

Analysis of the Effectiveness of the Romaco Killian KTP 720X Machine Using the Overall Equipment Effectiveness Method at PT XYZ

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The effectiveness of production machinery is one of the key factors determining the success of manufacturing processes, particularly in the pharmaceutical industry, which demands high accuracy and consistent product quality. PT XYZ utilizes the Romaco Killian KTP 720X as one of its main machines in the tablet compression process. However, during the period from January to September, the machine's production output did not meet the company's target. This condition highlights the need for a systematic evaluation of the machine's performance. This study was conducted using the Overall Equipment Effectiveness (OEE) method, a comprehensive indicator used to assess machine effectiveness based on three main components: availability, performance, and quality. Production data were collected through direct observation, company documentation, and interviews, covering loading time, downtime, operation time, actual output, number of defective products, and the machine's ideal cycle time. The results show that the machine's average availability was 68.00%, performance was 29.14%, and the quality rate reached 99.11%. These components generated an OEE value of 19.52%, which is significantly below the international standard of 85% established by the Japanese Institute of Plant Maintenance (JIPM). The low OEE value is primarily attributed to the performance component, which falls far below the required standard, indicating that the machine does not operate at its ideal speed. These findings underscore the need to improve process efficiency, optimize machine speed settings, and evaluate operational procedures to enhance machine performance and ensure the achievement of the company's production targets.

Keywords: Overall Overall Equipment Effectiveness (OEE), Machine Performance, Availability–Performance–Quality.

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1. Introduction

The pharmaceutical industry is one of the strategic sectors that plays an important role in meeting the health needs of the community (Saxena et al., 2022). As part of the national health system, the pharmaceutical industry is required to produce high-quality, safe products that are available on time. To support this achievement, pharmaceutical companies must ensure that the production process runs efficiently and effectively, including at the tablet printing stage, which is one of the forms of preparation with the largest production volume (Abaci et al., 2021; Gioumouxouzis et al., 2019).

PT XYZ is a pharmaceutical company that produces various tablet preparations and is highly dependent on the performance of tablet printing machines to meet production capacity. One of the machines used is the Romaco Killian KTP 720X, a high-speed tablet printing machine that is theoretically capable of producing large quantities of tablets efficiently. The hope is that this machine can help the company achieve its monthly production targets and maintain the stability of the drug supply chain.

However, the reality on the ground shows that the machine's performance has not reached the company's targets. During the period from January to September, the machine was unable to produce the required output and deviated from the expected production capacity. The machine's low performance has the

potential to cause various consequences, such as delays in the distribution of finished products, a backlog of work in the next production process, and the risk of disrupting market demand fulfillment.

Various previous studies have extensively discussed measuring production machine effectiveness using the Overall Equipment Effectiveness (OEE) method in various industrial sectors. Andrianto (2023) applied OEE to a UH-61 machine and found that low OEE values were primarily due to performance factors resulting from unstable machine speeds. Research by Ariyah (2022) on batching plant machines showed that high downtime and non-standard setup times were the main causes of low availability. Yuniawan and Garside (2021) also emphasized that OEE is a key indicator in a lean manufacturing approach to identifying waste on the production line. Meanwhile, Wijaya et al. (2022) found that applying OEE was able to identify the six dominant big losses in industrial printing machines. These research results demonstrate that the OEE method is an effective tool for evaluating machine performance in various manufacturing industry contexts.

Furthermore, Berdotu et al. (2025) applied the OEE method to a digital printing machine and found that despite a relatively high quality rate, performance remained the main limiting factor in machine effectiveness. Juraev (2022) research, which draws on Nakajima's OEE concept, emphasizes that discrepancies between a machine's theoretical capacity and actual operational conditions are often caused by human factors, work methods, and the production environment. However, most previous research has focused on general manufacturing industries, such as metal, printing, and construction, and few have specifically examined high-speed tablet presses in the pharmaceutical industry. Furthermore, some studies have focused solely on OEE calculation results without deeply linking them to the operational context and characteristics of the machines studied. This indicates a limited understanding of the causes of low machine effectiveness in industries demanding high precision such as pharmaceuticals.

Based on this review of previous research, a research gap can be identified: the lack of comprehensive studies analyzing the effectiveness of high-speed tablet presses by integrating actual operational data over a relatively long period of time in the pharmaceutical industry. Furthermore, previous research has not specifically examined the contribution of each OEE component to the failure to achieve production targets on the Romaco Killian KTP 720X machine. Therefore, the novelty of this research lies in the in-depth application of the OEE method to a pharmaceutical tablet press machine with mass production characteristics and very high quality demands. This study not only calculates the OEE value but also identifies the dominant components that cause low machine effectiveness based on actual operational data. Thus, the research results are expected to provide practical contributions to companies in formulating more targeted strategies for improving machine performance and enriching OEE studies in the context of the pharmaceutical industry.

