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Overall Labor Effectiveness (OLE) Method for Analyzing Employee Performance in the Musical Instrument Industry

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Abstract

The production processes in the musical instrument industry are highly diverse, ranging from manual operations to full automation. The musical instrument industry examined in this study is predominantly characterized by manual production processes. In manual production, the role of operators is crucial in determining productivity levels. The Buffing Section is a workgroup within the painting department responsible for polishing components of musical instruments. Observations conducted from September to November revealed that the productivity of this group had not met the company's target of 82%. Productivity was recorded at 70% in September, 77% in October, and 72% in November. To evaluate this condition, operator performance effectiveness was measured using the Overall Labor Effectiveness (OLE) method. OLE is used to assess labor productivity efficiency in manufacturing by examining the cumulative impact of three elements—availability, performance, and quality—on output. To identify the priority factors affecting productivity, the Analytical Hierarchy Process (AHP) method was employed. Additionally, Root Cause Analysis (RCA) was conducted to analyze the causes of problems and propose improvements. The results of the study showed an OLE value of 76%, indicating that the operational performance effectiveness was below the global standard. AHP analysis revealed that the primary factor influencing the low OLE value, which should be prioritized for problem analysis and improvement, was the quality factor, with an eigenvector value of 0.70. To further identify quality-related issues, RCA analysis highlighted the most dominant defects based on a Pareto diagram, namely rough surfaces (69.74%) and dull finishes (15.61%). The primary causes of these defects were, Uneven operator skills, Improper machine settings, Inadequate sanding processes, Incorrect pressure during the buffing process, Excessive or insufficient use of wax, Poor workplace cleanliness.

Keywords: Productivity; Overall Labor effectiveness; Analytical Hierarchy Process; Root Cause Analysis.

INTRODUCTION

Human resources (HR) are critical to enhancing a company's productivity. Effective HR management is essential to developing competent HR. This management can be achieved through proper employee performance measurement, a systematic process to evaluate an individual's work (Mangkuprawira & Hubeis, 2023). A well-designed performance measurement system can assist companies in managing, controlling, planning, and executing activities to achieve their organizational goals. Labor effectiveness is critical in determining productivity across various sectors, influencing economic growth and organizational performance. Understanding the factors contributing to labor productivity is essential for enhancing overall effectiveness in the workplace. Labor productivity is the total hours worked to produce goods and services. This highlights the importance of skilled labor in maintaining a competitive edge in the market (Hayat & Rao, 2020).

Furthermore, labor productivity can be influenced by various operational factors. A deep understanding of productivity parameters is essential, as inefficiencies can lead to significant cost overruns (Tsehayae & Fayek, 2016). Therefore, improving worker efficiency is crucial to achieving the targets set by policy (Wandahl et al., 2021). The music industry under study has three main departments in its production process: the woodworking, painting, and assembly departments. The Buffing section is a workgroup within the painting department responsible for smoothing and polishing the wooden cabinets of musical instrument spare parts. During the production period, the Buffing section has not achieved the targeted productivity improvement of 15% (from

0.72 units/person/hour to 0.82 units/person/hour). The current productivity condition of the Buffing section is shown in Fig. 1.

