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Machine Modification and Material Replacement to Reduce Production Cost Using PDCA Method with Fishbone Diagram and Why Why Analysis

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ABSTRACT

In the fierce competition in the Industrial world, meeting customer needs to maintain loyalty and trust is a major concern. In this case, the order received at Job 23xxx was in the form of UNP bending which is a new model and has never been produced. The existing machine does not meet the needs of completing this job; therefore, the initial plan was chosen to use the welded plate. The welded plate is a waste of time and material. Thus, there must be a machine modification for UNP bending. Machine modification is done by adding a stopper (JIG) so that the roll plate machine can turn into a UNP roll machine. Quality and speed of completion time are the main goals so that customers continue to entrust work to our company. PDCA method with fishbone diagram and why analysis is applied in solving this problem. The present study was conducted by comparing the number of process sequences, process time, and material requirements. Welded plate requires 5 process sequences while UNP material only requires 3 process sequences. Completion of work using welded plate requires 4.874 hours while UNP material only requires 0.807 hours for 1 set of products. This means that the process with UNP material only takes 16.65% of the welded plate process. This makes work completion faster. The cost of welded plate material is Rp. 1,335,956 while UNP material is Rp. 950,756, meaning the cost of UNP material is 71% compared to welded plate material. Saving material costs Rp. 385,200 or 29% per 1 set.

Introduction

The oil and gas industry is huge. PT B is a company manufacturing pipe supports used in the oil and gas industry. In its development, PT B realizes that the competition in this industry is so significant that innovation and continuous improvement are needed to compete and survive. Continuous improvement is defined more generally as an ethos in an organization that aims at eliminating all wastage in all processes or systems through sustained improvement [1]. The dynamics of competition is a change that arises because of competition within the company to compete for consumers.

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In a positive sense, competition is all efforts made to attract customers to the company for obtaining profits [2].

Fulfilling customer needs is crucial to maintaining loyalty and trust. Therefore, orders will continue to be received. Consumer trust is the willingness of one party to accept the risk of another one based on the belief and expectation that the other party will take the expected action [3]. The recent problem is the demand for unusual or custom product models, which creates problems in the process of completing the job.

The current machine is not specific for the UNP material roll process as requested in this job drawing. Thus, the initial decision was the use of welded plate material which can be directly applied in the process.

The use of welded materials creates a lot of waste in terms of the material itself and time in the manufacturing process. The material will be wasted because the cutting plan for making UNP bending using plates is radius or curved. Making UNP using welded plates also requires a lot of methods and handling so the processing time will be longer.

Material is a large percentage of costs that must be incurred by the company. If a lot of material is wasted, it will reduce the company's profit, and even worse if there is no profit the company will lose money. According to Ardhianto, profit is the excess of total revenue over total expenses, also called net income or net earnings. The quality and speed of work completion time is the key to success in making customers happy and will continue to entrust their work to our company. This obviously cannot be achieved if there are many problems in the process.

Product quality is the combination of properties and characteristics that determine the extent to which output can fulfill the prerequisites [4].

The aim of this study is to find alternative solutions to Job 23xxx so that delivery time can be met according to customer expectations. In addition, this work aims to avoid waste of material and process time so that production costs can be reduced. Accordingly, PDCA method is chosen with fishbone diagram and why analysis to solve this problem.

Materials and Methods

Methods

The method used in this study is quantitative research that describes the number of processes, process time, and the amount of material costs used when using welded plates compared to UNP materials. The research approach uses PDCA implementation with problem mapping using fishbone diagrams and why-why analysis. The stages of PDCA are as follow:

The first phase (Plan): In this phase, the problem is identified to clearly be solved, and then measurable and achievable goals are set.

The second phase (Do): This phase aims to implement the action plan after an experiment design. Furthermore, unexpected events learned lessons and acquired knowledge must be considered.

The third phase (Check): In this phase, the results of the actions implemented in this phase are analyzed and evaluated to check whether there have been improvements, or not.

The fourth phase (Act): This phase consists of developing methods aimed at standardizing the improvements (in the case objectives have been achieved). In addition, the other improvement opportunities are examined [5].

The fishbone diagram or cause and effect diagram is a diagram developed by Dr. Kaory Ishikawa in 1943 which is used to show the cause-and-effect relationship of a problem or deviation [6].

By repeatedly asking the question "Why" (five is a good rule of thumb), the layers of symptoms are peeled away that can lead to the root cause of a problem. Although this technique is called "5 Whys," you may find that you will need to ask the question fewer or more times than five before you find the issue related to a problem [7].

