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The Effect of Machine Maintenance and Layout on the Production Process

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Abstract: This research aims to analyze the influence of machine maintenance and layout on the production process at PT. Indonesian Packaging Creations. The research method used is a quantitative approach with an associative research design. Data was collected through a questionnaire distributed to 50 respondents who were employees at the company. Data analysis was carried out using multiple linear regression to test the hypothesis that had been formulated. The research results show that machine maintenance has a positive, but not significant, influence on the production process, with a regression coefficient of 0.019 and a significance of 0.738. On the other hand, layout is proven to have a significant influence on the production process, with a regression coefficient of 0.883 and a significance value of 0.000. The simultaneous test shows that the two independent variables have a significant effect on the production process, with a calculated F value of 84.82. This research emphasizes the importance of optimal machine maintenance and efficient layout design to improve the smoothness of the production process. This research provides recommendations for management of PT. Kreasi Kemas Indonesia to implement a better maintenance system and redesign the factory layout to support operational efficiency**.**

Keywords: Efficiency**,** Machine Maintenance, Manufacturing Industry Production Process

A. Introduction

The manufacturing industry is one of the sectors that has experienced rapid development throughout the world, especially in the context of globalization and technological advancement (Palange & Dhatrak, 2021). One of the important sub-sectors is the packaging industry, which plays a vital role in supporting various other sectors (Effendy & Gopar, 2024), such as food, beverages, and consumer goods (Achouch et al., 2022). In the manufacturing industry, the effectiveness of the production process is a major factor in determining the competitiveness of a company (Foresti et al., 2020). An optimal production process can increase productivity, efficiency, and product quality (Ciano et al., 2021). One of the important factors that affect the smooth running of the production process is machine maintenance and the layout of production facilities (Ayvaz & Alpay, 2021). Good machine maintenance can

prevent unexpected damage, reduce production downtime, and extend the operational life of the machine (Dalzochio et al., 2020). Meanwhile, an efficient layout can improve work processes, reduce material travel time, and minimize waste of resources (Lango et al., 2024).

Machine maintenance in an industry involves a series of activities designed to ensure equipment is operating properly and prevent breakdowns that could hinder production (Paul & Chowdhury, 2020). Regular maintenance will reduce the risk of production disruptions, increase operational efficiency, and ensure consistent product quality (Salawu et al., 2023) (Ruiz-Sarmiento et al., 2020). Without adequate maintenance, production machines are vulnerable to disruptions that can lead to delays, high repair costs, and potentially even greater losses for the company (Li et al., 2021).

In addition to machine maintenance, another factor that greatly influences the production process is the factory layout (Liu et al., 2021). A well-designed layout can increase production efficiency by reducing material and labor movement time, and facilitating coordination between production units (Zheng et al., 2021). Conversely, an unorganized layout can cause various problems (Sastra et al., 2024), such as increased waiting time, increased worker fatigue, and difficulty in managing workflow (Dogan & Birant, 2021).

In an era of increasingly tight industrial competition, manufacturing companies must be able to optimize machine maintenance and production layout to increase competitiveness (Jamwal et al., 2021). Machine maintenance and production facility layout are two key factors that can affect the efficiency of the production process (Lee et al., 2020). Good machine maintenance can reduce downtime and improve machine performance, while an optimal layout can smooth workflow and reduce transportation time (Shahin et al., 2020). Previous studies have shown that planned maintenance and efficient layout contribute significantly to productivity in the manufacturing sector (Mutaufiq & Aisyyah, 2021), (Bousdekis et al., 2021). However, there is still a lack of research that examines the simultaneous relationship between these two variables and the production process in packaging companies (Siregar et al., 2024).

PT. Kreasi Kemas Indonesia, as a company engaged in the packaging industry, faces challenges in increasing the efficiency of its production process to meet increasing market demand. Dynamic market conditions and global competition require companies to not only focus on product quality but also pay attention to operational efficiency. The efficiency of the production process is very important in maintaining the stability of product supply and optimizing the use of company resources.

