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Analysis of Waste in the 3 Kg LPG Gas Delivery Process Using the Lean Distribution Method

Priyatna Septedi Inrianto[1], Farida Pulansari[1], Sinta Dewi[1]

[1]*The National Development University "Veteran" of East Java, Industrial Engineering, Surabaya, Indonesia*

**Corresponding Author: Priyatna Septedi Inrianto*
Email: 21032010135@student.upnjatim.ac.id

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Abstract

This study aims to identify waste in the 3 kg LPG delivery process at PT Nahatolu Miragas Prima and provide improvement proposals to improve distribution efficiency. The main problem is the delivery lead time that exceeds the estimated ideal time, causing delays to distribution partners. The method used is lean distribution with steps such as data collection of the distribution process, process flow mapping using Value Stream Mapping, and identification of waste based on 8 types of waste. Weighting was done through a questionnaire to determine the most dominant waste, followed by cause analysis using fishbone diagrams and formulation of improvement proposals using the 5W+1H approach. The results showed that the main wastes were in the waste activities of waiting, excess processing, and non-utilized talent. The application of future stream mapping shows the potential to significantly reduce distribution time by reducing the lead time of the distribution process from 732 minutes to 574 minutes. In conclusion, the lean distribution method is effectively used to identify and reduce waste in the LPG distribution flow by increasing the activity of the 3 Kg LPG distribution process by 21,5%.

Introduction

Efficient distribution plays a crucial role in ensuring the sustainability and competitiveness of companies in an increasingly complex global competitive landscape (Sudirjo, 2023; Kalandarovna & Gizi, 2023; Jaboob et al., 2024). An inefficient distribution system can lead to various forms of waste, ultimately impacting operational efficiency and customer satisfaction (Grant et al., 2023; Carbone et al., 2021). PT Nahatolu Miragas Prima, which operates in the distribution of 3 kg LPG gas, faces issues related to high delivery lead times, reaching 732 minutes compared to the ideal estimate of 520 minutes. This results in delivery delays and a decline in service quality.

Increasing pressure from consumers regarding service speed and delivery accuracy has prompted companies to optimize all of their distribution activities (Russell & Taylor, 2019; Ghodake et al., 2024; Oteri et al., 2023; Paluzzi et al., 2025). In this context, companies need to systematically identify activities that do not add value and trace their root causes in a structured manner. Lean distribution offers a framework that enables companies to focus on reducing waste such as waiting, transportation, and non-utilized talent through distribution process mapping and quantitative performance measurement (Slack et al., 2020; Putri & Ernawati, 2024; Ali, 2025). With this approach, each process in distribution can be evaluated based on its contribution to achieving ideal delivery times and customer satisfaction.

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Lean distribution is a systematic method that aims to identify and eliminate activities that do not add value (waste) in the distribution flow (Sarjiman et al., 2023; Zylstra, 2005). The application of lean methods, which originally developed in the manufacturing sector, has now been widely adapted to the service sector, including logistics and distribution (Prasetyawan & Ibrahim, 2020; Arianto, 2020). This approach has proven effective in enhancing distribution efficiency by utilizing tools such as Value Stream Mapping (Shobur et al., 2021), Fishbone Diagram (Ramadhanti et al., 2023), and the 5W+1H framework for structured improvement planning (Paillin et al., 2020).

LPG distribution, as a vital energy product, demands high reliability in its delivery process. Problems such as cylinder backlogs, unintegrated documentation, and waiting activities contribute significantly to wasted time and resources (Fattahillah et al., 2020; Putri & Ernawati, 2024). Several previous studies have shown that waste such as waiting, motion, and excess processing are dominant causes in energy distribution (Nugraha & Adianto, 2021; Hambajawa et al., 2020; Ulfah et al., 2023).

Research by Nurlaeli, Pulansari, Hayati, & Setyoningsih (2023) also emphasizes the importance of the lean distribution approach in minimizing lead time in the textile distribution sector. By mapping the distribution flow and identifying points of waste using VSM and activity analysis methods, they succeeded in significantly reducing delivery times. This study demonstrates that distribution improvements are not only relevant in the energy sector but are also highly applicable in other industries facing lead time challenges.

Studies such as those conducted by Rakhmasari and Dharmayanti (2023), Ngerndee et al. (2022), and Triana et al. (2024) state that the integration of lean with process mapping tools such as Process Activity Mapping and VALSAT can produce significant improvements in lead time and operational efficiency. The implementation of a comprehensive lean strategy not only reduces waiting time and logistics costs but also enhances flexibility and responsiveness to market demand (Kholil et al., 2021; Garside & Rahmasari, 2017).

This study differs from previous studies in that it specifically applies lean distribution to the delivery process of 3 kg LPG by distribution agents, which has characteristics that differ from the distribution of manufactured products. 3 kg LPG is a subsidized product with a distribution system controlled by the government, thus requiring an efficiency approach that still considers safety aspects and compliance with regulations (Rahmat et al., 2021; Milenkov et al., 2020). The research gap lies in the application of lean distribution in the context of micro-scale LPG distribution (agents), which has not been extensively explored academically.

