World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

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Identification and optimization of production processes on 200 TS A6 engine using lean manufacturing approach at PT Trimitra Marganda Unggul Tegal

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World Journal of Advanced Research and Reviews, 2025, 28(02), 1827-1833

Publication history: Received 06 October 2025; revised on 20 November 2025; accepted on 22 November 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.28.2.3907

Abstract

PT. Trimitra Marganda Unggul (TMU) is a manufacturing company that focuses on producing underbody components for motorcycles and cars. One of the key performance indicators utilized is Gross Stroke per Hour (GSPH), which serves as a reference for production targets and evaluations of machine productivity. This study aims to identify the factors impeding the achievement of the production target or GSPH for the 200 TS A6 machine, while also providing recommendations for improvement to enhance productivity using a Lean Manufacturing approach. From October to December 2024, the average GSPH recorded on the 200 TS A6 engine was 265 strokes/hour, which is below the company's standard of 320 strokes/hour. The analysis using Process Activity Mapping (PAM) indicates the presence of significant non-value-added (NVA) activities leading to inefficiencies in the production process. The proposed improvement recommendations are estimated to yield a 69% increase in GSPH compared to previous records.

Keywords: Production Efficiency; GSPH; Lean Manufacturing; Process Activity Mapping

1. Introduction

The manufacturing industry is a sector that contributes significantly to national and global economic growth. To maintain competitiveness, manufacturing companies are required to improve operational efficiency and productivity. Low efficiency levels can have an impact on increased operating costs, product delivery delays, and decreased customer satisfaction. One of the indicators used to measure the performance of the production line is Gross Stroke per Hour (GSPH), which is a standard reference for production targets [1] [2]. GSPH is a measure that shows the number of strokes or up-and-down steps of a press machine in an hour and serves as a parameter to evaluate the efficiency of the production process. Accurate determination of GSPH is essential to ensure that production targets can be achieved according to established specifications and cycle times. The production process is said to be productive if the number of components produced is equal to or more than the predetermined GSPH. Unachieved GSPH values can indicate inefficiency, worthless activities, and decreased productivity of production units [3].

PT Trimitra Marganda Unggul (TMU) is a manufacturing company that focuses on the production of underbody components for motorcycles and cars. One of the main machines used in the production process is the 200 TS A6 engine, which has a production target or GSPH of 320 strokes/hour. However, based on data from the last three months (October to December 2024), the machine was only able to reach an average of 265 strokes/hour, or around 82.81% of the set target. Failure to achieve this target has the potential to cause production targets to not be achieved, resulting in delivery delays and increased production costs.

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This research aims to increase productivity through the Lean Manufacturing approach, which is a systematic method to identify and eliminate waste and worthless activities through continuous improvement. This approach aims to increase the efficiency and effectiveness of the production process so that it is expected to produce an optimal production process by focusing on eliminating activities that do not add value and optimizing the process flow. Thus, it is hoped that GSPH can increase from the previous value [3].

2. Material and methods

This research was conducted at PT. Trimitra Marganda Unggul in the LIK Takaru Complex, Tegal Regency, Central Java, from January 2, 2025, to January 31, 2025. Initial studies involved literature reviews and fieldwork to identify issues related to unmet production targets on the 200 TS A6 engine. The literature review focused on theories relevant to Lean Manufacturing, GSPH, Process Activity Mapping (PAM), Time and Motion Study, and Root Cause Analysis (RCA) utilizing the 5 Whys method. Field studies encompassed direct observations and interviews with production staff.

Data processing began with an analysis of GSPH data from the A6 machine for the three months (October to December 2024), sourced from daily production reports, to assess actual performance against company standards. Subsequent identification involved consistent products processed on the A6 machine and analysis of their cycle times, calculated using the Stopwatch Time Study (SWTS) method [3].

3. Results and discussion

3.1. Data Collection

Primary data were gathered from direct observations of the operator's work activities on the 200 TS A6 machine, along with informal interviews with the Head of Production, QC Department, and PPIC Department. Secondary data were sourced from the A6 engine production reports.

The study utilized production GSPH data to provide an overview of A6 machine performance, alongside analyzed production volume and frequency over the last three months.

3.2. Data Processing

3.2.1. A6 Engine Production Data

GSPH data for the previous three months (October to December 2024) is presented in Table 1.

Table 1 GSPH Data A6 Machine

Moon	**Number of *Strokes* / hours**	**Percentage**
October	252	78.75%
November	243	75.94%
December	300	93.75%
Average	265	82.81%

3.2.2. Cycle Time Data

Cycle time measurements were carried out using the Stopwatch Time Study (SWTS) method for each product.