Results and Discussion

The outline of the problem in completing job 23xxx is the availability of machines that do not match the job model obtained from the customer so the quick thinking is to complete using existing machines with familiar methods and materials. Its effect is the amount of production

costs. The production costs are those incurred when a production occurs in a manufacturing company (Figure 1) [8].

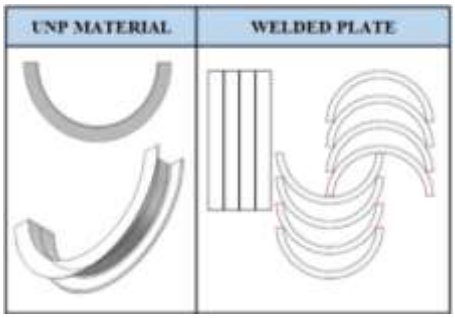
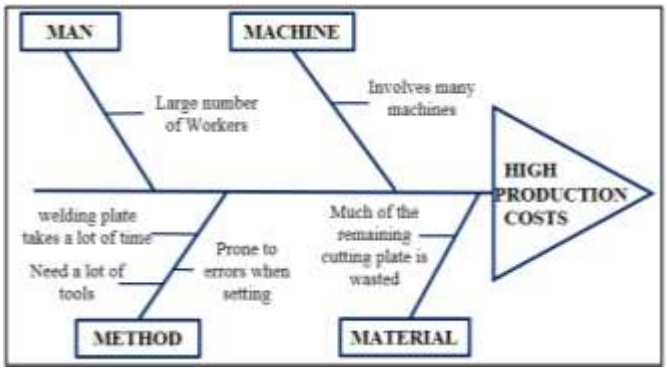


Figure 1: Illustration of the difference between UNP material and welded plate

The (*Plan*) stage begins by identifying problems to find factors that cause high production costs. The method used is to use the following causal fishbone diagram (Figure 2).



Figures 2: Fishbone diagram of high production costs

From the fishbone diagram above, it can be seen that production costs are influenced by 4 main factors, namely:

Material: a lot of material is wasted due to an inefficient cutting plan (curved cutting model).

Machinery: many machines are needed to complete jobs using welded plates.

Man: Need more workers

Methods: There are several influencing factors including the use of welded plate takes a lot of time, requires a lot of tools, and is prone to errors during the setting process due to the complex design.

Using Why analysis, we can find out why the first choice is a welded plate which makes the production cost high:

1) Why are production costs high?

Because the process manufacturing process UNP uses plate welded requires many work centers and many workers, the process is long, and material is wasted.

2) Why should use welded plate?

The roll cost at the subcont is expensive.

3) Why roll in sub-cont?

Because in-house does not have the appropriate machines and methods.

4) Why not to have a method?

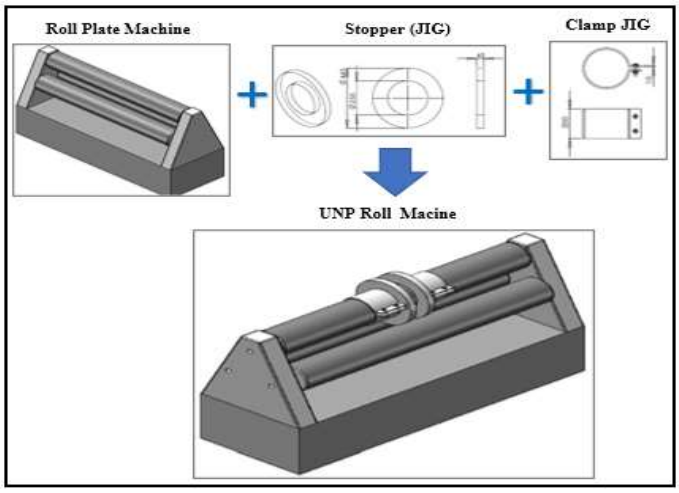
Because the process is new and there is no R & D.

5) Why is there no R&D yet?

Because so far the products received are still standard according to the catalog, so there is no need for R&D.

The second stage (Do) is to modify the machine so that material replacement can be done. The

initial step of improvement to reduce the production cost on job 23xxx is to modify the machine to roll the UNP according to the drawing given. In this role of machine modification, the basic theory is only simple, namely adding a stopper (JIG) to the roller axle to provide space according to the UNP dimensions. The following illustrates the modification of the roll plate machine so that it can roll UNP (Figure 3).



Figures 3: Illustration of the modification a roll plate machine into a UNP roll machine

The picture above illustrates how the modification of the existing machine, namely the roll plate with adding a plate stopper (JIG) and locking using clamping can make the machine change its function into a UNP roll machine [9].