One of the important factors in achieving production efficiency is machine maintenance and the layout of production facilities. Good machine maintenance can

reduce downtime, extend machine life, and ensure smooth production processes. On the other hand, an effective production facility layout can minimize material travel time, reduce waste, and improve workflow. The combination of optimal machine maintenance and layout can have a positive impact on the company's operational efficiency.

However, there are still limitations in research that discusses the simultaneous influence of machine maintenance and production facility layout on the production process, especially in the context of a packaging company such as PT. Kreasi Kemas Indonesia. Therefore, this study is important to examine how these two variables interact and affect the production process as a whole. The results of this study are expected to not only provide academic contributions but also become a practical reference for company management in developing more effective operational strategies.

Based on the problems explained, therefore, this study aims to (1) Analyze the effect of machine maintenance on the production process at PT. Kreasi Kemas Indonesia. (2) Analyze the effect of layout on the production process at PT. Kreasi Kemas Indonesia. (3) Analyze the simultaneous effect of machine maintenance and layout on the production process at PT. Kreasi Kemas Indonesia. This study is expected to contribute to improving operational efficiency at PT. Kreasi Kemas Indonesia and become a reference for further research in the field of operational management. This study is also expected to provide practical recommendations for company management in optimizing machine maintenance and layout design to achieve better production results.

B. Methods

Research Approach and Design

This research method uses a quantitative approach with an associative research design. The quantitative approach was chosen because this study aims to analyze the relationship between variables objectively and measurably. An associative research design is used to explore the relationship between machine maintenance and layout variables to the production process at PT. Kreasi Kemas Indonesia. In this study, there are two independent variables, namely machine maintenance and layout, and one dependent variable, namely the production process. This design allows simultaneous analysis of the influence of both independent variables on the dependent variable, so that it can be seen how much each variable contributes to the production process.

Population and Sample

The population in this study were all employees of PT. Kreasi Kemas Indonesia, totaling 50 people. Because the population is relatively small, this study used a

saturated sampling technique, where all members of the population were used as samples. This technique was chosen to ensure that the data obtained were more representative and accurate, and were able to provide a comprehensive picture of the influence of machine maintenance and layout on the production process.

Data collection technique

The data in this study were collected through a questionnaire specifically designed to measure the variables of machine maintenance, layout, and production process. The questionnaire consisted of several statement items using a five-point Likert scale, namely: Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. Before being distributed to respondents, the questionnaire was tested for validity and reliability to ensure that the instrument used can measure what is intended well. Validity testing was carried out using the Pearson correlation technique, while reliability testing was carried out using the Cronbach's Alpha method.

Data Analysis Techniques

Descriptive Analysis

This analysis is used to describe the characteristics of respondents based on demographic data such as age, gender, education level, and length of service. In addition, descriptive analysis is also used to describe the distribution of respondents' answers to each item in the questionnaire.

Validity and Reliability Test

Validity Test is conducted to ensure that the research instrument actually measures the intended concept. Validity test is conducted by looking at the correlation value between each question item and the total score of its variables. If the correlation value is greater than 0.30, then the item is considered valid. Meanwhile, Reliability Test is conducted to test the internal consistency of the research instrument. Reliability test is conducted using the Cronbach's Alpha method. If the Cronbach's Alpha value is more than 0.60, then the instrument is considered reliable.

Classical Assumption Test

To ensure that the regression model used meets the requirements, several classical assumption tests are carried out, namely: Normality test to ensure that the residual data is normally distributed, using the Kolmogorov-Smirnov test. Multicollinearity test to ensure that there is no strong linear relationship between the independent variables. Heteroscedasticity test to ensure that the residual variance is constant.

C. Results and Discussion

Respondent Characteristics Based on Education

In a research study, understanding respondent characteristics based on education is crucial as it provides insights into the educational background of the participants. Education level can significantly influence perceptions, attitudes, and behaviors, which may affect research outcomes. Table 1 presents the educational characteristics of the respondents, illustrating the distribution of educational attainment within the sample. Analyzing this data helps to contextualize the findings and assess whether the educational composition of the respondents aligns with the study's objectives and target population. Furthermore, it allows for a deeper understanding of how educational background may correlate with other variables under investigation.