Table 2 A6 Machine Production Cycle Time

Yes	***Parts* and *Processes***	Cycle Time(s)
1	58316-BZ090 (Blank Process)	11.41
2	58316-BZ0100 (Bending Process)	7.80
3	58171-KK010 (Blank Process)	10.69
4	57686-BZ150 (*Piercing Process*)	8.93
5	57435-0K010 (Trimming Process)	12.82

3.2.3. Actual GSPH Calculation

The GSPH value calculation reveals machine productivity based on strokes/hour, using the formula:

$$\text{GSPH} = \frac{3600s}{Clyle\ Time}$$

For example, for the Blank Process (58316-BZ090)

$$\text{GSPH} = \frac{3600s}{Clyle\ Time} = \frac{3600s}{11{,}41s} = 315\ stroke/jam$$

Table 3 Actual GSPH Calculation Results

No	***Share***	**Actual GSPH (*strokes*/hour)**
1	58316-BZ090 (*Blank*)	315
2	58316-BZ0100 (*Bending*)	461
3	58171-KK010 (*Blank*)	336
4	57686-BZ150 (*Piercing*)	403
5	57435-0K010 (*Trimming*)	280

The actual GSPH calculation results are then compared to the company's GSPH standard of 320 strokes/hour. This comparison is presented in the form of a graph so that the difference in the performance of each product can be seen more clearly, as shown in Figure 1.

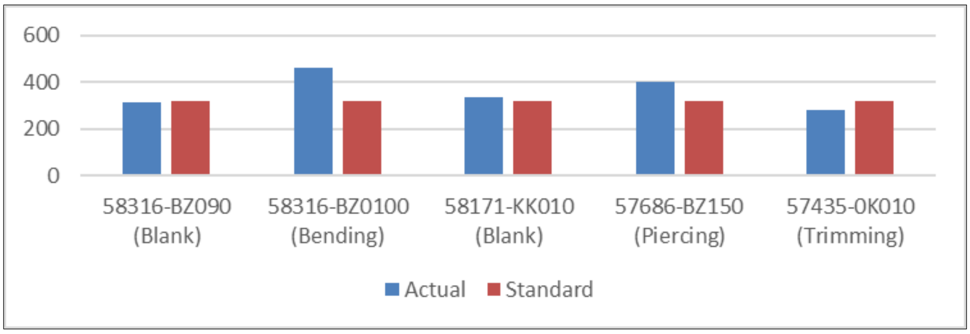

Figure 1 GSPH Comparison

3.2.4. Process Details of Selected Products

The product 57435-0K010, having the lowest actual GSPH value, was selected for further analysis. Table 4 outlines the trimming process steps.

Table 4 Product Working Steps 57435-0K010

Yes	Working Steps	Time(s)
1	Pick Up Materials from the Carts	3.75
2	Take Materials and Put them on the *Anniversary*	1.78
3	Press the Push Button	1.30
4	Take *Trimming Products*	1.42
5	Grab *the Scrap* and Store it on the Side	1.09
6	Moving Products to E*mpty Box*	1.57
7	Scrap Removal	1.92
	Total Time	12.82

3.2.5. Identification of Activity and Waste

Using Process Activity Mapping (PAM), all work steps in producing part 57435-0K010 were evaluated to identify waste and enhance efficiency (Table 5).

At the identification stage, Process Activity Mapping (PAM) was used to map all work steps in the production process of part 57435-0K010. Process Activity Mapping (PAM) is a technique used to analyze and describe all activities in the production process with the aim of identifying waste and increasing efficiency [5]. Table 5 shows the results of the identification of activity and waste.

3.3. Analysis and Suggestions for Improvement

3.3.1. Identify the Root of the Problem

The identification of waste is followed by the 5 Whys method to find the root causes that contribute to cycle time and productivity. 5 Why's Analysis is a method used to identify the root cause of a problem through the process of asking "why" repeatedly until there is no longer an answer to be given, aiming to explore all possible causes of the problem to gain a deeper understanding [6]. The root cause analysis for waste 1 is presented in Table 6.

