Internal Supply Chain Risk Management Using Failure Mode and Effect Analysis (FMEA) and Value at Risk (VaR) (Case Study in PT Agro Muda Berkarya)

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Abstract—In the agricultural industry, the risk variability in the internal supply chain is very high which is influenced by various factors, namely humans, weather, nutrition, pests, and others. These risks must be mapped so that companies in the agricultural industry can avoid failed harvest, increase their productivity, and has the capability in producing quality crops. The high possibility of risk in the agricultural industry especially in Indonesia, reducing the possibility of investment by private or foreign companies, this can be corrected by having a clear risk assessment in any agricultural commodity investment plans. The investment plan assessment is carried out in order to determine the probability of possible losses and profits. PT. Agro Muda Berkarya is a company engaged in the agricultural sector, producing and trading agricultural commodities on a national and international scale. This company, which is located in Bogor, generates its operational activities with an initial focus on food crop cultivation, PT. Agro Muda Berkarya started production with an initial capital of 5000m2 and produced ginger as main crop with luffa as the intercoping crop. In carrying out the planting process, PT Agro Muda Berkarya wants to know the risks that can arise and mitigation action throughout the internal supply chain and probability of return in the business investment. This business investment focuses on luffa and ginger plants. In this final project, identification and risk profiling was carried out using Failure Mode & Effect Analysis (FMEA) and Value at Risk (VaR) with the Monte Carlo Simulation methodology to determine the probability of losses and profits on investing in ginger and oyong as intercoping plant. Last, Return on Investment (ROI) were calculated in order to understand company business performance.

Keywords—Risk Management, Internal Supply Chain, FMEA, VaR, Monte Carlo Simulation, ROI.

I. INTRODUCTION

Indonesia has become one of the biggest agricultural country in the world. Most of the population works in the agricultural industry. Indonesia also has good natural resources that could be used to become the biggest agricultural economy (GDP) by as much as 13.45% of the world's GDP. Therefore, based on this contribution, the agricultural sector becomes one of the main sectors in driving the economic development of Indonesians. Therefore, based on this contribution, the agricultural sector becomes one of the main sectors in driving the economic development of Indonesia. According to Global Business Guide, Indonesia is the world's largest producer of palm oil as well as coffee, rubber, cocoa, sugar, tropical fruits and spices. Nevertheless, among all favorite commodities, Indonesia still imports spices when in fact Indonesia has suitable land for producing it. This phenomenon occurs due to higher local spices compared to other South Asia spices. PT. Agro Muda Berkarya believe, current condition can be solved through investment in producing spices so that there is no supply and demand gap. PT. Agro Muda Berkarya is an agricultural company that engages in production and trade. Spices has become one of the main planting commodities due to the high demand and lack of parties that process spices on a large scale. PT. Agro Muda Berkarya also produces horticultural crops such as luffa (oyong) to support land productivity as well as the risk on cultivating spices plants. According to the data from the Ministry of Agriculture 2015 - 2019, ginger has various levels of productivity, therefore creating variation that could lead to several risks. The probability of risk located in all internal supply chain PT Agro Muda Berkarya that refers to the chain of activities within a company that usually consist of production, distribution, purchasing, and sales. The internal company supply chain must be successful in order create...
integration working environment and efficient system of work. The internal supply chain plays a big role in determining final product is ready and good to appear in the market and the demand can be fulfilled on time. Those activities in internal supply chain PT Agro Muda Berkarya are categorized in a form of business process such as precultivation, soil cultivation, cultivation process, corps maintenance, harvest and post harvest. Risk in every internal supply chain will directly affect the crops productivity. Those risks could be mapped by using other horticulture plants such as luffa (oyong) in order to reduce the risk of long-term ginger planting from the start of the planting until harvesting which takes approximately eleven months. although luffa (oyong) is intercropped to reduce the risk of ginger plants, there are risks that could have an impact to both crops productivity. The productivity influence by several factors, those factors are the variation of prices in the market, weather condition that directly affect plants nutrition, unrecognized pests and human error that leads to luffa and ginger productivity. Those risks are assessed by using various tools. In this final paper, the author considers to use Failure Mode & Effect Analysis (FMEA) because the method are able to identify and prioritized potential failure modes in a system, process, service or product [1]. The risk that already identified by using Failure Mode & Effect Analysis (FMEA) then perfected by implementing Value at Risk method using Monte Carlo simulation to understand the possibility of revenues and Return on Investment (ROI) on ginger commodity and inter-cropping vegetables.
Table 1.
Overall Risk Identification

