Decision Support System for Manufacturing Division Priority using AHP Method

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Abstract—In the competitive manufacturing landscape, especially in stamping and automobile parts production, optimizing production processes is a paramount challenge. This study addresses a manufacturing company's vulnerability to production reporting manipulation and inaccuracies in manual report generation. To tackle these challenges, we propose a vital system to combat the complexities and inaccuracies in existing reporting methods that significantly impede decision-making and operational efficiency. We introduce a novel, integrated system combining a production information system with an Analytical Hierarchy Process (AHP)-based decision support system. This hybrid solution aims to streamline report generation and boost decision-making within production divisions. The approach involves deploying a web-based system to simplify report creation and ensure accuracy and timeliness. The decision support system utilizes AHP to facilitate division prioritization, addressing critical issues promptly with data-driven insights. AHP's practicality and reliability assist in evaluating criteria for effective division prioritization. The implementation of this system marked significant improvements in production data management, evident from a substantial 68.17% user satisfaction rating. These results demonstrate the system's efficacy in enhancing decision-making, refining production processes, and boosting overall productivity. Furthermore, the system provides valuable insights into operator performance, fostering management recognition and appreciation, thus promoting transparency and accountability. The integration of an information system with AHP-based decision support emerges as a potent solution for manufacturing companies confronting similar challenges.

Keywords: Analytical Hierarchy Process; Decision Support System; Division Prioritization; Manufacturing Production; Production Information System

1. INTRODUCTION

Production is the cornerstone of any organization, whether it's involved in the manufacturing of goods or the provision of services. It represents the culmination of various organizational activities, intricately woven into management hierarchies, with the ultimate goal of creating value. This value creation is not a mere consequence of random actions but a deliberate process that combines advanced technology, efficient resource utilization, and strategic decision-making. The role of information in this process cannot be overstated, as it serves to refine these processes and guide crucial decision-making, thus forming an essential part of the organizational structure [1]. In this context, the division process in the study faces two main problems: vulnerability to manipulation in production reporting, leading to potential data inaccuracies and poor decision-making, and inefficiencies in manual report generation, causing delays and errors in a fast-paced manufacturing environment. These issues are rooted in the outdated and non-standardized reporting and decision-making processes within the production divisions.

In the manufacturing sector, particularly, companies are constantly navigating a labyrinth of complex challenges to streamline their production processes. This sector is a vibrant arena where the integration of industrial activities with information technology plays a pivotal role to promote manufacturing and information technology (ICT) integration [2]. In today's highly competitive business landscape, this integration is not just beneficial but vital for survival and growth. A case in point is a manufacturer specializing in stamping and automobile parts. This company's concentrated efforts in enhancing production capacity, leveraging technological advancements, optimizing material utilization, and integrating information technology have borne significant fruits. Over a period of just three months, these concerted efforts led to an impressive 49% increase in production. This remarkable surge, propelled by escalating customer demand and efficient information exchange, lucidly highlights the criticality of merging technology with information flow in the manufacturing sector to realize efficient production.

Delving deeper into the production department of this company reveals two primary issues that were impeding its effectiveness. The first issue revolved around the complex task of division prioritization. The sheer volume and irregularity of production data posed a significant challenge, making data processing and decision-making a daunting task. The second issue pertained to the generation of production reports. Managed by team leaders and production administrators, this process was fraught with the risk of data manipulation, leading to consequential delays and inefficiencies.

To address these challenges head-on and enhance the efficiency and effectiveness of the production process, the introduction of a web-based production information system is proposed. This innovative system is meticulously designed to streamline data management and is poised to incorporate the Analytical Hierarchy Process (AHP) methodology to refine division prioritization. The use of the AHP method is intended to carry out calculations related to the criteria weight because to form a priority order the division must define the criterion weight first [3]. This methodology will be instrumental in evaluating criteria and assigning consistent values, ensuring that critical issues are not just addressed but done so promptly and effectively [4]. The selection of this method is rooted in its demonstrated success in facilitating informed decision-making across a spectrum of fields [5],[6].
In the context of this research, the strategic utilization of the Analytical Hierarchy Process (AHP) is specifically tailored to prioritize divisions within the production department. This prioritization is not arbitrary but is meticulously based on criteria extracted from daily production reports, enriched by expert opinions and deep domain knowledge. AHP offers a systematic and quantifiable method to evaluate and rank divisions, a process that is integral for the efficient allocation of resources and the timely resolution of pressing issues.