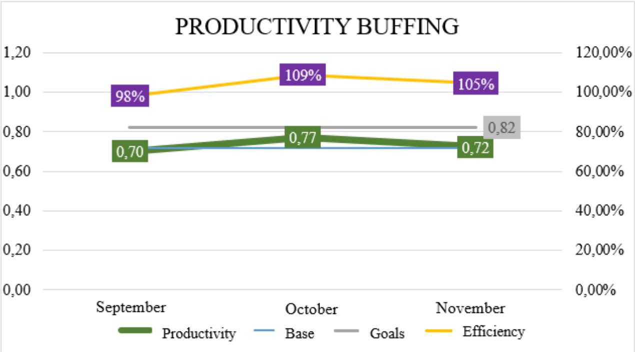

Figure 1. Productivity in the buffing section

The absence of operator performance effectiveness measurements causes the failure to achieve the productivity target. Operators play a critical role in production outcomes, as their performance significantly impacts both the quality and quantity of production. Additionally, suboptimal utilization of operator work time can lead to a decline in production volume. Therefore, a study was conducted using the Overall Labor Effectiveness (OLE) method, which evaluates performance effectiveness through three key elements: availability, performance, and quality. OLE is a tool to measure the overall effectiveness of labor based on three elements: availability, performance, and production quality (Bonci et al., 2022). By utilizing the OLE method, companies can identify various inefficiencies and their root causes, enabling them to implement targeted actions to enhance workforce effectiveness and overall productivity. OLE can assist companies in reducing costs and identifying opportunities to improve overall productivity and profitability by measuring labor contribution (Devani & Syafruddin, 2018). The OLE method is particularly valuable in manufacturing environments, where labor efficiency directly affects production effectiveness and competitiveness. Furthermore, the Analytical Hierarchy Process (AHP) was applied to identify the most influential elements. At the same time, the Root Cause Analysis (RCA) approach was used to determine the root causes of the problems and propose corrective actions to prevent and resolve the identified issues (Doggett, 2005).

Performance refers to the quality and quantity of results an employee achieves in fulfilling the duties and responsibilities assigned based on specific measures and within a given timeframe. Employee performance is influenced by three key factors: individual factors, psychological factors, and organizational factors. Performance measurement evaluates an individual’s job performance (Mangkuprawira & Hubeis, 2023). This evaluation considers eight criteria: work quantity, work quality, job knowledge, creativity, cooperation, reliability, initiative, personal attributes, and overall quality(Brabec & Jáčová, 2022).

Overall Labor Effectiveness (OLE) is a method used to measure the productivity efficiency of manufacturing companies from a labor perspective. It evaluates the cumulative impact of three key elements—availability, performance, and quality—on output (Brabec & Jáčová, 2022). Companies can use the OLE method to assess employee performance and obtain performance information as a percentage score. The World-Class Standard's OLE score benchmark is 85% (Brabec & Jáčová, 2022). Availability refers to the percentage of working time during which employees contribute effectively to the production process (Rahmadiani & Kusrini, 2023). The measured time is calculated by dividing productive work time (the time spent by operators performing their tasks without breaks) by the total time allocated for production activities (as determined by company working hours). In general, company working hours are based on a 40-hour workweek, as stipulated by the Ministry of Manpower.

$$A = 100\% - \frac{LTn}{WYT}$$

A	:	Availability Ratio
LTn	:	Loss of Working Hours
WYT	:	Available Time

The data used for calculating the availability ratio includes working hour loss data, such as absence records, transfers out, non-production time, and transfers within the Buffing section during effective working days from September 2023 to November 2023. Performance is a measurement of labor productivity based on the actual output produced, divided by the target set by the company (Hayat & Rao, 2020). This metric also reflects the output generated within a specific working time and can be influenced by factors such as instructions, equipment, materials, training, and worker capabilities (Rahmadiani & Kusrini, 2023).

$$\mathrm{P} = \sum_{n=1}^{k} \frac{\mathrm{Pn}}{\mathrm{T}} \times 100\%$$

P	:	Average Performance Ratio
K	:	number of observations
Pn	:	day n production result
T	:	production target

The data used to calculate the performance ratio comprises actual daily production output and daily production targets for 8 working hours, as determined by the company. The production output in this context refers to the number of cabinets produced by the Buffing workgroup daily. The data for daily production output and targets were collected during effective working days from September 2023 to November 2023. Quality measures the ability of workers to produce defect-free products that meet the quality standards set by the company [4]. Several factors influence quality, including material quality, worker knowledge, and proper work instructions and equipment (Rahmadiani & Kusrini, 2023).

