International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 7, 2020
ISSN: 1475-7192

Application Of Lean Manufacturing Using Value Stream Mapping On Bearing Replacement Process For Electric Motor (Case Study: Pt. Pembangkit Jawa Bali - Pltu Indramayu)

[1]Abdi Robbi Ikhsan, [2]Mitha Haqi, [3]Muhammad Radityo, [4]Daffa Primatifar, [5]Riki Ridwan Margana[1]

ABSTRACT: *Electric motor is an equipment that is widely used in industry to support the production process. Inside the electric motor there are components, one of which is bearing. Bearing on an induction electric motor is an important component that functions as a bearing between the shaft surface and the motor housing. Bearing components are not spared from damage so it needs a repair process within a certain period so that the production process is not interrupted for too long. The process of repairing electric motors is one of them is bearing replacement, in the process of bearing replacement can use 2 types of tools, namely heater bearings and bearing fittings. Both of these methods have their own ways at each step of their work and have different durations. Implementation of Lean Manufacturing Using Value Stream Mapping Tools aims to see the whole process of bearing replacement in an electric motor from the beginning to the end of the process and to identify the waste that occurs during the process.*

The process of replacing the bearings on an electric motor which is currently carried out using a heater bearing tool for the installation process requires a total processing time of 11,445 seconds. And after making improvements to the work process and minimize the waste that occurs then the total time needed for bearing replacement work to be 10.005 seconds.

Keywords: *lean manufacturing, electric motors, heater bearings, value stream mapping*

I. INTRODUCTION

Along with the rapid development of the economy and technology, demanding industries at this time to carry out the production process to the fullest with the condition of the equipment / machinery that is ready to be used for operation. To achieve optimal equipment conditions, good maintenance must be done on the machine so that it can help the production process to the maximum. Good maintenance is maintenance that is carried out on target according to the job desk on the maintenance schedule and equipment requirements. Maintenance is all activities carried out to maintain the condition of an item or equipment, or return it to certain conditions. Machine Maintenance is a Modern Approach presenting a strategic place to preserve the functioning of the equipment, avoid the consequences of failures, and ensure the productive capacity of the equipment.

[1] [1]abdi.robbi@widyatama.ac.id, [2]mitha.haqi@widyatama.ac.id, [3]radityo.muhammad@widyatama.ac.id, [4]daffa.primatifar@widyatama.ac.id, [5]riki.ridwan@widyatama.ac.id
Jurusan Teknik Industri Fakultas Teknik Universitas Widyatama
Jl. Cikutra No.204A, Sukapada, Cibeunying Kidul, Kota Bandung, Jawa Barat 40125, Indonesia

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

Electric Motor is one of the most vital equipment in the production process at PLTU Indramayu. Therefore, care on the electric motor must really be done. Because if there is a disturbance in the electric motor will affect the electricity production process. in addition to the costs incurred for maintenance on the electric motor, the company also suffered losses due to production processes that were not optimal.

In electric motor repair the bearing installation process uses the value stream mapping (VSM) approach, which is describing the process of repairing an electric motor from the beginning until the electric motor is finished to be taken by the customer. In bearing installation using a heater bearing, it is found that waste is waiting, the bearing installation process uses a heater bearing by means of the bearing being heated for a few minutes so that the bearing expands and makes it easy to install. In addition to using heater bearings in bearing installation there are also bearing fittings that make the bearing installation process faster.