Table 1. Respondent Characteristics Based on Education

No	Education	Number of Respondents	Presentation
1	High School/Vocational School	26	52%
2	Diploma	3	6%
3	Bachelor	21	42%
	Total	50	100%

Table 1 above shows that the majority of respondents are high school/vocational high school graduates, which is 26 people or 52% of the total respondents. This result shows that more than half of the respondents have a high school education background, either from general high school (SMA) or vocational high school (SMK). This dominant number may indicate that most of the workforce in the study population comes from high school graduates, who may be more available in sectors or fields of work relevant to this study.

Respondents with a Diploma level of education, which amounted to 3 people or around 6% of the total respondents. This percentage shows that only a small portion of the population has a diploma educational background. Diploma is a level of education that is between secondary education and undergraduate education, which is usually more focused on certain expertise or skills that are applied in the world of work. The low number of diploma graduates in this sample could be caused by several factors, such as the availability of workers with this level of education in the field being studied, or recruitment preferences that are more inclined towards high school or undergraduate graduates.

The last category is Bachelor (S1), with the number of respondents as many as 21 people or around 42% of the total research population. This proportion shows that almost half of the respondents have higher education at the undergraduate level. The presence of a large number of bachelor's graduates in the research population may indicate that the job or position being studied requires higher skills or understanding, thus attracting workers with higher educational qualifications.

Based on the data in table 1, it can be concluded that the majority of respondents have a high school/vocational high school education level, which reflects that the jobs or industries that are the focus of the study are mostly filled by workers with secondary education backgrounds. This can have implications for work patterns, skills needed, and the level of complexity of tasks given to employees. In addition, the presence of 42% of respondents with a bachelor's degree shows that jobs in the study population also involve workers with higher academic backgrounds. This could be because certain positions in the organization require deeper skills and competencies, such as in administration, management, or strategic planning. Conversely, the relatively small number of respondents with a diploma (6%) may indicate that diploma graduates have a more limited role in this population. It could be that diploma graduates are not found in many of the fields of work studied, or it could also be because job requirements tend to recruit high school/vocational high school or bachelor's degree graduates rather than diploma graduates.

Based on the results of the study, it was found that respondents had a high school/vocational high school education level (52%), followed by bachelor's degree graduates (42%), and diploma (6%). This study is in line with several previous studies that examined the characteristics of workforce education in various sectors. Research (ref) on the Manpower in the Manufacturing Sector The results of the study showed that 60% of the workforce in the manufacturing sector were high school/vocational high school graduates, while 30% were diploma graduates, and only 10% had a bachelor's degree. The difference with this study lies in the higher percentage of diploma graduates in the manufacturing sector compared to the current study. This shows that in the manufacturing sector, workers with diploma education are more needed. Research (Haviland & Robbins, 2021) on the Public Sector This study found that the workforce in the public sector mostly consisted of bachelor's degree graduates (55%), with 30% high school/vocational high school graduates, and 15% diploma graduates. Research (Portella & França, 2024) on the Manpower in Private Companies The results of this study showed that 50% of the workforce were high school/vocational high school graduates, 20% diploma graduates, and 30% bachelor's degrees. This comparison shows that high school/vocational high school graduates still dominate, but there is a larger portion of Diploma graduates compared to this study. This could indicate that private companies have a more flexible recruitment policy for Diploma education levels.

Respondent Characteristics Based on Length of Service

Length of service is one of the important aspects in analyzing the characteristics of respondents in a study. Length of service not only reflects the level of experience and skills of a person in carrying it out but is also closely related to the loyalty and commitment of employees to the organization. The longer the length of service, generally the higher the employee's understanding of the work culture, operational procedures, and the vision and mission of the organization. In this study, the

distribution of respondents' length of service was collected into three categories: less than 2 years, 1-2 years, and more than 5 years. This classification aims to see how differences in length of service can affect respondents' perceptions, attitudes, and behaviors towards the variables studied. Length of service analysis also helps identify certain patterns, such as the tendency of job satisfaction levels, productivity, or employee engagement levels based on how long they have worked in the organization. Thus, data on respondents' length of service provides an important contribution in understanding respondents' profiles in more depth and in interpreting research results more accurately.

