Jurnal Media
Teknik dan
Sistem Industri

Jurnal Media Teknik & Sistem Industri
Vol. 10, No. 1, (2026), 65 – 75
http://jurnal.unsur.ac.id/JMTSI

e-issn: 2581-0561
p-issn: 2581-0529
DOI 10.35194/ jmtsi.v10i1.6026

The Effect of Work System Optimization on the Efficiency and Productivity Assembly Workstation Product Using an Integrated TMS

Dony Susandi [1*], Hafni Rizanuddin Nur [2], Intan Kusuma Dewi [3], Asri Nurhasanah [4]

Universitas Majalengka, KH. Abdul Halim Street No 103, Majalengka 45418, Indonesia
[1] dys@unma.ac.id*; [2] hafni.rn@unma.ac.id; [3] ikd@unma.ac.id; [4] asrinur367@gmail.com
* Corresponding author

ARTICLE INFO

Article history
Received: February 2026
Revised: April 2026
Accepted: April 2026

Keywords
Time and Motion Study
Value Stream Mapping
Therblig
Ergonomics
Automotive Industry

ABSTRACT

Productivity is an important aspect in the manufacturing industry, including in the assembly process of the Cover Seat Belt Anchor product at PT Solo Plastik Indonesia. Problems found include the absence of standard work methods, high variations in operator movements, and irregular process times that result in motion waste and fluctuating production achievements. This study aims to analyze the existing work system and develop proposals for improvement methods to increase efficiency and productivity. The methods used include Time and Motion Study (TMS), Value Stream Mapping (VSM), right-left hand maps, therblig analysis, motion economy principles, and stopwatch study. Data was obtained through direct observation, measurement of operator work time, and identification of motion elements. The results show that 5 ineffective motion elements can be eliminated or combined. The proposed work method can reduce standard time from 60 seconds to 48.83 seconds per unit (efficiency ±9.3%), balance the use of the right and left hands, and reduce motion waste. The implementation of standardized work methods has the potential to increase operator productivity and work quality, in line with the current trend in the automotive industry that integrates lean manufacturing and ergonomics.

1. Introduction

Productivity is an essential statistic for maintaining the competitiveness of the industrial sector. Productivity is quantified as the ratio of output to input and signifies the capacity to utilize resources efficiently [1], [2]. Productivity is not only influenced by work speed but also by the application of appropriate work methods and the elimination of non-value-adding activities [3]. The design of an effective work system becomes an important approach in efforts to improve productivity; a satisfactory work system must consider the interaction of humans, machines, methods, and the environment [4]. The scientific approach to work design was initiated by F.W. Taylor, who focused on time measurement, and F.B. Gilbreth, who developed motion studies to create more efficient work sequences. The Time and Motion Study (TMS) emerged from the synthesis of the two and has proven beneficial in augmenting productivity [5], [6].

Additionally, lean manufacturing methods, such as Value Stream Mapping (VSM), have been widely utilized to clarify processes and identify waste [7]–[9]. Multiple studies on TMS have shown effectiveness in standardizing timelines and improving work procedures in specific industrial processes, such as greenware production and wheel component fabrication [10], [11]. However, studies on the final assembly process, marked by complex movement variations and requiring the balance of bilateral hand coordination by the operator, are few. This gap necessitates research employing an integrated approach that amalgamates TMS, VSM, right-left hand maps, Therblig analysis, and motion economy principles to develop more efficient and ergonomic work methods [12], enhance manufacturing energy efficiency [13], and assess the impact of organizational climate [14]. Although these studies make significant contributions to the development of work methods, most focus on general production processes or relatively simple sub-assemblies. There remains a research deficit concerning the implementation of integrated work methods in the final assembly process within the automotive sector, especially those that involve intricate motion variations and necessitate optimal right-left hand coordination balance.

In the automotive component manufacturing industry, assembly processes play a critical role in determining overall production efficiency because they involve intensive manual operations and high movement variability. At PT Solo Plastik Indonesia, the assembly workstation for the Seat Belt Anchor Cover product exhibits significant performance inefficiencies that affect production flow stability. Production data indicates an imbalance between upstream and downstream processes. The injection molding process produces approximately 576 units per day, whereas the assembly station can complete only 480 units per day, resulting in an accumulation of work-in-process (WIP) inventory of approximately 96 units per day. This imbalance causes components to experience waiting times exceeding 24 hours before entering the quality control stage. Additionally, observations reveal inconsistent operator movements, absence of standardized work methods, and uneven utilization of the right and left hands during assembly activities.

