JTBC: Jurnal Teknologi dan Bisnis Cerdas
Volume 2 Nomor 1, Maret 2026
e-ISSN : 3109-8924
DOI: 10.64476/jtbc.v2i1.71

STANDARD TIME ANALYSIS AS A BASIS FOR PRODUCTION CAPACITY PLANNING AND BOTTLENECK IDENTIFICATION IN THE MP24Z PROCESS AT PT X

ANALISIS WAKTU BAKU SEBAGAI DASAR PERENCANAAN KAPASITAS PRODUKSI DAN IDENTIFIKASI BOTTLENECK PADA PROSES MP24Z DI PT X

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ABSTRACT

This study aims to analyze production capacity and identify potential bottlenecks in the MP24Z production process at PT X based on standard time data. The research used a descriptive quantitative approach by utilizing secondary data from previous work measurement using the stopwatch time study method. The data analyzed included cycle time, normal time, and standard time on machine 20, machine 41, and machine 29. Production capacity was calculated by dividing available working time by the standard time of each machine, while bottleneck identification was conducted by comparing standard time and production capacity among machines. The results show that machine 20 has the lowest standard time of 3.58 minutes per unit, resulting in the highest production capacity of 16.76 units per hour or 117.32 units per day. Machine 41 has a standard time of 4.25 minutes per unit with a production capacity of 14.12 units per hour or 98.82 units per day. Meanwhile, machine 29 has the highest standard time of 4.96 minutes per unit, resulting in the lowest production capacity of 12.10 units per hour or 84.68 units per day. Based on these results, machine 29 is identified as the potential bottleneck in the MP24Z production process. The findings indicate that standard time data can be further utilized not only as a work measurement result, but also as a basis for capacity planning, machine performance comparison, and production improvement prioritization.

Keywords: *standard time, production capacity, bottleneck, work measurement, MP24Z.*

ABSTRAK

Penelitian ini bertujuan untuk menganalisis kapasitas produksi dan mengidentifikasi potensi bottleneck pada proses produksi MP24Z di PT X berdasarkan data waktu baku. Penelitian menggunakan pendekatan deskriptif kuantitatif dengan memanfaatkan data sekunder dari hasil pengukuran kerja sebelumnya menggunakan metode stopwatch time study. Data yang dianalisis meliputi waktu siklus, waktu normal, dan waktu baku pada mesin 20, mesin 41, dan mesin 29. Kapasitas produksi dihitung dengan membagi waktu kerja tersedia dengan waktu baku pada masing-masing mesin, sedangkan identifikasi bottleneck dilakukan dengan membandingkan waktu baku dan kapasitas produksi antar mesin. Hasil penelitian menunjukkan bahwa mesin 20 memiliki waktu baku paling rendah sebesar 3,58 menit per unit, sehingga menghasilkan kapasitas produksi tertinggi sebesar 16,76 unit per jam atau 117,32 unit per hari. Mesin 41 memiliki waktu baku sebesar 4,25 menit per unit dengan kapasitas produksi sebesar 14,12 unit per jam atau 98,82 unit per hari. Sementara itu, mesin 29 memiliki waktu baku paling tinggi sebesar 4,96 menit per unit, sehingga menghasilkan kapasitas produksi paling rendah sebesar 12,10 unit per jam atau 84,68 unit per hari. Berdasarkan hasil tersebut, mesin 29 teridentifikasi sebagai mesin yang berpotensi menjadi bottleneck pada proses produksi MP24Z. Temuan ini menunjukkan bahwa data waktu baku tidak hanya dapat digunakan sebagai hasil pengukuran kerja, tetapi juga dapat dikembangkan sebagai dasar perencanaan kapasitas, perbandingan kinerja mesin, dan penentuan prioritas perbaikan produksi.

Kata Kunci: waktu baku, kapasitas produksi, bottleneck, pengukuran kerja, MP24Z.

