Design tools for underground pipe welding on welding tie-in parts using value engineering method

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Abstract. In the industrial world, tools are needed to carry out all work activities, one of the aids on pipe connection. The research entitled the design of underground pipe welding tools in the welding tie-in section with value engineering methods. As for the background of this title, because the company does not achieve the target on the welding tie-in, it is caused by the process of fit-up is too long, narrow space and the tools used too much. Has a problem formation how to design a tool to facilitate fit up underground pipe (tie-in) and how the final welding process before and after using tools. And the purpose of the research to design the underground pipe welding aids with value engineering methods so that faster job time and more efficient workforce can also know the performance and result of implementation. This research uses field observation method directly with the following stages, functional analysis phase, creative stage, evaluation phase, percentage stage, and implementation. In data collection and data processing using Nordic Body Map questionnaire to find out the types of complaints experienced by workers during the preparation process of the tool up to the welding process on the welding tie-in. From this research is generated tool welding process in the underground pipe welding in the form of clamp aids made of iron plate with total cost IDR 2,713,000.00. Based on the results of the Nordic Body Map questionnaire, after using the tool cannot find a complaint on the worker, and the amount of labor from the initial process to the end is enough with six people on each team/group.

1. Introduction
PT. XYZ is one of the companies engaged in construction services, including oil and gas since 2003 to date has contributed to the distribution of gas pipelines owned by government. One of the BUMN-owned companies that use services from PT. XYZ is PT. PGN (Persero). In the gas pipeline welding process, especially pipeline and piping are divided into 2 parts, namely pipe-up welding (line-up) and underground pipe welding (tie-in) (Figure 1).

A Pipeline is a network that is used as a distributor of water pipes, sewage, gas, or fluid hydrocarbons from sources (for example reservoirs, steam plants, oil and gas wells, refineries) by pipes which are channeled to distributors. The pipe can be stored on the ground (above ground), or in the ground (underground) or even in the sea. The pipe diameter used in the pipeline is quite large, between 6-48 inches apart from that the distance is very far, and tends to be straight.

A Piping is system that connects between equipment in one facility using a pipe system, with a short distance with a pipe diameter of 1-4 inch. The Piping is used to distribute gas from the metering to industry or households. Welding of pipes on the ground (line-up) is the process of connecting pipes by bringing together the two ends of the pipe with parallel pipe position, using a buffer or commonly
called shapod and threepods. In the process of welding the pipe on the ground (line-up) almost no obstacles were found both in terms of work time and progress targeted by the company unless there are natural disruptions such as rain.

![Figure 1. Line Up Welding](image)

Underground welding (tie-in) is the process of connecting pipes with limited space for underground pipe connection work (tie-in) requiring a very long time compared to the line-up welding work. This is due to space limited motion, the position of the pipe to be connected is not aligned, so that workers must adjust / fit-up first so that the two parts of the pipe can be straight and can then be connected. The adjustment / fit-up process is done on both parts of the pipe by channeled from both sides by using a beam as a base, but if the position of the pipe is lower and one is higher then use blockchain and three pods to lift one section of the pipe to be parallel. During this process, welders cannot produce productivity.

To work on pipe settings (fit-up) requires a workforce of at least 7 people including welders, of which the task is 2 people at the bottom to install and operate channeled, 3 people to install and operate the chain block, 1 person to lowering work tools such as beams and at the same time keeping the water pumping machine. If the work position is channeled by water/drainage, the average work time required to set a pipe connection of 4 - 6 inch diameter requires at least 4 hours of welding work. From the aforementioned problems, it is necessary to have a tool that facilitates the fit-up process so that the target of the company can be achieved, the tools that are planned to be made will be used for the tie-in connection in the form of pipe clamps using hydraulic double as a tool for push / unify the two parts of the pipe in the welding process, as for the tools used at present include jacks, wood beams, iron plates, blockchains, three pods and jack clamps.

2. Related Works

Designing is a fundamental proposition that transforms something that already exists into something better, through three processes: identifying problems, identifying methods and implementing a problem-solving. In other words, programming, drafting, and implementation of the design (John Wade, 1997).