$$\mathrm{Q} = \sum_{\mathrm{n}=1}^{\mathrm{k}} \frac{\mathrm{Pn} - \mathrm{Dn}}{\mathrm{Pn}} \times 100\%$$

Q	:	Quality Ratio
K	:	number of observations
Pn	:	n-day production result
Dn	:	number of defective products produced on the n^{th} day

The data used for quality ratio data is defective production data and production target data per day during effective working days in September - November. Next is calculating the OLE score by multiplying the three elements, which is then compared to the world standard of the OLE score.

$$\mathrm{OLE} = \mathrm{A} \times \mathrm{P} \times \mathrm{Q}$$

OLE	:	Overall Labor Effectiveness
A	:	Availability Ratio
P	:	Performance Ratio
Q	:	Quality Ratio

The Analytical Hierarchy Process (AHP) was developed in the early 1970s by Dr. Thomas L. Saaty, a mathematician from the University of Pittsburgh (Saaty, 1987). AHP is a functional hierarchy model incorporating human perception as its primary input. It can address multi-criteria decision-making problems by performing pairwise comparisons of each element within the hierarchy (Anjani & Pratiwi, 2021). Root Cause Analysis (RCA) is a method used to identify and determine the root causes of specific problems to develop and implement solutions that prevent and address these issues (Saaty, 1987). According to Rooney and Heuvel (2004), the RCA process involves four main steps: data collection, causal factor charting, root cause identification, and the development of corrective actions.

The 5 Why's Analysis is a structured approach that involves repeatedly asking "why" to uncover the root causes of a problem. This iterative questioning process helps form a causal chain that leads to the primary cause, enabling effective corrective actions to resolve existing problems (Doggett, 2005). Brainstorming is an effective approach used to generate diverse ideas and solutions within a limited timeframe by engaging participants or relevant groups. This method aims to gather a wide range of opinions, information, and experiences, which are then synthesized into a shared knowledge base for problem-solving and decision-making.

The Pareto diagram is a tool used to identify and prioritize the causes of problems by organizing them according to their significance level. This tool classifies issues from those requiring immediate attention to those of lesser urgency. A Pareto diagram combines a bar graph that categorizes and quantifies data with a line graph representing cumulative data distribution. The Fishbone diagram, or the Ishikawa diagram or cause-and-effect diagram, is used to systematically analyze problems by identifying their causes and effects, represented in a visual "fishbone" structure (Suryoputro et al., 2017). This diagram is useful for detailing and categorizing problems using the 5M + 1E framework: man, machine, material, method, measurement, and environment. It provides a clear and detailed visual representation of problem sources, facilitating a structured approach to problem-solving (Suryoputro et al., 2017).

RESEARCH METHOD

The research methodology employed in this study combines quantitative and qualitative approaches to evaluate operator performance effectiveness in the Buffing section of a musical instrument manufacturing industry. Data were collected through direct observation, interviews with workers in the Buffing section, and questionnaires to identify priority factors influencing the Overall Labor Effectiveness (OLE) value. OLE was calculated based on three main factors: availability ratio, performance ratio, and quality ratio. The Analytic Hierarchy Process (AHP) method was applied to determine follow-up priorities. Root Cause Analysis (RCA) was utilized from the selected priorities to identify the root causes of problems and propose solutions to address the issues. Supporting data were obtained from primary sources, such as company records and observations, and secondary sources, including academic literature and previous studies.

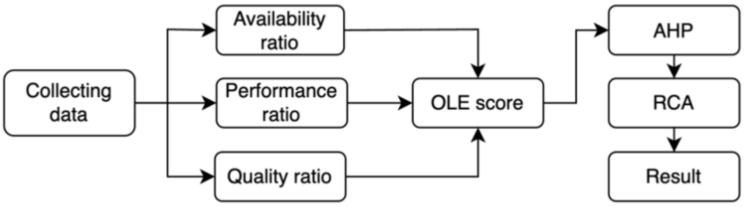

Figure 2. Research method

RESULT AND DISCUSSIONS

a. Overall Labor Effectiveness

The OLE score was calculated using observational data from effective working days between September 2023 and November 2023, and the results were subsequently averaged.