INTRODUCTION

In the manufacturing industry, production efficiency is one of the key factors that determines a company's ability to meet market demand, maintain product quality, and optimize the use of production resources. Increasingly competitive industrial conditions require companies not only to focus on the quantity of output produced, but also on how time, labor, machines, and work methods can be used effectively. Work measurement is one of the important approaches that can help companies determine standard time, identify process inefficiencies, and improve operational productivity. Hartanti et al. stated that work measurement is an important tool for improving productivity in industrial and business areas, particularly in determining standard time in production processes (Hartanti, 2016).

Standard time plays a strategic role in production systems because it serves as a basis for setting work targets, capacity planning, production scheduling, labor cost control, and productivity evaluation. Lukodono stated that work time measurement using the stopwatch time study method can be used to determine standard time and formulate improvements in work processes within production activities (Lukodono & Ulfa, 2018). Similarly, Manaruzzaki et al. emphasized that work time measurement is highly important in the manufacturing industry because it can help determine production process completion time, optimal workforce requirements, effective work schedules, workload analysis, and production cost reduction (Manaruzzaki et al., 2022).

In the context of production management, cycle time and standard time function not only as measures of work duration, but also as indicators of process capability. Jovanović et al. explained that the manufacturing cycle is related to the duration of production activities required to complete a manufacturing process with optimal capacity utilization (Jovanovic et al., 2014). Therefore, the lower the standard time of a machine or workstation, the greater the potential production capacity that can be generated within a certain period. Conversely, a higher standard time may indicate capacity limitations, workload imbalance, or potential constraints in the production flow.

Production capacity planning is important because it helps companies estimate the amount of output that can be produced based on the available effective working time. Standard time data can be used to calculate production capacity per hour, per shift, or per day. Agustin showed that standard time calculation through direct observation using stopwatch time study can be used as a basis for improving work hour arrangements and increasing production productivity (Agustin & Rusindiyanto, 2024). Meanwhile, Taqwatullah et al. explained that standard time measurement can be used to determine production capacity within a work cycle (Taqwatullah & Nugraha, 2022). Thus, standard time is not only valuable as a technical measurement result, but also as a basis for managerial decision-making in production planning.

In addition to being used to calculate capacity, standard time data can also be utilized to identify potential bottlenecks in a production system. A bottleneck is a point, machine, or workstation that has lower capacity than other parts of the system, thereby limiting the overall production rate. Urban explained that bottleneck identification is an important issue in the manufacturing industry because it can help companies determine priorities for production system improvement (Urban & Rogowska, 2020). Skoogh et al. also emphasized that throughput bottleneck identification is an important initial step before companies take improvement actions to increase throughput (Skoogh et al., 2023).

Recent studies on bottlenecks in manufacturing systems show that bottlenecks can be static, dynamic, or shifting, depending on production conditions, machine availability, process time variation, and changes in workload. Tang et al. classified bottleneck identification methods into several approaches, including static model-based approaches, simulation-based approaches, and data-driven approaches (Tang et al., 2024). In research based on standard time data, initial bottleneck identification can be conducted by comparing process time or standard time among machines. A machine with the highest standard time has the potential to become a capacity-limiting point because it requires a longer time to complete one unit of product.

Unidentified bottlenecks can cause various operational impacts, such as increased waiting time, accumulation of work-in-process, imbalance in production flow, and failure to achieve output targets. Studies on delays and bottlenecks in manufacturing show that process analysis can be used to identify the causes of delays and capacity constraints in production systems (Turgay et al., 2025). Therefore, standard time-based capacity analysis is important so that companies can identify which machine has the lowest production capability and should be prioritized for process improvement.

PT X is a manufacturing company engaged in the automotive and electronics sectors, with one of its production activities involving the MP24Z process. Previous work measurement on the MP24Z process was conducted on machine 20, machine 29, and machine 41 using the stopwatch time study method. The study calculated cycle time, normal time, and standard time for each machine. The results showed that machine 20 had a standard time of 3.58 minutes, machine 41 had a standard time of 4.25 minutes, and machine 29 had a standard time of 4.96 minutes. These results indicate that each machine has different process capabilities, with machine 29 having the highest standard time among the three observed machines.

