

ANALYSIS OF THE CONCEPT OF RE-ENGINEERING IN GAS DISTRIBUTION PROJECTS TO IMPROVE PROJECT IMPLEMENTATION EFFICIENCY

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KEYWORDS	ABSTRACT
re-engineering; construction method; gas distribution project; time efficiency; cost efficiency. Info Article Accepted: Revised: Approved:	Gas distribution projects are part of energy infrastructure that require high efficiency in terms of time, cost, and quality of implementation. However, in practice, several main work items are still carried out using conventional methods that potentially lead to resource inefficiencies. This study aims to analyze the application of the <i>re-engineering</i> concept in the implementation methods of gas distribution projects to improve overall project efficiency. This research employs a mixed-methods approach, combining quantitative and qualitative analyses. The analysis focuses on two main work items, namely excavation works and polyethylene (PE) pipe installation. The existing method, open cut excavation, is compared with alternative methods resulting from the re-engineering process, namely the combination of open cut with manual horizontal boring and open cut with the <i>Horizontal Directional Drilling</i> (HDD) method. Quantitative data were obtained from the analysis of the cost budget plan, S-curve schedule, work duration, and labor productivity, while qualitative data were collected through field observations, interviews, and project document reviews. The results indicate that the application of the re-engineering concept to construction methods significantly improves project time and cost efficiency. Alternative methods using manual horizontal boring and HDD are proven to be more effective under certain conditions compared to the existing method, particularly in reducing work duration and indirect project costs. This study is expected to serve as a reference for PT PGAS Solution and other construction practitioners in selecting more efficient, economical, and sustainable gas distribution project implementation methods.

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INTRODUCTION

The construction industry, including the energy and utility sectors, is a strategic sector that plays an important role in supporting national economic growth. One of the crucial forms of infrastructure projects is the gas distribution project to industrial and household customers (Ginting & Sidabutar, 2024). This project requires effective management, including technical precision and managerial efficiency. According to (Tobgay, 2005), one of the main challenges in construction projects in Indonesia is the low efficiency in implementation due to weak control over time, cost, and quality (Puruhita, 2018). The readiness of building construction companies to implement re-engineering in Surakarta region (Simatupang & Astuti, 2023).

In the context of construction projects, re-engineering can be applied to analyze existing processes, identify non-value-added activities, and redesign work processes to be more efficient and adaptive. Research by (Tifany & Dachyar, 2021) emphasizes that the application of re-engineering in construction projects can reduce implementation time projects up to 15–20% through the integration of process-based work systems and information technology. Therefore, the application of this concept to gas distribution projects by PT PGAS Solution is important to be explored further (Putra et al., 2022).

Gas distribution projects to customers are part of energy infrastructure that requires high efficiency in its implementation. The two main work items that determine the success of the project are the excavation of the soil and the installation of polyethylene (PE) pipes. In practice, both jobs are still mostly done manually (Rifai & Subali, 2022). This causes various obstacles such as delays in implementation time, cost overruns, and low labor productivity (Yuliana & Santoso, 2021).

In addition, the lack of standardization of work procedures (SOPs) in the field often leads to variations in implementation between work teams, which has an impact on inefficiencies and inconsistencies in the quality of connections (GEBRE, 2014). The use of modern tools such as fusion machines or Hydraulic Drilling Directional (HDD) is also still limited, so that the productivity of pipe connections is not optimal and results in delays of up to 15–20% in certain segments (Bismantaraa et al., 2021). Another factor that also affects is the less effective method of placing and straightening pipes, which can trigger technical errors, re-dismantling work, and waste of time (Hwang et al., 2017).

Thus, this study aims to evaluate the existing processes in the project, then redesign the process using the re-engineering approach, and measure its impact on time, cost, and quality efficiency. The results of this study are expected to make a theoretical and practical contribution to the development of construction project management strategies, especially in energy sector projects. As stated by (Nathanael, 2023), improving work processes through systemic and innovative approaches is the main key to improving the performance of infrastructure projects in developing countries (Shaheer, 2017).

Based on the background that has been described, this study formulates problems regarding the analysis of time and costs in each gas distribution pipeline work method, the potential cost efficiency and time effectiveness through the application of re-engineering, and the determination of alternative work methods that are most effective and efficient (Namirah et al., 2024). This study aims to analyze the comparison of time and cost of each method, identify the level of efficiency and effectiveness of the work implementation, and determine the optimal work method, so that it is expected to make an academic contribution to the development of the concept of re-engineering in energy infrastructure projects as well as practical benefits in the form of recommendations for more efficient, economical, and productive implementation methods for PT PGAS Solution and similar contractors (Nazaria et al., 2024). The limitations of the research are focused on a case study of the gas distribution project to PT PGN (Persero) Tbk customers carried out by PT PGAS Solution, with an emphasis on the analysis of implementation methods, cost budget plans, and S-curves based on effectiveness and efficiency aspects (Ayra & Santosa, 2025).

METHOD

Research Methods

This study analyzes the influence of the length of time and cost required for each different pipeline installation work method, to determine the best working method for piping work on a gas pipeline project to customers. The object of this study is the Installation of Distribution Pipes and MRS of Dr. Kariadi Semarang Hospital by PT PGAS Solution which is carried out in the company's operational area. This project has a contract value of IDR 2,175,000,000 with the scope of work in the form of excavation, installation of gas pipelines, and connection of installations to customers. The focus of this study is to compare the efficiency of project implementation between conventional methods and methods that have been re-engineered using the principle of re-engineering, as well as to assess their impact on productivity, implementation time, and project costs. The location of the research site stretches from Jalan Batan Selatan from Jalan Dr. Soetomo to Jalan Menteri Supeno, Semarang City, Central Java Province.