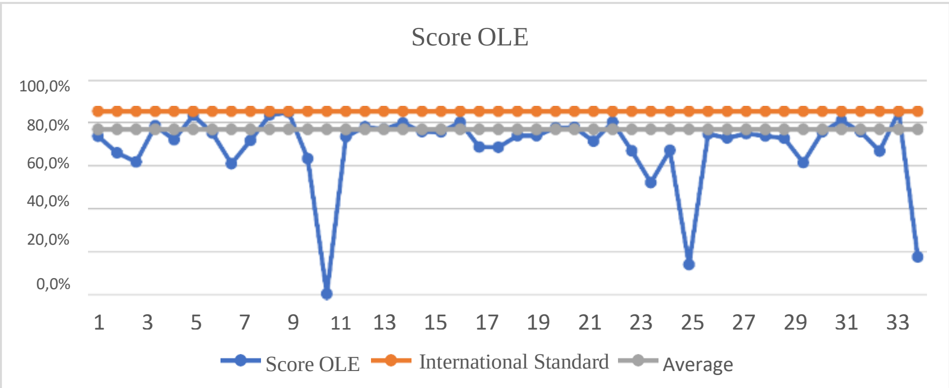

Figure 3. Comparison of OLE Score

Based on the graph presented, the OLE score forms a horizontal pattern. The average OLE score achieved by the Buffing section is 76%, which falls below the global standard of 85%. When analyzed daily, the OLE score exhibits fluctuations. Of the 64 data points analyzed, 44 scores fall below the global standard, while the remaining 20 exceed the standard. From the table provided, it is evident that among the three OLE factors, the quality ratio factor is the only one below the global standard, with a score of 81%. In contrast, the other two factors exceed the global standard.

Table 1. OLE Score

Ratio	Score	International Standard
Availability	91%	90%
Performance	102%	95%
Quality	81%	99,9%
Overall Labor Effectiveness	76%	85%

b. Analytic Hierarchy Process

AHP questionnaire is useful for giving weight to the criteria or 3 factors of OLE by considering other factors so that a priority value is obtained. The AHP questionnaire is given to related parties who thoroughly understand the production process in the Small UP Buffing section as experts or respondents.

Table 2. AHP Table

Kriteria	Availability	Performance	Quality	1	2	3	4 = 3/2	5 = Sum 4/Sum 1	6 = (5 - Sum 1)/(Sum 1- 1)	7	8 = 6/7
				Total Weight Matrix	***Eugen Vector***	**Perkalian Matriks**	***Eugen Value***	***λ maks***	***CI***	***IR***	***CR***
Availability	0,125	0,077	0,143	0,345	0,115	0,347	3,016				
Performance	0,250	0,154	0,143	0,547	0,182	0,553	3,033	3,054	0,027	0,580	0,047
Quality	0,625	0,769	0,714	2,109	0,703	2,189	3,114				
Total	1	1	1	3	1	3,088	9,163				

It was found that the eigenvector value of the most significant criteria was for quality criteria of 2.109, performance of 0.182, and availability criteria with the lowest value of 0.115. In the calculation of the consistent test between criteria, a consistent ratio of 0.047 is produced, which means that the data is consistent, and the calculation results are said to be correct because the results of the concatenation ratio ≤ of 0.1.

