

# Application Of Methods Engineering To Optimize The Efficiency Of Forklift Use In A Logistics Company

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## ABSTRACT

The objective of the study was to ascertain the extent to which the implementation of method engineering optimizes efficiency in the use of forklifts in a logistics company in Callao during the year 2025. The analysis entailed the examination of a population equivalent to the total pallet transfers recorded daily for a period of 45 days during the pre-test and post-test stages. This approach ensured that no sampling was applied in the data collection process. The research was approached using a quantitative method, with an explanatory level and a pre-experimental design. The collection of data was facilitated by the use of various instruments, including record sheets, digital stopwatches, and checklists. The findings indicated substantial enhancements after the integration of method engineering. The total efficiency exhibited an increase of 24.73%, transitioning from 77.25% (pre-test) to 96.35% (post-test). Operating efficiency exhibited an improvement of 18.09%, ascending from 80.19% to 94.70%. Consequently, economic efficiency was optimized by 24.44%, with a notable shift from 77.43% to 96.35%. Wilcoxon's statistical test confirmed significant differences between the two stages ( $p < 0.05$ ). The application of method engineering has been demonstrated to enhance the operational efficiency, economic efficiency, and overall efficiency of forklift use. This finding substantiates the efficacy of method engineering as a pivotal instrument in the optimization of logistics processes.

**KEYWORDS:** Methods Engineering, Operational Efficiency, Economic Efficiency, Logistics, Forklifts.

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## Introduction

In a global environment characterized by intense competition and mounting pressure to enhance productivity, large-scale logistics companies face persistent challenges in optimizing their internal processes to deliver effective, secure, and timely services. In the context of activities characterized by a constant flow of materials, such as in warehousing and distribution systems, enhancing operational efficiency assumes a particularly salient role. In this context, methods engineering emerges as a pivotal instrument, facilitating the examination, restructuring, and standardization of procedures that exert influence on production and costs. This approach contributes to the reduction of lost time, the enhancement of work ergonomics, and the assurance of a logical sequence in activities. This approach is consistent with SDG 9, as it "contributes to minimizing the waste of materials, time, and energy, making processes more sustainable, and therefore optimizing the use of natural resources

in production systems" (UN, 2024). Consequently, methods engineering is presented as a pivotal resource for enhancing the efficiency and sustainability of operations within the logistics sector. The augmentation of international trade underscores this necessity. According to the World Trade Organization, "the volume of merchandise trade has grown by 3.6% quarter-on-quarter and 5.3% in the initial quarter of 2025, a growth that is particularly notable in regions such as Africa, Asia, and South America. This increase has led to heightened demands on logistics chains, compelling them to adapt their processes to be faster, more accurate, and more cost-effective. This adaptation is crucial for preventing delays, enhancing operational capacity, and maintaining competitiveness at a global level. In pallet handling, a pivotal activity in warehouses, terminals, and consolidation centers, any inefficiency can have ramifications on the supply chain, affecting deadlines, costs, and the quality of service.

Consequently, method engineering emerges as a structural imperative to sustain growth in operations and enhance the performance of handling equipment. In the Latin American context, methods engineering has emerged as a pivotal element in the continuous improvement strategies employed by industrial and logistics enterprises. According to González and Patiño (2017), the implementation of this strategy has been shown to favor "the reduction of waste and increase the competitiveness of organizations." The incorporation of technologies such as operational systematization and predictive maintenance serves to fortify this movement by facilitating the identification of bottlenecks and opportunities for enhancement with greater clarity. In the context of industrial engineering, several Latin American countries, including Mexico, Colombia, Brazil, and Peru, have adopted methodologies such as time study, activity analysis, and approaches based on Lean Manufacturing. The implementation of these methodologies has yielded substantial improvements in key performance indicators, including response capacity, time reduction, and resource use. In this sense, Freivalds and Niebel (2008) emphasize that these methodologies enable precise comprehension of task execution within a production system, thereby providing a scientific foundation for its restructuring. In the Peruvian context, this need is further compounded by the expansion of the logistics and export sector. According to PROMPERÚ (2024), "exports from the non-traditional agricultural sector exhibited an increase of 21.6% compared to the previous period," thereby underscoring the significance of optimizing processes that depend on the efficient handling of goods. Nevertheless, numerous companies continue to encounter operational challenges stemming from a paucity of standardization, inefficient resource use, and inadequate technical training of personnel. Research conducted by Rocha and Montoya (2019) demonstrates that the implementation of methods engineering in Peruvian companies has enabled a substantial reduction in production times and an enhancement in the distribution of work. This finding is particularly pertinent to the logistics sector, where the operation of forklifts necessitates precision, continuity, and organization. A case study of a

company located in Callao revealed several factors that affected the efficiency of forklift usage. The Ishikawa diagram was used to identify problems related to raw materials, method, labor, machinery, environment, and measurement. The most significant contributing factors were as follows:

- "Pallets in poor condition and accumulations of disorganized pallets."
- "Lack of a daily work plan."
- "Inadequate assignment of tasks to operators."
- "Forklifts in poor condition and with inadequate maintenance."
- "Insufficient number of forklifts."
- "Damaged areas and/or imperfections in the floor."
- The absence of standardized times and productivity metrics, such as KPIs.