Although the previous study successfully determined the standard time for each machine, further analysis is still needed to examine how the standard time affects production capacity and potential bottlenecks in the MP24Z process. Standard time data can be developed into production capacity analysis by calculating the estimated number of units that can be produced within a certain working period. In addition, comparison of standard time among machines can be used as an initial basis for identifying the machine with the lowest capacity. Studies on manufacturing productivity also show that time study and work measurement can help companies standardize operations, identify inefficiencies, and improve overall productivity (Ramadhan et al., 2024).

Based on the above discussion, this study aims to analyze the production capacity of the MP24Z process based on the standard time of machine 20, machine 29, and machine 41. In addition, this study aims to identify the machine that has the potential to become a bottleneck and to provide recommendations for production planning and work process improvement. The contribution of this study lies in the utilization of standard time data not only as a work measurement result, but also as a practical basis for capacity planning, machine performance comparison, and production constraint identification in a manufacturing environment.

METHODS

This study used a descriptive quantitative approach. This approach was applied because the study aimed to analyze numerical data, including standard time, production capacity, and the comparison of production capabilities among machines. A quantitative approach is appropriate for systematically processing numerical data in order to draw conclusions based on calculation results (Ghanad, 2023).

The object of this study was the MP24Z production process on machine 20, machine 29, and machine 41 at PT X. The data used in this study were secondary data obtained from previous work time measurements using the stopwatch time study method. The data included cycle time, normal time, and standard time for each machine. The use of secondary data allows researchers to utilize available data to answer new research objectives, as long as the data are relevant to the problem being studied (Wickham, 2019).

The main data used in this study were the standard times of each machine. Based on previous measurement results, the standard time of machine 20 was 3.58 minutes, machine 41 was 4.25 minutes, and machine 29 was 4.96 minutes. These data were used as the basis for calculating production capacity and identifying potential bottlenecks in the MP24Z process.

Data analysis was carried out in three stages. First, the standard time data for each machine were compiled. Second, production capacity was calculated based on the standard time. Third, the production capacity of each machine was compared to identify the machine with the lowest capacity as a potential bottleneck. Standard time was used because it can serve as a basis for determining production targets, work scheduling, and productivity evaluation in manufacturing systems (Lukodono & Ulfa, 2018; Manaruzzaki et al., 2022).

Production capacity per hour was calculated using the following formula:

$$PC_h = \frac{60}{ST}$$

Where:

PC_h = *Production Capacity per Hour*
ST = *Standard Time per Unit*

Meanwhile, production capacity per day was calculated using the following formula:

$$PC_d = \frac{EWT}{ST}$$

Where:

PC_d = *Production Capacity per Day*
EWT = *Effective Working Time per Day*
ST = *Standard Time per Unit*

In this study, the effective working time was assumed to be 420 minutes per day. This assumption was used because the company's actual effective working time was not explicitly available in the previous data. Therefore, the daily production capacity results can be adjusted if the company applies a different effective working time.

Bottleneck identification was conducted by comparing the standard time and production capacity among machines. The machine with the highest standard time and the lowest production capacity was categorized as the machine with the potential to become a bottleneck. This approach is in line with the concept that a bottleneck is a resource or process with limited capacity that can restrict the overall output of a production system (Skoogh et al., 2023; Urban & Rogowska, 2020).

The research analysis flow was designed to show the stages of data processing, starting from standard time data to the formulation of improvement recommendations. These stages included the use of standard time data, production capacity calculation, capacity comparison among machines, bottleneck identification, and the development of improvement recommendations. In summary, the research analysis flow is presented in Figure 1.