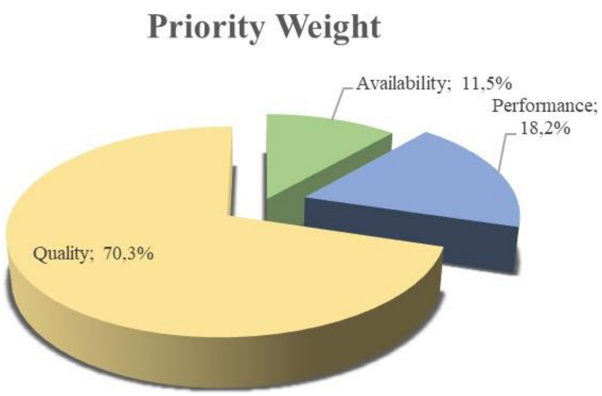

Figure 4. Priority weigh of score AHP

Based on the calculations that have been carried out, the highest weight of the Eugen vector is the quality criterion or factor with a value of 0.70 of the three existing factors. This shows that the quality factor is the most dominant or influential factor in the Buffing section and is the top priority for analyzing the causes of problems and improvements. Parameters are used to minimize subjectivity in the calculation of AHP. Based on the calculations, the consistency ratio value is 0.047, which means that the calculations or results obtained are valid because they have a CR value ≤ 0.1.

c. Root Cause Analysis

This study's problem analysis and improvement recommendations were conducted using the Root Cause Analysis (RCA) method with several tools, including Pareto Diagrams, the 5 Why method, and Cause-and-Effect Diagrams. The company uses the quality ratio to assess operator performance, which measures the relationship between actual production output and product defects and sets targets.

From September to November, the average quality ratio in the Buffing section was only 81%, significantly below the global standard of 99.9%. This shortfall is primarily attributed to the high number of defective products or Not Good (NG) items. Although management targets a zero NG rate, defective products persist, necessitating repair actions by operators. To address this issue, the causes of defects were identified using a Pareto Diagram to analyze the most dominant types of NG, along with Cause-and-Effect Diagrams to explore the contributing causal factors. The Pareto Diagram was utilized to determine the dominant defect types caused by the buffing process in the Small UP Buffing section. The cumulative percentage of NG was calculated based on historical In Check data from September to November (Figure 5). The analysis identified five major types of NG caused by the buffing process: "nonge", cross, rough, dull, and ripple. These defect types were identified through interviews with repair operators, section leaders, the In Check Section Small team, and the Buffing Section foreman.

Table 3. Defect Ratio Accumulation

Type of Defect	Total	Defect Ratio	Accumulation
Rough	8288	69,74%	70%
Dull	1855	15,61%	85%
Riak/Yase	1524	12,82%	98%
"Nonge"	151	1,27%	99%
Cross	66	0,56%	100%
Total Defect	11884	100%	100%

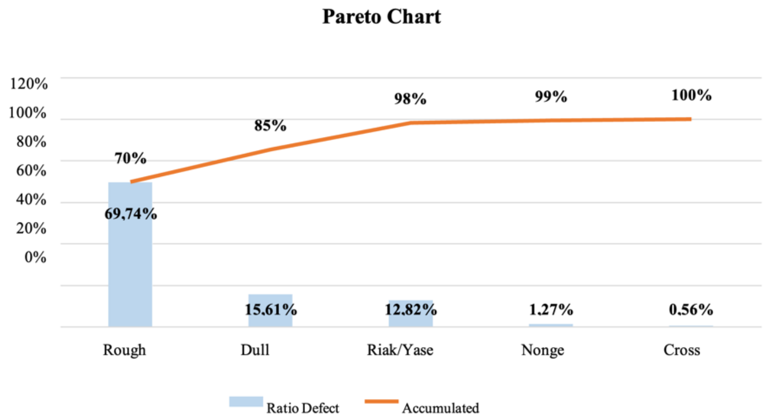

Figure 5. Pareto Chart

Based on the results of the Pareto diagram, it was observed that the highest number of defects or non-conformities (NG) from September to November were rough defects, totaling 8,288 pieces, accounting for 69.74% of all defects. Dull defects were the second most common, with 1,855 pieces representing 15.61%. Rough defects constitute the most significant percentage among the five identified types of defects, in alignment with the Pareto principle, followed by dull defects. This indicates that the dominant issues in the Buffing section are rough and dull defects.