Aids are a tool used to assist workers in doing a job so that the work is easier to do, does not endanger workers and the work becomes more effective. Welding is one of the techniques for joining metal by melting some of the parent metal and filler metal.

Value Engineering is an array of methods to reduce production costs or use of goods and services without reducing the quality and performance that exists (Chaidir, 2007).

This method is a step that must be done by conducting research or design. The steps in value engineering are as follows:

1) Information stage, which is the stage of seeking as much information as possible about the existing problems, the factors that influence the problem and the plan for improvement.
2) Function Analysis Phase, which is the stage of analyzing each of the main functions and supporting functions.
3) Creative Stage, that is at this stage the identification of alternatives that can be selected in product planning is identified and identifying costs that can be reduced without reducing the value of the product’s function.
4) The evaluation phase is, namely evaluating alternative alternatives in product planning and determining the best alternative used for product planning reference.
5) Orientation Stage, which is the stage of finding problems and preparing a research plan.
6) Development phase, namely the stage of determining the best alternative and developing the alternatives chosen in product planning.
7) Presentation Stage, which is the stage of presenting from an alternative chosen to the management team to get approval for the alternative.
8) The implementation phase, which is the implementation stage and implementing of selected alternatives to product planning that has been approved by the team management

3. Method

Figure 2 shown the research flow, which is including the research background, preliminary studies, research objective, and data processing.

![Research Flow Diagram](image_url)

**Figure 2.** Research flow

4. Results and Discussion

Based on the comparison of the analysis of functions that exist in each design alternative, it can be seen that alternative designs 1, 2 and 3 are able to fulfill the function of each component, both primary and supporting functions, so that it can facilitate the process of fit-up work on underground pipe welding section in the tie-in section of the gas pipe installation work at PT. XYZ.

In terms of aesthetics, design alternative 1 is almost entirely made of iron plate base material so it requires painting to have a good appearance but the locking system still uses nuts and bolts with the composition all of 2 bolts on the left side and on the right side, so that it takes longer time when using it. In alternative designs 2 is almost entirely made of stainless steel so it does not require painting the appearance is good. But it has not been categorized as perfect because it uses hydraulic/one-sided jack so that the fit-up process of both parts of the pipe still has no precision. In the alternative design 3 is made entirely of iron and steel with double hydraulic / jack with the main function as ring clamping.
locking. This makes it easier for workers in the fit-up process because it can be set from both sides of the jack to get the desired fit-up results (Figure 3). In addition, the number of workers in the pipe fit-up process in the tie-in hole is done by 2 workers. Looking at the price function, alternative design 1 is IDR 2,566,000.00, alternative design 2 is IDR 5,977,500.00 and alternative design 3 of IDR 2,713,000.00. In terms of ease of use and time of work and the difference in manufacturing costs that are not too far between alternatives 1 and 3 that is equal to IDR 147,000.00. So it can be decided that the selection of alternative designs falls to the alternative design 3 of making underground pipe welding aids in the tie-in section of PT. XYZ.

![Figure 3. The Tools](image)

5. Conclusion
Based on the analysis of the selection of alternative designs 1, 2 and 3 using the value engineering method, the alternative design is chosen 3, the consideration is easier in operation, simple, practical and fit-up results as expected with a manufacturing cost of IDR 2,713,000.00. Based on the position and how to use the tool during the fit-up process, the workers are easier to load work tools and do not need as many people. Based on data calculations, the ignition of the target in the welding tie-in job experienced a very significant increase of 25.04%, this after using underground pipe welding aids in the welding tie-in. Based on the Nordic Body Map questionnaire, there were no pain complaints from the workers when the pipe fit-up was 100% at the upper neck, back, waist and hips to 0%, from 80% of the left upper arm, the right upper arm became 0%, from complaints of 60% complaints on the left shoulder, right shoulder, left palm and right palm to 0%, and from 40% complaints on the left knee, right knee becomes 0%.

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