Based on this background, this study aims to identify wasteful activities in the distribution flow of 3 kg LPG using the Lean Distribution method and formulate improvement proposals that can reduce delivery lead time. The approach used includes Value Stream Mapping analysis, waste weighting through questionnaires, root cause analysis using Fishbone Diagrams, and solution formulation using the 5W+1H method. With this method, it is hoped that this study can make a real contribution to improving the efficiency of domestic energy distribution, making it faster, more accurate, and more resource-efficient.

Methods

The study was carried out at the PT Nahatuli Miragas Prima, Surabaya between January and February 2025. The study design used a quantitative descriptive approach to a case study, which was further supplemented by qualitative approaches to make sure that the distribution process of 3kg LPG gas was explored not in terms of quantitative indicators alone, but also by a grounded sense of the realities on the ground. This kind of mixed strategy provided the possibilities of finding both the quantifiable inefficiencies and those contextual determinants which give birth to them so that the research was situated in the working conditions of five

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outlets of the distribution partners in Benowo Perak and Romokalisari and so that the information was not in the abstract theoretical level.

The research was initiated by an exploratory stage; direct observation of the daily distribution activities was carried out. At this stage, the researchers went into the working environment to experience the rhythm of the work interactions between the staff, the actual processes of handling LPG cylinders and administrative processes that accompany each delivery cycle. Observations were not used as a visual record only but as the tool to understand decision-making practices in the field and understand how delays build-up in the seemingly basic procedures. In order to incorporate these observations into the academic discourse, a comprehensive literature review of the pertinent material was conducted, including the articles on lean distribution waste identification and analysis software, including Value Stream Mapping and Fishbone analysis. This initial step laid the conceptual framework where further analysis would be based on thus making sure that empirical sensitivity and theoretical rigor were maintained in the study.

After gaining familiarity with the situation in the field, the research was followed by the identification of variables. Independent variables included the eight types of wastes that are continuously mentioned in lean approach, i.e. waiting, non-utilized talent, excess processing and motion among others. The actual activity flow in the LPG distribution process was the dependent variable in which it was hypothesized that these waste factors affected. Introducing specific relationships between variables at this stage proved to be beneficial in staying within the focus and quantifiable paradigms of the research when it entered analytic phases.

Four supplementary methods were then applied to collect data. Firstly, the order of activities and the exact amount of time each stage of distribution took, SPBE filling to delivery to partner outlets, was observed in the field. Second, four respondents who had direct operational positions, namely, the Director of Operations, the Manager, the Head of Warehouse, and the Field Supervisor, were interviewed in-depth. Their perceptions helped the researcher to have a glimpse into the system as opposed to the surface observation only. Third, a questionnaire based on a Likert scale was sent to identify the occurrence and intensity of waste events based on the opinions of the experienced staff. Fourth, the distribution workflow had been documented in detail thus giving the foundation of subsequent process mapping that was an accurate reflection of the actual flow, not based on assumptions. Collectively, all these four approaches provided the research with quantitative strength and qualitative insight.

After the data has been collected, a Current State Map with Value Stream Mapping was created. All the documented activities were mapped with respect to time spent on them and also based on their position in the sequence of distribution. The map showed the real organization of work, where there was value creation and where time was spent without equivalent value addition. The activities were then divided into value-added, non-value-added and necessary but non-value-added category, which became critical in determining practical goals that could be achieved through improvement. It was further discussed with the help of creation of a Process Activity Map, when all the steps were characterized by operation, inspection, transportation, storage, or delay. The inefficiency of the distribution flow was particularly pronounced during this stage since the instances of delays and rechecks became easily observed when projected as the blocks of the activity structure.

The data in the form of questionnaires was processed and ranked to determine the most important categories of wastes. The raw perception data was converted into weighted scores to allow the study to uncover the three sources of inefficiency that prevailed which are waiting, excess processing and the untapped talent. The study did not end at classification and proceeded to root-cause exploration through Fishbone Diagrams. The step entailed further consideration by locating possible causes in the Man, Method, Machine, Material,

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Environment, and Measurement dimensions. This analysis has helped understand that inefficiency is not caused by a single significant fault but tends to take place as a result of small frictions, including the lack of integration of documents, the lack of a schedule discipline, and the improper use of employee potential.

The study moved to the phase of improvement proposals with 5W +1H after the explanation of root causes. Every suggested solution was explained in the terms of the problems to be solved, their importance, location, or the people to be held responsible, time of action, and how this should be done. The future state map was then visualized, showing the proposed strategies in an improved and time-saving distribution system. With the help of the simulation, the lead time corresponding to 732 minutes was estimated to decrease to 574 minutes which would indicate a significant improvement in case unnecessary actions are removed.

Results and Discussion

LPG 3 Kg Distribution Process Flow Data

The distribution activity process at PT Nahatoulu Miragas Prima is divided into seven categories, which are organized according to the specific activities in each category. The details of the activity flow will be presented through the following warehousing flowchart.