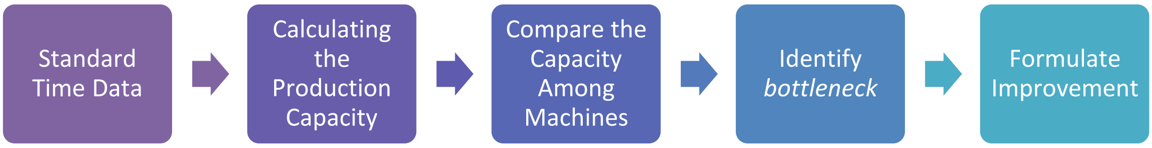

Figure 1. Research Analysis Flow

Figure 1 shows the analysis flow used in this study. The analysis process began with the use of standard time data obtained from previous measurement results. The standard time data were then used as the basis for calculating the production capacity of each machine. After the production capacity was obtained, the next stage was to compare the capacity among machines to determine differences in production capability among machine 20, machine 29, and machine 41. The comparison results were then used to identify the machine with the potential to become a bottleneck, namely the machine with the lowest production capacity or the highest standard time. The final stage of the analysis flow was to formulate improvement recommendations aimed at increasing production capacity, balancing workload, and reducing constraints in the MP24Z production process.

RESULTS AND DISCUSSION

Standard Time Data of the MP24Z Process

The main data used in this study were the calculation results of cycle time, normal time, and standard time in the MP24Z production process on machine 20, machine 41, and machine 29. The data were obtained from previous work time measurements using the stopwatch time study method. The use of standard time in production analysis is important because standard time can serve as a basis for determining capacity, production targets, and work productivity evaluation. This is in line with Hartanti et al., who explained that determining standard time is necessary to establish an appropriate workload at workstations and improve productivity (Hartanti, 2016).

Table 1. Cycle Time, Normal Time, and Standard Time Data of the MP24Z Process

No	Machine	Cycle Time (minutes)	Normal Time (minutes)	Standard Time (minutes)
1	Machine 20	2.16	2.31	3.58
2	Machine 41	2.20	2.53	4.25
3	Machine 29	2.40	2.95	4.96

Based on Table 1, machine 20 has the lowest standard time, namely 3.58 minutes per unit. Machine 41 has a standard time of 4.25 minutes per unit, while machine 29 has the highest standard time, namely 4.96 minutes per unit. This difference in standard time indicates that each machine has different production capabilities. Machines with lower standard time have the potential to produce more output within the same working period, while machines with higher standard time tend to have lower production capacity.

Production Capacity per Hour

Production capacity per hour was calculated by dividing the available time in one hour, namely 60 minutes, by the standard time of each machine. Capacity calculation based on standard time is relevant because time study and work measurement are used to determine standard time that can support work planning, productivity measurement, and production process control (International Labour Office, 1992).

$$PC_h = \frac{60}{ST}$$

Table 2. Production Capacity per Hour Based on Standard Time

No	Machine	Standard Time (minutes/unit)	Production Capacity per Hour (units/hour)
1	Machine 20	3.58	16.76
2	Machine 41	4.25	14.12
3	Machine 29	4.96	12.10

Based on Table 2, machine 20 has the highest production capacity, namely 16.76 units per hour. Machine 41 is able to produce 14.12 units per hour, while machine 29 is only able to produce 12.10 units per hour. These results indicate that machine 29 has the lowest production capability compared with the other two machines.

Production Capacity per Day

Production capacity per day was calculated using the assumption of an effective working time of 420 minutes per day, or equivalent to 7 effective working hours. This assumption was used because the company's actual effective working time was not explicitly available in the previous data.

$$PC_d = \frac{EWT}{ST}$$

Table 3. Production Capacity per Day Based on Standard Time

No	Machine	Standard Time (minutes/unit)	Production Capacity per Day (units/day)
1	Machine 20	3.58	117.32
2	Machine 41	4.25	98.82
3	Machine 29	4.96	84.68

Based on Table 3, machine 20 has the highest estimated production capacity, namely 117.32 units per day. Machine 41 has a capacity of 98.82 units per day, while machine 29 has the lowest capacity, namely 84.68 units per day. These results show that differences in standard time among machines directly affect differences in daily production capacity. With the same working time, a machine with a lower standard time will produce a higher capacity.