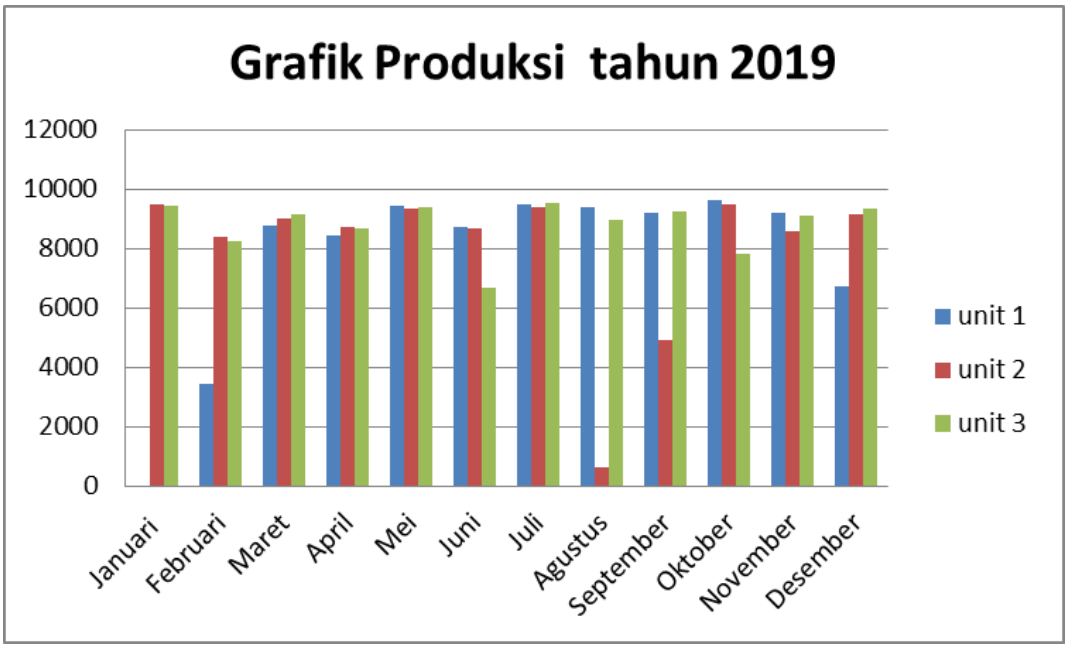

Figure 1 Total Electricity Production in 2019

II. STUDY OF LITERATURE

2.1 Definition of Value Stream Mapping

Value Stream Mapping (VSM) is one of the tools of quality management tools that can be used to design the current state (current state) of a production process by providing opportunities to make improvements and reduce waste. Value Stream Mapping uses the principle of the Lean theory of improving the quality of the product, reducing operational and inventory costs, increasing productivity and comfort while working to reduce waste (time).

Value stream mapping uses standardized symbols. Value stream mapping symbols are grouped into several categories, namely process, material, information, and general symbols. Process symbols are symbols to describe flow charts such as customers or suppliers, processes, data boxes, work cells and operators. Material symbol is to describe inventory, shipment, stock point kanban, pull material, safety stock, and external shipment. Information symbols are to describe processes such as central control points, manual info, and electronic info. General symbol for describing kaizen burst, value-added and non-value-added time.

The benefits of Value Stream Mapping in general are to help improve overall business process activities and increase the effectiveness and efficiency of work process activities. The advantages of using Value Stream Mapping are:

- Knowing the points of inventory buildup in a business process.
- Helps to see the entire business process that is currently running
- Help design desired business processes, processes that are efficient, effective and free of waste.

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

Value Stream Mapping can display data about business process activities from the beginning of the process to the end of the process, so this tool is often used before starting a Lean Six Sigma project initiative. VSM will show the parts that need to be considered in detail and improved with improvement projects. Value stream mapping can be designed for each product that has specific specifications or it can also be designed for each common product such as the same working process. After determining specific products or product groups, the next step is to look at customer demand to determine takt time, which is the time required for the production of a product according to the level of customer demand.

The steps of the value stream mapping process are (Yu et al., 2019)

- Identification of product groups or service groups to be analyzed.
- Analyze the current conditions and describe them in the general process scheme.
- Gather supporters such as outputs, time outputs, and employees.
- Formulate an ideal process based on customer demand, which is a condition in the future. In this step the parameters that will be used are the time set-up of the tool or machine, the amount of work in progress, and a list of repairs or development needed.
- Determine an action plan to produce the improvements needed to achieve future conditions.

2.2 Types of Value Stream Mapping

1. Current State Map

Current State Map is used to map the conditions on the current production floor, so that it can identify the source of waste and what types of waste occur.

Stages of making the current state map

- Determine the production process that will be used as a model-line, the aim is to focus research on one type of product as a reference and representation of the ongoing production system
- Keep a record of each production process
- Use a stopwatch to find out the cycle time in each production process
- Conduct discussions in the production process area, the aim is to understand the process, know about the capacity of the production machine, the number of operators needed to work on the production process.
- Making production flow maps for each process category.

2. Future State Map

The Future State Map is used for the proposed work process improvement plan from the Current State Map. To design a future state map can be done with several stages such as eliminating unnecessary processes, combining processes, simplifying work processes.