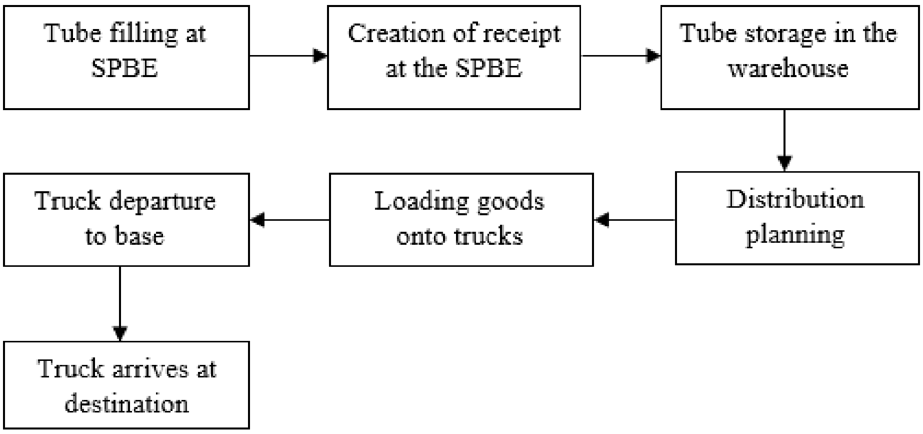

Figure 1. Process Flow of 3 Kg LPG Distribution

Weighting Questionnaire Data

This questionnaire was created to determine the presence of waste in the 3 Kg LPG distribution process, based on statements that describe the actual conditions in the field. There are 8 types of *waste* that are used as a reference, complete with an assessment table. This questionnaire has been filled in by 4 respondents consisting of the Director, Operations Manager, Head of Warehouse, and Field Supervisor. The results of the data recap in table 4.2 contain the determination of the weighting score of 8 types of *waste* with a scale of 1 (very rarely occurs) to 5 (very often occurs).

Table 1. Recapitulation of Questionnaires on *Waste*

Waste	**Respondents**			
	R1	**R2**	**R3**	**R4**
Defect	2	2	1	2
Overproduction	3	2	3	2
Waiting	4	4	5	5
Non Utilized Talent	3	3	2	3
Transportation	2	2	1	1
Inventory	1	2	2	2
Motion	3	2	2	3

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Excess Processing	2	3	3	4

Source: Questionnaire Recapitulation (2025)

Process Activity Mapping

Based on the data in Table 1.2, the distribution process flow is grouped in the *Process Activity Mapping* table which explains the condition of the 3 Kg LPG distribution from filling the cylinder at the SPBE until the truck arrives at the destination location. Activities are classified into three categories including *value added, non-value added*, and *necessary non-value added*, as well as five types of activities including operations, transportation, inspection, *storage*, and *delay*.

Table 2. *Process Activity Mapping* Pendistribusian LPG 3 Kg

No.	**Activities**	**Category**			**Type**					**Time (Minutes)**
		VA	**NVA**	**NNVA**	**O**	**T**	**I**	**S**	**D**	
1	Recording the number of empty tubes			NNVA			I			15
2	waiting for admin to create documents for charging to SPBE		NVA						D	10
3	loading tubes onto trucks	VA				T				18
4	Rechecking the number & suitability of data		NVA				I			11
5	Waiting in line for departure		NVA						D	8
6	Vehicle preparation and daily check			NNVA	O					12
7	Travel from agent to SPBE	VA				T				45
8	Waiting for the entry queue at SPBE			NNVA					D	22
9	Checking driver's documents and license			NNVA			I			7
10	Empty tube drop to *staging* area			NNVA		T				18
11	Visual inspection of empty tubes			NNVA			I			20
12	Empty weight weighing			NNVA	O					11
13	Placement of tubes into filling machine			NNVA	O					15
14	The process of filling LPG into cylinders	VA			O					30
15	Removal of tubes from filling machine			NNVA	O					11
16	Full tube reweighing			NNVA	O					7
17	Leak check			NNVA			I			5
18	Resealing of tubes with authorized seals			NNVA	O					5
19	Verify the number of tubes that have been filled		NVA				I			8
20	Creation of Distribution Letter (DO Letter)		NVA		O					10
21	Coordination with transport truck drivers		NVA						D	6
22	Tube loading to truck	VA				T				35
23	Handover of the Road Letter and Supporting Documents to the Driver			NNVA	O					2

