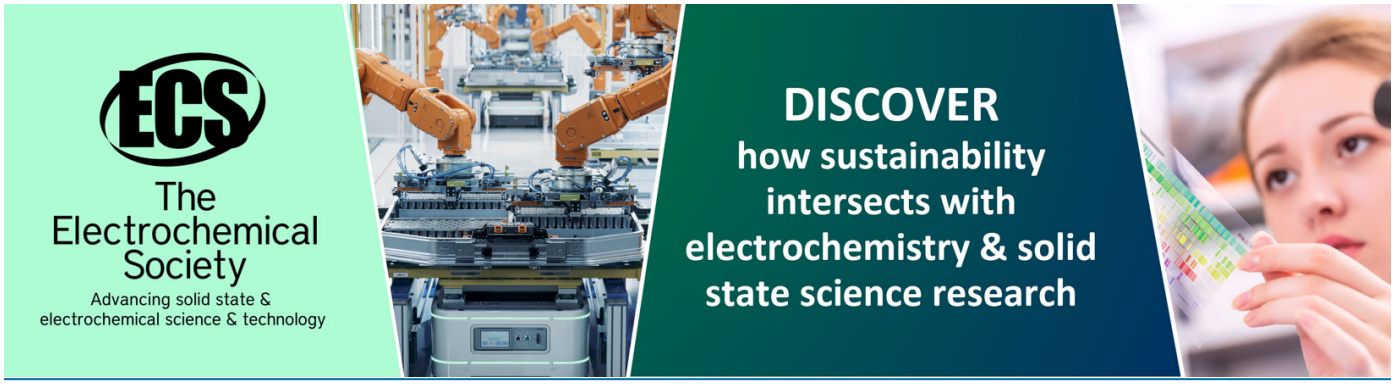
Combination of Value Stream Mapping and House of Risk Methods to Eliminate Waste in Productivity Enhancement in Production Area of Fertilizer Company



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Combination of Value Stream Mapping and House of Risk Methods to Eliminate Waste in Productivity Enhancement in Production Area of Fertilizer Company

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Abstract. Success in ensuring agricultural production through fertilizer production is the key to strengthening national food security. PT X is a domestic company producing ZA fertilizer. In this study, the endeavor to implement lean manufacturing with a nine wastes (E-DOWNTIME) approach to eliminate waste, so productivity can be increased by relying on a combination of VSM and HOR methods to identify wastes to propose remedies to the risks arising from waste on the ZA production floor, through FGD. This research focuses on risks to waste each production process flow according to the business process adopted. The results showed a waste of waiting, defects, excess processing, and EHS on the ZA production floor. 28 risk events were identified and 28 risk agents were identified. After two alternative repairs were selected namely replacement of the drum filter shaft and replacement of the turbine rotor, the duration of the NVA was 79 minutes reduced. Corrosion, aging, and abrasion machines / tools are the selected risk agents, representing that operating machines have shown a decline in performance due to age, so that a gradual machine update is necessary.
Keywords: VSM, HOR, Lean manufacturing, E-DOWNTIME, Productivity

1. Introduction

Indonesia is famous as an agricultural country. The performance of the national agricultural industry contributes to the growth of the agricultural sector which increases every year. Success in ensuring agricultural production is the key to strengthening national food security. Fulfillment of quality fertilizer production as a result of market demand that continues to increase from year to year. High-quality, subsidized fertilizer, stable prices and easily accessible can bring benefits for producers to consumers. The great responsibility of meeting fertilizer needs in order to strengthen national food security while at the same time striving for fertilizer exports as a commodity that benefits the country, is carried out by strengthening the national fertilizer industry.

PT X is a fertilizer producing company. PT X is not only known to produce fertilizer products, but also non-fertilizer products. PT X has a vision to become a producer of fertilizers and other chemical products that are highly competitive and the products most demanded by consumers. To realize this vision requires commitment from management to the production line and is proven by optimal performance that will produce high productivity. Like the concrete efforts that have been carried out by many other manufacturing industries that hold fast to the company's commitment and continue to strive to achieve its vision and mission. However, company data shows that there are problems on the

production floor that have the potential to cause waste. There are several waste classified into nine types namely Environmental, Health, and Safety (EHS), Defect, Overproduction, Waiting, Non-utilized / Underutilized Talent, Transportation, Over Inventory, Motion, and Excess Processing or abbreviated as E-DOWNTIME [1]. Thus, the application of methods from many scientific fields is needed in order to eliminate the waste immediately.

