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Quality

Analysis of Value-Added Activities and Non-Value-Added Activities in the Production Process of Car Body Stands Using the Manufacturing Cycle Effectiveness (MCE) Method

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A B S T R A C T

PT. XXX is a manufacturing fabrication company whose production process still involves non-value-added activities, resulting in a mismatch between planned and actual timelines, including a three-day delay in the production of the Car Body Stand. This study aims to identify value-added and non-value-added activities, calculate cycle time, and analyze Manufacturing Cycle Effectiveness (MCE) by comparing predicted and actual timelines, as well as to propose improvements to enhance production performance. The findings show that total value-added activities reach 480.5 hours, while non-value-added activities account for 41 hours. The predicted cycle time is 467 hours, whereas the actual cycle time extends to 551.5 hours. The MCE is 88.9% under predicted conditions and 85.8% in actual conditions. After implementing the proposed improvements, non-value-added activities decrease to 27 hours, and the cycle time improves to 523.5 hours, leading to an increased MCE of 90.4%. Overall, these results suggest that reducing non-value-added activities can effectively improve production efficiency and reduce delays.

1. INTRODUCTION

Productivity efficiency is the most effective way to evaluate a company's ability to provide production standards that can be improved. Productivity requires value-added activities to transform resources into goods and services. If the generated non-value-added activities are minimal, the production process becomes more efficient. During the execution of production, if a significant amount of non-value-added activities is generated, it will lead to delays, a decrease in work quality, and an increase in operational costs. Delays in project completion can be detrimental in terms of both time and cost. Production costs and the time utilized must be as efficient as possible in any activity so that costs can be minimized from the original plan.

According to Maulina (2024), Value Added Activities are activities required to carry out business operations, thereby providing value and increasing company profits. Meanwhile, according to Nurdiansyah (2022), Non-Value Added Activities are unnecessary activities that should be eliminated or reduced within business processes because they hinder company performance.

PT. XXX is a company engaged in manufacturing fabrication, producing tanks, enclosures (generator set housings), and other products. In its production process, the company still uses equipment and machinery that are not yet modern, causing several production activities to require a considerable amount of time. Therefore, the production process still contains non-value-added activities that contribute to time inefficiency, particularly in the Car Body Stand manufacturing process, where production optimization has not yet been fully achieved due to non-value-added activities consuming a significant amount of time. Consequently, these activities need to be minimized to improve production efficiency. This condition occurs because several worker activities have not been operating optimally, such as the sandblasting process which is still performed manually, painting using a simple spray method, as well as packing, transportation, and inspection processes that require relatively long processing times, thereby affecting delivery schedules. Previous studies have also shown that activities such as waiting time, transportation, and manual processes are forms of waste that can increase cycle time and reduce production effectiveness (Bashori, 2023).

Table 1. Car Body Stand Project Activity Schedule

Stage	Duration (hours)
Preparation & Planning	17
Production Process	459,5
Completion	45
Total	521,5

(Source: Observation Results, 2020)

Based on Table 1, the total time required to complete the Car Body Stand product, from the preparation and planning stage until the product is delivered to the customer, is 521.5 hours. To identify worker activities that cause changes in activity duration and delivery schedules, an activity analysis is required to determine which worker activities contain non-value-added activities, thereby reducing the effectiveness of the production process.

The production process that generates value changes in the Car Body Stand includes both value-added activities and non-value-added activities occurring during the preparation and planning stage, production process, and finishing stage. By conducting an activity analysis on the Car Body Stand manufacturing process, it is expected that production effectiveness can be determined based on the activities performed by comparing processing time with cycle time, resulting in a measurement of effectiveness through Manufacturing Cycle Effectiveness (MCE).

Therefore, the analysis of value-added activities and non-value-added activities in production activities can improve production effectiveness and eliminate or reduce activities that do not provide added value. As a result, the productivity achieved in the manufacturing of other products can also increase.