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24	Recording truck departure time from SPBE			NNVA			I			1
25	Travel to key agents/distributors	VA				T				45
26	Waiting for loading and unloading		NVA						D	15
27	Verification of shipping documents (DO, road letter)		NVA				I			8
28	Dropping the tube from the truck	VA				T				26
29	Tube placement in warehouse storage area			NNVA				S		17
30	Recording incoming stock to warehouse book/system			NNVA			I			5
31	Checking the daily distribution plan			NNVA			I			8
32	Compile a list of bases to be sent			NNVA	O					5
33	Waiting for the admin to create the DO letter		NVA						D	10
34	Tube loading to truck	VA				T				30
35	Checking quota and stock of tubes according to DO			NNVA			I			7
36	Awaiting preparation of distribution vehicle road warrant		NVA						D	14
37	Input shipping data to SIMOL3 / Pertamina distribution system			NNVA	O					12
38	Prepare load checklist sheet (number, condition of tubes)		NVA						D	8
39	Fleet preparation in the loading and unloading area		NVA			T				10
40	Vehicle and distribution equipment inspection		NVA				I			10
41	Retrieval of tubes from storage area			NNVA	O					15
42	Manual/auxiliary loading of tubes onto trucks	VA				T				25
43	Hand over the DO to the driver			NNVA	O					2
44	Recording of tube stock out			NNVA			I			5
45	Waiting for route instructions or road orders		NVA						D	5
46	Truck departure to base	VA				T				60
47	Confirm arrival to the base officer			NNVA	O					1
48	Waiting for base admin to verify documents		NVA						D	5
49	Verification of shipping documents		NVA				I			2
50	Dropping the tube from the truck	VA				T				25
51	Compilation of tubes to storage area			NNVA				S		15
52	Retrieval of empty cylinders from the base			NNVA	O					10

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Total	**10**	**16**	**26**	**15**	**11**	**14**	**2**	**10**	**732**

Source: PT Nahatolu Miragas Prima (2025)

Based on the data above, the distribution process flow is depicted through *current stream mapping* (VSM). A description is provided of the situation that occurs throughout the process, starting from filling the tube at the SPBE until the truck arrives at the destination location. The total duration of the entire warehousing process was recorded as 732 minutes.

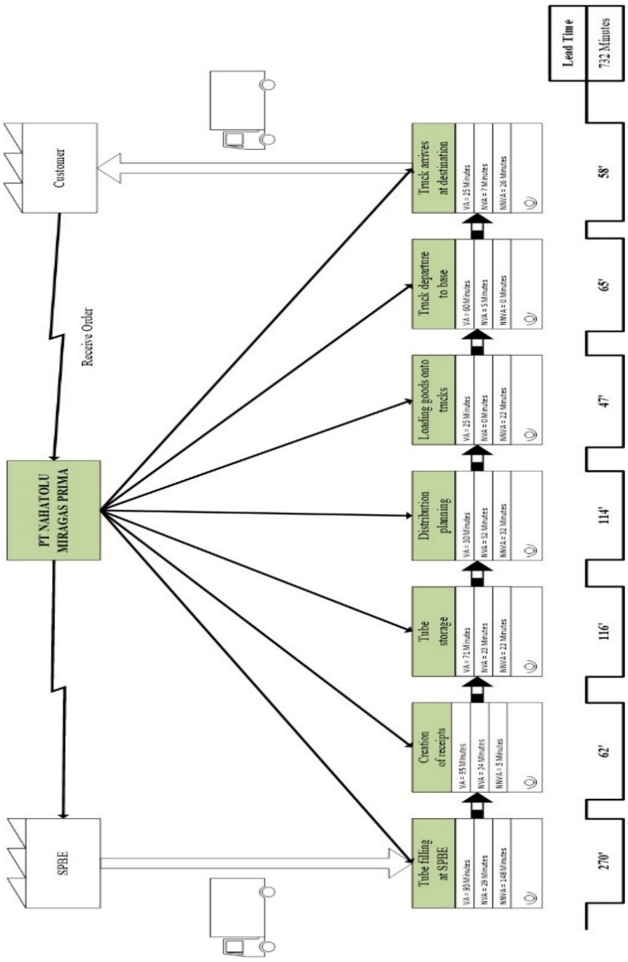

Figure 2. Current Stream Mapping of 3 Kg LPG distribution

Based on table 3, the number and percentage of each category and type of activity are obtained below.

Table 3. Frequency and Time Percentage by Type

Type	Frequency	Percentage	Time	Percentage
Operation	15	29%	148	20%
Transportation	11	21%	337	46%
Inspection	14	27%	112	15%
Storage	2	4%	32	4%
Delay	10	19%	103	14%
Total	52	100%	732	100%

Based on table 4.4, it is known that the type of *operation* activity with a frequency of 15 or 29%, the type of *transportation* activity with a frequency of 11 or 21%, the type of *inspection* activity with a frequency of 14 or 27%, the type of *storage* activity with a frequency of 2 or

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4%, and the type of *delay* activity with a frequency of 10 or 19%. It can also be seen that the time of *operation* activity type is 148 minutes or 20%, *transportation* activity type is 337 minutes or 46%, *inspection* activity type is 112 minutes or 15%, *storage* activity type is 32 minutes or 4%, and *delay* activity type is 103 minutes or 14%.

Table 4. Percentage of Frequency and Time by Category

Category	Frequency	Percentage	Time	Percentage
VA	10	19%	339	46%
NVA	16	31%	140	19%
NNVA	26	50%	253	35%
Total	52	100%	732	100%

Based on table 1.5, it can be seen that there are VA activity categories with a frequency of 10 or 19%, NVA activity categories with a frequency of 16 or 31%, and NNVA activity categories with a frequency of 26 or 50%. It can also be seen that the time of the VA activity category is 339 minutes or 46%, the NVA activity category is 140 minutes or 19% and the NNVA activity category is 253 minutes or 35%. From these results, *non-value added* activities can be eliminated and some time on *necessary non-value added* activities can be reduced.