The versatility and adaptability of AHP are evident from its widespread adoption in diverse fields, all of which highlight its potential to significantly enhance decision-making processes. For the manufacturing company under study, AHP emerges as an effective framework to prioritize divisions within the production department. This approach is pivotal in mitigating operational issues and optimizing production processes, thereby contributing to the overall efficiency of the organization.

In conclusion, the integration of a web-based production information system with an Analytical Hierarchy Process (AHP)-based decision support system represents a significant advancement in manufacturing production management. This approach, which builds upon previous research in decision support systems (DSS) that utilized AHP in various contexts, is particularly innovative in addressing the specific challenges of manufacturing divisions. For example, Munthafa's research [7] in the Siliwangi University's Journal applied AHP in a DSS for determining student achievement, demonstrating the effectiveness of AHP in systematic decision-making with a criterion consistency ratio well below the 10% threshold. Similarly, another study [8] employed AHP for a Funding Decision Support System, enhancing the process of selecting eligible citizens for aid fund distribution.

Moreover, the work by Hafiz [9] explored the use of the Product Weighted Approach for the Best Employee Selection Decision Support System, highlighting the importance of recognizing employee excellence. Additionally, insights from [10] on a Scholarship Decision Support System using the SAW Method contributed to the ongoing development of methodologies for selecting suitable candidates based on specific criteria and weights. Furthermore, research [11] on the application of the Profile Matching Method in Employee Performance Assessment emphasized the importance of objective assessment in management decisions.

The collective findings of this study emphasize the uniqueness and effectiveness of various DSS methodologies, AHP, in providing solutions to different decision-making scenarios. The AHP method, with its accuracy in determining, selecting, and ranking priorities, proved to be very useful in the production department of manufacturing settings, where it helps in simplifying data management, reporting processes, and criteria assessment for effective division priorities. It not only strengthens the theoretical framework but also the practical application of AHP in production management in the manufacturing sector, marking a new benchmark in innovative DSS solutions. In addition, the integration of Data Flow Diagram (DFD) theory is a critical step in understanding and detailing how data moves across software systems. DFD, as a structured analysis technique, provides a clear visual view of data flows and interprocess interactions in a system context [12], [13]. Thus, the merger of AHP and DFD not only improves the theoretical understanding of the DSS solution, but also brings in-depth operational clarity in the context of its practical application.

2. RESEARCH METHODOLOGY

2.1 Research Stage

![Figure 1. Research Stage](image-url)
Figure 1 presents a structured flowchart detailing the methodological progression in the development of a sophisticated web-based decision support system employing the Analytical Hierarchy Process (AHP). The initial phase of our scholarly inquiry, termed "Needs Analysis," is pivotal in isolating the fundamental issues the system seeks to address. This phase necessitates comprehensive interaction with potential end-users via methodically designed surveys and interviews, alongside a meticulous examination of extant systems to define the desired functionalities, system requirements, and find solutions [14], [15]. Advancing into the "Data Collection" phase, our scholarly endeavor concentrates on the acquisition of primary data directly from prospective end-users and secondary data from relevant academic journals and literature, with the aim of achieving an in-depth understanding of the essential technical and operational specifications for the system.