III. RESEARCH METHODS

This research methodology contains an overview or steps to be carried out in conducting research. This needs to be determined so that research can be carried out in a structured manner. Steps to be taken must include starting from studying the problem until it is

repairs to a system that can be generated so that the problem can be resolved as follows:

a. Preliminary survey

Preliminary survey is the first step that must be done in research, to get a clear picture of the object of research.

b. Study of literature

Literature study is used to study scientifically and theoretically on problems that have been previously restricted to come from books, journals, scientific papers, articles, theses and various sources from the internet by experts who can be accounted for.

c. Identification of problems

Problem identification is done to look for problems that are happening and find the cause of the problem.

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

d. Formulation of the problem

The formulation of the problem is the breakdown of the problem being studied in the study.

e. Data collection

Data collection is done to collect all the data needed in research. Data needed in this study such as repair cycle time, number of operators, working tools used, company hours of work data, type of electric motor, electric motor repair process, etc.

f. Data processing

After data collection, the data is processed to find recommendations for improvement in electric motor repairs. Data processing starts from calculating the standard time of each process, making the creation of value stream mapping, identifying waste and then giving recommendations for improvement.

g. Conclusion

The final stage is to make conclusions obtained from the results of data collection and processing that have been done.

IV. RESULT AND DISCUSSION

4.1 Making Value Stream Mapping

Value Stream Mapping is an illustration of the process of replacing bearings in electric motors that took place in research conducted at the PLTU Indramayu including the flow of information. Value Stream Mapping is the initial stage in identifying waste that occurs in the process of repairing electric motors. The description of Value Stream Mapping can be seen in Figure 4.

4.2 Value Stream Mapping Analysis

After the process of making Value Stream Mapping, the mapping can be used as a reference to identify waste that occurs along the value stream. Current state map analysis is done by grouping activities that are included in value added (VA), non value added (NVA) and necessary but not value added (NBVA). The grouping of these activities can be seen in Table 1.

Table 1 Works with Heater Bearings

	Activity	**Time (s)**	**Category**
1	Disconnect Coupling	3600	VA
2	Tools replacement	15	NVA
3	Remove the DE and NDE side bearing covers	600	VA
4	Tools replacement	30	NVA
5	Remove the DE and NDE side bearings	600	VA
6	Tools replacement	60	NVA
7	Clearing	1800	VA
8	Tools replacement	120	NVA
9	DE and NDE side bearing installation	1200	VA
10	The bearing to be installed waits for expansion	600	NVA
11	Installation of DE and NDE side bearing covers	600	VA
12	Tools replacement	120	NVA
13	Coupling Installation	300	VA
14	Test function	1800	VA
TOTAL		**10.500**	**VA**
		945	**NVA**
		11.445	**VA & NVA**

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

Seen from Table 1, the total time in activities with the value added (VA) category is 10,500 seconds while the activities with the non value added (NVA) category are 945 seconds. It is known that activity number 10 in Table 1 is the largest non-value added (NVA) activity that takes 600 seconds. The value of non-value added (NVA) in bearing replacement activities for electric motors at the Indramayu power plant should be reduced so that further identification is needed.

4.3 Identification of Waste

The following is the identification of waste found in PLTU Indramayu:

a. Overproduction

In the process of replacing bearings in electric motors at PLTU Indramayu there is no excessive production.

b. Waiting time

PLTU (Steam power plant) which most of the production process uses electric motor equipment, thus causing frequent damage to electric motors. One of the processes for repairing an electric motor is bearing replacement. After the installation process, when replacing a bearing using a heater bearing, it cannot proceed directly to the next process, because the bearing must expand first so that it is installed properly. Bearing expands at a temperature of 80 ° C - 85 ° C so that the bearing can be installed in the bearing holder (shaft) properly, the process causes waiting time.

Figure 2 Bearing Heater Machine

c. Transportation

In the process of replacing bearings on electric motors at PLTU Indramayu there is no waste of transportation types, because bearing replacement work is carried out at the same place and the working tools used have been prepared in advance.

d. Overprocessing

All processes carried out on bearing replacement have value added value (VA), so there is no repetition of processes or processes that are considered less important or processes that have no added value.

e. Excess Inventory

Replacement bearings for electric motors do not have the waste of excessive types of inventory both raw materials and finished products.

f. Montion

Movement during the bearing replacement process for the electric motor was not identified as a waste, so there was no waste in the movement type.

g. Product defects

Defective products produced during the bearing replacement process may occur if the installation of the bearing using the engine heater bearing is incorrect. However, defective products can be avoided if the bearing installation is correct.