Determination of Critical *Waste*

Penentuan *waste* kritis dilakukan melalui kuesioner yang dibagikan kepada 4 orang yang berkompeten dalam kegiatan proses pendistribusian LPG 3 Kg. Hasil dari kuesioner tersebut ditampilkan pada tabel 1.6 di bawah.

Table 5. Critical *Waste Ranking*

Types of Waste	Respondents				Score	Weight	Ranking
	1	2	3	4			
Defect	2	2	1	2	7	0,09	7
Overproduction	3	2	3	2	10	0,12	4
Waiting	4	4	5	5	18	0,22	1
Non Utilized Talent	3	3	2	3	11	0,14	3
Transportation	2	2	1	1	6	0,07	8
Inventory	1	3	2	2	8	0,10	6
Motion	3	1	2	3	9	0,11	5
Excess Processing	2	3	3	4	12	0,15	2
Total					81	1	

Source: Data processed (2025)

Based on the critical *waste ranking* in table 1.6, the score, weight, and *ranking of* each type of waste are obtained. It is found that the top 3 critical *wastes* include waste *waiting*, *excess processing* and *non-utilized talent.*

Waste Identification

Waste of Waiting

This waste occurs when the process has to stop because it is waiting for something that should be ready, such as waiting for the truck to arrive, waiting for documents, or waiting for the queue to fill the cylinder. For example, waiting for a turn to fill an LPG cylinder because there is a long line at SPBE, or waiting for shipping documents that have not been processed.

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Waste of Excess Processing

Waste occurs when there are processes or stages in distribution that are performed more than necessary, or do not add value to the product. These processes only add time and cost without providing additional benefits. Checking the quality of LPG cylinders more than once or involving many inspection steps that should not be necessary as the cylinders are definitely in good condition when they leave the SPBE.

Waste of Non Utilized Talent

This waste occurs when employees have skills or knowledge that go beyond their job, but are not utilized. This causes their potential to be wasted and reduces productivity

Identification of Factors Causing Waste

Based on table 1.6, the results obtained the top 3 critical *wastes* from 8 existing *wastes* in order, namely *waste waiting, excess processing* and *non-utilized talent*. With this, it is necessary to identify the causal factors behind the emergence of these wastes through the following *fishbone* diagram:

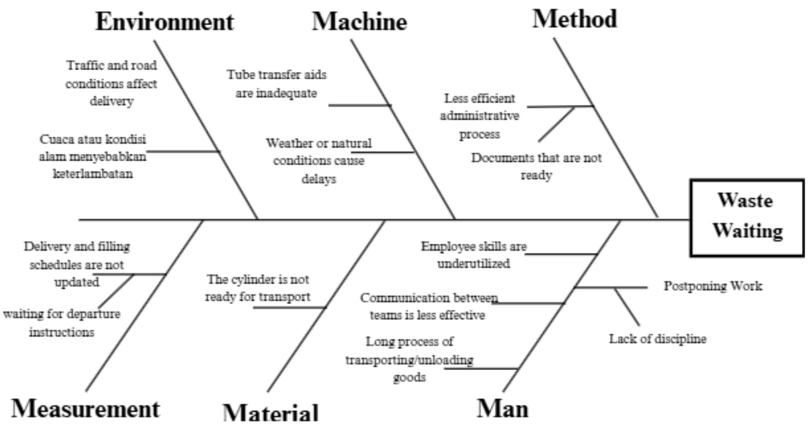

Figure 3. Fishbone Diagram of Waste Waiting

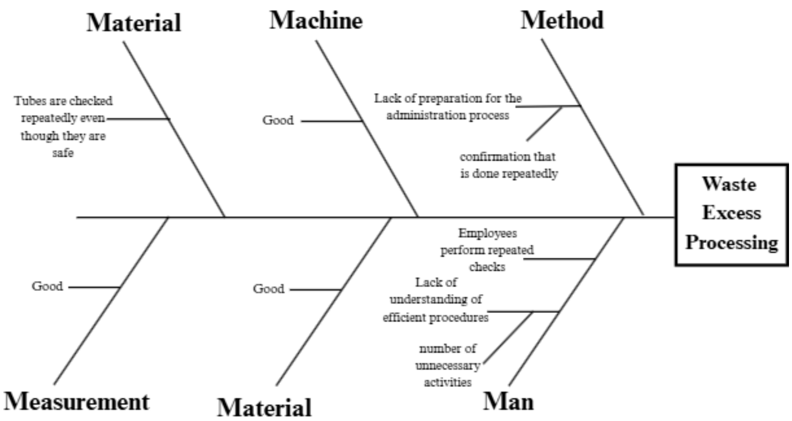

Figure 4. Fishbone Diagram of Waste Excess Processing

The improvement proposal stage is a step to provide solutions to the problems found. Based on the identification using *fishbone* diagrams of waste that occurs in critical areas, the next step is to develop improvement proposals that can support the research objectives. In this case, the analysis is carried out using the 5W+1H approach to formulate the right solution.