Table 2. Observation Data of the Car Body Stand Project Timeline

Stage	Description	Duration (Days)		Remarks
		Estimated	Actual	
Preparation & Planning	Material	3	3	-
Process	Frame	42	41	*Marking* *Cutting* *Drilling* *Fit-Up Assembly* *Welding* *Finishing*
	Painting	18	14	*Painting primer* *Painting intermediet* *Painting finishing*
Waiting		2	6	Waiting for paint to dry
Delivery		4	5	Delivery to MRT Depot
Inspection		3	4	QC Department
Storage		3	5	-
Total		75	78	

(Source: Secondary Data, 2020)

Based on the Table 2, it can be seen that there are differences between the initial planned timeline and the actual production process timeline. The difference lies in the total manufacturing time of the Car Body Stand, where the initial estimated timeline was 75 days, while the actual timeline reached 78 days. Therefore, there was a delay of 3 days in the Car Body Stand manufacturing process, with the resulting Manufacturing Cycle Effectiveness (MCE) values being 89.9% for the estimated timeline and 85.7% for the actual timeline.

Among the six stages of the production process, the stage with the most significant time difference was the storage stage, which differed by 2 days between the estimated and actual timelines. This difference occurred because the raw materials required for painting experienced procurement constraints, resulting in delayed delivery of the materials. Consequently, the production process encountered implementation obstacles, causing several units to be stored temporarily before processing could continue once the painting materials arrived.

Therefore, improvements in production process activities are necessary to ensure operations can proceed according to the just-in-time schedule established in the initial planning. To determine the effectiveness of the Car Body Stand manufacturing process, it is necessary to develop a proposed process improvement based on the production activities of the Car Body Stand in order to compare production effectiveness using the Manufacturing Cycle Effectiveness (MCE) method.

2. STUDY LITERATUR

2.1 Production Planning

Production planning is the process of managing resources, processes, and outputs to ensure they operate effectively and efficiently (Farhan Akmala Putra, 2025). Planning serves as a guide for activities, a control tool for deviations, a means to identify obstacles, and a mechanism to prevent uncontrolled growth (Hantono, 2025).

2.2 Productivity

Productivity is the ratio between output produced and input used (Ningsih, 2024). Factors affecting productivity include technical, production, organizational, personnel, financial, management, governmental, and location factors. Productivity increases when non-value-added activities can be reduced through MCE analysis.

2.3 Efficiency

Efficiency is the best comparison between input and output. Efficiency is closely related to productivity and reflects an organization's ability to optimize the use of resources (Putri, 2025).

2.4 Effectiveness

Effectiveness is the level of success in achieving organizational goals. Effectiveness focuses on output and target achievement rather than the use of input (Pangestu, 2024).

2.5 Value Added Activities

Value-added activities are activities that provide added value to a product in the eyes of customers. These activities improve product quality and customer satisfaction and should be maintained.

2.6 Non Value Added Activities

Non-value-added activities are activities that do not provide added value and need to be reduced or eliminated because they cause waste (Maulina, 2024).

2.7 Activity analysis

Activity analysis is used to identify and classify activities into value-added and non-value-added categories.

Cycle time components include:

a. Processing time (value-added time)
b. Inspection time
c. Moving time
d. Waiting time
e. Storage time

2.8 Manufacturing Cycle Effectiveness (MCE)

Manufacturing Cycle Effectiveness (MCE) is a measure of production process effectiveness based on the proportion of value-added activities (Rosikin, 2024).

Cycle Time = processing time + inspection time + waiting time + storage time + delivery time……………..... Pers. 1

Manufacturing Cycle Effectiveness =(Processing Time / Cycle Time) x 100% ………………………..Pers.2 (Sudiantoro, 2025)

3. METODELOGI PENELITIAN

This study uses a quantitative approach with a case study method on the Car Body Stand production process at PT. XXX. The focus of the research is to analyze production activities to identify value-added and non-value-added activities, as well as to measure production process effectiveness using the Manufacturing Cycle Effectiveness (MCE) method.