4.4 Analysis of the emergence of waste

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

The waste that occurs when replacing bearings for electric motors at PLTU Indramayu relates to the process of installing new bearings using a heater bearing machine which causes waiting time for each bearing replacement activity.

4.5 Recommendations for Improvement

Eliminating waste of the type of waiting time is replacing the heater bearing tool with a bearing fitting, the function of the bearing fitting is the same as the heater bearing, which is the tool used to install the bearing on the bearing mount (shaft). The use of bearing fittings can accelerate the process of mounting bearings and the waiting time after mounting a bearing from 600 seconds to 60 seconds (can be seen in Table 2). So that waste of waiting time can be eliminated in the process of replacing bearings for electric motors. In this Table 2, the total time in the bearing pairs activity is using the Bearing Fitting with the value added (VA) category of 9,600 seconds while for the activities with the non value added (NVA) category by 405 seconds.

Figure 3 Bearing Fitting

Table 2 Work using Bearing Fittings

	Activity	Time (s)	Category
1	Disconnect Coupling	3600	VA
2	Tools replacement	15	NVA
3	Remove the DE and NDE side bearing covers	300	VA
4	Tools replacement	30	NVA
5	Remove the DE and NDE side bearings	600	VA
6	Tools replacement	60	NVA
7	Clearing	1800	VA
8	Tools replacement	120	NVA
9	DE and NDE side bearing installation	300	VA
10	Tools replacement	60	NVA
11	Installation of DE and NDE side bearing covers	300	VA
12	Tools replacement	120	NVA
13	Coupling Installation	300	VA
14	Test function	1800	VA
TOTAL		**9600**	**VA**
		405	**NVA**
		10.005	**VA & NVA**

V. CONCLUSIONS

After doing research on the improvement of the electric motor, the productivity of work activities can be optimized by using the concept of lean manufacturing. Through the depiction of work process flow using VSM (value stream mapping). The process of replacing bearings for electric motors using a heater bearing tool takes 11,445 seconds to

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

complete the process. After repairing the process of replacing bearings for electric motors using Bearing Fittings, it takes 10.005 seconds. The difference is seen in the bearing installation step, when using the Heater Bearing tool the installation process takes 1,200 seconds while using the Bearing Fitting tool only takes 300 seconds. Besides speeding up the bearing installation process, the waiting time after the bearing installation process is lost. When using a bearing heater after the bearing installation process, there is a waiting time of up to 600 seconds because the bearing installed must expand first to proceed to the next process. Whereas when using a Bearing Fitting tool after the bearing installation process can proceed to the next process, the time between the process of mounting the bearing with the installation of the DE and NDE side bearing cover only takes 60 seconds to replace the working tool only.

VI. REFERENCES

[1] Anvari A, I. Y., Hojjati S M H.(2015). A Study On Total Quality Management And Lean Manufacturing: Through Lean Thinking Approach. World Applied Sciences Journal, Vol. 12, No. 9, pp. 11-19. Hines, P.; & Taylor, D. 2000. Going Lean. Cardiff,

[2] Bhasin, S., & Burcher, P.(2016). Lean Viewed as a Philosophy. International Journal of Manufacturing Technology Management, 17(1), 56-72

[3] Fandi Ahmad, Dimas Aditya.(2019). *Minimasi Waste dengan Pendekatan Value Stream Mapping*, *18*, 1.

[4] Gaspersz, V.; dan Fontana, A.(2015). Lean Six Sigma for Manufacturing and Engineering. Proceedings of International Conference on Industrial Engineering and Operations Management 2011. Kuala Lumpur.

[5] Hernadewita, Euis Nina Saparina Yuliani, dan Dewi A. Marizka. (2017). *Penerapan Value Stream Mapping Pada Industri Part dan Komponen Automotive*, 2.

[6] Hidayat, Rahmat, Ishardita Pambudi Tama, dan Remba Yanuar Efranto. (2015). *Penerapan Lean Manufacturing Dengan Metode Vsm Dan Fmea Untuk Mengurangi Waste Pada Produk Plywood.* Jurusan Teknik Industri Universitas Brawijaya, hlm 1032-1043.