These conditions indicate the presence of motion waste, inefficient work sequences, and ergonomic imbalance, which collectively reduce productivity and increase operational variability. Despite the widespread application of Time and Motion Study (TMS) and lean manufacturing tools in manufacturing improvement initiatives, previous studies predominantly analyze these methods separately or within relatively simple production contexts. Limited research has investigated the integrated application of TMS, Value Stream Mapping (VSM), right–left hand mapping, and Therblig analysis simultaneously, particularly in complex final assembly operations within the automotive component industry.

The synthesis of the literature indicates that these methods are pertinent not only in the general manufacturing context but also correspond with recent studies in the automotive sector that underscore the significance of integrating TMS with lean and ergonomic principles to mitigate work imbalances and motion waste [15]–[18]. For example, studies by Zhang et al., [16] and Kumar & Lee [17] demonstrate that optimizing work methods with a combined approach can increase assembly line efficiency by over 10% and significantly reduce operator fatigue.

Previous studies have applied work measurement and motion study techniques to improve assembly productivity through time analysis and ergonomic evaluation. However, most studies address motion analysis and standard time determination separately. This study extends the state of the art by integrating Therblig-based micro-motion analysis, performance rating, and allowance evaluation into a unified framework. The novelty lies in directly linking motion-level analysis with validated standard time optimization in an industrial assembly environment.

The issues raised are (1) the current condition of the work system in the seat belt anchor cover assembly process; (2) operator work activities that cause motion waste; and (3) how to apply TMS, VSM, right-left hand maps, and Therblig analysis to analyze the work system and propose improvements to the seat belt anchor cover assembly process at PT Solo Plastik Indonesia. The goal is to reduce waste, balance the use of the operator's right and left hands, improve work efficiency and productivity, and contribute to the evolving literature in the field of modern automotive manufacturing. By employing these analytical techniques, the sources of motion waste can be systematically identified, enabling the development of targeted improvement strategies to enhance assembly process efficiency, strengthen operational practices, and improve operator performance.

2. Method

This research uses a work measurement and method improvement study, commonly applied in industrial engineering to evaluate and optimize manual work systems. The research focuses on analyzing existing assembly operations through time and motion study techniques to identify inefficiencies and develop improved work methods [17].

2.1 Type and Approach of Research

In this study, the methodology integrates several analytical tools, including TMS, VSM, right–left hand analysis, and Therblig motion analysis. These tools are employed to measure work performance, identify non-value-added activities, and redesign the assembly process to achieve improved productivity and operational efficiency of seat belt anchor covers within an actual production environment at PT. Solo Plastik Indonesia.

2.2 Object and Scope of Research

This method was chosen because it can find movement waste, set standard timeframes, and recommend better ways to do the work that are also more efficient [17], [18]. VSM is also used to map the flow of the production process to find activities that contribute value (VA) and those that don't (NVA). Therblig analysis breaks the work down into its basic movement parts and finds the ones that aren't working. The right-left hand map is used to assess the balance of both hands' usage by the operator, while the principles of motion economy are applied to design a more ergonomic work method.

2.3 Data Collection Techniques

Data collection was conducted through direct observation at the assembly station, work time measurement with a stopwatch time study, and detailed recording of movement elements. The data in this study includes the production process system, movement patterns, and operator working time. Production flow data is obtained by identifying all activities to find waste in the form of unnecessary movements and waiting time, while worker activity data is collected by recording every assembly movement that occurs in the production process.

Based on its source, the data consists of primary data obtained through field observations and work time measurements, as well as secondary data from company documentation and previous research. All data are on a ratio scale, allowing for accurate and in-depth quantitative analysis to identify opportunities for work system improvement. The evaluation of operator performance uses the Westinghouse method due to its ability to systematically evaluate four main factors: skill, effort, conditions, and consistency—resulting in an accurate rating factor. Table 1. show the operator performance evaluation table using the Westinghouse method [20].

The Westinghouse rating system evaluates operator performance based on four factors: skill, effort, working conditions, and consistency. Each factor contributes an adjustment value used to determine the performance rating in time study analysis. The overall performance rating is calculated by summing the adjustment values from all four factors.

2.4 Research Procedures or Stages

To determine the standard time and standard output of production in the assembly process before improvements are made, a stopwatch study was used [4]. The initial sample taken consisted of 30 replications for each assembly process as implemented.