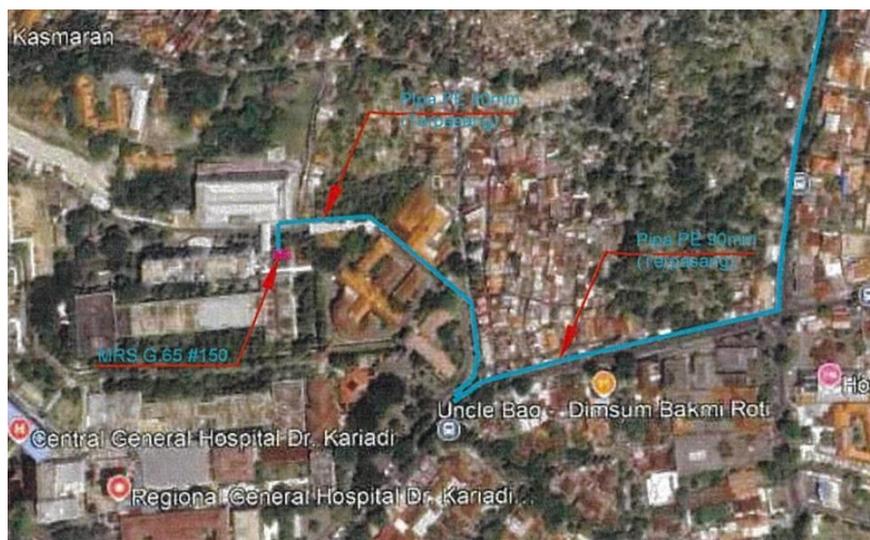


Figure 1. Research Location

Data Collection Methods

Data collection is one of the important stages in research, namely the process of obtaining relevant and accurate information to answer research problems. In this study, the data collected consisted of primary data and secondary data. Primary data was obtained directly through interviews and observations of project-related parties, while secondary data was obtained from project documents, archives, and supporting literature references.

This study applies a mix-method approach, which is a combination of descriptive qualitative methods and quantitative methods. The researcher and the team collected data and information from the resource persons involved in the implementation of the project, namely the Construction Service Provider Team and the Construction Management Consultant Team who have authority in the implementation of the project.

Some of the data collection techniques applied in this study include:

1. Data Type

The data used is divided into two, namely:

- a. Primary Data: data obtained directly through interviews and observations at the project site related to the implementation of the project before and after the implementation of the re-

engineering concept.

- b. Secondary Data: data obtained from project documents, contract archives, deviation reports, technical drawings, time schedules, and relevant literature study references, to support the analysis process.

2. Interview

The interview technique is a primary data collection method that is considered effective because it allows researchers to obtain information directly from sources who are actively involved in the implementation of the project. Interviews are conducted through structured and semi-structured conversations to explore information about work conditions, obstacles faced, and potential that can be improved through re-engineering.

The steps that will be taken in the collection of data through interviews include:

- a. Conduct interviews with the Construction Service Provider Team and the Construction Management Consultant Team. The questions are designed based on a list of indicators of performance assessment of construction implementation as well as obstacles that arise during the project.
- b. Interviews were conducted jointly and individually, both in formal and informal forums facilitated by researchers. The results of the interview are recorded in the form of minutes or special notes which are then analyzed.
- c. The data from the interview results were analyzed according to the data processing method that had been established in this study.

3. Documentation

Documentation is included in the secondary data set and is a non-interaction technique carried out by researchers so that the data obtained is more accurate and maximized. This data was obtained by observing the administrative files of the implementation of construction from related sources to determine the results of the research.

4. Literature Studies

Literature studies are carried out by collecting and studying literature, books, scientific journals, and previous research reports related to research topics. The purpose of this study is to strengthen the theoretical foundation and support the discussion of the research.

5. Data source

The data sources in this study come from individuals and documents that can provide information about the implementation of the project. These parties include the Project Management Team, Construction Service Providers, and Construction Management Consultants who are involved during the implementation of the project.

Data Processing Methods

The data processing process in this study uses an interactive data analysis approach that takes place from the collection stage to the final analysis. This stage includes the process of data reduction, data presentation, and conclusion drawn. The data that has been obtained through interviews, observations, documentation, and literature studies is processed by sorting out relevant information, arranging the data into tables or matrices, and presenting the data according to the flow of the research topic. The matrix is then used to facilitate the process of drawing conclusions systematically. This technique refers to the concept of data analysis according to (Nurman et al., 2021) which states that the data processing process must be carried

out continuously and consistently until the end of the research.

Data Analysis Methods

The analysis in this study was carried out with the help of the Microsoft Excel program to compile a time schedule, calculate time deviations, and compare project cost budgets. The initial stage is a data validity test to ensure that the data obtained is valid, accurate, and objective, through checking the suitability of the informant, extending the observation by returning to the field to conduct observations and re-interviews, and confirming the data to the informant after the data is compiled to obtain approval. Furthermore, time analysis was carried out by calculating the deviation between the planned schedule and the realization of work in the field based on the project time schedule using Excel, so that the level of delay or acceleration of the implementation of the work can be known.