A thorough examination of the Vester matrix revealed that the most significant contributing factors were the absence of standardization in scheduling, the dearth of a structured daily work plan, and the paucity of performance metrics. The Pareto diagram confirmed that these critical causes represented the origin of 80% of the problem, thereby evidencing the need to intervene through method engineering to achieve significant improvements in the operation. The central research problem was formulated based on the diagnosis. The objective of this study is to determine the extent to which the implementation of Methods Engineering will enhance the efficiency of forklift use in a logistics company by the year 2025. Consequently, a series of specific inquiries were formulated to assess operational and economic efficiency after the implementation of the method. The overarching objective of the study was to ascertain the way method engineering contributes to the optimization of overall efficiency in forklift use. Specific objectives were delineated with the aim of investigating its impact on operational and economic efficiency. The theoretical underpinnings of this approach are rooted in the rigorous application of the scientific method, encompassing the use of measuring instruments and a comparative analysis between the pre-test and post-test stages. The practical justification is rooted in the resolution of a tangible problem that impacts logistics performance, while the

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economic justification is associated with the reduction of costs from the standardization of processes and the enhancement of operational efficiency. The study provides empirical evidence that method engineering is imperative in real logistics environments. It demonstrates that standardizing activities, defining standard times, and reorganizing the operational flow can markedly improve efficiency in the use of forklifts.

#### Literature review

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Methods engineering is a pivotal instrument within the domain of industrial engineering, with the objective of scrutinizing and enhancing labor procedures through the eradication of superfluous activities and the maximization of resource use. As Barnes (1980) notes, "method engineering is understood as the systematic analysis of current work methodologies with the aim of perfecting them through scientific principles," thereby underscoring its emphasis on efficiency and standardization. This method enables the observation, documentation, and redesign of tasks, with the objective of eliminating redundant actions, reducing downtime, and establishing protocols that ensure optimal performance. According to González and Patiño (2020), method engineering "focuses on the continuous improvement of processes through an exhaustive analysis of the activities carried out in the company," which underscores its importance for organizations that need operational control and constant progress.

The analysis of methods is predicated on two essential technical foundations: the study of movements and the study of times. In the context of movement studies, Niebel and Freivalds (2008) define it as "the systematic analysis of the movements of the human being when performing a job, aimed at eliminating or reducing ineffective ones," emphasizing its contribution to ergonomics and the efficient use of physical effort. The principles of economy of motion, as articulated by Frank and Lillian Gilbreth in 1917, underpin this methodology by establishing guidelines aimed at minimizing superfluous movement, enhancing task coordination, and averting worker fatigue. These principles assume particular relevance in the context of logistics

activities, which frequently entail repetitive tasks, pallet handling, and forklift operation. These activities demand precision, order, and the minimization of superfluous movements.

Conversely, the time study is a methodical procedure that aims to ascertain the time required to complete a task under standard working conditions. Niebel (2009) posits that this process "aspires to establish an average time to execute an activity effectively," thereby providing a quantitative foundation for capacity planning, workload balancing, and productivity evaluation. To achieve this objective, tasks are meticulously divided into fundamental components, repetition is employed to ensure mastery, pacing is assessed using methods such as Westinghouse, and supplements are incorporated to address fatigue, personal needs, and unavoidable delays. The aggregate of these elements enables the calculation of standard time, which is regarded as a reference measure that guides operational decisions and the organization of work within a company.

Efficiency, defined as the capacity to achieve the desired outcomes with minimal resources, is the fundamental variable associated with method engineering. González and Patiño (2020) characterized it as "the ability of an organization to perform a job using the minimum of energy or resources," thereby underscoring its relevance in any production or service process. This concept encompasses two key aspects: operational efficiency, which pertains to the optimal use of available time, and economic efficiency, which focuses on the rational allocation of financial resources. In the domain of logistics, Slack and Johnston (2016) have delineated the concept of an efficient company as one that generates value through the use of fewer resources, the product of well-designed processes, the appropriate use of technology, and effective personnel management. This understanding suggests that efficiency encompasses more than merely reducing work time; it encompasses enhancing quality, reducing costs, and facilitating a more organized operational flow.

The extant research provides substantial support for the correlation between method engineering and efficiency in diverse productive sectors. For instance,

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studies in manufacturing, agribusiness, and services demonstrate substantial reductions in time, effective workflow reorganization, and significant productivity improvements following the adoption of techniques such as process analysis, motion study, and standard timing. The thesis examined further explores this relationship, demonstrating that operational inefficiencies often stem from three key factors: the absence of standardization, the lack of performance indicators, and the presence of unclear procedures. In this context, it is demonstrated how tools such as the Ishikawa diagram facilitated the identification of the primary causes of the problem. These causes include "the absence of a daily work plan, the inadequate allocation of tasks to workers, forklifts in poor condition with minimal maintenance, an insufficient inventory of forklifts, deteriorated areas and/or imperfections in the floor, and the lack of standardized times for daily activities." These factors contribute directly to diminished levels of operational and economic efficiency.