| No | Activity | Sub-activity | Information | Risk Description | Risk Code |
|----|----------|--------------|-------------|-----------------|-----------|
| 1  | Pre- Cultivation | Pre-Planting Spray | Weeds spraying is carried out two weeks before tillage is carried out with the aim of killing weeds | Soil contaminated by chemical substances | PC1.1 |
|    |          | Loosening the Ground | In order to create form beds on the farm | Unsafe act by the farmers while using machine | SC1.1 |
|    |          | Applying Fertilizer | Manure and chemical fertilizer | The amount of fertilizer is less or more than the ideal fertilizer needed on the soil | SC1.2 |
| 2  | Soil Cultivation | Mulching Process | Mulching done in order to make sure there is no weeds that will be live in cultivation main area or planting point | The installation of mulch by farmers is not tight and strong | SC1.3 |
|    |          | Create Planting Point | the planting point is made with a certain range for maximum planting efficiency | Range of planting point is not efficient (too close or far between planting point) | SC1.4 |
| 3  | Cultivation | Laying the seeds | Luffa and ginger seeds are planted in each planting point | Seeds quality that is far from standards | C1.1 |
|    |          | Watering process | Luffa and ginger need water to maximize the quality of the product | The amount of water is less or more than it should be | M1.1 |
|    |          | Stake Installation | Luffa growth is determined by the height of the stake because luffa will have space to grow vertically | Stake not strong enough to hold plants from winds and extreme weather | M1.3 |
| 4  | Maintenance | Fertilization | Maintaining the amount of nutrition given to both Luffa and Ginger | The amount of fertilizer is less or more than the ideal pest needed on the plants | M1.4 |
|    |          | Pest Control | Ensure pests do not grow and spread in the planted area | Wrong type of fertilizer | M1.5 |
|    |          | Winding shoots and stems | Luffa stems needs to be twisted to be able to grow at a certain height, this action done after luffa stems grow | Unrecognize pest that is occur in the farm | M1.6 |
|    |          | Picking the commodity | Farmers start to picking up commodities in harvest stage | The rope is not strong enough in holding the Luffa | M1.7 |
| 5  | Harvest & Post Harvest | Commodity Sorting | Making sure there is no defect product that will be distribute to the market | Take commodities that are not ready for harvest | HP1.1 |
|    |          | Packing | Ensure the quality of product before sending commodity to the customers | Farmers are not careful in picking the plants | HP1.2 |
|    |          |                | | Negligence of workers in determining the quality of standardized plants | HP1.3 |
|    |          |                | | Material of the packaging is easy to be damage | HP1.4 |

The next step is determining the severity, occurrence and detection need to be done in order to know which effect is having the highest severity, probability of occurrence and detection in PT Agro Muda Berkarya. The process of determining this process is accompanied by company operational director. After defining each of activities indicator, calculate the Risk Priority Number (RPN). The result of RPN calculation indicates which activity is the most dangerous in company internal supply chain.

After determining the RPN of each risk, start to define risk factor priority using pareto analysis. Pareto analysis is conducted in order to find out 20% of the causes effect 80% of problems. By using this methodology, PT Agro Muda Berkarya will know which causes need to be done immediely. This process carried out by several steps, the first step is to convert each Risk Priority Number (RPN) into perceantage, the second step is to create the cumulative percentage in each RPN, the third step is to create the pareto chart in order to have a understandable visualization 20% of causes effect 80% of problems.