Cost analysis is carried out by preparing a Cost Budget Plan (RAB) for each implementation method, both conventional methods and post-re-engineering methods, to assess budget efficiency. The preparation of the RAB is carried out by creating a table containing work items, volume, units, unit prices, and calculating the total, subtotal, and grand total prices using the calculation formula in Microsoft Excel. After obtaining the results of the cost and time analysis of the two methods, a comparative analysis was carried out to determine the most efficient and effective method in terms of duration and cost. In addition, Pareto analysis is used to identify the largest cost components that have the most influence on the total budget, by sorting costs from largest to smallest, calculating cumulative totals, and determining the percentage and cumulative percentage of each work item.

RESULTS AND DISCUSSIONS

Project Data

In the preparation of this final project, the author collected project data first. The data is primary data and secondary data that will be used in the preparation of the final project.

1. General Project Data

General project data was obtained by means of a field survey on May 15, 2025. The general data of the project from the gas pipeline connection project to the customer are as follows:

- a. Project Name : Gas Distribution Pipeline Installation Project and MRS DR. KARIADI Semarang Hospital
- b. Location : Central Semarang District, South Semarang District
- c. Length of Work: 1.97 km
- d. Contract Value : IDR 2,229,375,000,00,- (Two Billion Two Hundred Twenty-Nine Million Three Hundred Seventy-Five Thousand Rupiah)
- e. Owner : PT Perusahaan Gas Negara, Tbk
- f. Contractors : PT PGAS Solution

In the Gas Distribution Pipeline Installation Project and MRS RSUP DR. Kariadi Semarang connected the gas distribution from the pipeline network located on Jl. Mayjen Sutoyo. The construction of this network serves to meet the gas needs of DR. Kariadi Hospital.

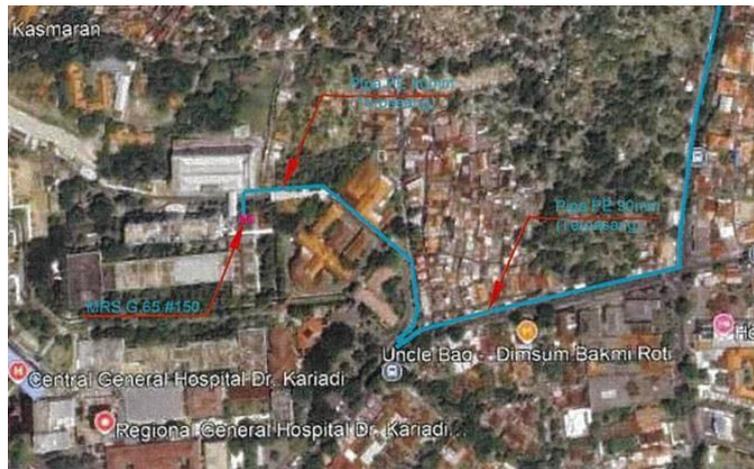


Figure 2. Project Location
(Source: PT PGAS Solution)

In addition, the author also obtained some secondary data or supporting data that is important for the analysis material of this thesis research by visiting the project contractor company on May 15, 2025, including:

- 1) Data Engineering Design (DED), pipeline layout, HDD layout details, pipeline crossing layout details, and selected excavations are all examples of Data Engineering Design (DED) working drawing documents that can be used as a reference in the construction of pipeline networks.
- 2) Data Engineering Estimate (EE), For data engineering estimation, a RAB document or cost budget plan, consisting of various work items, can be used. As shown in Attachment 4.2 of the RAB for the Installation of Gas Distribution Pipes and MRS of Dr. Kariadi Semarang Hospital.

Based on attachment 4.2 RAB for the Installation of Gas Distribution Pipes and MRS of Dr. Kariadi Semarang Hospital, this Cost Budget Recapitulation data is made with Microsoft Excel with the following steps:

- a. Start program Microsoft Excel
 - b. Create a title in the top cell as a RAB identity as per the title and project name
 - c. Create a table that is tailored to your needs, generally consisting of column numbers, job descriptions, total prices. Meanwhile, the rows are filled in according to the work items to be made.
 - d. Fill in the table that has been created based on the attachment of the project RAB document. Next, it is necessary to enter the amount of the job price and the job description column.
 - e. Fill in the Total Work Price column by typing the Excel summation formula for each job. For example, you have to write the Excel formula $=SUM(H10:H22)$ to calculate the price of the product, and then press enter
 - f. Fill in the Value Added Tax (Insurance) column of $2.5\% \times$ the total price of the work. With the excel formula written $=SUM(H25*2.5\%)$ then press enter
 - g. In the column of the total price of the work, namely with the excel formula, it is written $=SUM(H25:H26)$ lau press enter
- 3) Implementation Method Document

Data on implementation methods describing the mastery of the completion of the work

from start to finish, including the stages and sequence of the main works and the description and working methods of each of the main types of work that can be technically accountable, can be found in Appendix 4.3. Working Methods of Gas Distribution Pipeline Installation and MRS of Dr. Kariadi Semarang Hospital.

4) Project Time Schedule

The S-curve is a commonly used tool for compiling project schedules. Using this s-curve, we can see the progress of the work each week and assess the weight of each work. This s-curve is useful as a reference for project progress. The Data Timing Program is attached in appendix 4.5. Schedule for the Implementation of Gas Distribution Pipeline Installation Work and MRS of Dr. Kariadi Semarang Hospital.