A complementary perspective is offered by analytical tools such as the Vester matrix, which facilitates the degree to which identified causes influence the system's behavior, and the Pareto diagram, which aids in the identification of critical causes in accordance with the 80/20 rule. In this instance, it was determined that the primary causes of the issue were the absence of standardized times in operational activities, the lack of a daily work plan, and the absence of performance measurement criteria. This analysis indicates that methodological and organizational failures are at the core of the problem, thereby substantiating the implementation of method engineering to achieve substantial improvements.

This conceptual foundation enables the conclusion that methods engineering is a highly effective tool for optimizing logistics processes, particularly in loading, storage, and transport activities within warehouses. The implementation of this system has been shown to contribute to the reduction of variability in performance, the establishment of labor standards, the optimization of times, and the improvement of the use of forklifts. These are vital resources in companies that handle large volumes of cargo daily. Moreover, the impact of this initiative has been shown to yield tangible benefits, including a reduction in operating

costs, a decline in overtime, enhanced resource planning efficiency, and an increased responsiveness to market demands that are both growing and variable. Therefore, the correlation between the notions of method engineering, movement study, time study, and efficiency furnishes the requisite theoretical underpinnings to comprehend the significance of employing these instruments in authentic logistics scenarios. A case in point is the research analysis, which elucidates how continuous enhancement is paramount to attain competitiveness and operational sustainability in logistics contexts.

#### Materials & Methods

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The study was conducted using a quantitative approach, as Vizcaíno et al. (2023) have noted. This approach "measures, and is presented through numerical data, the criteria that are examined in a population," thereby facilitating an accurate measurement of changes in efficiency before and after the intervention. This approach was deemed appropriate due to the nature of the variables analyzed, which include total, operational, and economic efficiency. These variables are expressed as percentages, necessitating a comparative statistical analysis to observe their evolution.

The nature of the study was applied, as its objective was to solve a real problem of operation within a logistics company. According to Hernández, Fernández, and Baptista (2014), this type of research "integrates theoretical knowledge in real situations with the aim of solving specific problems," which corresponds to the need identified in the company to improve the use of forklifts through method engineering. This applied approach enabled the evaluation of the operating system's performance and the suggestion of concrete improvements that would have an immediate impact on daily operations.

The research was of an explanatory nature, as it sought to identify cause-and-effect relationships between the implementation of method engineering and the effectiveness in the use of forklifts. According to Arias (2012), the objective of explanatory research is to establish cause-and-effect relationships through the identification of causes or effects. This is a critical step in determining whether the intervention was responsible for the changes observed. This level facilitated comprehension of the correlation between

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process redesign, standard times, and the efficiency of the logistics system.

The methodological design employed was pre-experimental, aligning with the assertions made by Kerlinger and Lee (2002). These scholars contend that experimental design serves to "ensure the accuracy of conclusions regarding causality, thereby reducing the influence of extraneous factors." In this context, the study employed a pre-experimental design with a single measurement group both before (O1) and after (O2) the intervention (X). This design enabled the direct effect of method engineering to be analyzed. The scheme that was implemented was:

- O1: prior measurement of total, operational and economic efficiency.
- X: Implementation of method engineering (study of movements, study of times, standardization).
- O2: post-intervention measurement.

The population under study comprised all pallet transfers executed during a 45-day period, encompassing the pre- and post-race stages. Consequently, the sample was deemed to be representative of the total population, as previously stated in the document. The sample exhibited an exact match with the population; consequently, the process of sampling was rendered superfluous. This approach facilitated the acquisition of a comprehensive representation of the operating behavior, obviating the necessity for assumptions regarding the samples.

The independent variable in this study is method engineering, which Kanawaty (1996) defines conceptually as "the exhaustive analysis of the procedures of a work process carried out in order to use productive resources effectively and efficiently." Its operational definition was applied through a meticulous examination of the study of movements and the study of times, which made it possible to identify non-productive actions, record the pace of work, establish normal times, and define standard times for each operational task that involves the use of forklifts.

Three primary instruments were utilized in the acquisition of data:

- Record sheet, used to document the operational sequence and daily efficiency results.

- Digital stopwatch, designed to measure cycle times, transfer times and duration of each operational sub-process.
- Checklist, used to standardize observation and verify compliance with the method during pre-test and post-test measurements.

The procedure entailed direct observation of tasks related to the use of forklifts, the subsequent segmentation of activities into their constituent components, and the documentation of the associated temporal elements. Subsequently, normal times were calculated, and supplements for fatigue and unavoidable delays were added. The standard time for each activity was then defined. Subsequent to this, an intervention was executed that was predicated on engineering techniques. This intervention encompassed the restructuring of the workflow, the redistribution of the design of the space, the standardization of procedures, the elimination of superfluous movements, and the training of personnel. Subsequent to the implementation of these enhancements, the measurement process was reiterated under the same methodological conditions.

In order to validate the hypothesis, the Wilcoxon statistical test was applied. This particular statistical test is considered to be suitable for the purpose of comparing paired pre-test and post-test measurements. The results of the analysis indicated that the p-value (sig) was less than 0.05, thereby confirming the alternative hypothesis. This finding suggests that the intervention generated statistically significant differences in terms of efficiency. The findings indicated a marked improvement from 24. The total efficiency of the system was 73%, which is equivalent to 18. The efficiency of operations was found to be 9% and 24%, respectively. The findings indicate that method engineering has a positive and relevant effect on the performance of the evaluated process, as evidenced by its contribution to economic efficiency, which was confirmed at 44%.

