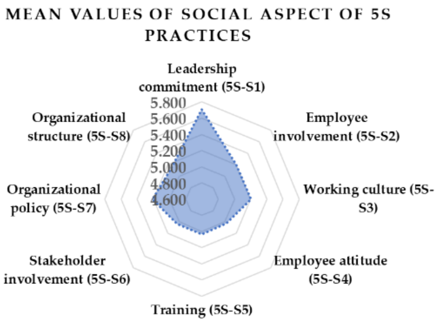
Table 3: Statistical descriptive of relational coordination of 5S Practices

Variable/Indicators/Items	Value		Mean	SD	CV
Relational Coordination (RC)	Min	Max			
Intentional communication between leaders and workers (RC1)	2.00	7.00	5.382	1.199	0.223
Quality relationship between leaders and workers (RC2)	2.00	7.00	5.664	1.156	0.204
Intentional communication between workers and workers (RC3)	2.00	7.00	5.412	1.247	0.230
Quality relationship between workers and workers (RC4)	2.00	7.00	5.550	1.217	0.219
Intentional communication between the company and the customer (RC5)	2.00	7.00	5.405	1.277	0.236
Quality relationship between company and customer (RC6)	2.00	7.00	5.481	1.176	0.215
Intentional communication between the company and supplier (RC7)	2.00	7.00	5.344	1.187	0.222
Quality relationship between company and supplier (RC8)	2.00	7.00	5.382	1.162	0.216

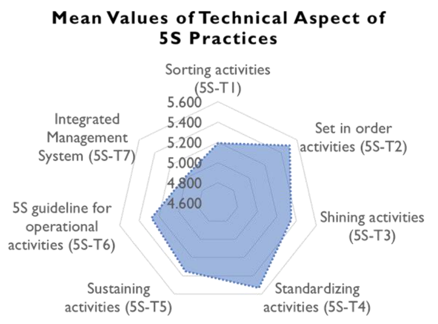
For more analytical convenience, the results of the performance measurement referring to descriptive analysis are also shown through a visualization of a radar diagram for each variable, as shown in Figure 2.

Table 4: Statistical descriptive of sustainability performance

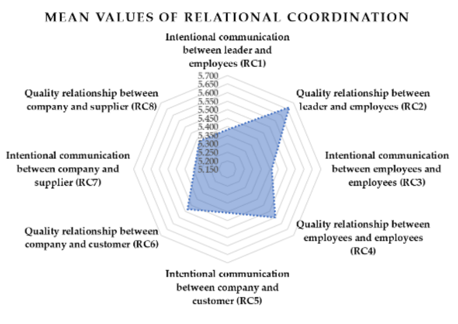
Variable/Indicators/Items	Values		Mean	SD	CV
Sustainability Performance (SP)	Min	Max			
Minimizing the overall production cost (SP1)	1.00	7.00	5.168	1.327	0.257
Minimizing production time (SP2)	1.00	7.00	5.321	1.216	0.228
Maintenance efficiency of work equipment (SP3)	1.00	7.00	5.481	1.182	0.216
Enhance the quality of the process (SP4).	2.00	7.00	5.405	1.217	0.225
Enhancement of the quality of the product (SP5)	2.00	7.00	5.550	1.276	0.230
Efficient use of energy in the workplace (SP6)	1.00	7.00	5.221	1.631	0.312
Minimizing utilization of materials (SP7)	1.00	7.00	5.397	1.512	0.280
Efficient usage of the work area (SP8)	1.00	7.00	5.374	1.637	0.305
Risk reduction in waste management (SP9)	1.00	7.00	5.359	1.597	0.298
Performance of the waste recycling system (SP10)	1.00	7.00	5.183	1.608	0.310
Enhancing employee morale (SP11)	2.00	7.00	5.427	1.419	0.261
Improved employee work discipline (SP12)	2.00	7.00	5.290	1.445	0.273
Improved employee safety and health (SP13)	2.00	7.00	5.511	1.333	0.242
Increasing employee work productivity (SP14)	2.00	7.00	5.397	1.347	0.250
Improving stakeholder collaboration (SP15)	2.00	7.00	5.382	1.368	0.254