Table 5 Identify Activity and Waste

Yes	Activity	Time(s)	PAM Activities					Ket.	*Waste*
			O	T	I	D	S		
1	Grab materials from the cart	3.75		3.75				NVA	*Transport*
2	Take the material and put it in the *dies*	1.78	1.78					VA	X
3	Press the push button	1.30	1.30					VA	X
4	Take the trimming products	1.42	1.42					VA	X
5	Take *scrap* and store it on the side	1.09				1.09		NVA	*Overprocess*
6	Moving products to Empty *box*		1.57		1.57			NNVA	*Overprocess*
7	Scrap removal		1.92		1.92			NNVA	*Transport*

Table 6 5 Whys of Waste 1

Pick Up Materials from the Trolley *(transport)*	
Problems	The operator must walk far enough to retrieve the material from the trolley.
Why?	Because the material trolley is placed separately from the operator's work area.
Why?	Because there has been no adjustment to the layout of the work area that considers the optimal distance.
Why?	Because there is no standard procedure for the placement of trolleys/materials.
Why?	Because management has not prioritized the review of transportation distance.
Why?	Because it has not been realized that long transportation distances have a significant impact on GSPH results.
The Root of the Problem	The absence of a standard work layout (*layout*), which takes into account the optimal transportation distance in the work area.

A root cause analysis for waste 2 is presented in Table 7.

Table 7 5 Whys of Waste 2

Scrap and Save (*Overprocess*)	
Problems	The operator must take the s*crap* from the *dies* and then store it temporarily on the side.
Why?	Because there is no standard that regulates the disposal facilities of the *crap* in the production layout.
Why?	Because the management has not considered the disposal of crap activities as an important factor.
The Root of the Problem	The unavailability of easily accessible s*crap* disposal facilities in the production area resulted in operators adding work steps (*overprocess*).

A root cause analysis for waste 3 is presented in Table 8.

Table 8 5 Whys Waste 3

Moving Products to *a Box* (*overprocess*)	
Problems	The processed products cannot be directly placed into the final container. The operator must temporarily store it on the side, then move it again to the *empty box*.
Why?	Because there is no *easily accessible box* on the operator's side when the product is finished processing
Why?	Because the trolley as a place for the ox cannot be placed near the operator.
Why?	Because the working layout is not designed to put the b*ox* in the optimal position.
Why?	Since there is no standardization for the layout of placing the b*ox* near the operator position.
Moving Products to *a Box* (*overprocess*)	
Why?	Because the focus of improvement is still on the core process (production), while the final handling is less considered.
The Root of the Problem	The absence of a *final b-ox* placement available in the *work layout*, resulting in additional activities (*overprocess*) when moving the product to the final container.

The root cause analysis for waste 4 is presented in Table 9.

Table 9 5 Whys of Waste 4

Throwing Scrap into a Box (transport)	
Problems	The operator must leave the work area to dispose of scrap because the disposal site is not near the work area.
Why?	Because the scrap disposal site is not near the work area and there are no facilities to help dispose of scrap.
Why?	Because the production layout does not integrate the s crap disposal point near the workstation.
Why?	Because there is no standardization for the placement of scrap facilities in the work area.
Why?	Because management has not realized that the disposal of scrap has a significant effect on GSPH's results.
Why?	Because the focus of repair so far has been more directed towards the production process, while scrap disposal activities are considered unimportant.
The Root of the Problem	The unavailability of scrap disposal facilities placed in the work area, which requires operators to make additional trips to dispose of scrap and causes *transport waste*.

3.3.2. Improvement Recommendations

Based on identified waste and root causes, recommendations include

- Efficient facility layout planning.
  - Optimizing material flow and productivity by redesigning the workspace layout [7].
- Shutter making for dies.
  - Allows for immediate scrap disposal without temporary storage.
- Addition and improvement of work SOPs.
  - Improve documentation and implementation of work practices.
- Operator Training
  - Ensure workers are up-to-date on new procedures and conditions.
- Implementation of Monitoring system.
  - Track work processes for continual improvement

3.3.3. Evaluation of Estimated Results

If wasteful activities are effectively mitigated, trimming cycle time may reduce to 7.99 seconds, theoretically increasing GSPH from 280 strokes/hour to 450 strokes/hour a 60.7% improvement. Real-world validation of these estimates through implementation is crucial.

4. Conclusion

From October to December 2024, the 200 TS A6 engine at PT. Trimitra Marganda Unggul averaged a GSPH of 265 strokes/hour, significantly below the target of 320 strokes/hour. Analysis highlighted the 57435-0K010 product as the main contributor to low efficiency due to excessive cycle time. A focused examination revealed that 37.71% of the cycle time consists of non-value-added activities such as material retrieval and scrap disposal. Suggested improvements include layout optimization, shutter implementation on dies, and further training for operators, with potential GSPH rising to 450 strokes/hour with successful reduction of waste.

Compliance with ethical standards

Acknowledgments

The authors express sincere gratitude to all who supported this research, particularly PT. Trimitra Marganda Unggul for their permission and opportunity to conduct practical work. The completion of this research would not have been possible without the assistance of all involved parties.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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