#### Results

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##### Descriptive analysis of Total Efficiency

According to the amount of samples analyzed, the average for both stages is shown:

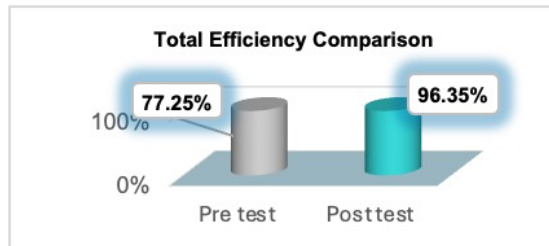


Fig. 1. Comparison of Total Efficiency

In relation to the values shown, it was identified that the total efficiency achieved an optimization of 24.38%. To do this, the following formula was applied:

Table 1. Calculation of the Total Efficiency improvement increment

TOTAL EFFICIENCY	
$Incremento = \frac{(Post\ test - Pre\ test)}{Pre\ test} \times 100$	
Pre-test	77.25%
Post test	96.35%
(↑) UPGRADE	24.73%

Then, the formula was applied, achieving an improvement of 24.73% in total efficiency, with the application of the 8 stages of Method Engineering. Therefore, with the application of Methods Engineering. Then, the analysis was carried out using the SPSS, v.25.

Table 2. Calculation of the Total Efficiency improvement increment

Total efficiency		Pre-test	Post test
N	Valid	45	45
	Lost	0	0
Stocking		77.25	96.35
Median		75.19	95.68
Fashion		75.19	97.49
Desv. Deviation		4.28	1.81
Variance		18.29	3.26
Asymmetry		0.43	0.12
Kurtosis		-1.00	-1.03

Consequently, statistical analyses have revealed a substantial increase in mean total efficiency, with a notable rise from 77.25% in the pre-test to 96.35% in the post-test. This finding suggests that a substantial enhancement in efficiency occurred subsequent to the temporal interval between tests or subsequent to the intervention. The median also exhibited a comparable increase (from 75.19 to 95.68), thereby substantiating that the majority of the participants attained noticeably elevated scores on the post-test. In sum, the findings of the post-test demonstrate a substantial and consistent increase in total efficiency in comparison to the pre-test, accompanied by a notably elevated mean and a substantially reduced variability in grades.

#### Descriptive Analysis of Operational Efficiency

According to the amount of sample analyzed, the average for both stages is shown:

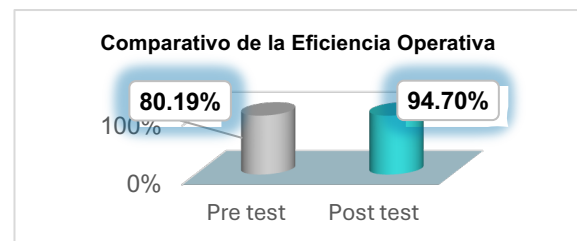


Fig. 2. Comparative of Operational Efficiency.

In relation to the values shown, it was identified that operational efficiency achieved an optimization of 18.09%. To do this, the following formula was applied:

Table 3. Calculation of the Total Efficiency improvement increment.

OPERATIONAL EFFICIENCY	
$Incremento = \frac{(Post\ test - Pre\ test)}{Pre\ test} \times 100$	
Pre-test	80.19%
Post test	94.70%
(↑) UPGRADE	18.09%

Subsequently, the previously mentioned formula was implemented, resulting in an 18.09% enhancement in operational efficiency through the integration of the eight stages of Method Engineering.

Consequently, the implementation of Methods Engineering is imperative. Subsequently, the analysis was executed with the use of the SPSS v.25 software.

Table 4. Description of Operational Efficiency

Operational efficiency		Pre-test	Post test
N	Valid	45	45
	Lost	0	0
Stocking		80.20	94.71
Median		79.09	95.05
Fashion		76.16a	97.26
Desv. Deviation		4.47	3.77
Variance		20.01	14.20
Asymmetry		0.32	-0.38
Kurtosis		-0.88	-1.18

Consequently, statistical analyses have revealed a substantial increase in mean total efficiency, with a notable rise from 80.20% in the pre-test to 94.71% in the post-test. This finding suggests that a substantial enhancement in efficiency occurred subsequent to the temporal interval between tests or after the intervention. The median also exhibited a comparable increase (from 79.09 to 95.05), thereby substantiating the finding that most of the participants attained noticeably higher scores in the post-test. In sum, the post-test results indicate a substantial and consistent enhancement in operational efficiency, as compared to the pre-test results. This increase is characterized by a notably elevated mean and a substantially reduced variability in grades.

#### Descriptive Analysis of Economic Efficiency

According to the amount of sample analyzed, the average for both stages is shown:

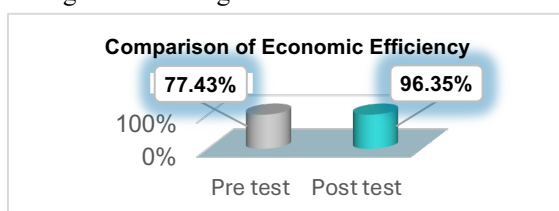


Fig. 4. Economic Efficiency Comparison.