Last, Risk mitigation consists of several action, which are avoiding risk, mitigating risk, transferring risk, and accepting the risk. In this process, all the effect of risk in PT. Agro Muda Berkarya internal supply chain will be determined by the form of risk mitigation.
C. Investment Assessment Phase

The first thing to do in making a model is to determine the variables that indicate revenue, which are plant productivity and crop market prices. Then, collect all the data needed. Data that has been collected especially luffa productivity and crop market prices. Then, collect all the variables that indicate revenue, which are plant productivity, luffa inventory, and season market prices. In addition, data is collected to determine the cost which includes luffa plantation cost, luffa labor cost, and luffa material cost. After the data collection is done and the data obtained is representative and in accordance with the requirements of the model, then the next step is to scale risk and simulation. After the data collection is done and the data obtained is representative and in accordance with the requirements of the model, then the next step is to scale risk and simulation.

Table 2. Risk Causes and Impacts Example for Several Risk Description

| Risk Description                          | Risk Code | Cause of Risk                                                                 | Effect                                      |
|------------------------------------------|-----------|-------------------------------------------------------------------------------|---------------------------------------------|
| Soil contaminated by chemical substances | PC1.1     | Unfriendly chemicals substances inside the weeds sprayer                      | The soil is not fertile and loses nutrients |
|                                          |           | Broken or damage spray                                                        |                                             |
|                                          |           | Poor Quality Control                                                          |                                             |
|                                          |           | Farmer don’t understand the amount of chemicals must be use to destroy weeds  |                                             |
|                                          |           | Poor performance monitoring                                                    |                                             |
|                                          |           | Untrained worker on the field                                                  |                                             |
|                                          |           | Broken loosening soil machine                                                  | Workers injured                             |
|                                          |           | There is no training provided by the management                               | Increasing company cost for workers healthcare and machine maintenance |
| Unsafe act by the farmers while using machine | SC1.1     | Unclear information in Standard Operating Procedure (SOP)                    |                                             |

Table 3. Severity Scale

| Rating | Description            | Criteria                      |
|--------|------------------------|-------------------------------|
| 10     | Extremely dangerous    | Failure might cause death of the worker or other entity that involve in the activity and/or system will breakdown without any warning |
| 9      | Very dangerous         | Failure might cause a serious injury and/or system breakdown with prior warning and need service after the event |
| 8      | Dangerous              | Failure might cause a minor to medium injury and might cause dissatisfaction of stakeholders, event that occur required a major repair or re-work |
| 6      | Medium danger          | Failure might cause a minor injury with small dissatisfaction from the stakeholders and/or major system problem |
| 4      | Low moderate danger    | Failure could cause a very minor injury but annoys stakeholder, easy repair or re-work, can be overcome with minor modification to the system or process |
| 3      | Small danger           | Failure might not cause a major injury, stakeholder might not aware of the failure. little or no effect to the system |
| 2      | Zero danger            | Failure causes no trouble and injury to all stakeholder and has no impact to the system |

Table 4. Occurrence Scale

| Rating | Description               | Potential failure rate          |
|--------|---------------------------|---------------------------------|
| 10     | absolute probability of occurrence | Failure happen at least once in a day or failure always happen almost at any time |
| 9      | unavoidable failure       | Predictable failure occurs, or in three or four days failure might occur |
| 8      | Huge probability of occurrence  | Frequently failure might occur, approximately once per week |
| 7      | Medium high probability of occurrence | Failure might occur once at a month |
| 6      | Medium probability of occurrence | Occasionally failure might occur, approximately every three months |
| 5      | Low probability of occurrence | Failure might occur, once per year failure might occur |
| 4      | Rare probability of occurrence | The failure almost never occur |

Table 5. Detection Scale

| Rating | Detection | Definition                      |
|--------|-----------|---------------------------------|
| 1      | Certain   | The design control will almost certainly any potential cause of failure |
| 2      | Very      | The design control has a very high chance to detect a potential cause of failure |
| 3      | High      | The design control has a high chance to detect a potential cause of failure |
| 4      | Moderate  | The design control has a moderately high chance to detect a potential cause of failure |
| 5      | High      | The design control has a moderate chance to detect a potential cause of failure |
| 6      | Low       | The design control has a low chance to detect a potential cause of failure |
| 7      | Very      | The design control has a very high chance to detect a potential cause of failure |
| 8      | Low       | The design control has a low chance to detect a potential cause of failure |
| 9      | Remote    | Remote chance the design control will detect a subsequent failure mode |
| 10     | Uncertain | Design control does not detect any potential cause of failure or subsequent failure mode |

been built according to the requirements or not. The objective of verification is to ensure the quality of the model, it involves activities such as inspection, walkthroughs and reviews. Meanwhile, validation is the process to ensure the model is representative to the real world by the help of expert judgement. According to Journal of Modern Applied Statistical Methods, 5000 replications are sufficient enough to produce stable results [2]. Therefore, author will have 5000 replications in order to create a stable result.