The UNP roll process is no different in principle from the usual roll plate process, but there are some concerns related to ensuring that the additional stopper is properly installed, and the placement of the material must be in its lane position, so the Standard Operational Procedure (SOP) is also changed according to the analysis and observation during the trial process so that safety remains the main thing and the product quality is also by the predetermined quality standards.

The third stage (*Check*) evaluates the results of the roll process after the machine modification is complete. In the trial roll process on the modified machine using UNP material no major problems were found to arise, there was only a slight improvement for the addition of 100 mm UNP material length as a pre-bending material during the roll process. Pre-bending is needed to make the radius at the end of the clamp perfect, this is very important so that when using there are no problems. Training and knowledge sharing of the UNP roll process must be carried out and ensured to be consistent with the new SOP to the roll machine operator (Table 1).

The fourth stage (*Action*) is to carry out the improvement process of replacing plate material with UNP material with the new SOP that has been made. This material replacement has an impact on several things that will benefit the company and the ending is that the company's profits will be greater than the initial plan using plate roll. Some of the benefits of this improvement are:

The process sequence becomes shorter. The efficiency of UNP material usage can be seen from the following process sequence comparison:

Based on the above data, it can be concluded that the use of UNP material requires fewer process sequences when compared to a welded plate. The use of welded plate requires 5 process sequences, while the use of UNP material only requires 3 process sequences. This will make efficient use of machines so that unused machines can be used for completing other jobs. Besides machine efficiency, fewer process sequences mean that the manpower requirements are also less than the welded plate

process. Efficiency is the ability to use the right resources [10].

1) The time required will be less, this will reduce the process time so that the completion of this work will be faster. The following is a comparison of time in 1 set.

Table 2 provides data on a very significant time difference, the use of welded plate takes 4,874 hours to complete 1 set of products. While the use of UNP material only takes 0.807 hours to complete 1 set of products, meaning that the use of UNP material is only 16.65% of the welded plate process time. This will certainly make this work completed on time and even faster than customer expectations. On-time delivery time will make the customer happy because the plan they made will run as expected. One of the problems in a project is the availability of goods that are not by the plan that has been made.

2) The cost of purchasing materials becomes more economical. The difference in materials and prices required between welded plate and UNP materials can be seen in Table 3.

The material price comparison Table 3 shows that the use of UNP material is cheaper than welded plate. The work using a welded plate requires a material cost of Rp. 1,335,956 while the use of UNP material only requires a material cost of Rp. 950,756. In other words, UNP material costs are only 71% compared to the welded plate material costs. Saving cost/difference of Rp. 385,200 or 29% of the original plan using welded plate material per 1 set. This will have a big impact on the profits earned by the company.

Table 1: Process sequence comparison

Squence process	Material	
	Plate welded	UNP
Cutting	√	√
Roll	√	√
Setting	√	x
Welding	√	x
Finishing	√	√

Table 2: Processing time comparison

Squence process	Material	
	Plate welded	UNP
Cutting	2,460	0,260
Roll	0,467	0,467
Setting	0,427	0
Welding	0,853	0
Finishing	0,640	0,080
Total	4,847	0,807

Table 3: Comparison of material prices

Material	Requirement	UOM	Material prices
Plate welded	1,84	M	1,335,956
UNP	1	Bar (6M)	950,756
	Material cost saving		385,200

Conclusion

Timely completion of work and good product quality are the goals. PT B's main goal is to provide maximum service to customers. The successful modification of the machine is the beginning of the smooth running of this project so that the plan to replace welded plate material with UNP material can be carried out. From the process sequence table, it is obtained that the use of UNP material only requires 3 out of 5 process sequences that should be done if using welded plate material. The work timetable also shows a very significant comparison, namely the use of UNP material only takes 16.65% of the original plan using welded plate material. These two things prove that the completion of this work will be

much faster than the use of welded plate material, which means that we can achieve the customer's expectations who want work on time with good quality. Customer satisfaction is a term frequently used in marketing. It is a measure of how products and services supplied by a company meet or surpass customer expectations. The material price comparison table shows that the cost requirement for using UNP material is only 71% when compared to the initial plan for using plate-welded material. In addition to saving time, the company also benefits from saving material costs, this will make the profit earned by the company even greater. One of the company's goals is to achieve maximum profit. Suggestion for the company: the establishment of an R&D department to prepare itself to expand the opportunity to get jobs outside the standard job so that order intake can be even greater.

Conflict of Interest

No potential conflict of interest was reported by the authors in this study.

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