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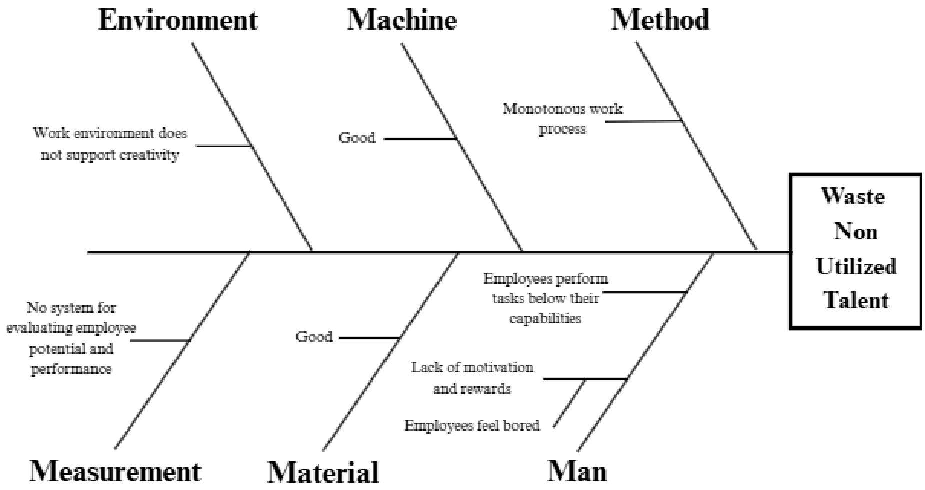

Figure 5. Fishbone Diagram of Waste Non Utilized Talent

Table 6. Proposed improvements using 5W+1H

What	**What are the causes of the delay and length of the LPG 3 Kg distribution process?**
	The identification of waste has been analyzed and found to be caused by several main factors, namely people, machines, methods, materials, measurements and environmental conditions.
Why	**Why is there a need for an improvement plan for the 3 Kg LPG delivery process?**
	Improvement planning needs to be done to reduce waste, especially the three *wastes* with the top 3 weight *rankings* which include *waste waiting, waste excess processing* and *waste non-utilized talent* which are the most critical wastes in the company, so that the LPG 3 Kg distribution time can run more effectively and efficiently.
When	**When does the improvement plan need to be carried out?**
	The improvement plan is carried out after knowing the results of the identification of waste that occurs in the 3 Kg LPG distribution process.
Where	**Where does the improvement plan need to be carried out?**
	Improvement plans need to be carried out on several activities in the distribution of 3 Kg LPG that result in waste, including the process of preparing vehicles and matters covering administration, as well as the process of *loading* and *unloading* LPG cylinders.
Who	**Who has the right to make improvements in the LPG 3 Kg distribution process?**
	Corrective actions will be carried out by all workers involved in the LPG 3 Kg distribution process, especially the admin and warehouse *helper*.
How	**How are improvements proposed?**
	• ***Man*** **Factor** - 100% of employees involved in managing LPG distribution should rotate jobs every 3 months to prevent burnout and improve their skills. For example, workers who usually only transport LPG cylinders could be given the responsibility of evaluating distribution routes or conducting quality checks on cylinders. - 90% of data delivery and communication between teams should be done using digital platforms such as *Slack* or *Microsoft Teams* within 1 month of implementation, with a 50% reduction in communication response time. • ***Machine*** **factor** - Install GPS-based tracking devices and sensors on trucks to monitor vehicle performance and condition in *real-time*. The system can provide early warnings if the truck is underperforming or if there are potential breakdowns. It also helps in selecting more efficient routes. - Establish long-term maintenance contracts with service providers to ensure trucks remain in optimal condition with a maximum period of 1 month. • ***Method*** **factor** - Implement an integrated ERP (*Enterprise Resource Planning*) system to handle the administration of LPG filling and distribution. For example, use the system to automatically record every cylinder filling transaction, as well as create delivery and filling status reports in the form of *dashboards* that can be accessed in *real-time* by managers. The target is to have 100% of the

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administration process integrated in the ERP system within 6 months, with a 60% reduction in administrative data processing time.
- Review administrative SOPs to ensure that there are no repetitive steps by using digital forms to simplify data entry and reduce reliance on manual recording. With the target that administrative procedures should be streamlined by reducing 30% of irrelevant steps within the first 3 months.

- ***Material* Factor**
  - It uses *sensor-based* technology and IoT to monitor the physical condition of LPG cylinders in *real-time*. Each cylinder is equipped with a chip or sensor that can check whether the cylinder is damaged or unsafe for distribution. The results of this monitoring are directly connected to the management system which indicates which cylinders need to be checked further. Implement a *monitoring* system to monitor the eligibility status of the cylinders so that only cylinders that need to be checked will be sent for checking.
  - Using *barcodes* on each tube ensures that each tube's status and quality is accurately recorded without the need for repeated checks. By scanning the *barcode*, information about the tube is automatically recorded, reducing manual checks.