After generating monte carlo simulation, Return on Investment is carried out to understand how good the investment will be, this phase is conducted after all the possibility of revenue has occur from the simulation. Make sure the initial investment value is already determined possibility of revenue has occur from the simulation. Make sure the initial investment value is already determined. Therefore, author will have 5000 replications in order to create a stable result. Last calculate the
ROI by deviding present value revenue with company initial investment in a specific period of time.

D. Risk and Business Investment Analysis Phase

In this process, the risk mitigation action that already determined before will be analyze in order to give a comprehensive understanding about reason in choosing a particular risk mitigation action. Furthermore, the Return on Investment will also be elaborated in this process in order to give a clear understanding on how good is the investment by looking the Return on Investment.

E. Conclusion and Suggestions

This phase will explain the conclusion based on the risk assessment analysis and investment analysis and based on the objectives of this research. Suggestions will be given for future research of similar topics.

III. DISCUSSION

A. PT Agro Muda Berkarya Company Profile

PT. Agro Muda Berkarya is one of the companies engaged in the agricultural sector, carrying out production activities and trading of agricultural commodities on a national and international scale. PT. Agro Muda Berkarya was established in 2020, producing with an initial capital of 5000 m2 and producing products of vegetables and spices namely: Luffa and Ginger. To run the 5000 m2, the total human resource that allocated in the farm is around 5 farmers, consist of one head farmer and four-day worker farmer, which only work when there are task that require couple of workers.

PT Agro Muda Berkarya implement intercropping cultivation system in order to achieve highly productivity investment and also several other benefits. Intercropping is one of the way to increase diversity in farming ecosystem by cultivating two or more crops simultaneously in one specific land for one season of cultivation.

B. Identification of Risk

The first step is to list all the internal supply chain activities inside PT Agro Muda Berkarya. From pre-cultivation, soil cultivation, cultivation, maintenance, harvest until post harvest. To understand PT Agro Muda Berkarya internal supply chain, below is presented the activity flow chart in Figure 2.

After knowing all the activities occur, determine the possible risk that might occur in each of activities namely risk description. Table 1 presented the list of all activities in detail with the risk description. Suggestions will be given for future research of similar topics.

C. Identification of Risk Causes and Impacts

Following the risk identification, the next step is to determine the causes and consequences of each risk. Causes and impacts that already determined will be consider as one of the properties in identifying risk priority number (RPN). Using this approach will enables the identification of root causes from several factors. Below presented the example of fishbone that is used to identify the causes of risk of “unsafe act by the farmers while using machine”

Based on the fishbone diagram in Figure 3, Author capable of defining all causes that might occur in the internal supply chain. In addition, risk impacts also identified in each of the activities in order to easily define the severity scale of the potential risk. In Table 2 will show the example of detail of risk causes and impacts.

Above information has been identified by the Author, each of potential risk has their own impacts and causes.

| Risk Description | Effect | Severity | Probability of Occurrence | Probability of Detection | RPN |
|------------------|--------|----------|---------------------------|--------------------------|-----|
| Soil contaminated by chemical substances | The soil is not fertile and loses nutrients | 7 | 2 | 3 | 42 |
| Unsafe act by the farmers while using machine | Workers injured | 6 | 3 | 5 | 90 |
| The amount of fertilizer is less or more than the ideal fertilizer needed on the soil | Increasing company cost for workers healthcare and machine maintenance | 5 | 3 | 5 | 75 |
| The soil lack of nutrition | The soil lack of nutrition | 4 | 2 | 2 | 16 |