The discrepancy between the theoretical capacity of the machine and its actual performance needs to be analyzed comprehensively using systematic measurement methods. In this case, Overall Equipment Effectiveness (OEE) is one of the most appropriate methods because it can describe machine effectiveness through three main aspects, namely availability, performance (machine speed), and quality (quality of products produced). By analyzing these three aspects, companies can find out which parts most affect machine effectiveness and formulate targeted improvement measures.

2. Methods

This study uses a quantitative approach because all analyses are based on numerical data related to machine operational performance. This approach was chosen so that the results obtained can be measured objectively and provide a realistic picture of the actual condition of the Romaco Killian KTP 720X machine

during the production period. The data collection process was carried out through two main sources, namely primary data and secondary data.

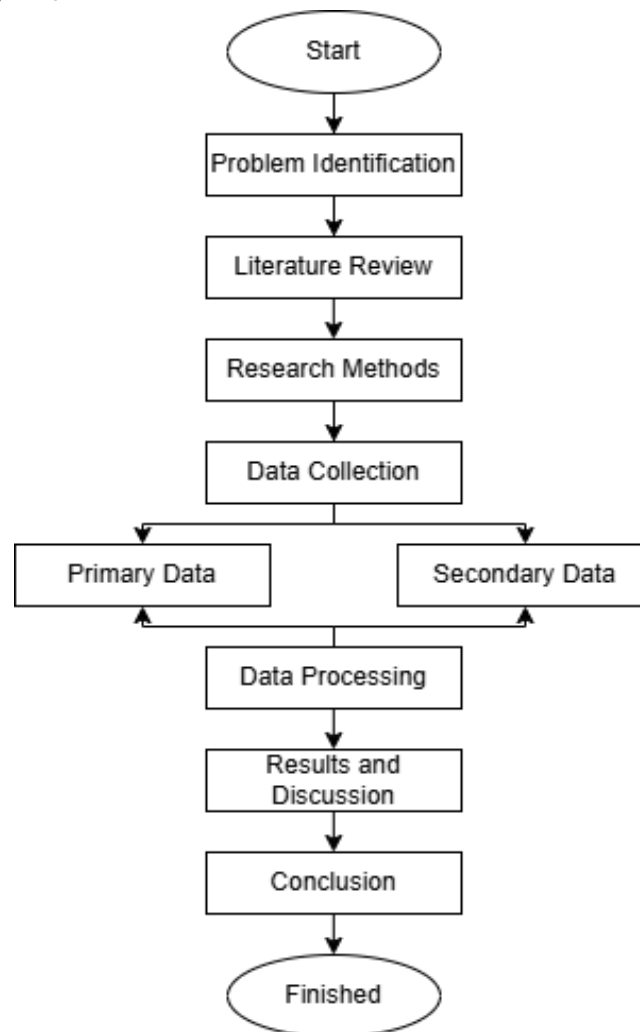


Figure 1. Research Flowchart

Primary data was obtained through direct observation in the production area. Observations were made by observing how the machine operated, the behavior of operators in controlling the machine, setup procedures, and various obstacles that arose during the tablet printing process. Through these observations, the researchers obtained a clear picture of how the machine worked in everyday operational conditions. In addition, interviews were also conducted with machine operators, maintenance technicians, and related personnel to obtain more in-depth information about work habits, machine setup procedures, the use of supporting equipment, and technical obstacles that often occur during machine operation. Secondary data was obtained from internal company documents, such as running time, downtime, planned downtime, operation time, actual output, number of defective products, and ideal cycle time of the machine. This data is an important element in calculating the Overall Equipment Effectiveness (OEE) used in this study.

The OEE method assesses machine effectiveness based on three main components, namely:

1. Availability, which is calculated by comparing actual operating time with planned operating time. This component shows the extent to which the machine is available for use in the production process.
2. Performance, which measures the conformity between actual output and the machine's maximum capacity. Performance shows how fast the machine operates compared to its ideal speed based on the ideal cycle time.

- Quality, which calculates the percentage of products that meet quality standards compared to the total number of products produced.