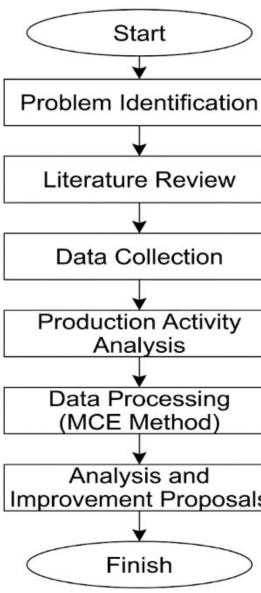

Figure 1. *Flowchart*

4. RESULTS AND DISCUSSION

4.1. Result

4.1.1. Production Activities

The data collected indicates the presence of non-value-added activities in the Car Body Stand manufacturing process at PT. Sentra Mekanindo TM, which caused changes in the production timeline and delays in delivery schedules.

Table 3. Production Activity Schedule

Stage	No.	Activity	Duration (hours)
Preparation & Planning	1	Product design	4
	2	Raw material requirement planning	7
	3	Ordering raw materials	6
Production Process	4	Steel plate raw material inspection	14
	5	Steel plate marking	42
	6	Steel plate cutting	56
	7	Steel plate drilling	35
	8	Sandblasting	4.5
	9	Fit-Up assembly	56
	10	Welding	56
	11	Finishing (sanding)	42
	12	Primer painting	129.5
	13	Intermediate painting	10.5
	14	Finish painting	14
Completion	15	Inspection	14
	16	Labeling	7.0
	17	Packing	21
	18	Shipping	3
Total			521.5

(Source: Observation Results, 2020)

Based on Table 3, the production activity schedule shows that the Car Body Stand manufacturing process consists of several stages. The first stage is the planning stage, which includes three activities: product design, raw material requirement planning, and raw material ordering. The next stage is the production process stage, which consists of 11 activities, namely raw material inspection (steel plate inspection), marking of steel plates, cutting, drilling, sandblasting, fit-up assembly, welding, sanding, and painting, which includes primer, intermediate, and finishing processes. From the overall production process, the activities are classified into two categories, namely value-added activities and non-value-added activities.

4.1.2. Data Processing

Based on research conducted on the Car Body Stand manufacturing process at PT. Sentra Mekanindo TM, the factory normally operates for 7 hours per day from Monday to Friday and 4 hours on Saturdays. When there is a high volume of orders, workers may perform overtime for up to 3 hours. The total number of units produced is 14 units. The following are the details of the Car Body Stand production activities:

1. Car Body Stand Production Activities
   a. Value-Added Activities (VAA)
   This series of activities is necessary for producing the product; therefore, it is categorized as value-added activities.

Table 4. Value Add Activity

No.	Activity	Duration (hours)
1	Product design	4
2	Steel plate marking	42
3	Steel plate cutting	56
4	Steel plate drilling	35
5	Sandblasting	4.5
6	Fit-Up assembly	56
7	Welding	56
8	Finishing (sanding)	42
9	Primer painting	129.5
10	Intermediate painting	10.5
11	Finish painting	14
12	Labeling	7.0
13	Packing	21
	Total	477.5

(Source: Observation Results, 2020)

   b. Non Value Added Activities (NVAA)
   Non-value-added activities do not directly affect changes in the resulting product, either in terms of quantity or quality, that provide benefits to customers. These activities need to be reduced in order to achieve production process efficiency.

Table 5. Non Value Add Activity

No	Activity	Duration (hours)
1	Material Requirement Planning	7
2	Raw Material Ordering	6
3	Steel Plate Raw Material Inspection	14
4	Inspection	14
5	Delivery	3
	Total	44

(Source: Observation Results, 2020)

Based on Tables 4 and 5, which present value-added activities and non-value-added activities derived from the production activity schedule in Table 2, it can be seen that the longest duration in Table 5 occurs in the raw material inspection and finishing inspection activities, each taking 14 hours. This occurs because there is only one quality control worker responsible for conducting the inspection process, resulting in a lengthy inspection time.

2. Cycle Time Calculation
Based on the data above, the cycle time calculation obtained is as follows::
A. Predicted timeline cycle time
Processing time = (42 days + 18 days) × 7 hours/day
= 420 hours
Inspection time = 3 days × 7 hours/day = 21 hours
Waiting time = 2 hours
Storage time = 3 days × 7 hours/day = 21 hours
Delivery time = 3 hours

Cycle Time = Processing time + Inspection time + Waiting time + Storage time + Delivery time
= 420 + 21 + 2 + 21 + 3
= 467 hours.