The subsequent phase, "Criteria Determination," involves the precise articulation of relevant criteria and sub-criteria within the AHP framework, which is informed by the strategic planning requirements of production managers or Management, in close consultation with Production Administrators and derived from meticulous analysis of production reports. The establishment of four distinct classifications of criteria—Explanation, Troubleshoot, Standard, and Target—reflects a collaborative consultative process. This stage is marked by the creation of a decision hierarchy, with the overarching goal at the apex, cascading down to the defined criteria and sub-criteria. Each criterion is rigorously appraised via pairwise comparison matrices, ensuring a robust evaluative process. Transitioning to the "Criteria Weight Value" phase, the pairwise comparison matrices are constructed with precision, utilizing the AHP scale and synthesizing evaluations from domain experts as well as user feedback. The matrices undergo normalization to facilitate the determination of the relative weights assigned to each criterion and sub-criterion.

Concluding our methodological approach is the "Implementation of AHP Assessment on the Web" phase, which is dedicated to the design of an interactive web interface that facilitates user engagement and input. This phase is characterized by the seamless integration of the AHP algorithm into the web-based system, enabling the meticulous processing of inputs and the derivation of accurate outputs. The system undergoes exhaustive functional and user testing to validate its effectiveness, embodying a commitment to ongoing refinement and enhancement responsive to user feedback. Our methodical and strategic approach is underpinned by the ambition to craft a decision support system that significantly enhances the decision-making process within a diverse array of organizational contexts, underscored by the rigorously established criteria of Explanation, Troubleshoot, Standard, and Target.

2.2 Analytical Hierarchy Process (AHP)

According [16] the Analytical Hierarchy Process (AHP) approach allows one to assign a value corresponding to the degree of preference for a particular alternative. A hierarchical structure can be utilized to categorize and choose options using these values [17]. AHP serves as a decision-making tool using an Eigen approach for pairwise comparisons, calibrating numbers from qualitative to quantitative scales. Pairwise comparisons that come after the hierarchy's design let the user ascertain the weight coefficients of each parameter and criterion and, consequently, how they affect the objective [18]. The development of a hierarchy of criteria and the factors influencing a choice is suggested by AHP. The objective needs to be positioned at the top of the hierarchy Error! Reference source not found..

Figure 2. General Structure of AHP

Table 1. Comparison Matrices

<table>
<thead>
<tr>
<th>Important Score</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equally important</td>
</tr>
</tbody>
</table>

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Submitted: 06/12/2023; Accepted: 08/01/2024; Published: 10/01/2024
Table 1 defines a scoring system for prioritizing criteria in decision-making, with ‘1’ indicating criteria of equal importance and higher scores like ‘3’, ‘5’, ‘7’, and ‘9’ denoting increasing levels of importance, up to ‘9’ for the utmost importance.

c. Synthesizing compared criteria to calculate priorities by normalizing and averaging matrix values.
d. Testing consistency to ensure decisions are well-measured and considerations are coherent, involving matrix multiplication and calculating the maximum eigenvalue ($\lambda_{\text{max}}$)
ed. Computing the Consistency Index (CI) using the formula

$$CI = \frac{\lambda_{\text{max}} - n}{n-1}$$

Description:
- CI = Consistency Index (CI)
- $\lambda_{\text{max}}$ = Eigen vector maximum
- n = Sum Element
f. Determining the Consistency Ratio (CR) with is the Random Consistency Index.

$$CR = \frac{CI}{IR}$$

Description:
- CR = Consistency Ratio (CR)
- CI = Consistency Index (CI)
- IR = Indeks Random Consistency
g. Checking the Consistency of the Hierarchy

To ensure the hierarchical consistency in the Analytical Hierarchy Process (AHP), the Consistency Ratio (CR) must be calculated. If the CR exceeds 10% or 0.1, the criteria assessments and judgment data need to be revised. Conversely, a CR below 10% or 0.1 indicates that the criteria assessments and judgments are valid and accurate.

Below is the Error! Reference source not found. for the Consistency Index (CI) along with the Random Consistency Index values:

<table>
<thead>
<tr>
<th>Number</th>
<th>Criteria</th>
<th>RI_n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>0.58</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>0.90</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>1.12</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>1.24</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>1.32</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>1.41</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>1.45</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td>1.49</td>
</tr>
</tbody>
</table>

Table 2 outlines the Consistency Index (CI) values that correspond to different numbers of criteria, which are used to assess the consistency of pairwise comparisons in AHP, a CI close to ‘0’ indicates high consistency. In summary, maintaining a CR below 0.1 is essential for the AHP analysis to be considered consistent and reliable.