These three components are calculated separately and then combined to obtain the OEE value, which describes the overall effectiveness of the machine. After all components of availability, performance, and quality were calculated, the study continued by analyzing the OEE value obtained to evaluate the effectiveness of the machine during the observation period. This analysis aims to identify which components contribute most to the decline in OEE value and understand the operational factors that affect machine performance. The final stage of the study is to formulate improvement recommendations based on the analysis results, so that companies can improve machine effectiveness and achieve production targets more optimally and consistently.

3. Results and Discussion

Result

The results of the Romaco Killian KTP 720X machine efficiency calculation using the Overall Equipment Effectiveness (OEE) approach. All data was obtained from PT XYZ's operational documents for the period January to September and processed to assess the machine's effectiveness in the tablet production process. The results presented include availability, performance, quality rate, and OEE values that affect machine effectiveness.

The Romaco Killian KTP 720X machine is the latest modern machine capable of producing an output of 712,500 tablets/hour based on the results of the Factory Acceptance Test. Running time shows the total time spent on the production process at PT XYZ within a month. Each month, the number of days the machine operates varies depending on the production schedule and whether or not there are overtime days.

PT XYZ has several planned downtimes, namely planned morning call, planned minor cleaning, planned room cleaning, planned standard machine setup, ishoma, and major standard cleaning. There are several downtimes that occur at PT XYZ, namely idle waiting for operator, major over standard cleaning, over standard machine setup, and motion. The following is the machine operating data for January to September, which can be seen in Table 1.

Table 1. Machine Operating Data for January-September

No	Month	Number of Days Machine Operates	Working Hours (minutes)	Number of Overtime Days	Overtime Working Hours (minutes)	Running Time (minutes)	Planned Downtime (minutes)	Downtime (minutes)	Loading Time (minutes)	Operation Time (minutes)
1	January	8	480	1	120	3960	1220	1100	2740	1640
2	February	17	480	0	120	8160	2410	2225	5750	3525
3	March	24	480	12	120	12960	3220	3061	9740	6679
4	April	26	480	14	120	14160	3220	1100	10940	9840
5	May	14	480	5	120	7320	3640	300	3680	3380
6	June	19	480	9	120	10200	2160	3765	8040	4275
7	July	13	480	0	120	6240	2430	1265	3810	2545
8	August	22	480	5	120	11160	1630	3320	9530	6210
9	September	11	480	0	120	5280	2620	1750	2660	910

Production output at PT XYZ is measured in tablets, with the total being a combination of several products processed in the same month. The following data on production output at PT XYZ can be seen in Table 2.

Table 2. Production Output Data

No	Month	Production Quantity (tablets)	Reject Start Up + Reject Process (tablets)
1	January	9.359.632	58.250
2	February	13.789.602	128.751
3	March	23.297.600	96.502
4	April	30.052.755	297.357
5	May	15.416.456	243.791
6	June	10.592.612	102.683
7	July	13.536.874	82.303
8	August	19.122.800	75.875
9	September	3.873.003	58.562

1. Availability Calculation

Availability is calculated based on loading time, downtime, and operation time data. The data obtained shows that the machine experienced several disturbances that reduced effective operating time. The following is an example of the Availability calculation for January.

$$Availability = \frac{1640}{2740} \times 100\% = 59,85\%$$

The results of the following month's calculations are presented in Table 3.

Table 3. Availability Calculation Results

No	Month	Operation Time (minutes)	Loading Time (minutes)	Availability
1	January	1640	2740	59,85%
2	February	3525	5750	61,30%
3	March	6679	9740	68,57%
4	April	9840	10940	89,95%
5	May	3380	3680	91,85%
6	June	4275	8040	53,17%
7	July	2545	3810	66,80%
8	August	6210	9530	65,16%
9	September	910	2660	34,21%
Average				65,65%

2. Performance

The calculation of the performance value requires data on total production output in Table 2, operation time data in Table 1, and ideal cycle time data. The machine used has a standard output of 712,500 tablets/hour or 11,875 tablets/minute, so the ideal cycle time value is 0.00008421. The following is an example of the calculation of the Performance value for January.

$$Performance = \frac{9.359.632 \times 0,00008421}{1640} \times 100\% = 48,06\%$$

The results of the calculations for the following months are presented in Table 4.