In relation to the values shown, it was identified that economic efficiency achieved an optimization of

24.44%. To do this, the following formula was applied:

Table 5. Calculation of the Total Efficiency improvement increment

ECONOMIC EFFICIENCY	
$Incremento = \frac{(Post\ test - Pre\ test)}{Pre\ test} \times 100$	
Pre-test	77.43%
Post test	96.35%
(↑) UPGRADE	24.44%

Then, the formula was applied, achieving an improvement of 24.44% in Economic efficiency, with the application of the 8 stages of Method Engineering. Therefore, with the application of Methods Engineering. Then, the analysis was carried out using the SPSS, v.25.

Table 6. Description of Economic Efficiency

Economic efficiency		Pre-test	Post test
N	Valid	45	45
	Lost	0	0
Stocking		77.43	96.35
Median		76.53	95.68
Fashion		75.19	97.49
Desv. Deviation		4.18	1.81
Variance		17.46	3.26
Asymmetry		0.38	0.12
Kurtosis		-0.94	-1.03

Consequently, statistical analyses have revealed a substantial increase in mean total efficiency, with a notable rise from 77.43% in the pre-test to 96.35% in the post-test. This finding suggests that a substantial enhancement in efficiency occurred subsequent to the temporal interval between tests or subsequent to the intervention. The median also exhibited a comparable increase (from 76.53 to 95.68), thereby substantiating the finding that the majority of the participants attained noticeably higher scores in the post-test. In sum, the post-test results indicate a substantial and consistent increase in economic efficiency in comparison to the pre-test results. This increase is

characterized by a notably elevated mean and a substantially reduced variability in grades.

#### Inferential Analysis of Total Efficiency

##### Normality test

The results of the sample of the total efficiency in the SPSS are entered, as detailed. The evaluation ranges are detailed below:

- Yes, sample (gl) < 50, Shapiro Wilk is tested
- Yes, sample (gl) > 50, Kolmogorof is analyzed

Table 7. Shapiro Wilk of Total Efficiency

Total efficiency	Statistical	Gl	Gis.
Pre-test	0.92	45.00	0.01
Post test	0.87	45.00	0.00

In short, according to the table shown, it is true that Shaprio-Wilk is analyzed, because the sample quantity is 45, and it is less than 50. Then, the second evaluation range is detailed:

- If the sig (p-value) < 0.05, the data does not exhibit normal – non-parametric behavior
- If the sig (p-value) > 0.05, the data exhibit a normal-parametric behavior

So, according to the result of the sig for the pre-test of 0.01, less than 0.05, and for the post-test of 0.00, less than 0.05, it is true that both do not present a normal behavior – non-parametric.

##### Hypothesis testing

The results of the sample of the total efficiency in the SPSS are entered, as detailed. The evaluation ranges are detailed below:

- If the sig (p-value) < 0.05, the Ha is affirmed
- Yes, the sig (p-value) > 0.05, the Ho is affirmed

Then, the hypotheses are raised:

Ho: The application of Method Engineering "does not" optimize the Efficiency in the use of Forklifts in a Logistics Company, Callao 2025

Ha: The application of Method Engineering "if" optimizes the Efficiency in the use of Forklifts in a Logistics Company, Callao 2025

Table 8. Total Efficiency Ranges

Total efficiency	N	Average Range	Sum of ranks
Negative Ranges	45A	23.00	1035.00
Post-test-Pre test Positive Ranges	0b	0.00	0.00
Draws	0c		
Total	45		

Table 9. Wilcoxon of Total Efficiency

Total efficiency	Post-test-Pre test
Z	-5,842b
Asymptotic sig. (bilateral)	0.00

Therefore, according to the sig it was 0.00, less than 0.05, that means that the Ha is affirmed. In other words, the Ha states "The application of Method Engineering "if" optimizes Efficiency.

#### Inferential Analysis of Operational Efficiency

The results of the sample of operational efficiency are entered into the SPSS, as detailed. The evaluation ranges are detailed below:

- Yes, sample (gl) < 50, Shapiro Wilk is tested
- Yes, sample (gl) > 50, Kolmogorof is analyzed

Table 10. Shapiro Wilk of Operational Efficiency

Operational Efficiency	Statistical	Gl	Gis.
Pre-test	0.92	45.00	0.00
Post test	0.89	45.00	0.00

In short, according to the table shown, it is true that Shaprio-Wilk is analyzed, because the sample quantity is 45, and it is less than 50. Then, the second evaluation range is detailed:

- If the sig (pvalue) < 0.05, the data does not exhibit normal – non-parametric behavior
- If the sig (pvalue) > 0.05, the data exhibit a normal-parametric behavior

So, according to the result of the sig for the pre-test of 0.00, less than 0.05, and for the post-test of



0.00, less than 0.05, it is true that both do not present a normal – non-parametric behavior.

#### Hypothesis testing

The results of the sample of operational efficiency are entered into the SPSS, as detailed. The evaluation ranges are detailed below:

- If the sig (pvalue) < 0.05, the Ha is affirmed
- Yes, the sig (p-value) > 0.05, the Ho is affirmed

Then, the hypotheses are raised:

Ho: The application of Method Engineering "does not" optimize operational efficiency in the use of forklifts in a logistics company, Callao 2025

Ha: The application of Method Engineering "if" optimizes operational efficiency in the use of forklifts in a logistics company, Callao 2025.