3. RESULT AND DISCUSSION

3.1 System Design Proposal

After analyzing the issues within the production department, a proposed system design was conceptualized. It includes a decision support system (DSS) to prioritize issues across the production divisions. The design process in Error! Reference source not found.4 encompasses:

a. Recording daily production, finished goods, and non-conformities (NGs) in the production information system.
b. Admin responsibilities include updating component data such as items, processes, operators, troubleshoots, and workdays. Criteria weights are predefined by management.
c. Input of daily production reports into the system by users or admins.
d. Special production reports and division priority modules are auto-generated.
e. Monthly production meetings by management to review these reports.

Figure 3. Overview Diagram

Figure 3 is a workflow diagram for a system that starts with user login, proceeds through stages of data input and validation, and culminates in the generation and validation of specialized reports and decision-making for division selection.

3.2 AHP Calculation Step

In our research, we utilized the Analytical Hierarchy Process (AHP) to identify priority areas in a production setting. This methodology involved establishing four key criteria—Description, Standard, Troubleshoot, and Target—rooted in the needs of production management and insights gleaned from production reports. The AHP method is instrumental in converting complex and unstructured problems into structured pairwise comparisons [19]–[21], providing a systematic approach to problem-solving in production contexts. To elucidate the process, key tables from the manual calculations are presented:

Tabel 3. Pairwise Comparison Matrix

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Troubleshoot</th>
<th>Standard</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>1</td>
<td>3/1</td>
<td>5/1</td>
<td>7/1</td>
</tr>
<tr>
<td>Troubleshoot</td>
<td>1/3</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Standard</td>
<td>1/5</td>
<td>1/3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Target</td>
<td>1/7</td>
<td>1/5</td>
<td>1/3</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3 illustrates the pairwise comparison of different criteria based on Saaty's scale, showing how each criterion is weighed against the others in terms of importance. This table forms the foundation of the Analytical Hierarchy Process (AHP) by providing a structured approach to evaluate and compare criteria, such as Description, Standard, Troubleshoot, and Target, against each other. Each cell in the table reflects how much more important one criterion is relative to another, guiding the decision-making process in a systematic and quantifiable manner.

Tabel 4. Normalization of Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Troubleshoot</th>
<th>Standard</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>1.000</td>
<td>3.000</td>
<td>5.000</td>
<td>7.000</td>
</tr>
<tr>
<td>Troubleshoot</td>
<td>0.333</td>
<td>1.000</td>
<td>3.000</td>
<td>5.000</td>
</tr>
<tr>
<td>Standard</td>
<td>0.200</td>
<td>0.333</td>
<td>1.000</td>
<td>3.000</td>
</tr>
<tr>
<td>Target</td>
<td>0.143</td>
<td>0.200</td>
<td>0.333</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Table 4 is where the values of the pairwise comparison matrix are adjusted to determine the relative importance of each criterion. This is done by dividing each element by its column total, ensuring a balanced and proportional comparison across all criteria. The resulting normalized values are crucial for accurately assessing the relative weights in the AHP process.

Tabel 5. Eigen Vector of Criteria
In Table 5, the Eigen vector values are derived from the normalized pairwise comparison matrix and represent the priority weights of each criterion in our AHP analysis. These values are calculated as the average of each row in the normalized matrix, effectively quantifying the relative importance of the criteria – Description, Standard, Troubleshoot, and Target – in the decision-making process. Higher Eigen vector values indicate greater significance, guiding the prioritization of these criteria in addressing production-related issues within the given context.

Table 6. Consistency Check

<table>
<thead>
<tr>
<th>A max</th>
<th>CI</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.119</td>
<td>0.04</td>
<td>0.044</td>
</tr>
</tbody>
</table>

Table 6 serves to verify the reliability of our pairwise comparisons in the AHP process. It calculates the Consistency Index (CI) and Ratio (CR), ensuring that the comparisons are logical and reliable, with a CR below 0.1 indicating acceptable consistency.