2. Re-Engineering Analysis

The following is the essence of the discussion in this study which consists of 4 stages, namely the information stage, creative stage, analysis stage, and recommendation stage.

1) Information Stage

The information stage is the initial stage of Re-Engineering which functions to collect as much information as possible about the research to be researched.

a. Breakdown Cost Model

In conducting the research, the breakdown cost model method was used to identify work. In the Gas Distribution Pipeline Installation Project and MRS DR. KARIADI Semarang Hospital, the Breakdown Cost Model is used to sort work items from the largest to the smallest with the percentage of each work item.

From the results of the recapitulation from the project cost table 4.1 above, an analysis was carried out and then a breakdown cost model method and a pareto graph were carried out as follows:

- a) Sorts work items from largest to smallest by showing the total price and percentage of the weight of each job. Then, use the following Excel formula to calculate the percentage of the job description: $\text{job price} = \text{job price} / \text{total job price}$.
- b) Calculate the cumulative price of work by totaling the price of the description calculated by the price of the previous description. $\text{Cumulative price of work} = \text{Rp cumulative of the previous row} + \text{Rp of the price of work}$ with Excel formula.
- c) Calculate the cumulative percentage of each work item. This can be done by using the following Excel formula: $\text{cumulative percentage of the previous row plus percentage of the job price}$.

Table 1. Breakdown Cost Model of Gas Pipeline Distribution and MRS of Dr. Kariadi Semarang Hospital

NO	WORK ITEM	COST (IDR)	PERCENTAGE	CUMULATIVE
1	PIPE MATERIAL PROCUREMENT	811,774,307	37.32%	37.32%
2	PREPARATION WORK	519,757,306	23.90%	61.22%
3	DEMOLITION WORK	16,507,479	0.76%	61.98%
4	MANUAL BORING WORK	358,364,028	16.48%	78.46%
5	PIPE INSTALLATION AND JOINTING WORK	87,242,351	4.01%	82.47%
6	CASING INSTALLATION, MARKER TAPE & CONCRETE SLAB WORK	15,071,412	0.69%	83.16%
7	HDD WORK	187,882,643	8.64%	91.80%
8	MRS WORK	34,577,320	1.59%	93.39%
9	REPAIR AND REINSTATEMENT WORK	96,664,613	4.44%	97.83%
10	CLEANING AND TESTING WORK	11,165,630	0.51%	98.35%

11	REPORTING WORK (Incl. Documentation & As-Built Drawing)	25,073,554	1.15%	99.50%
12	COMMISSIONING & PSSR WORK	6,485,464	0.30%	99.80%
13	COVID-19 PROTOCOL	4,433,893	0.20%	100.00%
TOTAL		2,175,000,000		

(Source : Author's Analysis)

Based on table 1 the results of the Breakdown Cost Model of Gas Pipeline Distribution and MRS DR. KARIADI Semarang Hospital, the following jobs were obtained:

- a) Material Procurement
- b) Prep Work
- c) Demolition Work
- d) Boring Manual Work
- e) Pipe Installation and Connection Work
- f) Casing, Marker Type & Concrete Slab Installation Jobs
- g) HDD Jobs
- h) MRS Jobs
- i) Repair Work and Fireplace Return
- j) Cleaning and Testing Work
- k) Reporting Jobs (Incl. Documentation & As Built Drawing)
- l) Commissioning & PSSR Jobs
- m) Covid 19 Protocol

According to the results of the breakdown analysis, the use of re-engineering in this study will be focused on pipe installation, manual horizontal boring, and HDD boring. based on the work items shown in Appendix 4.3. For the Distribution of Gas Pipes and MRS, dr. Kariadi Semarang Hospital uses Medium Density Polyethylene (MDPE) pipes with a diameter of 90 mm.

b. Function Analysis

Researchers in this re-engineering research will concentrate on the method of installing pipes. as shown in Appendix 4.3. Work Methods of Gas Pipeline Distribution Work and MRS of Dr. Kariadi Semarang Hospital. There are three different methods, namely Open Cut, Manual Horizontal Boring, and Horizontal Directional Drilling (HDD).) There are differences and similarities, which can be seen in the following table 2:

Table 2. Pipeline Implementation Method Checklist

No	Implementation Method	Open Cut	Boring Horizontal Manual	HDD
1.	MDPE Pipe Procurement	√	√	√
2.	Pipe Transportation/Curtain	√	√	√
3.	Pit Boring		√	√
4.	Tool Mobilization		√	√
5.	Pipe Installation	√	√	√
6.	Soil Excavation	√	√	
7.	Landfill	√	√	
8.	Urugan Sirtu Compacted	√		
9.	Gravel Urugan	√		
10.	Pipe Pressure Test	√	√	√
11.	Pipe Washing	√	√	√
13.	Procurement and Installation of Pipe Accessories	√	√	√

(Source : Author's Analysis)

In Table 2, it is known that the differences in the method of installing open cut pipes, manual horizontal boring, and Horizontal Directional Drilling (HDD) have differences. In the open cut, manual horizontal boring method, Horizontal Directional Drilling (HDD) has several similarities because it uses the same material, namely MDPE pipe.