The fields of lean manufacturing and safety did not escape the focus of the industry to be developed to adapt to real conditions. The use of lean manufacturing has been proven to be widely applied and is the most effective method in the manufacturing industry throughout the world in an effort to improve the operational efficiency of the company through the success of increasing yields with fewer resources compared to traditional manufacturing systems. Lean manufacturing is a system that aims to do production with minimum labor, minimum production area, minimum resource consumption, minimum inventory, minimum defective goods, short production time, and minimizing consumer dissatisfaction [2]. This success is related to the company's ability to identify and eliminate waste or waste in its manufacturing floor manufacturing system in order to be more responsive to customer demand while maintaining the quality of the products produced.

From a lean perspective, all types of waste found throughout the value stream process, which transforms from input to output must be eliminated in order to increase product value and subsequently increase customer value [3]. Value Stream Mapping (VSM) is one of the lean manufacturing methods to describe the conditions of the production process flow. Not only that, VSM can find various types of waste and try to eliminate it [4]. In VSM we can know the cycle time and lead time of the company's production process. For the process of making goods, value streams include suppliers of raw materials, manufacturing and assembling of goods, as well as distribution networks to users of the goods [3].

HOR is a method for identifying and calculating risks that must be borne by the company to find priority corrective actions that are appropriate to be implemented with reference to the company's ability. The HOR model can allow companies to choose a set of risk agents to treat and then prioritize proactive actions, to reduce the overall impact of the risk events caused by the risk agent [5]. The business process involved in preparing HOR is useful in guarding the identification of each risk that occurs in all activities in the business process that is used in a coherent manner. The method used to identify risks to HOR is the development of the Supply Chain Order Reference (SCOR) which consists of plan, source, make, deliver, and return. The risk identification method using SCOR which is generally implemented in the supply chain field is considered to have weaknesses, in addition to its implementation limitations that are only in the supply chain field, this method cannot accommodate changes management aspects [6].

2. Methods

In this study data processing was performed using a combination of two methods namely Value Stream Mapping (VSM) and (HOR), while the data collection to compile VSM (Current State Mapping and Future State Mapping) and HOR is done by interview and Focus Group Discussion (FGD) and by involving four section heads who are experts in the field of production.

1. Mapping the production flow with VSM in order to describe the production process from upstream to downstream, so as to make it easier to identify the waste and its causes that occur in each production flow of ZA products. Waste that has been identified is a risk event which will then be assessed by the HOR method. The whole process was carried out through interview techniques and FGDs.
2. Risk assessment of waste that occurs in each production flow of ZA products is carried out using the HOR phase 1 method, which begins by determining the risk event or risk event. Waste that occurs in the production process flow that has been mapped previously using the VSM method, is a risk event that will be assessed based on the level of severity and determined the cause or risk agent. After the risk agent is determined, it is then assessed based on the level of occurrence, and determines the correlation value between the risk event and the risk agent.

3. The next stage after conducting a risk assessment of waste using HOR method phase 1, the selected risk agent results based on ranking are used as input in designing alternative improvements with the HOR method phase 2. HOR phase 2 is used to prioritize preventive actions that companies must take to maximizing cost effectiveness in managing selected risk agents in HOR phase 1, thus taking into account the value of Total Effectiveness of Action (TEk) and Effectiveness to Difficulty Ratio (ETDk).
4. After identifying risks to choosing an alternative improvement with HOR, a production flow mapping is carried out using future state mapping after the implementation of selected preventive actions on the production floor of ZA products. In the future state mapping, it can be seen the difference in terms of time reduced by the results of risk mitigation efforts.

3. Result and Discussion

3.1Mapping Production Flow With Current State Mapping

Mapping in the form of current state mapping stated on Figure 1, mapping the production process flow of ZA products from carbonation, reaction, filtration, neutralization, evaporation and crystallization to drying and cooling. In the mapping, waste or waste identified and its causes are identified as risk events and risk agents, each of 28 risk events and 28 risks agent. The overall risk event and risk agent according to the E-DOWNTIME approach, are classified as waiting, defect, excess processing, and EHS waste. The process of producing ZA products requires time in a single production.