Table 11. Operational Efficiency Ranges

Operational efficiency	N	Average Range	Sum of ranks
Negative Ranges	45A	23.00	1035.00
Positive Ranges	0b	0.00	0.00
Draws	0c		
Total	45		

Table 12. Wilcoxon of Operational Efficiency

Operational efficiency	Post-test-Pre test
Z	-5,843b
Asymptotic sig. (bilateral)	0.00

Therefore, according to the sig it was 0.00, less than 0.05, that means that the Ha is affirmed. In other words, the Ha states "The application of Method Engineering "if" optimizes operational efficiency.

#### Inferential Analysis of Economic Efficiency

The results of the economic efficiency sample are entered into the SPSS, as detailed. The evaluation ranges are detailed below:

- Yes, sample (gl) < 50, Shapiro Wilk is tested
- Yes, sample (gl) > 50, Kolmogorof is analyzed

Table 13. Shapiro Wilk of Economic Efficiency

Economic efficiency	Statistical	Gl	Gis.
Pre-test	0.94	45.00	0.01
Post test	0.87	45.00	0.00

In short, according to the table shown, it is true that Shaprio-Wilk is analyzed, because the sample quantity is 45, and it is less than 50. Then, the second evaluation range is detailed:

- If the sig (p-value) < 0.05, the data does not exhibit normal – non-parametric behavior
- If the sig (p-value) > 0.05, the data exhibit a normal-parametric behavior

So, according to the result of the sig for the pre-test of 0.01, less than 0.05, and for the post-test of 0.00, less than 0.05, it is true that both do not present a normal behavior – non-parametric.

#### Hypothesis testing

The results of the economic efficiency sample are entered into the SPSS, as detailed. The evaluation ranges are detailed below:

- If the sig (p-value) < 0.05, the Ha is affirmed
- Yes, the sig (p-value) > 0.05, the Ho is affirmed

Then, the hypotheses are raised:

Ho: The application of Method Engineering "does not" optimize the economic efficiency in the use of forklifts in a logistics company, Callao 2025

Ha: The application of Method Engineering "if" optimizes the economic efficiency in the use of forklifts in a Logistics Company, Callao 2025.

Table 14. Economic Efficiency Ranges

Economic efficiency	N	Average Range	Sum of ranks
Negative Ranges	45A	23.00	1035.00
Positive Ranges	0b	0.00	0.00
Draws	0c		
Total	45		

Table 15. Wilcoxon of Economic Efficiency

Economic efficiency	Post-test-Pre test
Z	-5,842b
Asymptotic sig. (bilateral)	0.00

Therefore, according to the sig it was 0.00, less than 0.05, that means that the Ha is affirmed. In other words, the Ha states "The application of Method Engineering "if" optimizes economic efficiency.

#### Discussion

The findings indicate that the implementation of method engineering has yielded substantial enhancements in the efficiency of forklift use, culminating in an escalation of 24.73% in total efficiency. This progression is evident from a pre-test efficiency of 77.25% to a post-test efficiency of 96.35%. This enhancement validates the implemented intervention, grounded in movement analysis, time study, process standardization, and operational reorganization, effectively optimized pallet transfer and handling activities. As indicated in the document: The logistics process demonstrated a substantial enhancement, with an initial optimization rate of 24.73%, which subsequently increased to 77.25% in the pre-test stage. Following the implementation of Methods Engineering, the post-test recorded an impressive improvement, with an optimized rate of 96.35%.

This outcome aligns with extant research that has demonstrated the efficacy of method engineering in enhancing industrial processes. For instance, Saucedo, Valenzuela, and Báez (2021) demonstrated substantial decreases in operating times and labor costs, underscoring that their intervention "achieved an 87% reduction in operating time and a 57% improvement in labor costs," a result of the analysis of operations and the restructuring of the production process. As in the study, the enhancement was derived from the identification of activities that lacked added value and the subsequent redefinition of the operating flow.

The findings align with the conclusions of Espinoza (2022), who determined that the implementation of the work study program led to a significant reduction in non-productive time from 25% to 5%, accompanied by a substantial enhancement in efficiency, which increased from

75% to 94%. This evidence supports the principle that method engineering—and in particular the study of time and motion—is an effective tool for standardizing tasks, improving productivity, and reducing process variability. In accordance with this perspective, the thesis posits that "the engineering of methods and the study of times and movements is a tool that focuses on the constant improvement of procedures through a detailed analysis of the actions," which explains the positive impact obtained in the operational area evaluated.

In terms of operational efficiency, the 18.09% improvement indicates that the redistribution of activities, the elimination of unnecessary movements, and the definition of a standardized method have collectively enabled the reduction of cycle times and the maximization of the forklift's performance. Conversely, economic efficiency exhibited a 24.44% surge, signifying that the optimization of resources did not merely enhance productivity but also led to a reduction in the costs associated with the operation of the forklift. As indicated by the document, the implementation of the methods resulted in an enhancement of economic efficiency by 24.44%, with initial results showing 77.43% and subsequent outcomes reaching 96.35% in the post-test stage, thereby substantiating the financial viability of the intervention.