2) Creative Stage

After knowing that the pipe installation method is feasible to be re-engineered, the next stage is the creative stage where alternatives will be carried out to replace the original design. Some alternative methods of pipe installation work:

- a. Existing Open Cut Method
- b. Alternative I (Manual Horizontal Boring Method Open Cut Method)
- c. Alternative II (Open Cut Method Horizontal Directional Drilling Method)

Some of the factors that are considered in providing alternatives to the pipeline installation method are: Cost and Time

3) Analysis Stage

The analysis stage is a stage to evaluate and analyze the alternatives chosen at the creative stage. What will be done at the analysis stage is as follows:

- a. Pipe installation method
 - b. Time
 - c. Volume of Work
 - d. Cost
 - e. Cost and Time Comparison
 - f. Cost Efficiency Versus Time Effectiveness
- a) Pipe installation method

Based on the attachment document 4.3 Work Methods of Gas Pipeline Distribution Work and MRS RSUP DR. Kariadi Semarang, it can be known that in the implementation of open cut pipe installation work, manual horizontal drilling, Horizontal Directional Drilling (HDD).

a. Open Cut Method

In the scope of this project, the installation of pipes is carried out through the Open Cut method. Soil excavation is carried out both mechanically and by manual power to erosion and compaction. Mechanical excavation is carried out with excavators, while manual excavation is carried out with manpower/workers with manual equipment. Digging the road body or shoulder according to the design dimensions is a digging task. Soil excavation work must cover the entire excavation, including rock excavation, structures, and asphalt pavement.

Open cut excavation work is carried out by open excavation, so that pipe installation can be done more flexibly. Mechanical soil excavation work must be carried out carefully and thoroughly, because there are various existing facilities such as optical cables, PDAM pipes, and others. Excavation protection is installed to prevent avalanches, especially in bad weather conditions such as rain. This protection also serves to strengthen the quarry wall, so that the excavation remains intact, protect the surrounding building structure, and maintain the safety of workers against the risk of injury or injury, especially when the excavation slope is unstable. To ensure that the pipeline installation work runs effectively and efficiently, the stages of the pipeline installation work must be well made, in accordance with drawings and specifications, and ensure that K3L is implemented properly.



Figure 3. Open Cut Method
(Source: Boringan.com)

b. Boring Horizontal Manual

Manual Horizontal Boring referred to in this discussion is the work of hollowing or digging the soil using such equipment with human labor that it aims to make a horizontal or horizontal utility trajectory below the ground surface. This manual horizontal boring process that is carried out without a casing is commonly referred to as the "Katrek" or "Rojok Drill" method.

In this method, it is necessary to make an excavation hole or pit. On a pipeline crossing line, two or more pits are required. The pits are dug manually with human power or with the help of mechanical equipment such as excavators. This pit excavation serves as a place for workers to do work digging the soil in a horizontal direction which will later be used as a place for pipe entry. This pit can be called an exit pit. A final destination pit or pit is made on the opposite side of the pipeline crossing path, commonly called an enter point pit where the pipe will be inserted from this point and drawn to the exit pit. In its implementation, if needed, a pit will be made between the enter pit and the exit pit, commonly called pit relay.

Manual horizontal drilling or commonly known as manual horizontal drilling begins by installing a 1" drill bit on a 2 m long iron pipe. The drill bit is driven into the soil layer horizontally to the desired depth, with the help of wooden blocks. The pipe equipped with a drill bit is continuously pressed forward and backward towards the exit pit. If the boring hole has increased in length, the pipe is connected to the next pipe. In a relay, the drill bit is continuously pressed horizontally until it penetrates to the next pit.

After the drilling of the specified pipeline has been achieved, the next process is the process of enlarging the diameter of the excavated hole or boring to the desired size. This process is commonly referred to as "reamaring" or "reamer". To facilitate the reamerment process, water is needed that is drained into the boring hole. The water flowed into the boring hole comes from the water reservoir that has been prepared. During the reamer process, the height of the puddle caused by the water flowing into the pit must always be maintained with the help of a water pump machine.

The prepared (jointed) MDPE pipe per rod is lifted slowly with the help of human labor or heavy equipment. Then the pipe is lowered carefully into into the enter pit. After the MDPE pipe enters the pit hole, it is then pushed with human labor

and the help of a chain block tool. This work is done until the MDPE pipe really enters and according to the planned position.

If the pipe has been installed, the pit is closed again by stockpiling the pit using compacted sirtu extraction material or according to the instructions of the work director. The pit hoarding is carried out at the same time as the soil compaction process assisted by a vibratory roller machine. This process is carried out in stages until the desired thickness of the backfill is reached.



Figure 4. Manual Horizontal Boring Method
(Source: PT PGAS Solution)

c. Horizontal Directional Drilling (HDD)

Pipe installation work with the boring method is carried out under certain conditions where the implementation with this method will be more effective than the open cut method of excavation. The examples of the conditions in question are such as the condition of road crossings, where at the crossing the traffic is quite crowded and dense so that if carried out with the open cut method of excavation, it will have a big impact on the existing traffic. Another condition is such as at railway crossings, because it is not possible for railway lines to be changed, dismantled, or diverted because the railway line is a fixed line.