The final step involved applying a similar pairwise comparison and normalization process to alternatives derived from daily production data. Each alternative's importance was calculated based on the established criteria. The final outcome of the AHP analysis is a ranking of production divisions according to their prioritization for addressing specific issues. This ranking is derived from the calculated weights and consistency ratios, ensuring a systematic and objective approach to decision-making. Tabel 7 show division of DRILLING emerged as the highest priority, reflecting its critical role in the production process and the necessity of addressing its challenges promptly. This was followed by other divisions in order of their calculated importance.

Table 3. Alternative Eigen Vector – Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Information</th>
<th>Troubleshoot</th>
<th>Standard</th>
<th>Target</th>
<th>Final Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>0.112</td>
<td>0.055</td>
<td>0.053</td>
<td>0.023</td>
<td>0.243</td>
</tr>
<tr>
<td>Turret</td>
<td>0</td>
<td>0.121</td>
<td>0.023</td>
<td>0.013</td>
<td>0.157</td>
</tr>
<tr>
<td>New CNC</td>
<td>0.067</td>
<td>0</td>
<td>0.015</td>
<td>0.01</td>
<td>0.092</td>
</tr>
<tr>
<td>Milling &amp; Rolling</td>
<td>0.067</td>
<td>0.055</td>
<td>0.031</td>
<td>0.008</td>
<td>0.161</td>
</tr>
<tr>
<td>Old CNC</td>
<td>0.134</td>
<td>0.033</td>
<td>0</td>
<td>0.003</td>
<td>0.17</td>
</tr>
<tr>
<td>Punch</td>
<td>0.179</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.179</td>
</tr>
</tbody>
</table>

3.3 Program Interface

Designs for various system interfaces include login, main page, item data, process data, operator data, troubleshoot data, workday data, criteria data, daily production report input forms, finished goods report forms, NG data forms, downtime data forms, account settings, account management, activity log, classification of production report results, and division priority selection reports. Additionally, the integration of the Analytical Hierarchy Process (AHP) within the website is crucial, allowing for systematic decision-making based on the AHP's prioritization directly from the interface. This integration facilitates users to engage with the AHP process seamlessly, from criteria selection to final priority determination, enhancing the decision-making efficiency within the system.

a. Main page functionalities

The main page of the system in Figure 4 serves as the central hub for all functionalities, providing a user-friendly interface that allows easy access to various features. This page is designed to streamline user interaction, presenting clear and intuitive options for navigating through different sections of the system. It effectively consolidates key functionalities, ensuring that users can efficiently manage their tasks and access essential information with minimal effort. The layout is thoughtfully organized, ensuring that users can find what they need quickly and easily.
Figure 4. Main Page

Figure 4 shows a user interface for a production dashboard that displays charts comparing targets versus actual production outputs and troubleshooting across various divisions, aiding in quick visual analysis and decision-making.

b. Master Data Entry

Figure 5. Master Data Entry

Figure 5 interface of the proposed production information system. This crucial component is designed for the systematic input and management of master data, which forms the backbone of the system's functionality. The interface is meticulously structured to ensure ease of use, accuracy in data entry, and efficient management of core data elements essential for the system's operation. This section is integral for maintaining the integrity and reliability of the system, ensuring that all subsequent processes and decisions are based on accurate and up-to-date information.

c. Forms for entering daily production, finished goods, NG data, downtime.

Figure 6. Production Reports

Figure 6 presents a user interface designed for inputting critical data in a production information system. It showcases various forms that facilitate the entry of daily production metrics, details of finished goods, and data regarding non-conforming products (NG). Additionally, it includes sections for documenting instances of production downtime. This interface serves as a crucial tool for capturing and organizing key production data, ensuring accurate record-keeping and efficient monitoring of manufacturing processes.

d. Classification and reporting of production results, division priority selections, monthly operator reports, internal reports, Pareto reports, and more.
Figure 7. Operator Reports

Figure 7 presents an overview of a production information system, highlighting its key features for classifying and reporting production outcomes. It showcases tools for division priority selection, operator monthly reports, and internal and Pareto reports, demonstrating the system's efficiency in managing and presenting essential production data.