To address these predominant defects, a 5 Why's analysis and brainstorming sessions with relevant stakeholders were conducted. The findings were visualized using Cause-and-Effect Diagrams to identify the root causes of the dominant defect types. Subsequently, proposals for improvement were developed. The analysis involved field observations and interviews with the Buffing section's leader, sub-leader, foreman, and assistant manager.

The reasons behind these defects were identified through direct field observations in the Buffing Small UP section. Additional insights were gathered through 5 Why's analysis and brainstorming sessions involving stakeholders, including the leader, sub-leader, foreman, and the in-check Buffing team. The explanations for each contributing factor are detailed below.:

1. Man

The following provides a detailed explanation of human factors (Man) contributing to rough and dull defects in the Buffing section:

- Uneven Operator Skills

Operator skill levels vary significantly due to differences in employment status, such as permanent employees, contract workers, and transfers from other sections. Permanent employees typically possess higher skill levels because of their extensive experience, whereas contract workers and transfer-in operators often lack sufficient knowledge of the buffing process. To address this issue, intensive and regular training programs should be implemented for new contract workers, multi-skill training for transfer-in operators, and ongoing evaluation and supervision by leaders and sub-leaders.

- Lack of Thoroughness

Rushing to complete a job to move on to the next cabinet often causes a lack of operator thoroughness. Additionally, fatigue or poor physical condition can reduce concentration, causing final checks to be overlooked. A specific standard operating procedure (SOP) for final checks should be established before products enter the in-check phase to mitigate this issue. Socialization on the importance of final checks, along with a more even distribution of tasks, can also help reduce operator fatigue and improve focus.

- Lack of Operator Mindset

Operators often prioritize production speed over ensuring quality from the outset, leading to a preference for addressing cabinet repairs rather than conducting thorough final checks. Addressing this requires fostering a quality-first mindset among operators through training and reinforced awareness programs.

2. Machine

The following is an explanation of the machine factors that cause rough and dull defects in the Buffing section:

- Tilted Machine Table

The buffing process is carried out on a conveyor table; however, improper cabinet placement may cause the machine table to tilt. This misalignment results in the cartridge only partially contacting the cabinet, potentially leading to rough defects. To address this issue, stoppers and dummies are essential to ensure precise cabinet placement. Regular checks on isolation movement and routine machine maintenance must also be conducted.

- Lack of Cartridge Pressure on the Cabinet

Insufficient cartridge pressure during the buffing process can result in a rough texture and a lack of shine in the cabinet. This issue is particularly prevalent in manual-level machines where settings are improperly configured. To mitigate this problem, operators must ensure machine settings are correctly adjusted before initiating the process, and regular maintenance schedules must be implemented.

- Cartridge Diameter Size Reduced

The cartridge's minimum operational diameter is 30 cm; however, prolonged use can reduce its size, negatively impacting the buffing results and leading to rough and dull defects. To prevent this, periodic inspections and timely cartridge replacements are necessary. Furthermore, a procedure for regularly measuring cartridge diameter should be incorporated into the Work Instructions.

- Uneven Cartridge Condition

The cartridges on the Ryoto fine and rinse machines consist of four layers, each of identical size. Any inconsistency in layer size can cause the cartridge to become uneven, leading to sub-optimal buffing results and dull defects. To prevent these issues, periodic checks and additional work instructions must be conducted to ensure that the cartridge layers are of uniform diameter before installation.

3. Material

Regarding material factors, the root cause of rough and dull defects in the Buffing section can be attributed to an inadequate sanding or rinsing process and using less sharp abrasives compared to those used in the previous section, namely Sanding Small UP. To address this issue, it is essential to coordinate and collaborate with the Sanding Small UP section to ensure that the sanding process meets the required standards or to replace the abrasives with sharper ones during the rinsing process. The Buffing section has already implemented the proposed recommendations to mitigate these defects.