Based on the cycle time calculation in the predicted timeline, the total time obtained is 467 hours, consisting of 420 hours of processing time, 21 hours of inspection time, 2 hours of waiting time, 21 hours of storage time, and 3 hours of delivery time..

B. Cycle time timeline actual
a. Processing time

Table 6. Processing time

No.	Activity	Duration (hours)
1	Steel plate marking	42
2	Steel plate cutting	56
3	Steel plate drilling	35
4	Sandblasting	4.5
5	Fit-Up assembly	56
6	Welding	56
7	Finishing (sanding)	42
8	Primer painting	129.5
9	Intermediate painting	10.5
10	Finish painting	14
11	Labeling	7.0
12	Packing	21
	Total	473.5

(Source: Processed data, 2020)

b. Inspection time

Table 7. Inspection time

No.	Activity	Duration (hours)
1	Steel plate raw material inspection	14
2	Inspection	14
	Total	28

(Source: Processed data, 2020)

c. waiting time = 6 days x 2 hours = 12 hours.
d. storage time = 5 days x 7 hours/days = 35 hours.
e. Delivery = 3 hours.

Cycle Time = processing time + inspection time + waiting time + storage time + delivery time
= 473.5 + 28 + 12 + 35 + 3 = 551.5 hours

3. Calculation of Manufacturing Cycle Effectiveness (MCE)

Based on the cycle time calculation, the Manufacturing Cycle Effectiveness (MCE) result is obtained as follows:

A. Manufacturing Cycle Effectiveness in the predicted timeline
Manufacturing Cycle Effectiveness = (processing time / cycle time) × 100%
Manufacturing Cycle Effectiveness = (420 / 467) × 100% = 0.899 = 89.9%

B. Manufacturing Cycle Effectiveness in the actual timeline
Manufacturing Cycle Effectiveness = ($processing\ time$ / $cycle\ time$) x 100%

Manufacturing Cycle Effectiveness = (473,5 / 551,5) x 100% = 0,8585 = 85,9 %.

Based on the MCE calculation, it can be observed that the production activities in the Car Body Stand manufacturing process resulted in an MCE value of 89.9% in the predicted timeline, while the actual timeline produced an MCE value of 85.8%. Since the MCE percentage in the actual timeline is lower than that in the predicted timeline, improvement proposals are necessary for several activities to ensure that the production process can run optimally and more efficiently, thereby achieving a higher MCE percentage than both the actual and predicted timelines.

4. Proposed Engineering Improvements for Production Activities

A. Production Activities

To improve the efficiency of production activities, waste (time inefficiency) can be reduced in the raw material inspection and finishing inspection activities. Reducing inspection time will directly affect the final cycle time and the percentage value of MCE. Meanwhile, for non-value-added activities such as planning and ordering, reducing the time will not impact the production process, as these activities are outside the main production flow. For the delivery activity, it represents the ideal delivery time of products from PT. Sentra Mekanindo TM to the MRT depot in the Lebak Bulus area. As shown in Table 9, the proposed improvement engineering is presented as follows:

Table 8. Proposed Engineering for Production Activity Improvements

Value Add Activity		
No.	**Activity**	**Duration (hours)**
1	Product design	4
2	Steel plate marking	42
3	Steel plate cutting	56
4	Steel plate drilling	35
5	Sandblasting	4.5
6	Fit-Up assembly	56
7	Welding	56
8	Finishing (sanding)	42
9	Primer painting	129.5
10	Intermediate painting	10.5
11	Finish painting	14
12	Labeling	7.0
13	Packing	21
	Total	**477.5**
Non Value Add Activity		
No.	**Activity**	**Duration (hours)**
1	Raw material requirement planning	7
2	Ordering raw materials	6
3	Steel plate raw material inspection	7
4	Inspection	7
14	Shipping	3
	Total	**30**

(Source: Proposed Improvement Results, 2020)

