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 intercopping 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 intercopping plant. Last, Return on Investment (ROI) were calculated in order to understand company business performace.**

***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 th In Q3 2019, the agricultural sector contributes Gross Domestic Product (GDP) by as much as 13,45% country's priority sector to be developed. 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 Indonesians. 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,

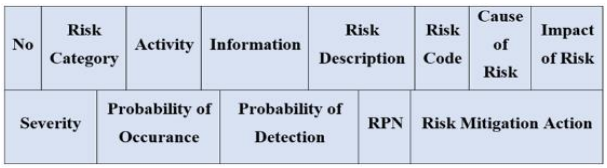

Figure 1. FMEA Framework.

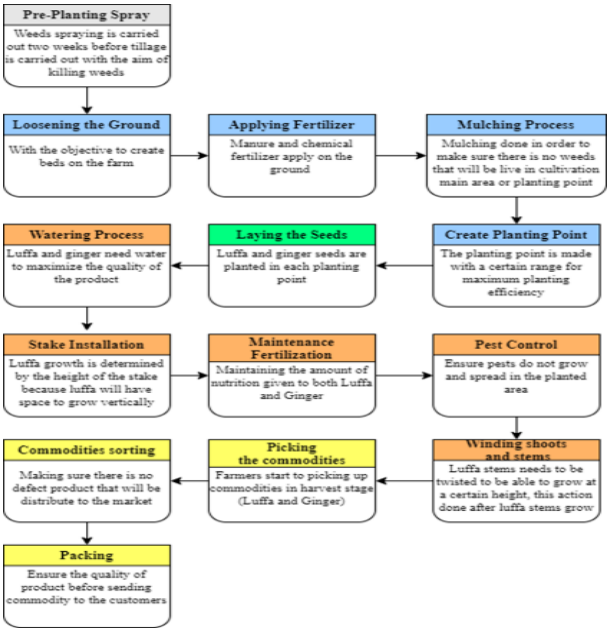

Figure 2. PT Agro Muda Berkarya Internal Supply Chain.

Indonesia still imports spices when in fact Indonesia has suitable land for producing it. This phenomenon occurs due to higher local spices compare 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

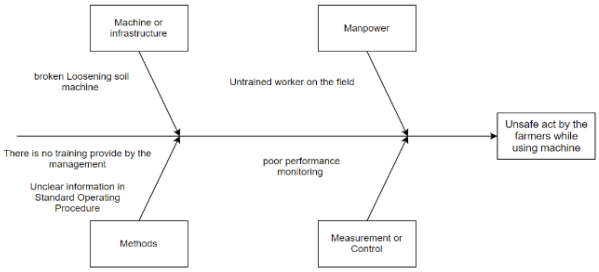

Figure 3. Fishbone Diagram Analysis Example.

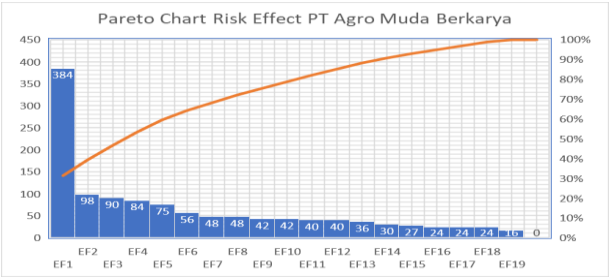

Figure 4. Pareto Chart Analysis in PT Agro Muda Berkarya Internal Supply Chain.

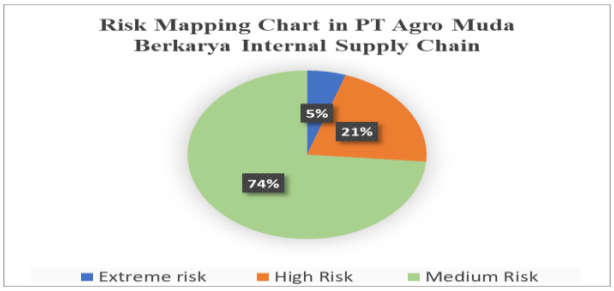

Figure 5. Risk Mapping.

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 pre-cultivation, 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.