4. Methods

In terms of method factors, the root causes of rough and dull defects in the Buffing section can be explained as follows:

- Lack of pressure during the buffing process

One of the primary causes of rough defects, based on method-related factors, is insufficient pressure applied during the buffing process. This issue often occurs when operators fail to apply adequate pressure on the cabinet against the cartridge during the buffing process on the Ryoto machine. Additionally, improper hand positioning or cabinet misalignment with the prescribed work instructions further exacerbates the problem. These deviations are frequently attributed to operators rushing to save processing time, ultimately compromising the quality of the buffing process.

- Over- or under-application of wax to the cartridge

The inconsistent wax application during the buffing process arises from applying wax to the cartridge based on subjective estimation, resulting in either excessive or insufficient wax on the cartridge. During the cabinet buffing process, this inconsistency can lead to rough and dull defects. An automatic wax dispenser with a predefined wax standard aligned with work instructions should be implemented to address this issue. Additionally, leaders and sub-leaders should monitor the wax application process to ensure compliance with the established standards.

- Lack of buffing process on ryoto fine and ryoto finish machines

In the cabinet buffing process within the Buffing section, three Ryoto machines are utilized: the coarse Ryoto, fine Ryoto, and finish Ryoto. During the buffing process, operators often perform the rinsing step on the fine and finish Ryoto machines briefly before sending the cabinet to the in-check section. This practice can lead to rough and dull defects, as residual wax from the coarse Ryoto machine may remain uncleaned or adhered to the cabinet surface. To mitigate this issue, it is imperative for leaders and sub-leaders to implement regular controls and inspections after the cabinet is processed. Additionally, they must ensure that operators adhere strictly to the buffing process outlined in the work instructions.

5. Environment

   The final factor involves environmental conditions, which significantly impact the work area in the Small UP Buffing section. Specifically, the work environment remains insufficiently clean, primarily due to the buffing process generating numerous wax flakes and scattered dust around the work area and the buffing machinery. Additionally, the disorganized stacking of jigs and overfilled cabinets further exacerbate the issue. These factors contribute to surface defects within the Buffing section, such as rough and dull finishes. Implementing a systematic schedule and task distribution for the 5S methodology (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) is recommended to address these challenges. Each operator's work area should adhere to these principles, with supervisors and team leaders actively monitoring production outputs and material flow to prevent the accumulation of goods in the Buffing section. Furthermore, shelf capacity must be increased, and enhanced coordination with preceding workgroups is essential to ensure the Buffing section's capacity aligns with production demands.

The following is an explanation based on the factor with the corresponding number:

1. Man Factor

   Lack of operator accuracy causes rough and dull defects in the Small UP Buffing section. The main cause of this problem is the lack of checking at the end of the buffing process before the product enters the in check section. To overcome this problem, it is recommended to socialize the importance of checking at the end of the process. The documentation of this proposal is in the form of socialization related to checking at the end of the process.
2. Machine Factor

   Defects are also caused by the reduced diameter of the cartridge. To solve this problem, it is necessary to add a process to the Work Instructions related to measuring the diameter of the catridge using a machine. Documentation related to this improvement includes a proposal to add a PK for measuring the catridge before the buffing process.
3. Material Factor

   Lack of sanding or rinsing can cause product defects. To resolve this issue, it is recommended that the Small UP Buffing section work with the Small UP Sanding section to replace sharper abrasives during the rinse process. Documentation related to this improvement includes increasing the abrasive sharpness from 600 to 1000 in the Sanding section to reduce defects.