Table 2. Respondent Characteristics Based on Length of Service

No	Years of service	Number of Respondents	Presentation
1	<2 Years	18	36%
2	1-2 Years	25	50%
3	>5 Years	7	14%
	Total	50	100%

From the table, it can be seen that the majority of respondents are in the 1-2 years of service category (50%), followed by the group with less than 2 years of service (36%), and the group with more than 5 years of service has the smallest number (14%). The <2 Years of Service Group (36%) means that almost one-third of the total respondents have relatively short work experience, which is less than two years. The data shows that a large number in this category indicates an active recruitment process in the organization, perhaps as a result of business expansion or replacement of employees who leave. The 1-2 Years of Service Group (50%) is the largest group with 25 respondents or 50% of the total respondents. So it can be seen that employees in this group have passed the initial adaptation phase and are beginning to understand their work patterns and responsibilities. If the company's policy supports career development and employee welfare, then this group has the opportunity to stay longer in the organization. Employees with 1-2 years of service tend to be in the evaluation stage of their work environment. If the organization provides good incentives, this group can develop into long-term employees.

Based on the distribution of tenure, there are several important things that companies can pay attention to, including: employees with less than 2 years of service need to ensure that there is an effective orientation and training program. This is important to help new employees adapt to the work culture and improve their skills. Consider policies that support career development, such as advanced training, job rotation opportunities, and performance-based incentives to keep them motivated to stay in the long term. The group with more than 5 years of service is relatively small, so it is important for organizations to ensure that senior employees continue to feel valued. This can be done through recognition for their contributions, providing leadership roles, and a good work-life balance.

Respondent Characteristics by Gender

Table 3. Respondent Characteristics by Gender

No	Gender	Number of Respondents	Presentation
1	Man	33	66%
2	Woman	17	34%
Total		50	100%

Table 3 shows that of the total 50 respondents who participated in the study, the majority were male, namely 33 people (66%), while women numbered 17 people (34%). This data provides an overview of gender distribution at PT. Kreasi Kemas Indonesia, which shows the dominance of male workers in the company. In the context of the manufacturing industry, male dominance in the number of workers often occurs because of the nature of the work that requires greater physical strength, machine operation, and work demands that can be heavier than other sectors. Meanwhile, female participation reaching 34% shows that there is female involvement in various aspects of the company's operations, although the number is still lower than men. In general, the manufacturing industry is often filled with more male workers due to historical factors and job demands. Jobs in this sector often involve heavy tasks such as lifting materials, operating heavy machinery, and long work schedules or challenging shifts. Therefore, the male dominance at PT. Kreasi Kemas Indonesia is in line with the general trend in this sector. However, with increasing automation and technological innovation, the role of women in manufacturing is growing. Modern technology allows more women to be involved in technical and managerial roles, not just administrative tasks.

Multiple Linear Regression Analysis

Multiple linear regression analysis to determine the effect of several independent variables on the dependent variable. In this study, the independent variables tested were machine maintenance and layout, while the dependent variable was the production process. Based on the results of the regression analysis presented in Table 4, it was found that layout had a significant effect on the production process, while machine maintenance did not have a significant effect.

Table 4. Regression Coefficient Results

No	Significant variables	Regression Coefficient	
1	Machine Maintenance	0.019	0.738
2	Layout	0.883	0,000

From the table above, it can be seen that machine maintenance has a regression coefficient of 0.019 with a significance value of 0.738, indicating that its influence on the production process is not significant. On the other hand, layout has a regression coefficient of 0.883 with a significance value of 0.000, indicating a significant influence on the production process. From this analysis it can be explained that (1) If

maintenance is not carried out routinely or is only carried out when damage occurs (corrective maintenance), then its impact on production will not be felt directly. (2) If the machine used is still in good condition or uses sophisticated technology, maintenance may not be the main factor affecting production.