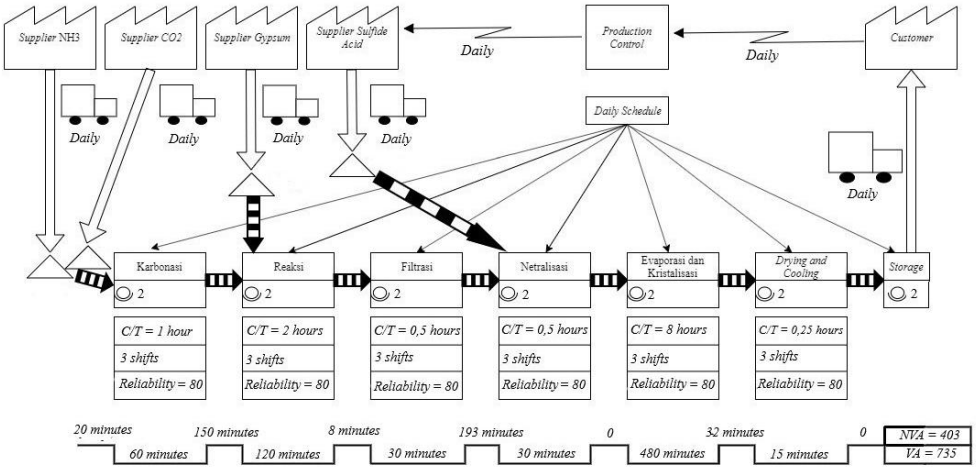

Figure 1 Current State Mapping of ZA Product

3.2 Risk Assessment of Waste With HOR Phase 1

According to the Supply Chain Operation Reference (SCOR) business process including plan, source, make, deliver, and return, there are 26 risk events with a composition of 1 risk event on the plan, 7 risk events on source, 16 risk events on make, 1 risk event on deliveries, and 1 risk event on returns. The most risk event is in make with a percentage of 64%. Whereas the severity that occurred was included in criteria 3 and 4. Criteria 3 became the most severe severity with 15 risk events or 54%. After identifying the risk event, a risk agent or risk agent is determined. There are a number of 28 risk agents, with the distribution of occurrence or the likelihood of occurrence in criteria 1, 2, 3, and 4. Criteria 3 is the most common occurrence criteria with a total of 15 risk agents or with a percentage of 53%. In ZA products, selected risk agents that will be continued on HOR 2 are aging machines / tools, corrosion machines / tools, ship arrival is unpredictable and abrasion machines / tools with notations respectively A8, A9, A3, and A11. The cumulative percentage of ARP values A8, A9, A3, and A11 are 8.5%, 14.6%, 19.9% and 25.2% respectively, based on Table 1 and Figure 2.

Table 1 Calculation of The Selected ARP Value

Risk Agent		Rank	ARP	Cumulative ARP	% ARP	Cumulative % ARP
Aging machines / tools	A8	1	252	252	8,5%	8,5%
Machine / tool corrosion	A9	2	180	432	6,1%	14,6%
The arrival of the ship is unpredictable	A3	3	156	588	5,3%	19,9%
Abrasion machine / tool	A11	4	156	744	5,3%	25,2%