Data Sufficiency

Data Sufficiency The data sufficiency test aims to ensure that the number of time measurements taken during the study is adequate to represent all activities in the assembly stage. In other words, we need to determine whether the collected sample is large enough to generalize the analysis results to the entire process [4].

$$N' = \left[\frac{\frac{k}{s}\sqrt{N.\sum x_i^2 - \sum(x_i)^2}}{\sum x_i} \right]^2 \quad (1)$$

Where:

N' = The requisite amount of data.
N = The actual amount of data.
S = The accuracy level, representing the maximum deviation of the forecast from the actual data (k = 95% and s = 5%, k/s = 40).
k = The confidence level, indicating the measurer's degree of assurance that the obtained result satisfies the accuracy criteria.

If N' exceeds N, further measurements are necessary.
If N' < N, early readings are adequate.

Tabel 1. Performance Assessment

Skill		Effort	
+ 0.15 A1	Super skill	+ 0.13 A1	Super skill
+ 0.13 A2		+ 0.12 A2	
+ 0.11 B1	Excellent	+ 0.10 B1	Excellent
+ 0.08 B2		+ 0.08 B2	
+ 0.06 C1	Good	+ 0.05 C1	Good
+ 0.03 C2		+ 0.02 C2	
0.00 D	Average	0.00 D	Average
- 0.05 E1	Fair	- 0.04 E1	Fair
- 0.10 E2		- 0.08 E2	
- 0.16 F1	Poor	- 0.12 F1	Poor
- 0.22 F2		- 0.17 F2	
CONDITION		**CONSISTENCY**	
+ 0.06 A	Ideal	+ 0.04 A	Ideal
+ 0.04 B	Excellent	+ 0.03 B	Excellent
+ 0.02 C	Good	+ 0.01 C	Good
0.00 D	Average	0.00 D	Average
- 0.03 E	Fair	- 0.02 E	Fair
- 0.07 F	Poor	- 0.04 F	Poor

Source: Adapted from Westinghouse Performance Rating System
(ILO, 1992; Barnes, Motion and Time Study)

1. Data Homogeneity Test

The homogeneity test aims to ensure that the variation in the collected sample times is not too large so that it represents the overall activity in the assembly process [4]. The testing procedure is as follows.

a. Compute the mean of the average values of the subgroup sections.

$$\bar{\bar{x}} = \frac{\sum \bar{x}}{k} \quad (2)$$

where:
$\bar{x}$ = The total sum of all group average values.
k = Number of subgroups formed

b. Calculate the actual standard deviation

$$\sigma = \sqrt{\frac{\sum(xi-\bar{\bar{x}})^2}{N-1}} \quad (3)$$

where:
N = Total sample size (amount of data).
$\bar{\bar{x}}$ = Grand Mean or the average of all data.
σ= Standard Deviation.
x_i = The value of the i-th data (single data).

c. Calculate the upper control limit (UCL) and the lower control limit (LCL)

$$\text{UCL} = \bar{X} + 3\sigma\bar{x} \text{ dan LCL} = \bar{X} - 3\sigma\bar{x} \quad (4)$$

2. Performance Rating

The determination of performance rating is carried out to normalize the working hours of the employees. This is due to the abnormality in working hours that can be caused by workers who work in an unreasonable manner, such as too fast or too long. Westinghouse is the method used in this study to determine the adjustment factor for the operator's work irregularity (p). The value of the adjustment factor (p) has three boundaries [19], namely:

a. p > 1 if the evaluator believes that the operator is working above normal or too fast.
b. p = 1 if the evaluator believes that the operator is working normally or reasonably.
c. p < 1 if the evaluator believes that the operator is working below normal or too slow.

3. Normal Time

The formula used to calculate normal time with performance rating is [19]:

Normal Time = Average Observation Time x (Rating Factor %) (5)

4. Standard Time and Flexible Time

The determination of standard time aims to establish the duration of time required for a worker to produce one unit, while the calculation of allowance time determines the reasonable additional time given for rest, personal adjustments, and minor disruptions [19].

Standard time = Normal time + (Normal time x %Allowance) or
Standard time = Normal time x (100% - %Allowance) (6)

5. Standard Output

The calculation of standard output is performed to determine how much output is produced in a unit of time [20]. To determine the standard output, use the following formula.

Standard output = 1/ Standard time (7)

2.5 Data Analysis Techniques

The next step is to analyze the processed data to obtain appropriate improvement proposals for the existing issues. The allowance value used is 32%, consisting of personal allowance, fatigue allowance, and delay allowance. The selection of this value refers to the industrial standard guidelines from the International Labor Organization (ILO) and ergonomic literature [20]–[23], which recommend a range of 30–35% for assembly work with high repetition and standing positions so that the standard time accounts for the need for rest, fatigue, and work obstacles (table 2).