Layout has a regression coefficient of 0.883 with a significance value of 0.000, which means that its influence on the production process is very significant. These results are in line with previous research (Muthia et al., 2023) which states that a good layout can increase operational efficiency. Some of the reasons why layout has a significant influence on the production process are (1) A well-designed layout allows for smoother work flow, reduces waiting time, and increases labor productivity (Iyer et al., 2023). (2) With an optimal layout, companies can reduce waste in the form of time, energy, and work space (Zaidi et al., 2022). (3) A good layout can increase worker comfort, reduce the risk of accidents, and increase work efficiency (Aswad, 2024).

This study provides several important suggestions for companies in improving production processes (1) Considering that layout has a very significant influence, companies need to re-evaluate their layout design to improve operational efficiency. (2) Although machine maintenance does not show a significant influence in this study, it does not mean that this aspect can be ignored. Companies may need to improve their maintenance strategy by implementing predictive maintenance or preventive maintenance. (3) In addition to machine layout and maintenance, other factors such as workforce skills, supply chain management, and production technology also need to be considered to improve overall productivity.

Simultaneous Test

This study aims to analyze the simultaneous influence of machine maintenance and layout on the production process. In the industrial world, production efficiency is greatly influenced by various factors, including the condition of the machine used and the layout of the production facility. Therefore, a deeper understanding of how these two variables affect the production process can help industrial managers improve the company's operational performance. The F test was conducted to determine whether machine maintenance and layout together have a significant influence on the production process. The test results show that the calculated F value is 84.82 with a significance level of 0.000. Because the significance value is less than 0.05, the null hypothesis (H_0) is rejected, while the alternative hypothesis (H_1) is accepted. These results indicate that machine maintenance and layout simultaneously have a significant influence on the production process. In other words, improvements in both of these aspects can increase overall production efficiency and effectiveness.

Although both variables have a significant influence, this study found that layout has a more dominant influence compared to machine maintenance. This finding is in line with previous research (Mutaufiq & Aisyyah, 2021) which states that an optimal

layout can increase operational efficiency and reduce waiting time in the production process. A good production layout allows for more efficient materials and labor, reducing obstacles that can slow down production. Conversely, although machine maintenance is important, its effect on production efficiency is not as strong as the influence of layout, especially if the maintenance system was previously in good condition.

Based on the results of this study, there are several suggestions that can be taken to improve the production process in the industry (1) Because layout has a greater influence on production efficiency, companies should focus on redesigning a more efficient layout to improve work flow and reduce waiting time. (2) Although its influence is smaller compared to layout, machine maintenance is still crucial to prevent downtime and damage that can hinder production. (3) Future studies can include other variables such as production technology, workforce skills, or external factors that can affect the results of the study.

D. Conclusion

The results of this study show interesting dynamics between machine maintenance and layout in influencing the production process at PT. Kreasi Kemas Indonesia. Because the analysis of machine maintenance results does not have a significant influence on the production process caused by several factors such as machine maintenance that has been carried out so far is still reactive maintenance rather than predictive maintenance. Maintenance that is only carried out when the machine is damaged will have an impact on high downtime and decreased production efficiency. In addition, the results of the study found that the layout was proven to have a significant influence on the production process, indicating that an optimal facility layout can improve workflow, reduce material transfer time, and maximize production space efficiency. A good layout can also improve work safety and comfort, thus having a positive impact on employee productivity. Meanwhile, the results of simultaneous testing showed that machine maintenance and layout together had a significant influence on the production process. These results indicate that machine maintenance still has an important contribution if integrated with an efficient layout arrangement. In this study, a good layout is able to compensate for deficiencies in machine maintenance. This study provides recommendations for implementing predictive maintenance through highly relevant analytical data to solve problems. Predictive maintenance allows companies to detect potential breakdowns early and plan maintenance in a timely manner, thereby reducing the risk of production disruption. In addition, the gradual placement of old machine parts is also a strategic step to maintain the continuity of the production process. Recommendations for further research can be made so that other companies can provide better generalizations. Comparing results across manufacturing industries will provide new insights into how machine maintenance and layout affect production in different contexts, as well as help identify best practices that can be applied.

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