CONCLUSION

The calculation results of Overall Labor Effectiveness (OLE) indicate that operators' performance in the Buffing section of the music industry is still ineffective, with an OLE value of 76%. This figure is below the global standard of 85%. The primary factor contributing to the low OLE is quality. Based on weighting analysis using the Analytical Hierarchy Process (AHP), improvement efforts are prioritized to address quality issues. To identify the root cause of declining product quality, the Root Cause Analysis (RCA) approach was employed. According to the RCA findings, the low-quality ratio is attributed to defects such as rough and dull surfaces. Using the 5 Why's analysis and brainstorming with experts, supported by the Cause-and-Effect Diagram (CED), the primary factors identified were human (man) and method (method). Proposed solutions include skill equalization among operators, enhancing the roles of leaders and sub-leaders in supervising tasks, and ensuring adherence to established work procedures.

REFERENCES

Anjani, R., & Pratiwi, I. (2021). Analisis Efektivitas Tenaga Kerja di Masa New Normal pada Departemen Finishing Menggunakan Overall Labor Effectiveness (OLE) (PT Iskandar Indah Printing Textile, Surakarta). *Seminar Nasional Teknik Dan Manajemen Industri*, *1*(1), 232–239. https://doi.org/10.28932/sentekmi2021.v1i1.80

Bonci, A., Stadnicka, D., & Longhi, S. (2022). *The Overall Labour Effectiveness to Improve Competitiveness and Productivity in Human-Centered Manufacturing* (pp. 144–155). https://doi.org/10.1007/978-3-030-99310-8_12

Brabec, Z., & Jáčová, H. (2022). Overall Labor Effectiveness as a Tool for Measuring Performance in a Given Company. *ACC Journal*, *28*(2), 7–18. https://doi.org/10.15240/tul/004/2022-2-001

Devani, V., & Syafruddin, S. (2018). USULAN PENINGKATAN EFEKTIVITAS TENAGA KERJA DENGAN MENGGUNAKAN METODE OVERALL LABOR EFFECTIVENESS. *Jurnal Ilmiah Rekayasa Dan Manajemen Sistem Informasi*, *4*(2), 150. https://doi.org/10.24014/rmsi.v4i2.5684

Doggett, A. M. (2005). Root Cause Analysis: A Framework for Tool Selection. *Quality Management Journal*, *12*(4), 34–45. https://doi.org/10.1080/10686967.2005.11919269

Hayat, A., & Rao, M. A. A. (2020). An Analytical Discourse on Islamic Precept of Ihsān and Labour Productivity. *Journal of Islamic Thought and Civilization*, *10*(101), 136–155. https://doi.org/10.32350/jitc.101.07

Rahmadiani, P., & Kusrini, E. (2023). Operator Performance Analysis Using Overall Labor Effectiveness Method with Root Cause Analysis Approach. *Asian Journal of Social and Humanities*, *1*(11), 918–927. https://doi.org/10.59888/ajosh.v1i11.106

Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. *Mathematical Modelling*, *9*(3–5), 161–176. https://doi.org/10.1016/0270-0255(87)90473-8

Mangkuprawira, S., & Hubeis, A. V. (2023). *Manajemen Mutu Sumber Daya Manusia*. Ghalia Indonesia.

Suryoputro, M. R., Sugarindra, M., & Erfaisalsyah, H. (2017). Quality Control System using Simple Implementation of Seven Tools for Batik Textile Manufacturing. *IOP Conference Series: Materials Science and Engineering*, *215*(1). https://doi.org/10.1088/1757-899X/215/1/012028

Tsehayae, A. A., & Fayek, A. R. (2016). System model for analysing construction labour productivity. *Construction Innovation*, *16*(2), 203–228. https://doi.org/10.1108/CI-07-2015-0040

Wandahl, S., Pérez, C. T., Salling, S., Neve, H. H., Lerche, J., & Petersen, S. (2021). The Impact of Construction Labour Productivity on the Renovation Wave. *Construction Economics and Building*, *21*(3). https://doi.org/10.5130/AJCEB.v21i3.7688