Table 2. Allowance Value

Allowance Component	Basis Determination	Value (%)
Personal	Standard industrial guideline	7
Fatigue	Standing posture + repetition + motion intensity	15
Delay	Minor interruptions & material handling	10
Total		32

Source: Adapted from allowance value (ILO, 1992; Barnes, Motion and Time Study).

The acquired data undergoes multiple analytical phases. First, the identification of effective and ineffective movement elements is carried out using Therblig analysis. Secondly, a right-left hand map is generated to assess the equilibrium of workload distribution between the operator's right and left hands. Third, a mapping of the actual conditions was conducted using VSM to identify points of process waste. To derive the normal and standard time from the time study analysis, you need to look at the quality and consistency of time data, apply the Westinghouse approach to figure out the adjustment factor, and add in allowances.

Based on the analysis results, a new work method was designed referring to the principles of motion economy, including the reorganization of layout, standardization of work sequences, and the preparation of proposed SOPs. The new work method was then validated through simulation and comparison with initial conditions to ensure an increase in efficiency and productivity. With the integration of this method, the research is expected to provide a comprehensive overview of the actual working conditions and produce a design of work methods that are efficient, ergonomic, and in line with the best practices of the automotive manufacturing industry.

3. Results and Discussion

3.1 Presentation of Research Results

The research results show that the material flow to produce seat belt anchor covers start with the supply of raw materials to the warehouse and is then processed in the injection molding machine with a cycle time of 50 seconds per unit. The process results are stored in WIP 1 for 60 minutes before being manually assembled with a cycle time of 60 seconds/unit. After assembly, the product is stored in WIP 2 for up to 24 hours before inspection at QC and then moved to the finished goods warehouse. The total distance between stations is 43 meters. There is an output imbalance between injection (576 units/day) and assembly (480 units/day), resulting in a WIP accumulation of 96 units/day and a waiting time of more than 24 hours. The improvement is focused on adjusting the assembly cycle to balance with the previous process. Here is Figure 1, which contains the current state mapping to map the production process.