Table 4. Performance Calculation Results

No	Month	Production Quantity (tablets)	Operation Time (minutes)	Ideal Cycle Time	Performance
1	January	9.359.632	1640	0,00008421	48,06%
2	February	13.789.602	3525	0,00008421	32,94%
3	March	23.297.600	6679	0,00008421	29,37%
4	April	30.052.755	9840	0,00008421	25,72%
5	May	15.416.456	3380	0,00008421	38,41%

No	Month	Production Quantity (tablets)	Operation Time (minutes)	Ideal Cycle Time	Performance
6	June	10.592.612	4275	0,00008421	20,87%
7	July	13.536.874	2545	0,00008421	44,79%
8	August	19.122.800	6210	0,00008421	25,93%
9	September	3.873.003	910	0,00008421	35,84%
Average					33,55%

3. Quality Rate

The calculation of the quality rate requires production quantity and total reject data from

$$QualityRate = \frac{9.359.632 - 58.250}{9.359.632} \times 100\% = 99,38\%$$

The results of the calculations for the following months are presented in Table 5.

Table 5. Quality Rate Calculation Results

No	Month	Production Quantity (tablets)	Total Reject	Quality Rate
1	January	9.359.632	58.250	99,38%
2	February	13.789.602	128.751	99,07%
3	March	23.297.600	96.502	99,59%
4	April	30.052.755	297.357	99,01%
5	May	15.416.456	243.791	98,42%
6	June	10.592.612	102.683	99,03%
7	July	13.536.874	82.303	99,39%
8	August	19.122.800	75.875	99,60%
9	September	3.873.003	58.562	98,49%
Average				99,11%

4. Overall Equipment Effectiveness Value

After obtaining the values for availability, performance, and quality rate, the next step is to calculate the OEE value. The following is an example of the OEE calculation for January.

$$OEE = 59,85\% \times 48,06\% \times 99,38\% = 28,59\%$$

The calculation results for the following month are presented in Table 6 below.

Table 6. OEE Calculation Results

No	Month	Availability	Performance	Quality Rate	OEE
1	January	59,85%	48,06%	99,38%	28,59%
2	February	61,30%	32,94%	99,07%	20,01%
3	March	68,57%	29,37%	99,59%	20,06%
4	April	89,95%	25,72%	99,01%	22,90%
5	May	91,85%	38,41%	98,42%	34,72%
6	June	53,17%	20,87%	99,03%	10,99%
7	July	66,80%	44,79%	99,39%	29,74%
8	August	65,16%	25,93%	99,60%	16,83%
9	September	34,21%	35,84%	98,49%	12,08%
Average					21,77%

Based on Table 6, the Overall Equipment Effectiveness (OEE) value of the Romaco Killian KTP 720X machine during the period from January to September showed quite significant fluctuations with an average value of 21.77%, which is still far below the international standard of 85% set by the Japanese Institute of Plant Maintenance (JIPM). The highest OEE value occurred in May at 34.72%, which was supported by high availability (91.85%) and relatively better performance compared to other months, although the quality rate

was slightly lower than other months but still in the very good category. Conversely, the lowest OEE value occurred in June at 10.99%, which was caused by a combination of low availability (53.17%) and very low performance (20.87%), although the quality rate remained high. In general, the quality rate in all months of observation was above 98%, so it was not a major factor in the decline in the OEE value. The consistently low OEE value is more influenced by suboptimal performance components and fluctuations in availability due to high downtime, thus indicating the need for improvements in machine operating speed and production downtime management.

Discussion

The findings of this study indicate that the effectiveness of the Romaco Killian KTP 720X machine at PT XYZ is still far from optimal, as reflected by the average Overall Equipment Effectiveness (OEE) value of 21.77%. This value is significantly lower than the international benchmark of 85% established by the Japanese Institute of Plant Maintenance (JIPM). Although the quality rate consistently exceeded 98% across all observed months, the availability and performance components showed substantial weaknesses. In particular, the performance component emerged as the most dominant factor contributing to the low OEE value, with an average of only 33.55%. These results suggest that the machine's inefficiency is not related to product quality, but rather to suboptimal utilization of machine speed and operational time.

A closer examination of the availability component reveals that fluctuations in machine availability were influenced by both planned and unplanned downtime. Planned downtime, such as cleaning, setup, and routine activities, is inherent to pharmaceutical manufacturing; however, excessive unplanned downtime, including idle waiting for operators and over-standard setup and cleaning, significantly reduced effective operating time. This condition led to lost production opportunities despite the machine's high theoretical capacity. The results also show that even during months with relatively high availability, such as April and May, the OEE value remained low due to weak performance. This indicates that improving availability alone is insufficient without simultaneously addressing performance losses.