| Risk Description | Effect | Probability of Occurrence | Probability of Detection | RPN |
|------------------|--------|---------------------------|--------------------------|-----|
| Weather uncertainty | Less productivity when harvest time is come | 384 | 98 |
| Unrecognize pest that is occur in the farm | Plants broken and cannot be distributed to the market | 3539 | 98 |
| Unsafe act by the farmers while using machine | Workers injured | 90 | 84 |
| The amount of fertilizer is less or more than the ideal pest needed on the plants | Unfulfilled nutrition leads to lowest productivity | 75 | 84 |
| Unsafe act by the farmers while using machine | Increasing company cost for workers healthcare and machine maintenance | 5 | 75 |
| Stake not strong enough to hold plants from wind and extreme weather | Lower productivity for luffa commodities | 56 | 75 |
| Take commodities that are not ready for harvest | Lower harvest quantity and productivity | 48 | 75 |
| The amount of water is less or more than it should be | Less productivity when harvest time is come | 48 | 75 |
| Soil contaminated by chemical substances | The soil is not fertile and loses nutrients | 42 | 75 |
| Seeds quality that is far from standards | Plants does not grow and producing plants | 42 | 75 |
the occurrence scale that is used in PT Agro Muda Berkarya Internal Supply Chain Risk Assessment. Table 5 presented the detection scale that is used in PT Agro Muda Berkarya Internal Supply Chain Risk Assessment. After defining all the Risk Priority Number (RPN) criteria, RPN each of activities is determined. In a particular condition, for severity that is above nine will directly become priority to handle. The calculation of RPN is carried out by multiplying the severity, probability of occurrence and probability of detection. The RPN will indicates how important the risk and the impacts are. Table 6 will be presented the example of table that consist of risk description, impacts, severity, occurrence, detectability value in each impact and final Risk Priority Number (RPN).

Each of risk description and impact has their own risk priority number, the above Risk Priority Number (RPN) only cover several risk descriptions from several internal supply chain activities. The RPN calculation need to cover all the risk description, all risk descriptions are elaborated in Table 1.

E. Pareto Analysis

Implementing analysis using Pareto, allow PT Agro Muda Berkarya to understand 80 percent of problems come from which 20 percent of causes. This analysis provides information that can help PT Agro Muda Berkarya to focus on particular problems. There are steps that Author conducted to carried out pareto analysis, first author list all the Risk Priority Number (RPN) from the highest to the lowest each of risk description and impacts. After all the RPN value already sorted, devide each of RPN value with the total of the RPN value to know each of risk contribution in percetage form. After that is to calculate the cumulative percentage. Last, create the Pareto chart using the RPN value and percentage to understand the Pareto visualization.

After following the steps in Figure 4, Author is capable to create Pareto Chart based on the highest to lowest RPN.

Based on the Pareto chart in Figure 4, the 80% point is in somewhere around EF10. Therefore, the 80% problems come from risk code EF1 until EF10. Those risks need to be priority in order to reduce risk in PT Agro Muda Berkarya internal supply chain. In Table 7 presented of risk and impact that is considered to be the priority.

Based on Table 7 risk priority summary, Author identified 10 risk that need to be mitigate, this does not mean that other risks are ignored and mitigation actions are not taken, but this is a priority that has a very large impact.

F. Risk Mapping and Mitigation Action

Determination of risk level is based on risk appetite by PT Agro Muda Berkarya by considering Risk Priority Number (RPN). Risk is divided into four levels, namely extreme risk, high risk, medium risk, and low risk. The level of risk acceptance is obtained from the results of company internal discussion. The results of the recap of the discussion regarding risk appetite produces a risk map in Table 8.

From the results of the calculation of the Risk Priority Number (RPN) and the mapping of risk appetite, Table 9 shows the results of the categorization of risk levels on PT Agro Muda Berkarya internal supply chain activities. Risk level identification example in Table 9 are plot by the risk appetite that already determine in the Table 8, with

Based on above causes, the most causes is from unclear information in Standard Operating Procedure (SOP).