The employment of the scientific method and the pre-experimental design facilitated an objective comparison of the status quo ante and post-implementation, thereby statistically substantiating that the observed enhancement was not merely a fortuitous occurrence. Wilcoxon's test validated the significance of the findings, as evidenced by the "value (sig) being less than 0.05, thereby validating the Ha" hypothesis. This indicates that the intervention effectively optimized the operational and economic efficiency of the process.

The findings of this study align with the theoretical postulates of González and Patiño (2020), who contend that method engineering is predicated on constant improvement through meticulous analysis of activities, thereby facilitating the identification and elimination of superfluous time. The study lends support to this claim by demonstrating a decline in activities that lacked added value, including excessive

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travel, prolonged waiting times, and a lack of prior standardization.

The findings indicate that method engineering is a highly effective tool for logistics processes, particularly in operations involving equipment such as forklifts, whose efficiency is contingent on proper coordination, standardization of tasks, and the correct organization of space and the flow of materials. The findings obtained in this study demonstrate a high degree of external validity, as evidenced by the strong consistency between the results and existing literature on the subject. These results indicate that the principles applied in this study can be replicated in other logistics or industrial environments that exhibit similar characteristics.

#### Conclusions

The findings suggest that the implementation of method engineering had a substantial impact on enhancing the efficiency of forklift use within the logistics company under scrutiny. As indicated in the document, "by applying methods engineering, efficiency was optimized by 24.73%, registering 77.25% in the pre-test stage, and subsequently efficiency was significantly optimized by 96.35% for the post-test," which shows that the redesign of the process, the standardization of activities, and the operational reorganization generated substantial improvements in the overall performance of the operation.

Regarding operational efficiency, the findings indicate that the intervention led to the elimination of superfluous movements, a reduction in non-productive time, and an enhancement in work sequence. The document explicitly states that "through the implementation of method engineering, it was possible to enhance operational efficiency by 18.09%, achieving 80.19% in the pre-test stage, and subsequently, it was possible to optimize operational efficiency significantly by 94.70% for the post-test," thereby validating that the standardization of the method and the redefinition of activities contributed to the enhancement of the forklift's productivity.

Conversely, economic efficiency exhibited substantial enhancements following the integration of method engineering, marked by an increase of 24.44%. The thesis posits that the implementation of methods engineering enabled the optimization of

economic efficiency by 24.44%, with a pre-test stage performance of 77.43%. Subsequent to the test, a substantial enhancement in economic efficiency was attained, reaching 96.35%, thereby underscoring the efficacy of the methodology. The findings indicate that the reduction in operating times, the enhancement in resource allocation, and the diminution in costs associated with forklift operations contributed directly to the financial enhancement of the process.

The reliability of these results was further substantiated by a statistical analysis. Wilcoxon's test confirmed that the differences between the pre-test and the post-test were statistically significant, since "the p-value (sig) was less than 0.05, affirming the  $H_a$ ," which shows that the methodological intervention effectively optimized the overall efficiency of the evaluated process and that the observed changes were not the product of chance.

The findings indicate that method engineering is an effective tool for improving forklift-dependent logistics processes. The standardization of the procedure, the reorganization of the operational flow, the analysis of times and movements, and the training of personnel were the driving factors that led to the achievement of sustainable improvements in both productivity and costs. The findings of this study underscore the significance of implementing continuous improvement methodologies in highly dynamic logistics environments. They further demonstrate the replicability of the principles of method engineering in other organizations that exhibit analogous characteristics.

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#### References

- [1] Arias, F. (2012). El proyecto de investigación: Introducción a la metodología científica (6.<sup>a</sup> ed.). Editorial Episteme.
- [2] Barnes, R. M. (1980). Estudio de métodos: Ingeniería de métodos y estudio de tiempos. Noriega Editores.
- [3] Cabanillas, J., & Leon, J. (2021). Aplicación de las herramientas de la ingeniería de métodos en el