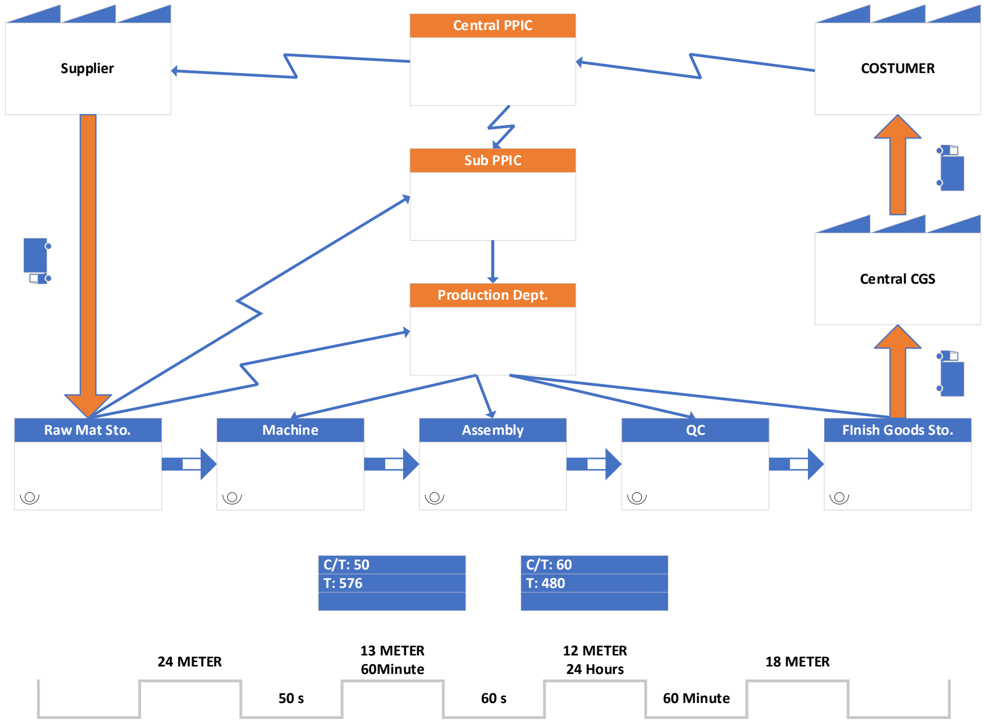

Fig. 1. Production process current state mapping

Next, Using the observed cycle time of 42.52 s and a performance adjustment factor of 0.87 in Eq. (5), the normal time was determined as 36.99 s, while application of Eq. (6) with a 32% allowance yielded a standard time of 48.83 s per unit, shown that lower than the company's standard of 60 seconds per unit. This indicates that the actual work method has the potential for acceleration compared to the conservative standards applied by the company. The difference can be explained scientifically because the time measurements in this study are based on actual field data, not on estimates or tolerances that tend to be more lenient [11][12]. This conclusion is confirmed in the data uniformity test in Figure 2 with the following results.

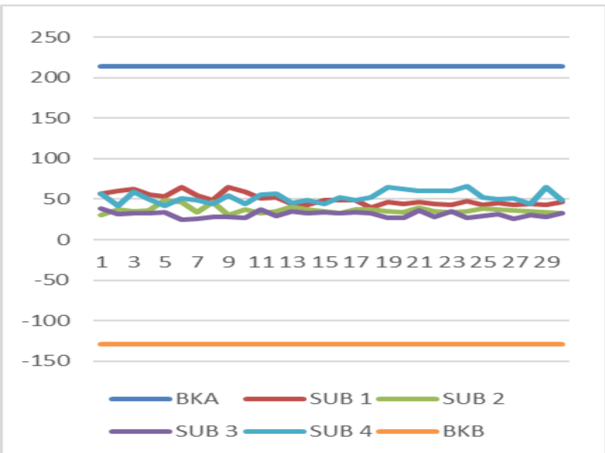

Fig. 2. UCL (BKA) & LCL (BKB)

Then, the analysis of the right- and left-hand maps shown in figure 3 reveals a significant imbalance in activity, where the right hand is active for 52.61 seconds, while the left hand is only active for 3.69 seconds in one cycle. This condition indicates that the principle of motion economy, which emphasizes the simultaneous use of both hands in a balanced manner, has not been optimally applied. The workload that is too dominant, on one hand, has the potential to cause fatigue and increase cycle time variability.

Peta Tangan Kanan dan Tangan Kiri							
Pekerjaan		: Perakitan Komponen *Cover Seat Belt*					
Departemen		: Produksi					
Nomor peta		: 1					
Dipetakan Oleh		: Asri Nurhasanah					
Tanggal Dipetakan		: 4 Juli 2025			Sekarang	YA	Usulan -
Tangan Kiri	Jarak (cm)	Waktu (det)	Lambang	Lambang	Waktu (det)	Jarak (cm)	Tangan Kanan
Memilih	50	1	ST	RE	1,8	60	Menjangkau
Mengjangkau	10	0,69	RE	U	1,9	-	Memakai
Memegang	-	52,61	G	I	2,3	-	Memeriksa
				RL	1,5	60	Melepas
				RE	3,5	15	Menjangkau
				RE	1,43	10	Menjangkau
				U	2	-	Memakai
				RL	1	10	Melepas
				I	6	-	Memeriksa
				ST	18,18	30	Memilih
				A	1,32	-	Merakit
				ST	2,04	30	Memilih
				A	2,16	-	Merakit
				ST	1,72	30	Memilih
				A	2,05	-	Merakit
				RE	3	10	Menjangkau
				RE & U	0,71	-	Memakai dan memeriksa
Mengarahkan	100	2	P	-			
TOTAL	160	56,3			52,61	255	
RINGKASAN							
WAKTU SETIAP SIKLUS					: 56,3		
JUMLAH PRODUK SETIAP SIKLUS					: 1		
WAKTU UNTUK MEMBUAT SATU PRODUK					: 56,3		

Fig. 3. The right- and left-hand maps

This imbalance is caused by the asymmetrical placement of components and tools, as well as the absence of standard operating procedures that regulate the division of left- and right-hand activities [15], which can lead to inefficient workflows and increased risk of injury for workers (See Figure 4).

Fig. 4. Actual left- and right-hand activities (risk of injury)

Based on the analysis of operator movements using the therblig principle (see table 3), it was found that most of the operator's work activities consist of non-value-added (NVA) movements such as reaching, releasing tools, and inspecting. Value-added (VA) movements only include the processes of assembling and directing components. Several activities, such as part selection and visual inspection, were identified as necessary but although they do not directly add value to the product, are still required to ensure quality and the continuity of the work process. In this context, certain non-effective motions, such as holding, are considered unavoidable but reducible, meaning they cannot be eliminated due to process and ergonomic constraints but can be minimized through work method improvement and workstation redesign based on motion economy principles.