Capacity Comparison Among Machines

The comparison of capacity among machines was conducted to determine the difference in production capability in the MP24Z process. This comparison is important because capacity imbalance among machines can lead to waiting time, work accumulation, and potential process constraints. In a production system, a bottleneck may occur when a resource has lower capacity than required by the production flow (Tang et al., 2024).

Table 4. Production Capacity Differences Among Machines

Machine Comparison	Capacity Difference per Hour (units/hour)	Capacity Difference per Day (units/day)
Machine 20 - Machine 41	2.64	18.50
Machine 20 - Machine 29	4.66	32.64
Machine 41 - Machine 29	2.02	14.14

Based on Table 4, the largest capacity difference occurs between machine 20 and machine 29. Machine 20 is able to produce 4.66 more units per hour than machine 29. In one effective working day, this difference reaches 32.64 units per day. This difference indicates that machine 29 has much lower production capability than machine 20.

Bottleneck Identification in the MP24Z Process

Bottleneck identification was carried out based on two main indicators, namely the highest standard time and the lowest production capacity. Based on the analysis results, machine 29 has the highest standard time, namely 4.96 minutes per unit, and the lowest production capacity, namely 12.10 units per hour or 84.68 units per day.

A bottleneck is a resource or process that limits production flow and reduces system throughput. Urban stated that bottleneck identification is important because it can help companies determine improvement priorities in the production system (Lukodono & Ulfa, 2018; Tang et al., 2024). In addition, studies on bottlenecks in manufacturing show that bottlenecks can be influenced by machine limitations, workload imbalance, process time variation, or other operational conditions (Ongbali et al., 2021).

Table 5. Identification of Potential Bottlenecks Based on Standard Time and Production Capacity

Machine	Standard Time (minutes/unit)	Capacity per Day (units/day)	Description
Machine 20	3.58	117.32	Highest capacity
Machine 41	4.25	98.82	Moderate capacity
Machine 29	4.96	84.68	Potential bottleneck

Based on Table 5, machine 29 can be identified as the machine with the greatest potential to become a bottleneck in the MP24Z production process. This is because machine 29 requires a longer time to complete one unit of product compared with machine 20 and machine 41. If the production process depends on output continuity among machines, the lower capacity of machine 29 may restrict the overall production rate.

Discussion

The results of this study indicate that standard time has a direct relationship with production capacity. Machines with lower standard time generate higher production capacity, while machines with higher standard time generate lower production capacity. This finding reinforces the function of standard time as a basis for capacity planning, production target setting, and productivity evaluation. Lukodono showed that standard time calculation results can be used as a basis for improving production process performance, including work arrangement and productivity improvement (Lukodono & Ulfa, 2018).

In the MP24Z process, machine 20 has the highest capacity, while machine 29 has the lowest capacity. This capacity difference indicates an imbalance in production capability among machines. Machine 29 requires special attention because it has the highest standard time and the lowest production capacity. In the context of production management, this condition may hinder the smooth flow of production if the output from machine 29 is unable to meet the overall production requirements.

This finding is consistent with the concept of bottlenecks in manufacturing systems, in which system capacity can be limited by the resource with the lowest capacity. Tang et al. explained that bottleneck identification can be carried out through static model-based, simulation-based, or data-driven approaches, depending on the characteristics of the production system and the available data. In this study, bottleneck identification was conducted in a simple manner by comparing standard time and production capacity among machines (Tang et al., 2024).

From a practical perspective, the results of this study show that standard time data are not only useful as the final result of work measurement, but can also be developed as a basis for production capacity analysis. By knowing the capacity of each machine, the company can set more realistic production targets, balance workloads, and determine improvement priorities for machines with the lowest capacity. This is in line with the principle of work measurement, namely that work time measurement can be used to establish work standards, identify areas for improvement, and increase productivity (Hartanti, 2016).