The proposed improvement engineering is carried out by reducing time in non-value-added activities, namely raw material inspection and finishing inspection. The inspection time, which was initially 1 hour per unit (a total of 14 hours for 14 units), is reduced to 30 minutes per unit (a total of 7 hours). This reduction is implemented because raw material inspection can be sufficiently performed using sampling methods and visual checks during the marking process. In the finishing inspection stage, efficiency is achieved through nozzle spray adjustment, reducing repeated coating thickness testing, weld inspection by multiple workers, and load testing conducted simultaneously for several units. As a result, the total time of non-value-added activities decreases from 41 hours to 27 hours, resulting in a time saving of 14 hours. Furthermore, cycle time and Manufacturing Cycle Effectiveness (MCE) calculations are conducted to determine the most efficient performance in the production process.

B. Cycle time timeline rekayasa usulan perbaikan

Table 9. Project Timeline for Car Body Stand – Proposed Improvement Engineering

No.	**Stage**	**Description**	**Duration (days)**
1	Preparation & Planning	Material	3
2	Process	Frame	41
		Painting	14
3	Waiting		6
4	Delivery		5
5	Inspection		2
6	Storage		3
	Total		**74**

(Source: Proposed Improvement Results, 2020)

Based on Table 9, the proposed improvement is implemented in the inspection stage. Referring to Table 8, the total inspection time is 14 hours or 2 days, while the storage time is 3 days, which is 2 days faster compared to the actual project timeline. This time reduction is achieved based on improvements in the preparation and planning process. Although the overall duration is similar to the actual project timeline, the proposed improvement focuses on ordering raw materials earlier, considering the long delivery time. This ensures that the production process can start earlier than in the actual timeline and reduces the storage time of raw materials before production begins. Meanwhile, during the 6-day waiting period, activities include preparation of shipping documents and files used as evaluation materials in the finishing inspection process, labeling, packaging, and finally product delivery.

a. Processing time

In the calculation of processing time, no improvement proposal is applied; therefore, it remains the same as in Table 4.5. The total processing time obtained is 473.5 hours.

b. Inspection time

Table 10. Proposed Engineering Improvement for Inspection Time

Description	Duration (days)
Steel plate raw material inspection	7
Inspection	7
Total	14

(Source: Processed data, 2020)

c. Waiting time = 6 days × 2 hours = 12 hours
d. Storage time = 3 days × 7 hours/day = 21 hours
e. Delivery = 3 hours

Cycle Time = processing time + inspection time + waiting time + storage time + delivery time
= 473.5 + 14 + 12 + 21 + 3 = 523.5 hours

Based on the cycle time calculation in the proposed improvement engineering timeline, the total time obtained is 523.5 hours, consisting of 473.5 hours of processing time, 14 hours of inspection time, 12 hours of waiting time, 21 hours of storage time, and 3 hours of delivery time. After calculating the cycle time values for the predicted, actual, and proposed improvement timelines, it is found that the proposed improvement is 28 hours faster than the total cycle time of the actual timeline. Furthermore, after calculating the cycle time for all three timelines, the purpose is to determine the Manufacturing Cycle Effectiveness (MCE) value.

C. Manufacturing Cycle Effectiveness
Manufacturing Cycle Effectiveness = ($processing\ time$ / $cycle\ time$) x 100% .
Manufacturing Cycle Effectiveness = (473,5 / 523,5) x 100% = 0,904 = 90,4 %.

Based on the MCE calculation results, the proposed improvement engineering timeline yields an MCE value of 90.4%. Calculating the MCE values for the three timelines aims to determine the highest MCE value among the three production process timelines. The highest MCE value occurs in the proposed improvement engineering timeline. Therefore, the greatest effectiveness is achieved when the production process is improved by reducing time in storage and inspection activities, in accordance with the proposed improvement timeline, which approaches 100%. This is because an ideal production process should result in a cycle time equal to the processing time, meaning an MCE of 100% (Mulyadi, 2003:279).

4.2. Discussion

Based on the production activity schedule table, the following results are obtained.