Table 3. Therblig Elements

Effective work elements	Non-effective work elements
Reaching	Holding (unavoidable but reducible)
Moving	Rest to overcome fatigue
Grasping	Positioning
Releasing load	Searching
Using	Selecting
Assembling	Planning
Disassembling	Unavoidable delay
Pre-positioning	Avoidable delay Inspection
	inspect

Source: Adapted from Therblig's Element
(ILO, 1992; Barnes, Motion and Time Study).

In therblig analysis, non-effective motions are classified as avoidable, unavoidable, or reducible. Certain elements such as holding are unavoidable but reducible, indicating that they cannot be eliminated entirely but can be minimized through motion economy improvements. The analysis of motion elements using the therblig method found that only 18% of total activities are truly value-added, while 22.1% include non-value-added activities and 61.2% are non-value-added but necessary activities. This condition shows that most of the time is spent on activities that do not actually add direct value to the product, such as component selection and repeated visual inspections. The high proportion of non-value-added activities aligns with Gilbreth's theory, which states that search and empty movement activities are waste that must be eliminated.

Additionally, the distance traveled by the right hand reaches 255 cm and the left hand 160 cm in one cycle, indicating layout inefficiency. This difference in distance extends the cycle time and indicates the need for improvements in workstation design so that components are within optimal reach and the use of both hands is balanced. These findings are in line with research that shows productivity improvement through the elimination of non-value-adding activities [5], [18]. However, this research is novel because it integrates Time and Motion Study (TMS), Value Stream Mapping (VSM), Right-Left Hand Mapping, and Therblig Analysis simultaneously, resulting in more comprehensive improvement recommendations.

3.2 Analysis of Findings

The research results show a significant gap between the actual work methods and the proposed work methods, both in terms of the balance of right-left hand workloads and the proportion of value-added (VA) activities to non-value-added (NVA) activities. The current working system condition of the cover seat belt anchor assembly, based on process flow mapping using value stream mapping (VSM), reveals a capacity discrepancy between the injection molding process (576 units/day) and assembly (480 units/day), resulting in a WIP accumulation of approximately 96 units/day and a component waiting time of 24 hours before entering the QC process. The main contributing factors are the misalignment of cycle times between processes and the suboptimal utilization of assembly capacity. Additionally, the total inter-station distance of 43 meters adds to the material transfer time and flow efficiency. Thus, the assembly station functions as a bottleneck that reduces the overall performance of the production chain and becomes the focus of improvement interventions.

The imbalance of the right-hand load, which is far more dominant, implies increased local fatigue, a higher risk of musculoskeletal injuries, and variability in daily output. This analysis emphasizes the importance of symmetrical workstation design and work sequence arrangements that allow for simultaneous use of both hands to maintain operator performance stability. Based on the Therblig approach, the principle of motion economy, and the right- and left-hand work maps. The results show that out of a total cycle time of 56.3 seconds per unit, only 10.14 seconds (18%) are classified as value-added (VA) activities, while 12.43 seconds (22.1%) are non-value added (NVA) activities, and 34.44 seconds (61.2%) are categorized as NVA but necessary. The dominant types of waste come from activities such as reaching, selecting, inspecting, and holding components, as well as the repetition of non-effective visual inspections. The analysis of the right- and left-hand work map also shows that the right hand dominates the entire process (±52.6 seconds), while the left hand is only active for ±3.7 seconds, indicating an unbalanced distribution of work. These findings confirm that the work layout is not ergonomic, and the principle of simultaneous hand usage has not been applied as explained in the motion economy theory.

The collected time data were statistically tested, and the results showed that the data were uniform (all values fell within UCL and LCL) and sufficient (the actual data count N = 120 was greater than N' = 100.32). The results of the work time measurement in the seat belt anchor cover assembly process show an average cycle time of 42.52 seconds. After adjustments with an operator performance rating of 0.87 and an allowance of 32%, a standard time of 48.83 seconds per component was obtained. The company currently uses a production target standard of 60 seconds per component, which is set based on previous work experience and internal policies. The difference of 11.17 seconds (9.3%) between the standard time from the research and the company's standard indicates that the actual work process has acceleration potential.