However, because this study uses secondary data, the specific causes of the high standard time on machine 29 cannot be directly confirmed. Therefore, the bottleneck identification results in this study are indicative, based on capacity comparison. Further research can be conducted through direct observation of work elements on machine 29, motion analysis, evaluation of machine condition, and observation of material flow to determine the main factors causing the low capacity of the machine.

Improvement Recommendations

Based on the analysis results, improvement recommendations are focused on machine 29 because this machine has the highest standard time and the lowest production capacity. The first recommendation is to evaluate the work method on machine 29. This evaluation is important to determine whether there are non-value-added activities, inefficient movements, or waiting time that cause the standard time to become higher. Work study is basically used not only to measure work time, but also to improve work methods so that the process becomes more efficient (International Labour Office, 1992).

The second recommendation is to review the technical condition and operational readiness of machine 29. The high standard time may be influenced by machine condition, disturbance frequency, or process instability. Lukodono, in his study, also recommended improvements in the form of reviewing machine maintenance schedules and providing supporting tools to improve process performance. Therefore, preventive maintenance and machine readiness checks need to be conducted regularly so that process time can be controlled (Lukodono & Ulfa, 2018).

The third recommendation is to rearrange the position of materials and supporting tools around machine 29. A better workplace arrangement can reduce the time required for material retrieval, material movement, and unnecessary operator movements. In the context of work measurement, a high standard time may indicate the need to evaluate work methods and workplace layout (Hartanti, 2016).

The fourth recommendation is to adjust production targets to the actual capacity of the machine. Since machine 29 has the lowest capacity, daily production targets need to consider the capability of this machine to prevent work accumulation or output delays. If the production target exceeds the capacity of machine 29, the company needs to consider adding working time, redistributing the production load, or improving the process on the machine.

The fifth recommendation is to conduct further measurements on the work elements of machine 29. Further measurement is needed to determine which part of the work contributes the most to process time. Bottleneck studies state that the identification of production constraints should be followed by cause analysis so that improvement actions can be directed appropriately (Ongbali et al., 2021; Tang et al., 2024). Thus, improvement recommendations should not only be based on capacity comparison results, but also on more detailed operational causes.

CONCLUSION

Based on the analysis of production capacity using standard time data in the MP24Z process at PT X, it can be concluded that each machine has different production capabilities.

Machine 20 has the lowest standard time, namely 3.58 minutes per unit, resulting in the highest production capacity of 16.76 units per hour or 117.32 units per day. Machine 41 has a standard time of 4.25 minutes per unit, with a production capacity of 14.12 units per hour or 98.82 units per day. Meanwhile, machine 29 has the highest standard time, namely 4.96 minutes per unit, resulting in the lowest production capacity of 12.10 units per hour or 84.68 units per day.

The capacity comparison results show that machine 29 has a considerable capacity gap compared with machine 20 and machine 41. Machine 20 is able to produce 32.64 more units per day than machine 29, while machine 41 is able to produce 14.14 more units per day than machine 29. This difference indicates a capacity imbalance among the machines in the MP24Z process.

Based on the indicators of the highest standard time and the lowest production capacity, machine 29 was identified as the machine with the greatest potential to become a bottleneck in the MP24Z production process. This condition indicates that machine 29 should be prioritized in process improvement efforts, as its lower capacity may restrict the smooth flow of overall production output.

Improvement recommendations are directed toward evaluating work methods, examining the technical condition of the machine, rearranging the position of materials and supporting tools, and conducting further measurements of work elements on machine 29. The company also needs to consider the actual capacity of each machine when setting production targets so that production planning becomes more realistic and balanced.

Overall, this study shows that standard time data can be used not only to establish work time standards, but also to serve as a basis for production capacity analysis and bottleneck identification. Therefore, the findings of this study can be used as a reference for the company in improving the effectiveness of production planning and determining improvement priorities in the MP24Z process.

ACKNOWLEDGMENT

The authors would like to express their gratitude to all parties who supported the implementation of this research.

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