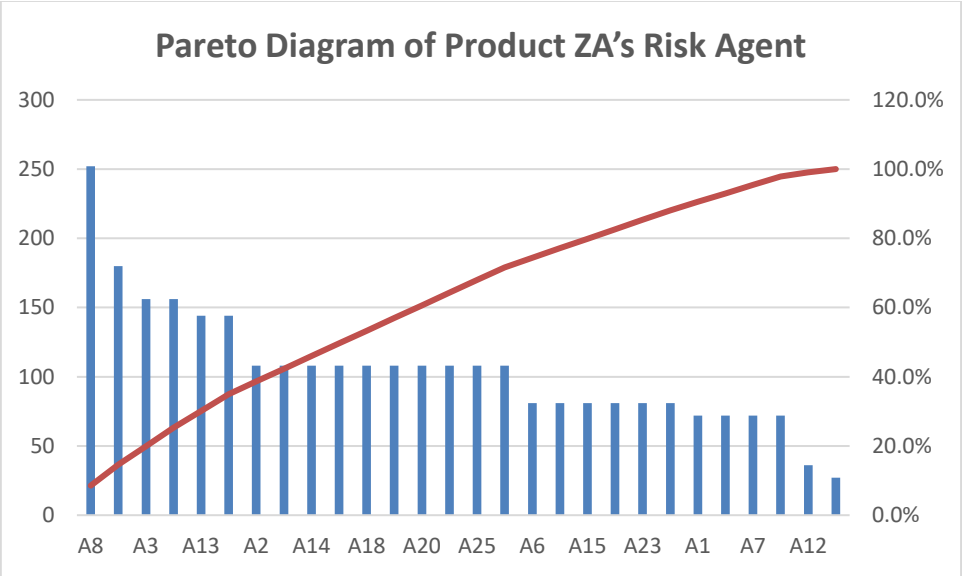

Figure 2 Pareto Diagram of ZA Product's Risk Agent

3.3 Alternative Design Improvement With HOR Phase 2

The results of the FGD agreed on the existence of 8 preventive actions as mitigation actions for selected risk agents, which were notated as PA1 to PA8. Preventive action has a correlation scale of 3 and 9 which means that preventive action has a moderate and large role in preventing the occurrence of risk agents and then the total effectiveness of action (TEk) value is carried out. The total effectiveness of action is formulated using equation 1. The acquisition of the total value of effectiveness of action (TEk) is further divided by the level of difficulty with a scale of 4 and 5 which means that the application of preventive action requires considerable and difficult resources, based on equation 2. This distribution results in the value of effectiveness to difficulty ratio (ETDk) which is then processed using the Pareto technique to obtain selected preventive actions, namely the replacement of the drum filter and the replacement of the turbine rotor, which are notated as PA3 and PA2, respectively. The cumulative percentage of PA3 and PA2 ETDk values are 15.8% and 28.5%, respectively, based on Table 2 and Figure 3.

$$TE_k = \sum_j \mathbf{ARP}_j E_{jk} \quad (1)$$

$$ETD_k = TE_k / D_k \quad (2)$$

Table 2 Calculation of The Selected ETDk Value

Preventive Action		Rank	ETDk	Cumulative ETDk	% ETDk	Cumulative % ETDk
Replacement drum shaft filter	PA3	1	567	567	15,8%	15,8%
Turbine rotor replacement	PA2	2	453,6	1020,6	12,7%	28,5%

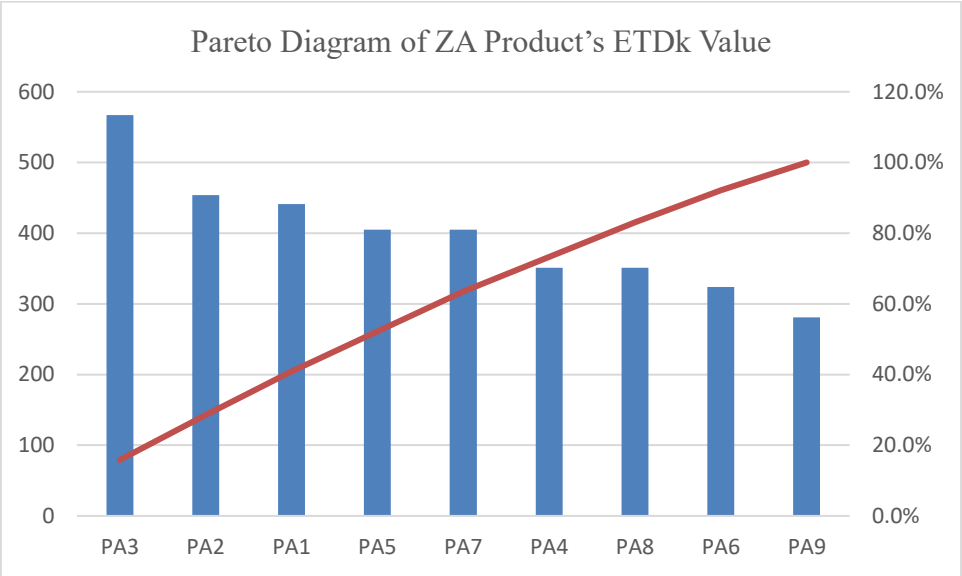

Figure 3 Pareto Diagram of ZA Product's ETDk Value

3.4 Mapping Production Flow With Future State Mapping

Mapping of production flow with future state mapping of ZA products in Figure 4, is done after the selection of alternative improvements to the waste or waste that occurs on the production floor. The duration listed is an estimate of the time that occurred after the two alternative improvements selected, namely the replacement of the drum filter and the replacement of the turbine rotor successfully applied to the carbonation and filtration process. Information regarding the duration of value added (VA), non-value added (NVA) and non-value added (NVA) is reduced by 79 minutes shown in Table 3.