D. Identification of Risk Priority Number (RPN)

Knowing only potential risks, causes and impacts are not enough, it is very important to also understand which risk that might possess the most severe threats to the company. The Risk Priority Number (RPN) consist of severity, probability of occurrence and detectability, all the three components are multiplied in order to know the final RPN number. Table 3, Table 4, Table 5 presented the criteria that is used in this final undergraduate thesis. Table 3 presented the severity scale that is used in PT Agro Muda Berkarya Internal Supply Chain Risk Assessment. Table 4 presented Risk Priority Number (RPN) and the mapping of risk appetite.
the base of RPN. Each risk level has their own proportion, Figure 5 present a chart that show the risk proportion visualization for overall risk that exist in PT Agro Muda Berkarya.

According to the chart, there are only 5% extreme risk on PT Agro Muda Berkarya internal supply chain risk potential, and the biggest proportion is on medium risk with the amount of percentage is around 74%. Nevertheless, all the risk with all risk level need to be tackle in order to reduce and eliminate risk in the internal supply chain.

To be able to give a clear and comprehensive understanding to PT Agro Muda Berkarya, will be presented risk mitigation action that associated with the potential risk in each activity, causes, impacts and Risk Priority Number (RPN). Risk mitigation action can be defined into eliminate risk, reducing risk, transferring risk and accepting the risk.

Figure 6 shows the proposed risk mitigation action, the character of action which are preventive means eliminate or reduce potential action that leads to risk and curative which means treat the risk that happened and action description. Based on Figure 6, there are no risk that are accepted because low risk did not identify in PT Agro Muda Berkarya internal supply chain.

G. Cultivation Investment

PT Agro Muda Berkarya has its own standards regarding cultivation. After the cultivation details are determined, investment regarding the luffa and ginger crop for 11 months must be presented because the data is needed to calculate Return on Investment (ROI) in the next chapter. Overall, there are four category investments, below is the summary of investment for ginger and luffa crop cultivation.

Table 10 indicates the total investment for luffa and ginger cultivation for area 5000 square meters in Bogor, Jawa Barat. The total investment value will be use in the calculation of return on investment.

H. Monte Carlo Simulation

In Monte Carlo simulation that conducted by Author, will be presented the probability of revenue for the investment of ginger and luffa as the intercropping vegetables. There are several variable that is consider in creating the monte carlo simulation, which are luffa productivity, ginger productivity, luffa prices and ginger pieces from November 2020 until March 2021. To validate the amount of relevant data to be taken, a slovin test was conducted with the aim of knowing how many samples needed to be taken from the PT Agro Muda Berkarya farm, so that it will be representative. Below is the formula of the slovin test.

\[ n = \frac{N}{1 + Ne^2} \]  

Where:

- \( n \) = Number of samples
- \( N \) = Total population
- \( e \) = Error tolerance

Based on the slovin test, author determine the margin of error 0.05 because Author has the confidence level 95% and accurate enough to be stated representative. The population size is generated from the amount of PT Agro Muda Berkarya farm total trees and it is around 4009. Based on the calculation, Author need to gather 364 data regarding luffa crop in PT Agro Muda Berkarya farm.

After gathering all the data from crop productivity and market prices and ensuring the data representative, Author determine the distribution of the data before simulating the model. Next, run the model to know the probability of revenue in this specific agriculture crops investment. Last, conduct a verification and validation. According to Journal of Modern Applied Statistical Methods, 5000 replications are sufficient enough to produce stable results [2]. Therefore, author will have 5000 replications in order to create a stable result. Below is the simulation Monte Carlo result for 10 replications as the example.

The data in Table 11 that is presented above gathered from PT Agro Muda Berkarya farm on ginger and luffa commodities and for luffa and ginger price generated from market prices, all between November 2020 until March 2021.

Based on the Monte Carlo simulation, the probability of revenue can be obtained. The revenue is carried out from months of business investment focus at ginger commodity and luffa as the intercropping plant. From the simulation it can be conclude that the probability average revenue from the 5000 replications is Rp 283,676,545.

I. Return on Investment (ROI) and Value at Risk (VaR) Analysis

Author calculates the probability of return on investment from the cultivation of ginger and luffa as the intercropping crop. The calculation is carried out by dividing the present value of revenue to the initial investment that already inform in the Table 10. To calculate the ROI, Author adjusted the value of revenue to the future due the inflation. According to the central bank, growth forecast for 2021 interest rate is at might be 5.1%, therefore in the calculation of present value of revenue, Author use 5.1% as the interest rate for eleven months of investment. Table 12 presented the Return
Investment (ROI) result example from Monte Carlo simulation.