- 
- cultivo de arroz para incrementar la rentabilidad en las empresas agrícolas del Valle Jequetepeque [Tesis de pregrado]. Universidad Nacional de Trujillo.
- [4] Cordova, L. (2021). Aplicación de la ingeniería de métodos para mejorar la productividad de la producción de pegamentos de cerámico de la empresa Yuraq Pacha [Tesis de pregrado]. Universidad Continental.
- [5] Correira, B. A., et al. (2005). Análisis de eficiencia y productividad: Enfoques paramétricos y no paramétricos. Editorial Académica.
- [6] Cruz, C. A. M., & Simonovich, R. K. O. (2024). Gestión de inventarios en el área de producción para la mejora de productividad en una empresa metalmeccánica, Ventanilla, 2024. [El tipo de publicación y el lugar de publicación no están claros, se formateó como trabajo inédito o general].
- [7] Cueva, J. (2021). Plan de mejora basado en gestión por procesos para desarrollar la productividad en la empresa Integración y Tecnología Global Protección S.A. Guayaquil, 2021. [El tipo de publicación y el lugar de publicación no están claros, se formateó como trabajo inédito o general].
- [8] Dávila, L., & Espinoza, S. (2022). Methods engineering in the productivity of manufacturing companies: a literature. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [9] Diaz, A., Florian, D., & Calla, V. (2022). Aplicación de ingeniería de métodos para incrementar la productividad de la línea de cocido en una empresa de producción de conservación de pescado. INGnosis: Revista de Investigación Científica.
- [10] Escalante, A., & González, D. (2016). Ingeniería industrial. Alfaomega Grupo Editor S.A.
- [11] Freivalds, A., & Niebel, B. (2008). Estudio del trabajo. McGraw-Hill Interamericana.
- [12] Fuentes, F. (2021). Propuesta de implementación del modelo Lean Manufacturing en el proceso productivo de una empresa de reparación, planchado y pintado automotriz para la optimización de la productividad en la ciudad de Arequipa, 2020 [Tesis de pregrado]. Universidad Católica de Santa María.
- [13] García, R. (2005). Estudio del trabajo (2.<sup>a</sup> ed.). McGraw-Hill Interamericana Editores S.A.
- [14] Gilbreth, F. B., & Gilbreth, L. M. (1917). Applied motion study: A collection of papers on the efficient method to industrial preparedness. Sturgis & Walton.
- [15] González, M., & Rivera, L. (2017). Aplicación del estudio de métodos y tiempos en procesos de manufactura en PYMES colombianas. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [16] González, S. E., & Patiño, D. (2020). Análisis de la influencia del estudio de tiempos y movimientos en la productividad de las empresas manufactureras: una revisión de la literatura científica entre los años 2005 – 2019. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [17] Guerrero, M., et al. (2024). Propuesta de mejora para la eficiencia productiva en las empresas textiles de la provincia Sullana-Piura. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [18] Hecklau, F. (2021). Análisis estructurado de metodologías para la evaluación de la capacidad tecnológica de los RTO: utilizando un enfoque de ingeniería de métodos. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [19] Hernández, C., et al. (2024). Ingeniería de métodos, medición del trabajo mediante el estudio de tiempos. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [20] Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, P. (2014). Metodología de la investigación. McGraw-Hill.
- [21] Kanawaty, G. (1996). Introducción al estudio del trabajo (4.<sup>a</sup> ed.). Oficina Internacional del Trabajo.
- [22] Kerlinger, F. N., & Lee, H. B. (2002). Investigación del comportamiento: Métodos de investigación en ciencias sociales. McGraw-Hill.

- 
- [23] Koontz, H., & Weihrich, H. (2004). *Administración: Una perspectiva global y empresarial*. McGraw-Hill Interamericana.
- [24] Niebel, B. W., & Freivalds, A. (2008). *Estudio del trabajo*. McGraw-Hill Interamericana.
- [25] Niebel, B. W., & Freivalds, A. (2009). *Ingeniería industrial y de métodos de trabajo*. McGraw-Hill.
- [26] Pacheco, K. (2023). Evaluación de indicadores de desempeño laboral en la Empresa Pública de Movilidad. Caso: Ciudad Salcedo [Tesis de maestría, Universidad Técnica de Cotopaxi]. Repositorio de la Universidad Técnica de Cotopaxi. <https://repositorio.utc.edu.ec/items/018ef5e4-78e2-4aaf-b346-60e254815893>
- [27] Parrales, O., & Amores, E. (2024). La eficiencia operativa y la productividad en la fabricación del aluminio en el sector metalúrgico del Ecuador. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [28] Perez, L. (2023). Aplicación de la ingeniería de métodos para mejorar la eficiencia operativa en la línea de envasado de una empresa de bebidas [Tesis de pregrado]. Universidad Nacional de Ingeniería.
- [29] Polit, D. F., & Beck, C. T. (2012). *Nursing research: Generating and assessing evidence for nursing practice*. Lippincott Williams & Wilkins.
- [30] Rivera, C., Casimiro, M., & Miranda, K. (2022). Implementación de la ingeniería de métodos para mejorar la productividad de la línea de operaciones en una empresa metal mecánica. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [31] Rocha, J., & Montoya, F. (2019). Impacto de la Ingeniería de Métodos en la productividad de una empresa peruana del sector textil. *Revista de Ingeniería Industrial*.
- [32] Sánchez, R., & Valdés, A. (2021). Lean Manufacturing como estrategia de mejora continua en la industria manufacturera latinoamericana. *Revista Latinoamericana de Ingeniería Industrial*.
- [33] Saucedo, L., Valenzuela, L., & Báez, H. (2021). Aplicación de ingeniería de métodos para el mejoramiento de operaciones en una empresa manufacturera de equipos de audio. [El tipo de publicación y la fuente no están claros, se formateó como trabajo inédito o general].
- [34] Slack, N., Brandon-Jones, A., & Johnston, R. (2016). *Operations management*. Pearson Education.
- [35] Yagual, L. (2022). La ingeniería de métodos y su efecto en la cadena de producción de la empresa Fontana, del cantón La Libertad, provincia Santa Elena [Tesis de licenciatura]. Repositorio de la Universidad Estatal Península de Santa Elena. <https://repositorio.upse.edu.ec/bitstream/46000/8344/1/UPSE-TII-2022-0007.pdf>