Pipelines that pass through national roads will also be easier to work with the boring method because the national road is the main connecting road between provinces so that if the installation of pipes is carried out with open excavations, it will have an impact on existing traffic. Other conditions that require the installation of pipes are carried out by the boring method, such as the existence of crossing drainage channels on pipelines, the existence of existing pipes that are obstacles to the planned route, narrow and congested roads, and certain other conditions. Boring with the Horizontal method

Directional Drilling or commonly called the HDD method is a

boring work using



Figure 5. Horizontal Directional Drilling Method (Source: PT PGAS Solution)

b) Time

The time of implementation of the work on the Gas Pipeline Distribution and MRS project of dr. Kariadi Semarang Hospital can be seen through the Time Schedule of the S curve, which is in attachment 4.5. Schedule for the implementation of the Gas Pipeline Distribution project and MRS of Dr. Kariadi Semarang Hospital. Through the S curve, the duration of each job can be known first. The duration of work can be determined by considering the volume of work and work productivity with the formula of equation 2.2 while the weight of work can be calculated by the formula in equation 2.3. Once the weight and duration are known, then the Time Schedule of the S curve can be created using the help of the Microsoft Office Excel application which has been described in chapter 3.7 before.

The weight and duration required for each method of pipe installation in the Gas Pipeline Distribution project and MRS RSUP DR. Kariadi Semarang are as follows:

Table 3. Recap of the Duration of the Work as Existing

No	Implementation Method	Open Cut (Day)	Manual Horizontal Boring (Day)	HDD (Day)
1.	MDPE Pipe Procurement	1	1	1
2.	Pipe Transportation/Curtain	2	2	2
3.	Pit Boring	-	4	1
4.	Tool Mobilization	-	1	1
5.	Pipe Installation	2	4	1
6.	Soil Excavation	20	7	-
7.	Landfill	2	1	-
8.	Urugan Sirtu Compacted	2	2	-
9.	Gravel Urugan	2	-	-
10.	Pipe Pressure Test	1	1	1
11.	Pipe Cleaning	1	2	1
13.	Procurement and Installation of Pipe Accessories	1	2	1
Total		34	27	9

(Source: Schedule for the Implementation of Gas Pipeline Distribution and MRS of Dr. Kariadi Semarang Hospital)

Alternative I

The time analysis carried out in the first alternative is by calculating the time needed for work on site which was originally carried out with the Open Cut method and then changed with the alternative method of Manual Horizontal Boring.

a. The volume can be seen in Appendix 4.3 RAB Gas Pipeline Distribution and MRS of Dr.

Kariadi Semarang Hospital.

- b. Productivity can be found through interviews that the author has conducted previously in a field survey on May 15, 2025, namely an interview with Mr. Sutadi as the main implementer of the project.
- c. Productivity for Open Cut work is 5.14 m/day. So in 1 hour it can be known that the productivity is 0.637 m/hour.
- d. Productivity for Manual Horizontal Boring work is 61 m/day. So in 1 hour the productivity can be known, which is 2.54 m/hour.

Example of calculation of Open Cut work duration:

Volume = 144 m

Productivity = 144/5.14 = 28.01 days = 4 weeks

Table 4. Comparison of Open Cut with Manual Horizontal Boring

No.	Work Description	Duration (Days)	Duration (Weeks)
1	Open Cut Work	28 Days	4 Weeks
2	Manual Horizontal Boring Work	3 Days	1 Week
Difference		25 Days	3 Weeks

(Source : Author's Analysis)

From table 4 above, it can be seen that the work with the Open Cut method has a longer duration than the manual horizontal boring method.

Alternative II

The time analysis carried out in the second alternative is by calculating the time needed for work at the site which was originally carried out by the Open Cut method and then changed by the alternative method of Horizontal Directional Drilling (HDD).

- a. The volume can be seen in Appendix 4.3 RAB Gas Pipeline Distribution and MRS of Dr. Kariadi Semarang Hospital.
- b. Productivity can be found through interviews that the author has conducted previously in a field survey on May 15, 2025, namely an interview with Mr. Sutadi as the main implementer of the project.
- c. Productivity for Open Cut work is 5.14 m/day. So in 1 hour it can be known that the productivity is 0.637 m/hour.

Meanwhile, productivity for HDD work is 90 m/day. So in 1 hour it can be known that the productivity is 3.75 m/hour.

Example of calculation of Open Cut work duration:

Volume = 144 m

Productivity = 144/5.14 = 28.01 days = 4 weeks

Table 5. Comparison of Open Cut with Manual Horizontal Boring

No.	Work Description	Duration (Days)	Duration (Weeks)
1	Open Cut Work	28 Days	4 Weeks
2	HDD (Horizontal Directional Drilling) Work	1.5 Days	1 Week
Difference		26.5 Days	3 Weeks

(Source : Author's Analysis)

From table 5 above, it can be seen that the work with the Horizontal Directional Drilling method has a much shorter duration compared to the Open Cut method. **Volume of Work**

The volume of pipeline work implementation is summarized in the table as follows:

- a. Open Cut

Based on attachment 4.3 of the RAB for Gas Pipeline Distribution and MRS of Dr. Kariadi Semarang Hospital in the work item column, the length of the pipeline network with the open cut method in each diameter is as follows:

Table 6. Open Cut Job Volume

No.	Job Description	Volume	Units
1	90 mm MDPE Pipe Fitting	144	m'
	Total Length	144	m'

(Source : RAB Gas Pipeline Distribution and MRS DR. Kariadi Semarang Hospital)

In Table 6, the total length of the network for work with the open cut method can be known, which is 144 meters.