Risk Description	Risk Effect	Risk Effect Code	RPN Highest to Lowest	Risk Level	Risk Mitigation Action	Characteristic	Mitigation Action Description
Weather uncertainty	Less productivity when harvest time is come	EF1	384	Extreme Risk	Eliminate Risk	Preventive	Building green house in the 5000sqm area, in oder to control weather uncertainty
Unrecognize pest that is occur in the farm	Plants broken and cannot be distributed to the market	EF2	98	High Risk	Reduce Risk	Curative	Pest cannot be avoid, but it can be reduce by using pestiside to control pest.
Unsafe act by the farmers while using machine	Workers injured	EF3	90	High Risk	Eliminate Risk	Preventive	Create training for farmers and ensure farmers understand in using machine
The amount of fertilizer is less or more than the ideal pest needed on the plants	Unfulfilled nutrition leads to lower productivity	EF4	84	High Risk	Eliminate Risk	Preventive	Create standards in the farm, for the use of fertilizer

Figure 6. Risk Mitigation Action Recommendation for PT Agro Muda Berkarya Internal Supply Chain.

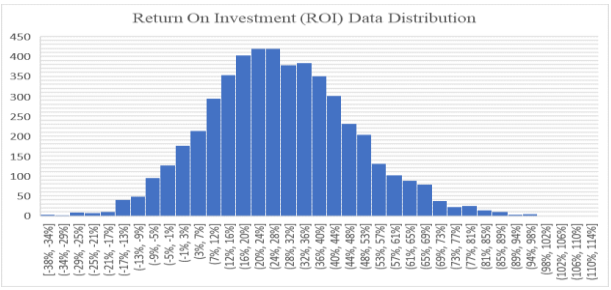

Figure 7. ROI Data Distribution for 5000 Replication.

II. METHODOLOGY

A. *Problem Identification Phase*

The first step is to identify the problem, Author realize there is a risk in agriculture business that effect crops productivity which indicates loss of investment and several problems are felt by PT. Agro Muda Berkarya. By understanding the problem that occur in agriculture business, author can determine the purpose of the research which to assess risk in PT. Agro Muda Berkarya and create the investment feasibility. This process also includes benefits formulation, limitation and assumption in solving the problem.

The next step is to to learn and understand the problem that want to be solve by looking for reference and methodology to conduct the research. Literature study consists of agriculture in Indonesia, Agriculture contribution to Indonesia economy, investment in agriculture, risk management in agriculture, risk management theory, Failure Mode and Effect Analysis (FMEA) for the basis of internal supply chain risk assessment, risk mitigation action theory for further recommendation, fishbone diagram theory to understand the causes of problems, pareto analysis for determining most of causes that influence problems effect, Value at Risk (VaR) to understand the basis financial risk assessment, Monte Carlo simulation to provide the possibility of revenues, and Return on Investment to understand how good is the business in terms of financial perspective (ROI). All the literature studies is carried out according to journals, books and trusted websites.

Next, field study conducted to understand PT. Agro Muda Berkarya business model include all the activities in company internal supply chain, reason in choosing a particular crop, cultivation details, production rate and

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
2	Soil Cultivation	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
		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
4	Maintenance	Watering process	Luffa and ginger need water to maximize the quality of the product	Weather uncertainty	M1.1
				The amount of water is less or more than it should be	M1.2
		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 extream weather	M1.3
		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
				Wrong type of fertilizer	M1.5
		Pest Control	Ensure pests do not grow and spread in the planted area	Unrecognize pest that is occur in the farm	M1.6
		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	The rope is not strong enough in holding the Luffa	M1.7
5	Harvest & Post Harvest	Picking the commodity	Farmers start to picking up commodities in harvest stage	Take commodities that are not ready for harvest	HP1.1
				Farmers are not careful in picking the plants	HP1.2
		Commodity Sorting	Making sure there is no defect product that will be distribute to the market	Negligence of workers in determining the quality of standardized plants	HP1.3
		Packing	Ensure the quality of product before sending commodity to the customers	Material of the packaging is easy to be demage	HP1.4

commodities price in market. Risk factors also validated by the company and farmers before risk mitigation recommendation given by the author. The data received by interviewing PT. Agro Muda Berkarya operational director and farmers.

After conducting literature study, the methodology that author used has been determine and from the field study, author will understand the business model and internal supply chain of PT Agro Muda Berkarya. In this process, the alignment of theory and model to the problem already understood in order to create beneficial impact to the company.

B. Risk Assessment Phase

The first process in creating risk profile for PT. Agro Muda Berkarya is to list all the activities in internal supply chain. The activities include pre-planting spray, loosening ground, applying fertilizer, mulching process, create planting point, laying seeds, watering process, stake installation, maintenance fertilization, pest control, winding shoots and stems, picking the crop, crop sorting, and packing. After knowing each of activities, list all the potential risk that might occur, effect and causes. Before assessing the severity, occurance, detection in each of the activities, in this section need to find basis score and scale of each indicators from trusted journal. Figure 1 is the FMEA framework that author used in the final project research

The next step is determining the severty, occurance and detection need to be done in order to know which effect is having the highest severity, probability of occurance and detection in PT Agro Muda Berkarya. The process of determining this process is accompanied by company operational director. After defining each of activities indictor, 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 immidietly. This process carried out by several steps, the first step is to convert each Risk Priority Number (RPN) into percetange, 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.