The results of this study are consistent with several previous studies that reported performance as the main contributor to low OEE values. Muthalib et al. (2020) found that machine speed losses were the dominant factor reducing OEE in industrial equipment. Nota et al. (2020) reported that inefficient setup processes and operational delays significantly reduced both availability and performance in batching plant machinery. Moussa & Hartman (2023) emphasized that OEE serves as an effective lean manufacturing indicator to identify productivity losses related to speed and idle time. Fantozzi et al. (2025) demonstrated that performance losses were among the most significant components of Six Big Losses in printing machines. Similarly, Yuan et al. (2021) found that despite high quality rates, machine performance remained the primary limitation in achieving optimal OEE. Sobirov (2025), referring to Nakajima's OEE framework, also highlighted that discrepancies between theoretical capacity and actual output are often caused by operational and managerial factors rather than technical limitations.

Despite its alignment with previous studies, this research also reveals a clear research gap. Most existing OEE studies focus on general manufacturing sectors such as printing, construction, and metal processing, while limited attention has been given to high-speed tablet press machines in the pharmaceutical industry. Pharmaceutical manufacturing has unique characteristics, including strict quality requirements, frequent cleaning, and regulatory compliance, which significantly affect machine utilization. Moreover, many previous studies rely on short observation periods or focus primarily on calculating OEE values without analyzing long-term operational patterns. This study addresses these limitations by using longitudinal data over nine months to capture fluctuations and recurring inefficiencies in machine performance.

The novelty of this research lies in its comprehensive application of the OEE method to a high-speed pharmaceutical tablet press machine using detailed operational data. Unlike previous studies that emphasize OEE calculation alone, this research provides an in-depth analysis of each OEE component to identify the dominant causes of inefficiency. The study demonstrates that even with excellent quality performance, low machine speed and frequent downtime can severely limit overall effectiveness. This finding is particularly relevant to the pharmaceutical industry, where machines often operate below their theoretical capacity due to operational constraints. Therefore, this research extends the application of OEE by highlighting performance optimization as a critical issue in precision-driven industries.

This study contributes both theoretically and practically to the field of industrial engineering and manufacturing management. From a theoretical perspective, it enriches the literature on OEE implementation in the pharmaceutical sector, which remains underrepresented in existing studies. Practically, the results provide valuable insights for PT XYZ and similar companies in identifying performance losses and prioritizing improvement efforts. The findings suggest that management should focus on optimizing machine speed, standardizing setup procedures, and reducing unplanned downtime to improve OEE.

4. Conclusion

Based on the results of research on the Romaco Killian KTP 720X machine, the average Overall Equipment Effectiveness (OEE) value for the period from January to September was 21.77%. In this category, the OEE value obtained is still far from the international benchmark set by the Japanese Institute of Plant Maintenance (JIPM), which is 85%. The value obtained is unacceptable because it causes significant economic losses and lowers the company's competitiveness. Among the values of availability, performance, and quality rate that make up the OEE value on the Romaco Killian KTP 720X machine, the value that most significantly affects the OEE value is the performance value. The average availability value obtained is 65.65%, which means that during the production process, the machine cannot be utilized optimally because there is still a lot of downtime, both planned and unexpected. This condition has an impact on the reduction of effective operating time that should be used to produce products. For performance, the average value obtained is 33.55%. This value indicates that the machine cannot yet operate at a speed that matches its ideal capacity. The low performance value illustrates that the output produced is still far below the machine's maximum capacity according to its technical specifications. The average quality rate value of 99.11% indicates that the machine can produce tablets with a very high level of quality. Defective products only appear in small quantities, so quality is not a significant factor in reducing the machine's effectiveness.

This study still focuses on analyzing machine effectiveness using the Overall Equipment Effectiveness (OEE) approach without conducting an in-depth analysis of the main root causes of low availability and performance values, such as the Six Big Losses analysis or Failure Mode and Effect Analysis (FMEA). Furthermore, the data used is limited to a nine-month period, so it does not fully represent annual operational variations that may be influenced by seasonal factors, changes in market demand, or company production policies. Therefore, further research is recommended to integrate the OEE method with advanced analysis tools, such as Root Cause Analysis (RCA), Total Productive Maintenance (TPM), or a lean manufacturing approach, to identify the causes of downtime and decreased machine speed more comprehensively. Future research can also expand the object of study by comparing several machines or production lines to obtain a comprehensive picture of equipment effectiveness. With this development, the research results are expected to be not only evaluative, but also able to produce more strategic and applicable improvement recommendations for improving the company's production performance.

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