b. Boring Horizontal Manual

Based on Attachment 4.3 of the RAB for Gas Pipeline Distribution and MRS of Dr. Kariadi Semarang Hospital in the work item column, the length of the pipeline network with the Manual Horizontal Boring method in each diameter is as follows:

Table 7. Manual Horizontal Boring Job Volume

No.	Job Description	Volume	Units
1	MDPE Manual Horizontal Boring 90 mm	1.728	m'
	Total Length	1.728	m'

(Source : RAB Gas Pipeline Distribution and MRS DR. Kariadi Semarang Hospital)

In Table 7 The volume of manual horizontal boring work can be determined the total length of the network for work with the Manual Horizontal Boring method, which is 1,728 meters.

c. Horizontal Directional Drilling (HDD)

Based on attachment 4.3 of the RAB for Gas Pipeline Distribution and MRS of Dr. Kariadi Semarang Hospital in the work item column, the length of the pipeline network with the Horizontal Directional Drilling (HDD) method in each diameter is as follows:

Table 8. Horizontal Directional Drilling (HDD) Work Volume

No.	Job Description	Volume	Units
1	HDD MDPE Pipe 90 mm	84	m'
	Total Length	84	m'

(Source : RAB Gas Pipeline Distribution and MRS DR. Kariadi Semarang Hospital)

In Table 8 the volume of Horizontal Directional Drilling (HDD) work can be determined the total length of the network for work with the Manual Horizontal Boring method, which is 84 meters.

c) Cost

1. Unit Price Analysis

Based on the RAB for Gas Pipeline Distribution and MRS of Dr. Kariadi Semarang Hospital, there are three work methods that are analyzed for unit prices. The Open Cut method (manual excavation) has a unit price of IDR 497,389/m', while the Manual Horizontal Boring method has a unit price of IDR 318,707/m'.

The Horizontal Directional Drilling (HDD) method has the highest unit price among the three methods, which is IDR 2,206,303/m'. The significant difference in unit price between these methods is the basis for consideration in choosing the most efficient and effective method of carrying out work for the project.

2. Price recapitulation as it exists

Based on the RAB project, the total price of the existing work using the Open Cut method

for a 90 mm diameter pipe is calculated based on a volume of 144 m' multiplied by the unit price of Rp497,389/m', resulting in a total cost of Rp71,624,016. Meanwhile, the Manual Horizontal Boring work with a volume of 1,728 m' resulted in a total cost of Rp550,725,696.

For Horizontal Directional Drilling (HDD) work with a volume of 84 m', the total cost generated is IDR 185,294,457. These three existing price recapitulation values are a comparative reference in evaluating cost efficiency if the method of implementing the work is replaced with an alternative method available.

3. Price Recapitulation with Alternative Methods

In Alternative I, the work segment on Jl. Kyai Saleh which originally used the Open Cut method was replaced with the Manual Horizontal Boring method. The recapitulation results show that the cost needed for Alternative I is IDR 45,893,808, lower than the existing Open Cut cost which reached IDR 71,624,016.

In Alternative II, the same segment is transferred using the Horizontal Directional Drilling (HDD) method. The cost needed for Alternative II is IDR 317,707,632, much higher than the existing cost of IDR 71,624,016. This shows that Alternative II is inefficient in terms of direct costs even though it has the potential to provide benefits in terms of technical and implementation time.

4. Cost and Time Comparison

A comparison between the existing Open Cut method and Alternative I (Boring Horizontal Manual) shows that the existing method has a longer implementation duration as well as more expensive costs than Alternative I. Thus, Alternative I is considered superior both in terms of cost efficiency and project implementation time effectiveness. On the other hand, a comparison between the existing Open Cut method and Alternative II (HDD) shows that although the existing method has a longer duration, it is much cheaper in terms of cost. The cost of Alternative II has increased significantly to reach 343% or more than three times compared to the existing method, so that is considered inefficient in terms of budget.

5. Cost Efficiency vs. Time Effectiveness

The application of alternative methods in this project also has an impact on indirect cost efficiency, such as staff monthly salaries/honorariums, general and office operational costs, and work costs that take place from the beginning to the end of the project. The existing indirect costs were recorded at IDR 65,000,000/month or an average of IDR 1,984,000/day, so that during the 90 days of implementation the total indirect costs incurred reached IDR 178,500,000.

In Alternative I with a duration of 73 days, the total indirect cost was reduced to IDR 144,783,333, resulting in an efficiency of IDR 33,176,667. Meanwhile, in Alternative II with the same duration, the total indirect cost became IDR 142,800,000 with efficiency amounting to Rp32,700,000. These two alternatives show that reducing the duration of implementation through more effective methods can directly improve the overall cost efficiency of the project.

d. Recommendation Stage

At the analysis stage, it was found that the cost and time required for each method from all locations varied greatly. There are methods that become more economical but have a longer duration or vice versa. Therefore, it can be recommended in order to achieve more cost-effective and short duration in each alternative, which is as follows:

- 1) Alternative I At these locations, it can be recommended to use the Manual Horizontal Boring method because it has more cost savings and a shorter time duration compared to the Open Cut method so that the work gets optimal results.
- 2) Alternative II This second alternative if reviewed from the duration of the work, the HDD method is very effective to recommend. But it has a much more expensive cost difference making it less efficient.