- ***Measurement* Factor**
  - Implement measurable KPIs such as on-time delivery, tube quality, and customer satisfaction levels within 3 months, with a target of improving on-time delivery by 20% within 6 months.
  - Ensure delivery schedules and data entry by staff are up-to-date and accurate to avoid errors in delivery arrangements.

- ***Environment* Factor**
  - Design a more open workspace with easy access between the warehouse and administration office.
  - Use GPS-based applications with *real-time* weather and traffic data integration (such as *Google Maps* or *Waze*) to select the best delivery route, which minimizes delays due to bad weather or traffic. The app should provide notifications to the driver in case of adverse weather conditions that may disrupt the journey.
  - Conduct regular risk analysis and identify areas vulnerable to natural disasters, and implement appropriate mitigation measures.

The proposed improvements contain 13 activities with the NVA category that are eliminated and 6 activities with the NNVA category to reduce the waste of time that occurs in the 3 Kg LPG distribution process and the following is a comparison table of the flow time of the 3 Kg LPG distribution process.

Table 7. Comparison of Activity Flow Time

Activity Flow	Time (Minutes)	
	Current Stream Mapping	Future Stream Mapping
Tube filling at SPBE	270	216
Creation of receipts	62	62
Tube storage	116	86
Distribution planning	114	62
Loading goods onto trucks	47	42
Truck departure to base	65	60
Truck arrives at destination	58	46
Total Lead Time	732	574

Based on table 1.8 there is a change in activity time in the LPG 3 Kg distribution process flow after the proposal is made to eliminate *non-value added* activities and reduce the time of

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necessary non-value added activities which include filling tubes at SPBE to 216 minutes from 270 minutes, in the flow of receipt making activities reduced to 62 minutes from 62 minutes, in tube storage activities to 86 minutes from 116 minutes, in the flow of distribution planning activities to 62 minutes from 114 minutes, in the flow of loading activities into trucks to 42 minutes from 47 minutes, in the flow of truck departure activities to the base to 60 minutes from 65 minutes and for the flow of truck activities arriving at the destination location to 46 minutes from 58 minutes. The total *lead time of* the proposed improvement is 574 minutes from the total *lead time of the real time* situation, which is 732 minutes. So that the total *lead time* in the LPG 3 Kg distribution process is reduced by 158 minutes.

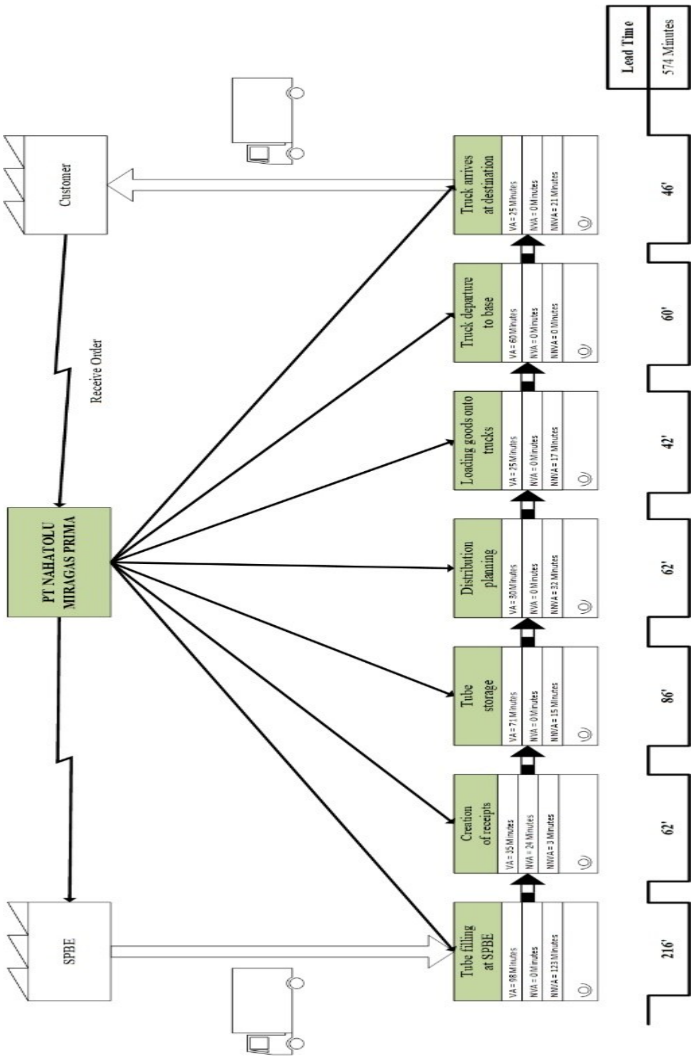

Figure 6. Future Value Stream Mapping

After improvements are applied to production activities, the next step is to calculate the efficiency level of the distribution process at PT Nahatolu Miragas Prima after implementing the proposed improvements. The goal is to determine the extent of the increase in time efficiency achieved in the distribution process. The calculation of production time efficiency is presented as follows:

$$\text{Efficiency} = \frac{Current\ lead\ time - lead\ time\ after\ improvement}{current\ lead\ time} X\ 100\%$$

$$= \frac{732-574}{350} X\ 100\%$$

$$= 21{,}5\%$$

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From the results of the above calculations, it can be concluded that after the implementation of the proposed improvements, the efficiency of the distribution process increased by 21.5% in one daily activity cycle or in the distribution process starting from filling the cylinder to the SPBE until the truck arrives at the base. This shows that the LPG 3 Kg distribution process has become more optimized because activities that do not provide added value have been eliminated. Thus, the proportion of time for value-added activities to the total distribution time has increased.