Thus, the proposal for improving the work system is based on the analysis of actual conditions and the principles of motion economy. The focus of the improvement proposal includes reducing non-value-added (NVA) activities, balancing handwork distribution, and increasing the efficiency of the assembly station. Analysis shows the presence of NVA activities in the form of repeated inspections with spray, rags, and marking on each product unit. This activity arises due to the presence of WIP, which causes dust to adhere to the components, necessitating the operator to clean the products before assembly. Despite its classification as NVA, the quality control function remains crucial. To reduce the frequency of movement without sacrificing quality, the implementation of a sampling inspection method is proposed, where inspection is only conducted on the initial components of every 10 production units. Thus, the frequency of repetitive inspection activities can be reduced, while the sequence of work elements in subsequent units is focused on the main activities (selecting, assembling, marking). This approach maintains product quality while simultaneously saving time and movement significantly.

This standardized work method not only makes workers more productive, but it also improves the quality of their work by making it easier for them to move around and reducing the physical load. With the reduction of hand travel distance and the elimination of unnecessary movements, the risk of assembly errors can be minimized, while the consistency of work results increases. The integration of TMS, VSM, right-left hand maps, and Therblig analysis simultaneously has proven effective in providing a comprehensive picture of the actual working conditions and the appropriate direction for improvement.

3.3 Implications of the Results

This research theoretically enhances the literature on the integration of time and motion analysis as a foundation for developing ergonomic and efficient work practices. The proposed methodology derived from these findings can be directly applied on the production line to minimize non-value-added operations, equilibrate the utilization of both hands, and enhance productivity by over 10% relative to the previous way. Thus, the initial hypothesis that there is potential for significant improvement in the work method of the cover seat belt anchor assembly process has been proven correct.

The theoretical implications can expand the application of the integrated TMS-VSM-Therblig work method in complex assembly. Practically, the feasibility of the proposed approach was validated through consultations with production supervisors and industrial engineering personnel at the company. The redesigned workflow and revised standard time were assessed in terms of operational compatibility, worker adaptability, and alignment with production targets. Expert evaluation indicated that the proposed standard time of 48.83 s per unit is consistent with current productivity targets and operational capacity, supporting the industrial applicability of the proposed method. In the long term, this approach has the potential to reduce production costs, increase customer satisfaction through timely delivery, and strengthen the company's competitiveness in the automotive component manufacturing industry.

4. Conclusion

This study demonstrates that the operational framework of the seat belt anchor cover assembly process at PT. Solo Plastik Indonesia still harbors inefficiencies that detrimentally impact productivity and efficiency. Scientific findings indicate an imbalance in the activities of the right and left hands, a dominance of non-value-adding movements such as searching and unladen transfers, as well as a relatively high proportion of non-value-adding activities. The standard time analysis results suggest that current work methods can be expedited relative to the company's requirements, and the adoption of recommended work method enhancements may considerably decrease standard time and augment daily production.

The novelty of this study lies in the integration of time and motion study (TMS), value stream mapping (VSM), right–left hand mapping, and Therblig analysis into a unified framework for simultaneous motion evaluation and standard time optimization in an industrial assembly process. The findings substantiate the research hypothesis, demonstrating that the integrated approach effectively identifies and mitigates non-value-added activities, while also fostering more ergonomic and productive work methods. Future research may focus on the implementation of the proposed work method design in the field to evaluate long-term productivity impacts on long-term productivity, as well as the integration with advanced ergonomic analysis and simple automation technologies to minimize reliance on repetitive manual operations.

Acknowledgment

We extend our deepest appreciation to Universitas Majalengka for awarding the Universitas Majalengka Internal Research Grant for the year 2025.

References

[1] M. Sinungan, *Produktivitas Apa Dan Bagaimana*. Jakarta: Bumi Aksara, 2009.

[2] P. M. Pardede, *Manajemen Operasi Dan Produksi*. Yogyakarta: Andi, 2005.

[3] E. Mahawati, *Analisis Beban Kerja Dan Produktivitas Kerja*. Yayasan Kita Menulis, 2021.

[4] I. Z. Sutalaksana, R. A., and J. H. T., *Teknik Perancangan Sistem Kerja*. ITB, 2006.

[5] I. Khadijah and A. Kusumawardhani, "Analisis Pengukuran Kerja Untuk Mengoptimalkan Produktivitas Menggunakan Metode Time and Motion Study," *Diponegoro J. Manag.*, vol. 5, no. 3, pp. 1–15, 2016.