Based on the ROI calculation for 5000 replications, the average ROI is 28%. This number indicates how good the investment for almost one year in ginger and luffa commodities. There is 93% return on investment which bigger than 0% or positive, it indicates good opportunity to invest. There is number of risks for the investment for around 7%, but it can be tackle through segmented industry operational activities is carried out by securing market such as luffa and ginger processing industry.

Furthermore, Author need to calculate the ratio of potential losses in PT Agro Muda Berkarya. Figure 7 is presented the ROI data distribution chart.

To interprate data using Value at Risk concept, Author calculate at 5% probability what is the possible ROI rate. With a 95% confidence level the worst investment for ginger and luffa as the intercopping crop loss will not exceed -3%.

I. CONCLUSIONS

Risk identification in PT Agro Muda Berkarya internal supply chain operational activities is carried out by identifying potential failures at each. Based on the results of the risk analysis carried out, Author obtained 17 types of risks, 17 types of impacts and 26 kind of causes in PT Agro Muda Berkarya internal supply chain activities.

Risk assessment is conducted using Failure Mode and Effect Analysis (FMEA) throughout PT Agro Muda Berkarya internal supply chain activities.

Risk assessment is conducted using Failure Mode and Effect Analysis (FMEA) throughout PT Agro Muda Berkarya internal supply chain activities. Based on the risk assessment, the biggest RPN is on weather uncertainty because the cause is coming from external factor which is climate. Lowest RPN goes to the amount of fertilizer is less or more than the ideal fertilizer needed on the soil because the probability of occurrence is small due to the exact amount of fertilizer given to the land and the probability of detection is also small because due to fertilizing scheduled activity. According to the pareto analysis, there are 10 risk that need to be priority from risk impact code EF1 until EF10 which has RPN value from 384 until 42.

The risk value is then categorized into risk levels based on the predetermined risk appetite. The risk appetite consist of extreme risk, high risk, medium risk, and low risk. The results of the risk mapping there is only 5% extreme, 21% high risk and the biggest proportion is on medium risk with the amount of percetange is around 74%. Other than that, the risk mitigation action is presented. In PT Agro Muda Berkarya case, there is no risk accepted because in risk assessment there is no low risk category. Above, there are 15 risk that will be eliminate, 3 that will be reduce and 1 that will be transfer.

Conducting Monte Carlo simulation will require several variables. There are investment value which is Rp128.520.000, Ginger and luffa productivity, and ginger and luffa market prices. All the data that Author acquire will be require for fitting distribution and then run the result using Microsoft Excel to determine the probability of revenue from this investment. The average of probability of revenue is Rp 283,676.545.

Return on Investment (ROI) calculation is conducted as the parameter of business investment in PT Agro Muda Berkarya. Author adjusted the value of initial investment to the future due the inflation. Author use 5.1% as the interest rate according to the central bank, growth forecast for 2021. The average ROI value is 28%, it can be conclude that the ROI is on the positive value. There are 93% ROI value that above 0% return and 7% ROI value is below 0%. Author believe it can be tackle by securing market such as luffa and ginger processing industry and through process excellence at the farm in order to create higher productivity. Author also calculate the ratio of potential losses using Value at Risk (VAR) method, with a 95% confidence level the worst investment for ginger and luffa as the intercopping crop loss will not exceed -3%.

REFERENCES

[1] M. Ebrahemzadigh, G. H. Halvani, B. Shahmoradi, O. Giabi, and others, “Assessment and risk management of potential hazards by failure modes and effect analysis (FMEA) method in Yazd Steel Complex,” open J. Saf. Sci. Technol., vol. 4, no. 03, p. 127, 2014.

[2] D. J. Mundform, J. Schaffer, M.-J. Kim, D. Shaw, A. Thongteeraparp, and P. Supawan, “Number of replications required in Monte Carlo simulation studies: A synthesis of four studies,” J. Mod. Appl. Stat. Methods, vol. 10, no. 1, p. 4, 2011.