CONCLUSION

Based on re-engineering research on the Gas Pipeline Distribution Project and MRS Dr. Kariadi Hospital Semarang, it can be concluded that the Open Cut method has a productivity of 5.14 m/day with a unit price of IDR 497,389, the Manual Horizontal Boring method has a productivity of 61 m/day with a unit price of IDR 318,707, while the Horizontal Directional Drilling (HDD) method has the highest productivity of 90 m/day with a unit price of IDR 2,205,886. The results of the analysis show that the Open Cut method have the lowest productivity compared to the other two methods; In alternative I, replacing Open Cut with Manual Horizontal Boring results in cost efficiency of 35.92% or Rp25,730,208 and time effectiveness of 18.89%, making it the most ideal alternative. Meanwhile, in alternative II, replacement with the HDD method did increase time effectiveness by 20.00%, but caused cost overruns by 343% so it was less efficient. Therefore, in the implementation of re-engineering, it is necessary to have complete and accurate data, careful use of applications such as Microsoft Excel to minimize analysis errors, and careful consideration of rising costs due to the acceleration of time; Researchers are also advised to analyze other work items to obtain better optimization in terms of time effectiveness and cost efficiency.

REFERENCES

- Ayra, A. D., & Santosa, W. (2025). Peran Resiliensi dalam Memediasi Pengaruh Budaya Manajemen Risiko Rantai Pasok terhadap Kinerja Organisasi. *AKADEMIK: Jurnal Mahasiswa Ekonomi & Bisnis*, 5(1), 332–346.
- Bismantaraa, R., Dinarianab, D., Jayadyc, A., Suryanid, F., & Nugrahae, H. (2021). Readiness and Influence of Value Engineering Implementation at the Construction Center of the Ministry of Defense of the Republic of Indonesia (Case Study of Belawan Hospital Construction). *Journal of Architecture and Civil Engineering*, 6(9), 1–17.
- GEBRE, M. (2014). *AN ASSESSMENT OF BUSINESS PROCESS REENGINEERING IMPLEMENTATION IN WATER WORKS CONSTRUCTION ENTERPRISE*. St. Mary's University.
- Ginting, H. S., & Sidabutar, Y. F. D. (2024). The Influence of the Construction of the Ocarina–Bengkong Bridge on Economic Aspects and Social Aspects In Bengkong District, Batam City. *Journal La Sociale*, 5(5), 1420–1431.
- Hwang, J., Rao, R. R., Giordano, L., Katayama, Y., Yu, Y., & Shao-Horn, Y. (2017). Perovskites in catalysis and electrocatalysis. *Science*, 358(6364), 751–756.
- Namirah, H. H., Nugraha, R. F., Djuanda, R., & Sembodo, T. A. P. (2024). Transformasi Bisnis Melalui Business Process Reengineering: Tinjauan Literatur Terhadap Penerapan dan Dampaknya pada Berbagai Sektor. *Economic Reviews Journal*, 3(4), 1761–1767.
- Nathanael, M. A. (2023). Service Quality Analysis to Increase Customer Satisfaction at Government-Owned Fuel Filling Stations in Indonesia. *Journal of Current Research in Business and Economics*, 2(1), 46–79.
- Nazaria, R., Wijaya, I. M. S., Pranudia, A. D., Wirawan, D., Male, H. D. C., & Veranita, M. (2024). *Indonesian Journal of Social*

- Business process reengineering in hospitals: a literature review of related methodologies and approaches. *Radinka Journal of Science and Systematic Literature Review*, 2(1), 262–270.
- Nurman, N., Zainal, Z., & Rajasa, Y. (2021). Good Governance in Structure Belantik Raya People's Market in Siak District. *Jurnal Kajian Pemerintah: Journal of Government, Social and Politics*, 7(2), 1–11.
- Puruhita, H. W. (2018). The readiness of building construction companies to implement re-engineering in Surakarta region. *AIP Conference Proceedings*, 1977(1), 30037.
- Putra, R. H., Cahyo, W. N., & Zhang, T. (2022). Re-Engineering The Business Process of Slickline and Electric Line Operation. *Spektrum Industri*, 20(1), 49–66.
- Rifai, A., & Subali, S. B. W. (2022). Supply Chain Risk Control Strategy for Aircraft Maintenance in the Era of the Covid-19 Pandemic. *J-MKLI (Jurnal Manajemen Dan Kearifan Lokal Indonesia)*, 6(2), 70–88.
- Shaheer, M. (2017). *Effects of welding parameters on the integrity and structure of HDPE pipe butt FUSION welds*. Brunel University London.
- Simatupang, D. N., & Astuti, R. (2023). Model Rapid Application Development (RAD) Untuk Rancang Bangun Sistem Informasi Monitoring Project Pada Branch Business Process Re-Engineering (BBPR) Team. *Innovative: Journal Of Social Science Research*, 3(6), 6683–6696.
- Tifany, E., & Dachyar, M. (2021). Modeling and analysis of a software development project with design structure matrix and simulation approach in an Indonesian startup. *11th Annual International Conference on Industrial Engineering and Operations Management, IEOM 2021*, 1631–1641.
- Tobgay, T. (2005). *Unique topography of the Bhutan Himalaya: implications for active tectonics*. The University of Texas at El Paso.
- Yuliana, V., & Santoso, S. (2021). Re-engineering and Technology Development on Reference Sample of Business Process (Case Study on Health Laboratory Service Company). *Jurnal Ilmiah Manajemen Dan Bisnis*, 7(2), 212–222.