As the results of the current study indicate, the use of lean distribution methodology can help to identify serious inefficiencies in the field of LPG logistics in case process mapping, waste assessment, and root-cause analysis are adopted simultaneously. The prevalence of waiting waste, then too much processing and not making use of talent, shows that the inefficiency is not only because of physical handling but also the relationship between the administrative validation, the order of work and the human deployment. This observation gives empirical support to the stand taken by Grant et al. (2023) who argued that modern logistics studies are demanding mixed analytical vantage points in their endeavors to account both technical performance and behavioural workflow dynamics. Similar inferences were made by Carbone et al. (2021), who established that the distribution systems that function under the regulatory requirements often experience an accumulation of procedural waiting, which reflects the presence of similar conditions as observed in the LPG environment.

It is further shown by evidence in recent research that a recurrent focus on time waste due to misalignment of processes is emphasized. Hambajawa et al. (2020) observed that the delays in cement distribution occur when the vehicle readiness and documents issuance are not synchronized, and Nugraha and Adianto (2021) found that the repetition of verification in the context of the absence of data integration increases the delays in delivering the cement. Paillin et al. (2021) showed that only when loading, handling, and administration are transformed into one stream, the waste is reduced. Parallel results given by Putri and Ernawati (2024) indicate that digital consolidation of documents reduce waiting and rework, but Rakhmasari and Dharmayanti (2023) focus on value-stream redesign combined with simulation that makes it possible to identify the improvement targets correctly. Sarjiman et al. (2023) also stressed that lean concepts are appropriate in the distributing of public goods when the goal is maximising the responsiveness devoid of the compliance.

The study also provides a strong support of the analytical tools, like Value Stream Mapping and Process Activity Mapping, in terms of visualising both the value-adding and non-value-adding steps. Jordan et al. (2020) state that mapping explains inefficiencies that are embedded in the daily operation, as it is evident in the current study. Nelfiyanti et al. (2023) and Ngerndee et al. (2022) showed that waste weighting as a quantified improvement sharpens the improvement priorities. According to Kholil et al. (2021) and Akbar (2023), lean analysis combined with structured formulations, including 5W1H, successfully turn the results of the diagnostic into the action plan of improvement. Such understandings are similar to the method employed herein that incorporates mapping, weighting, and the diagnosis of the causes before improvements strategies are formulated.

In the LPG energy industry, the available literature is minimal, but convergent. As Aryani (2022) noted, a revolution in the LPG distribution presupposes the changes in the operational patterns in order not to make the document bottlenecks. Wijaya (2024) has highlighted that route optimisation cannot be achieved when there is still no process of coordination between the document release and loading. Nikira (2025) found out that delivery inconsistencies are more likely to be due to a lack of coordination in the schedules and verifications than the transportation capacity. Compared to these studies, the current study contains a fine-grained operational diagnosis indicating that a significant increase in efficiency can be noted through

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the use of structural refinement of the workflow instead of through expansion of infrastructure.

The research reinforces the perception that lean distribution is extremely relevant to subsidised LPG distribution and indicates that minimisation of waiting, duplicate processing and underutilised worker capacity can reduce lead time without regulation safety. The discussion implies that the lean-oriented improvement can be extended to other domestic energy networks with the same features of operation, which places the present study as a reinforcement and an extension of the recent scholarly research.

Conclusion

To identify the level of *waste* that occurs at PT Nahatolu Miragas Prima, a weighting analysis of each type of *waste* is carried out. The results of the analysis show that the type of waste with the highest level is *waiting* at 22%, followed by *excess processing* at 15%, *non-utilized talent* at 14%, *overproduction* at 12%, *motion* at 11%. *inventory* at 10%, *defects* at 9%, and *transportation* at 7%. This research provides suggestions for improvements that are focused on reducing waste, especially in the 3 Kg LPG distribution process. Some of the suggested steps include eliminating 13 NVA activities and reducing the time of 6 NNVA activities that have the potential for waste. With the implementation of these proposals, the LPG 3 Kg distribution process time or *lead time* which previously reached 732 minutes can be reduced to 574 minutes, which shows that the time reduction is 158 minutes with a percentage reduction in *lead* time of 21.5%. This improvement has an impact on increasing delivery efficiency and minimizing the risk of delays that can lead to customers feeling poorly served. For further research development, the proposed improvements can be analyzed with other method approaches, such as the application of risk mitigation analysis and similar methods, to support companies in making more informed and effective decisions to reduce waste and improve the efficiency of the goods delivery process and can implement an integrated ERP (*Enterprise Resource Planning*) system to handle the administration of LPG filling and distribution.

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