3.4 Testing and Feedback

The testing phase, crucial for assessing the functionality and efficiency of the proposed system, employed Black Box Testing. This method focused on understanding the system's behavior without delving into its internal structures. Key aspects tested included:

a. Login and Session Management: Validation of secure login, role-based access, and logout functionalities, ensuring authentication and authorization integrity.

b. Data Entry and Report Generation: The system was tested for its ability to handle data input, modifications, and deletions in various modules like Data, Operator, and Troubleshooting. Special attention was given to the production report generation process, ensuring accuracy and timelines.

c. Decision Support System (DSS) Functionality: The DSS's capability to utilize the Analytical Hierarchy Process (AHP) for division priority selection was tested. This included verifying the accuracy of criteria weighting and the effectiveness of the prioritization process.

Feedback was gathered through a comprehensive questionnaire distributed among users, including Administrators and Managers. The questionnaire aimed to measure user satisfaction and system efficacy. The results indicated a general approval of the system, with suggestions for future improvements in usability and functionality. The overall positive feedback signified the system's potential in streamlining production processes and decision-making in the manufacturing environment.

3.5 Discussion

In light of the study's findings, the future development of the production information system must focus on generating data that is not only consistent and accurate but also reliable and accountable. This aspect is crucial for enhancing the credibility and utility of the system. Furthermore, the design of this application holds significant potential for adoption by similar companies, particularly in optimizing their production processes. The adaptability of the system to different industrial contexts amplifies its applicability and usefulness. Moreover, an important aspect of future development is the enhanced management of Human Resources (HR). The system should be designed to facilitate better HR management, which is a critical component in any production process. Effective HR management within the system can lead to improved productivity and efficiency, benefiting the organization as a whole. Another critical suggestion for future development is the ease of application of the decision support system's methodology. The methodology should be straightforward to implement in other decision support systems, ensuring its versatility and effectiveness across various scenarios. This adaptability will make the system more valuable and applicable across different sectors, allowing for broader implementation and utility.

In the context of the implemented Decision Support System (DSS), several key areas for future development and enhancement are worth discussing. Firstly, the integration of the DSS with the Analytical Hierarchy Process (AHP) demonstrated its effectiveness in division prioritization. To further improve its functionality, future efforts should focus on refining the AHP methodology, possibly incorporating advanced techniques or machine learning algorithms. Secondly, usability and user-friendliness should be prioritized, requiring enhancements in the user interface, real-time data visualization, and user training. Scalability, security, and data integrity are critical considerations, necessitating the system's adaptability to changing organizational needs and robust security measures. Finally, fostering collaboration and knowledge sharing within the organization through the DSS is essential, promoting transparency and cross-functional communication. Collectively, these development efforts will solidify the DSS's role in optimizing production processes and contribute to long-term competitiveness in the manufacturing sector.
4. CONCLUSION

Implementation of the production information system application plan and the decision support system has yielded a substantial improvement in the administrative processes of managing production information data within the production department, garnering an impressive 68.17% approval rate. The system's success lies in its ability to simplify the creation of production-specific reports, contributing to more effective decision-making processes. The incorporation of the Analytical Hierarchy Process (AHP) method has proven to be instrumental in prioritizing divisions, enabling management to address emerging challenges with efficiency and precision. Beyond operational enhancements, the system has positively impacted the overall quality of the production department. It serves as a valuable tool for evaluating operator performance, fostering a culture of recognition and appreciation from management. This not only boosts morale but also contributes to sustained improvements in productivity. The implemented system, therefore, stands as a strategic investment that aligns with organizational goals, bringing tangible benefits to the efficiency and productivity of the production department. As a result, the successful integration of these technologies exemplifies a forward-thinking approach, positioning the organization for continued success and advancements in production management.

REFERENCES