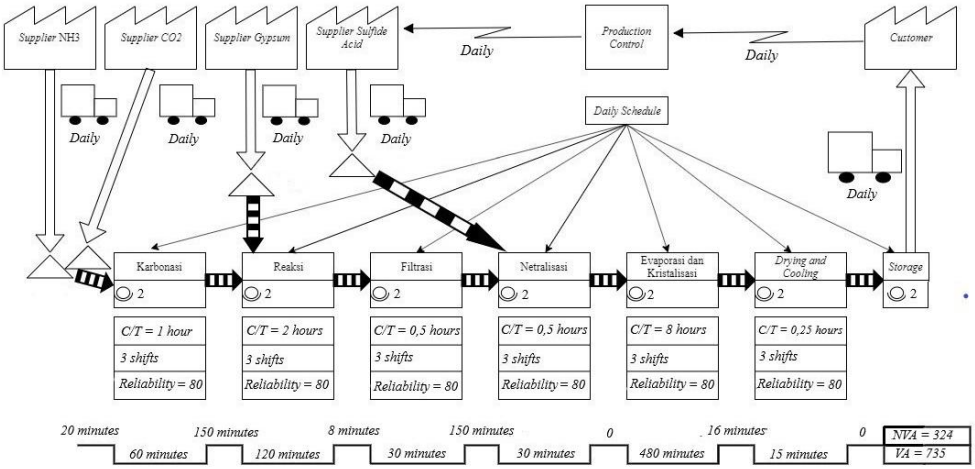

Figure 4 Future State Mapping of ZA Product

Table 3 Total Duration of VA, NVA, and NVA Reduced Products ZA

Production Flow	VA (minutes)	NVA (minutes)	NVA Reduced (minutes)
Carbonation	60	150	20
Reaction	120	8	0
Filtration	30	150	43
Neutralization	30	0	0
Evaporation and Crystallization	480	16	0
Drying and Cooling	15	0	0

In ZA products, the most dominating risk agent with an cumulative amount of 8.5% ARP is aging machines / tools. The aging machine / tool is related to the lifetime of the machine / tool. This happens because, there are still many machines / tools that have not been replaced with new units, so that a gradual replacement of machines / tools is needed. Recommendations for improvement for further research is to develop methods in the field of lean service and apply quantitative methods.

4. Conclusion

Current state mapping of the production process flow of ZA products from carbonation, reaction, filtration, neutralization, evaporation and crystallization to drying and cooling. In this mapping, waste or waste identified and their causes are identified as risk events and risk agents, each of 28 risk events and 28 risk agents. The overall risk event and risk agent for ZA products according to the E-DOWNTIME approach are classified as waiting, defect, excess processing, and EHS waste. The purpose of HOR phase 1 is to obtain a selected risk agent or cause of a risk event. On the production floor of ZA products, aging machines / tools and corrosion machines / tools are the selected risk agents denoted by A8 and A9, and the cumulative percentage of ARP values are 8.5% and 14.6% respectively. The purpose of HOR phase 2 is to obtain selected preventive actions. On the production floor of ZA products, there are 8 alternatives for preventive action improvement alternatives. Then two selected preventive actions are produced, namely the replacement of the drum filter and the replacement of the turbine rotor notated as PA3 and PA2 with a cumulative percentage of ETDk value of 15.8% and 28.5%. After two alternative improvements were chosen, namely the replacement of the drum filter and the replacement of the turbine rotor successfully applied to the carbonation and filtration process, eliminating waste and reducing NVA by 79 minutes. Corrosion machines / tools, aging machines / tools, and abrasion machines / tools are the selected risk agents for ZA products, representing that operating machines have shown a decline in performance due to age, so a gradual renewal of the machine is needed.

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