[7] Ikratinasari, Z. F. (2018). *Improving Quality Control Process Through Value Stream Mapping*, 221.

[8] Kusuma, Sabta Adi. (2015). Penerapan Lean Manufacturing Dalam Mengidentifikasi Dan Meminimasi Waste Di PT. Hilton Surabaya. Undergraduate Thesis. Surabaya: UPN Jatim.

[9] Mahfudh Asy'ari dan Djoko S. Gabriel. (2019). *Perancangan Peningkatan Kualitas Layanan Pelanggan dengan Value Stream Mapping Era Digital di Perusahaan Jasa Survei*, 2.

[10] Melton, T.(2015). The Benefits Of Lean Manufacturing. Chemical Engineering Research and Design, Vol. 83, No. 6, pp. 662-673.

[11] Yunita Dwi Setyastuti, Sri Murni Dewi, Agus Suharyanto. (2018). *Peningkatan Produktivitas Pada Proses Pracetak dengan Penerapan Construction Untuk Eliminasi Waste*, *11*, 187.

[12] Yu, D., Ebadi, A.G., Jermsittiparsert, K., Jabarullah, N., Vasiljeva, M.V., & Nojavan, S. (2019) Risk-constrained Stochastic Optimization of a Concentrating Solar Power Plant, *IEEE Transactions on Sustainable Energy*, https://doi.org/ 10.1109/TSTE.2019.2927735.

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

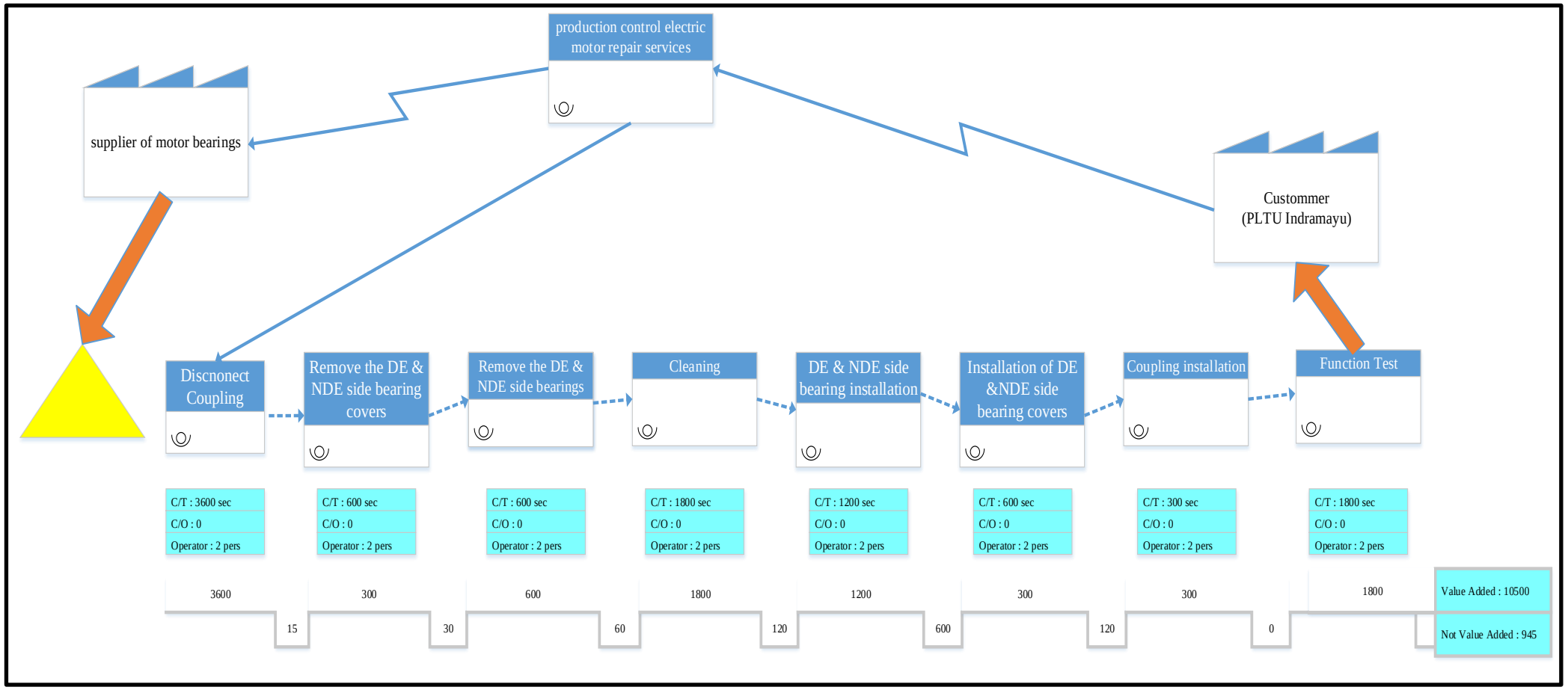

Figure 4 Value Stream Mapping Bearing Replacement (Current State)