1. Actual Timeline Production Activities
a. Value Added Activities (VAA)
Based on the value-added activities table, there are 14 value-added activities with a total duration of 480.5 hours. The longest activity occurs in the primer painting process, which takes 129.5 hours. In this process, 518 parts are painted for 14 units of Car Body Stand, with an average painting time of approximately 15 minutes per part.
b. Non Value Added Activities (NVAA)
Based on the non-value-added activities table, there are 4 non-value-added activities with a total duration of 41 hours. The longest activities are raw material inspection and finishing inspection, each taking 14 hours. Raw material inspection involves checking the condition of raw materials, while finishing inspection includes checking welding results, load testing, and thickness testing of the painting results.

2. Cycle Time
a. Cycle time in the predicted timeline
The total time is 467 hours, consisting of 420 hours of processing time, 21 hours of inspection time, 2 hours of waiting time, 21 hours of storage time, and 3 hours of delivery time.
b. Cycle time in the actual timeline
The total time is 551.5 hours, consisting of 473.5 hours of processing time, 28 hours of inspection time, 12 hours of waiting time, 35 hours of storage time, and 3 hours of delivery time.

3. Manufacturing Cycle Effectiveness (MCE)
a. Predicted timeline MCE
Based on the MCE calculation, the Car Body Stand production process produces an MCE value of 89.9%.
b. Actual timeline MCE
Based on the MCE calculation, the Car Body Stand production process produces an MCE value of 85.8%.

4. Proposed Improvement Engineering for Production Activities
a. Value Added Activities (VAA)
There are 14 value-added activities with a total duration of 480.5 hours. The longest activity occurs in primer painting, which takes 129.5 hours. This involves painting 518 parts for 14 units of Car Body Stand, with an average time of 15 minutes per part.
b. Non Value Added Activities (NVAA)
There are 4 non-value-added activities with a total duration of 27 hours, with each of raw material inspection and finishing inspection taking 7 hours. Raw material inspection involves checking material conditions, while finishing inspection includes checking welding results, load testing, and coating thickness testing.

5. Cycle Time (Improved Timeline)
The total time is 523.5 hours, consisting of 473.5 hours of processing time, 14 hours of inspection time, 2 hours of waiting time, 21 hours of storage time, and 3 hours of delivery time.

6. Manufacturing Cycle Effectiveness (MCE)
Based on the MCE calculation, the Car Body Stand production process produces an MCE value of 90.4%.

Thus, it can be concluded that the production activities are not yet optimal due to several time-consuming non-value-added activities, resulting in an MCE value below 100%. This indicates that the production process is not yet ideal because it still contains non-value-added activities. However, with the proposed improvement engineering, the MCE value becomes significantly higher compared to both the predicted and actual timelines.

To improve the MCE percentage, several steps can be taken, such as reducing time in raw material inspection and finishing inspection, as well as reducing material storage time, so that the production process can run more efficiently with proper raw material purchasing planning.

5. CONCLUSION

Value-added activities consist of 14 activities with a total duration of 521.5 hours, where the longest duration occurs in the primer painting process, amounting to 129.5 hours for 14 units. Meanwhile, non-value-added activities consist of 4 activities with a total duration of 41 hours, dominated by raw material inspection and finishing inspection, each taking 14 hours, including material checking, welding inspection, load testing, and paint thickness testing.

The cycle time in the predicted timeline was recorded at 467 hours, while the actual condition reached 544.5 hours. This indicates delays in the actual production process compared to the planned schedule.

The Manufacturing Cycle Effectiveness (MCE) value in the predicted condition was 89.9%, while the actual condition achieved 85.7%. The lower actual value indicates that the production process is not yet optimal because non-value-added activities still exist. Therefore, efficiency improvements can be achieved by reducing the time required for raw material inspection, finishing inspection, and storage through better material planning.

After implementing the proposed improvement engineering, the number of value-added activities remained at 14, but their duration decreased to 480.5 hours. On the other hand, non-value-added activities were successfully reduced to 27 hours, with each inspection activity reduced to 7 hours. The cycle time also decreased to 523.5 hours with a processing time of 473.5 hours, resulting in an increase in the MCE value to 90.4%.

This efficiency improvement was achieved through the implementation of visual- and sampling-based inspections, paint nozzle adjustment, reduction of repeated testing, as well as optimization of inspection and load-testing processes conducted in parallel.

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