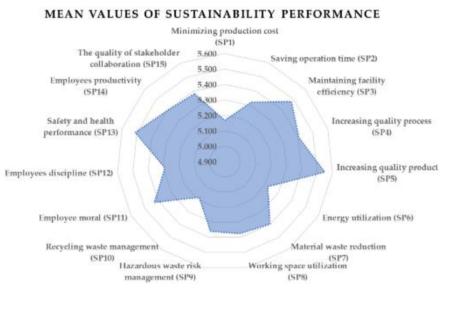
a. Achievement of SA5S



b. Achievement of TA5S



c. Achievement of RC



d. Achievement of SP

Figure 2: Radar chart performance of (a) SA5S, (b) TA5S, (c) RC, and (d) SP based on descriptive analysis

From the visualization of the radar chart in Figure 2, there is an imbalance in the values obtained from each indicator for all variables. This finding can serve as a basis for comprehensive performance improvement.

2.2 Discussion

The descriptive results in Tables 1 to 4 reveal the relative significance of SA5S, TA5S, RC, and SP in shaping the overall 5S performance. Table 1 shows that leadership commitment dominates the dimension (SA5S), confirming that human and managerial engagement remain central to sustaining 5S culture. Table 2 illustrates that technical activities, particularly standardizing and set in order, are relatively strong, yet integration with the management system is still weak. It highlights the need for alignment between procedural and organizational practices.

Table 3 emphasizes the role of relational coordination (RC), where communication quality between leaders and workers emerges as a key enabler of teamwork effectiveness. Meanwhile, Table 4 indicates that SP is strongest in human-related outcomes such as morale and safety but remains limited in cost reduction and energy efficiency indicators.

When analyzing the SA5S results (Figure 2(a)), leadership commitment is identified as the most crucial element in 5S Practices, as indicated by the highest average score of 5.902. Most manufacturing small and medium enterprises (SMEs) on Java Island of Indonesia rely largely on the vision, mission, and ability of their leaders to encourage employees and external stakeholders to achieve successful 5S Practices. However, the strength and durability of leadership commitment must be supported by endeavors to develop systems and management that are both effective and efficient.

Regarding TA5S performance indicators, the mean values show a high average level of implementation (Figure 2(b)). However, by comparison of the technical aspects, the integration of 5S Practices with the existing management system in SMEs has the lowest average score. Therefore, SMEs in Indonesia must emphasize the need to integrate 5S Practices with quality, environmental, safety, and occupational health management standards, leading to more measurable achievements.

When analyzing several RC indicators, the average score of 5.664 indicates the highest level of leadership appreciation (RC2) (Figure 2(c)). This number specifically relates to staff participation in 5S

Practices. The implementation of 5S Practices can have a beneficial effect on motivating staff in manufacturing SMEs to adopt these concepts. Nevertheless, it is crucial to maintain equilibrium in this matter and take proactive measures to enhance collaboration among employees and other stakeholders.

In terms of SP achievement, most manufacturing SMEs investigated in Indonesia show a rather adequate level of SP (Figure 2(d)). Unfortunately, when scores were compared across indicators, the mean score for reducing production costs was the lowest. This recommends that manufacturing SMEs systematically link all production processes to cost-cutting initiatives, ranging from high-priority to seemingly simple ones, such as 5S Practices. In contrast, the indicator pertaining to employee morale standards received the highest mean score of 5.550 in a descriptive sense. It shows the fact that the majority of Indonesian manufacturing SMEs value performance evaluation, not just financially, but also in terms of employee morale.

5.0 CONCLUSION

This study shows the results of measuring 5S Practices in an integrated manner between socio-technical aspects through the process of relational coordination towards improving sustainability performance in manufacturing SMEs in Java, Indonesia. The results show consistently high average values across all variables—SA5S, TA5S, RC, and SP. However, specifically, there is an imbalance in the achievement of the indicators of each variable. This indicates that there is generally a need for improvement in the achievement of each indicator across all variables. Finally, it can be concluded that the proposed 5S practice PMS can provide a comprehensive causal analysis at the input, process, and output levels. So that the results of this study can be the basis for improvement and monitoring tools for future studies on the same object.

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AUTHOR CONTRIBUTIONS

N. Setiawan: Conceptualization, Methodology, Writing—Original Draft Preparation; M.R. Salleh: Reviewing, Validation, and Supervision; H.A. Ariff: Validation and Supervision; M. Mashuri: Validation and Supervision.

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