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019

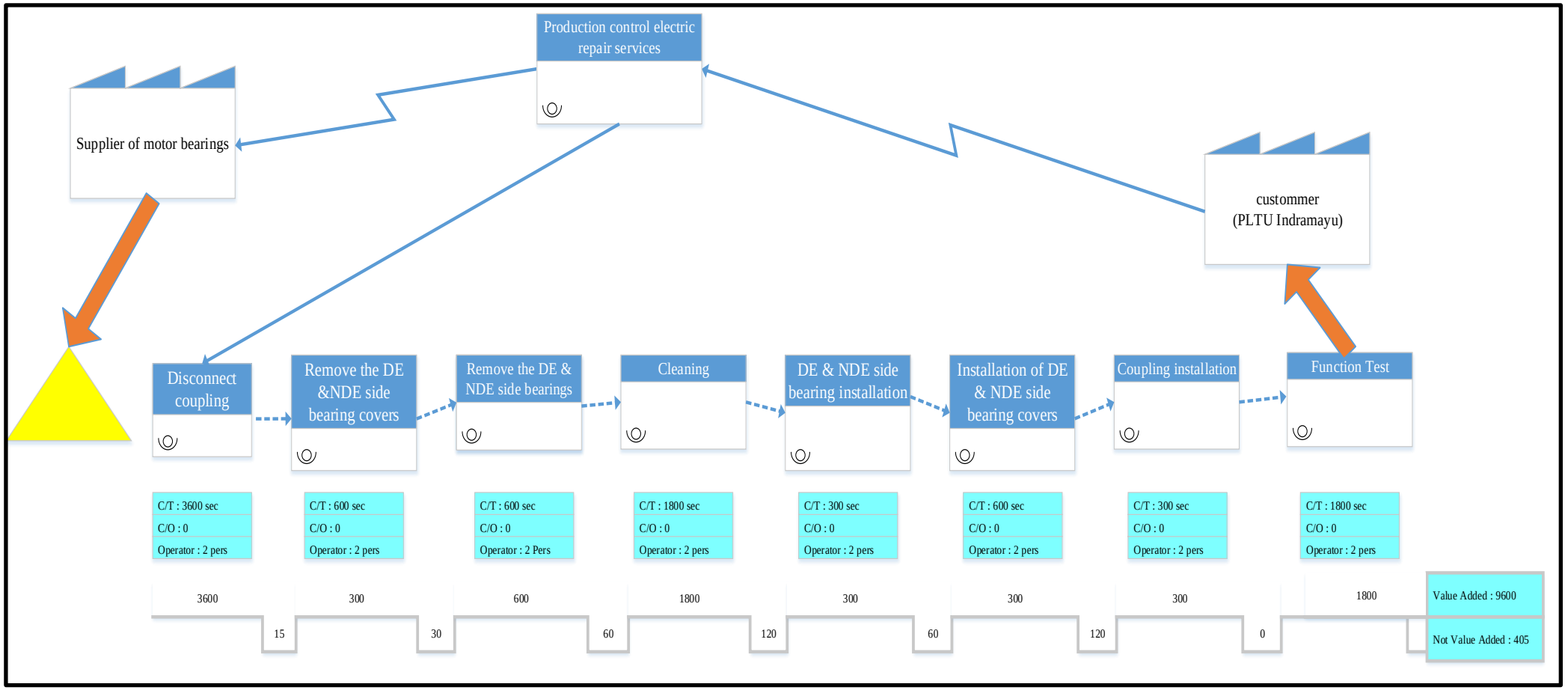

Figure 5 Value Stream Mapping Bearing Replacement (Future State)

Received: 10 Nov 2018 | Revised: 20 Dec 2018 | Accepted: 02 Jan 2019