[6] Y. Demmanggasa, "Studi Pengukuran Waktu Kerja Terhadap Peningkatan Kinerja Karyawan," *Jnsta Adpertisi J.*, vol. 3, no. 2, pp. 21–28, 2023, doi: 10.62728/Jnsta.V3i2.459.

[7] C. H. Sumerli and N. Mayselah, "Optimalisasi Produktivitas Dengan Metode Time and Motion Study Di Pt. Xyz," *J. Res. Ind. Syst. Eng.*, vol. 1, no. 1, pp. 1–12, 2023.

[8] S. L. Maknun and J. Aidil, "Implementation of Lean Manufacturing Approach Using Value Stream Mapping to Optimize Cycle Time and Reduce Process Waste (Case Study: CV Teguh Jaya Mandiri)," *IJIEM - Indones. J. Ind. Eng. Manag.*, vol. 5, no. 2, p. 589, 2024, doi: 10.22441/Ijiem.V5i2.22440.

[9] M. S. J. Rother, *Value Stream Mapping to Add Value and Eliminate Muda*. Lean Enterprise Institute, 2003.

[10] I. Fardiansyah, T. Widodo, and W. Anggraini, "Pengukuran Waktu Kerja Dengan Metode Time Motion Study Untuk Meningkatkan Produktivitas Kerja Produksi Greenware (Studi Kasus: PT XYZ)," *J. Ind. Manuf.*, vol. 7, no. 2, p. 85, 2022, doi: 10.31000/Jim.V7i2.6924.

[11] D. Ayu, M. Andris, and H. F. Satoto, "Analisis Waktu Standar Dalam Penentuan Jumlah Tenaga Kerja Pada Produksi Cage Wheel Dengan Metode Stopwatch Time Study (Studi Kasus: CV Lancar Jaya)," *J. Ilm. Tek. Dan Manaj. Ind.*, vol. 3, no. 1, pp. 371–380, 2023, doi: 10.46306/Tgc.V3i1.

[12] M. Basri and R. Arsal, "Pengaruh Efektivitas Dan Efisiensi Kerja Pegawai Terhadap Kinerja Organisasi Dinas Sosial Kota Kendari," *J. Publicuho*, vol. 5, no. 4, pp. 1127–1138, 2022, doi: 10.35817/Publicuho.V5i4.52.

[13] F. R. K. Syahputra, A. Suryadi, and E. Purnamawati, “Perancangan Meja Belajar Multifungsi Ergonomis Dengan Metode Pahl and Beitz Guna Mendukung Aktivitas Belajar Di Rumah,” *Juminten*, vol. 2, no. 4, pp. 121–132, 2021, doi: 10.33005/Juminten.V2i4.238.

[14] S. Kamuli, “Pengaruh Iklim Organisasi Terhadap Produktivitas Kerja Pegawai Di Sekretariat Daerah Kota Gorontalo.”

[15] A. A. Pangestu, A. Alamsyah, and P. Negara, “Implementasi Metode 5s (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) Pada Unit Reaching di PT XYZ Tekstil Majalengka.”

[16] Zhang, “Integrating Lean and Ergonomic Principles in Automotive Assembly Lines,” *Int. J. Prod. Res.*, pp. 4215–4230, 2023.

[17] L. C. Kumar, “Productivity Enhancement Through Combined TMS and Lean Tools in Automotive Industry,” *J. Manuf. Syst.*, pp. 201–212, 2022.

[18] N. F. Fatma and H. P. E. S., “Penerapan Lean Manufacturing Dengan Metode Value Stream Mapping Untuk Mengurangi Waste Pada Proses Pengecekan Material Bahan Baku Ke Lini Produksi,” *J. Ind. Manuf.*, vol. 7, no. 1, pp. 41–54, 2022.

[19] S. Wignjosoebroto, *Ergonomi Studi Gerak Dan Waktu*. 2006.

[20] I. L. O. L. Office, *ILO Guide to International Labour Standards on Occupational Safety and Health*.

[21] D. Susandi, A. Rijaluddin, and A. Chaliq, “Perancangan Stasiun Kerja Ergonomis untuk Operator Pemotongan Bahan Baku di Pabrik Genteng Jatiwangi, Kabupaten Majalengka,” *J. Metris*, vol. 15, no. 1, pp. 29–40, 2014.

[22] O. R. Occupational, H. Practice, and I. D. Countries, *OR OCCUPATIONAL HEALTH PRACTICE IN*.

[23] B. Ralph M., *Motion and Time Study: Design and Measurement of Work*. New. York: John Wiley and Sons, 1980.