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 Broken or demage spray There is no standard in using chemicals sprayer Poor Quality Control Farmer don't understand the amount of chemicals must be use to destroy weeds Poor performance monitoring	The soil is not fertile and loses nutrients
Unsafe act by the farmers while using machine	SC1.1	Untrained worker on the field Broken loosening soil machine There is no training provided by the management Unclear information in Standard Operating Procedure (SOP)	Workers injured Increasing company cost for workers healthcare and machine maintanance

Table 3.
Severity Scale

Severity Rating Scale		
Rating	Description	Criteria
10	Extremely Dangerous	Failure might cause death of the worker or other entity that invlove in the activity and/or system will breakdown without any warning
9 8	Very dangerous	Failure might cause a serious injury and/or system breakdown with prior warning and need service after the event
7 6	Dangerous	Failure might cause a minor to medium injury and might cause dissatification of stakeholders, event that occur required a major repair or re-work
5	Medium Danger	Failure might cause a minor injury with small dissatisdaction from the stakeholders and/or major system problem
4 3	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
2	Small danger	Failure might not cause a major injury, stakeholder might not aware of the failure. little or no effect to the system
1	Zero danger	Failure causes no trouble and injury to all stakeholder and has no impact to thr system

Table 4.
Occurance Scale

Occurance Rating Scale		
Rating	Description	Potential failure rate
10	absolute probability of occurance	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 7	Huge probability of occurance	Frequently failure might occur, approximately once per week
6 5	Medium high probability of occurance	Failure might occur once at a month
4 3	Medium probability of occurance	Occasionally failure might occur, approximately every three months
2	Low probability of occurance	rare occurance, once per year failure might occure
1	Rare probablity of occurance	The failure almost never occure

Table 5.
Detection Scale

Detection Rating Scale		
Rating	Detection	Definition
1	Certain	The design control will almost certain any potential cause of failure
2	Very High	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 High	The design control has a moderately high chance to detect a potential cause of failure
5	Moderate	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 Low	The design control has a very low chance to detect a potential cause of failure
8	Remote	Remote chance the design control will detect a subsequent failure mode
9	Very Remote	Very remote chance the design control will detect a subsequent failure mode
10	Uncertain	Design control does not detect any potential cause of failure or sabsequent failure mode

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 data is validated using slovin test in order to know how much data will be representative.

After the data collection is done and representative and in each variable column is complete, 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. Verification model carried out by checking model design and program in order to check the model has 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, walk-throughs 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 before conducting the Return on Investment (ROI) calculation. Then calculate the present value of potential revenue in the future before compared to the initial investment in order to create a valid estimation considering there is a inflation in the coming year. Last calculate the

Table 6.
RPN Identification example for several risk description.

Risk Description	Effect	Saverity	Probability of Occurance	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
	Increasing company cost for workers healthcare and machine maintanance	5	3	5	75
The amount of fertilizer is less or more than the ideal fertilizer needed on the soil	The soil lack of nutrition	4	2	2	16

Table 7.
Risk Priority Summary

Risk Description	Risk Effect	Risk Effect Code	RPN Highest to Lowest
Weather uncertainty	Less productivity when harvest time is come	EF1	384
Unrecognize pest that is occur in the farm	Plants broken and cannot be distributed to the market	EF2	98
Unsafe act by the farmers while using machine	Workers injured	EF3	90
The amount of fertilizer is less or more than the ideal pest needed on the plants	Unfulfilled nutrition leads to lowes productivity	EF4	84
Unsafe act by the farmers while using machine	Increasing company cost for workers healthcare and machine maintanance	EF5	75
Stake not strong enough to hold plants from winds and extream weather	Lower productivity for luffa commodities	EF6	56
Take commodities that are not ready for harvest	Lower harverst quantity and productivity	EF7	48
The amount of water is less or more than it should be	Less productivity when harvest time is come	EF8	48
Soil contaminated by chemical substances	The soil is not fertile and loses nutrients	EF9	42
Seeds quality that is far from standards	Plants does not grow and producing plants	EF10	42

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.

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.

Table 8.
PT Agro Muda Berkarya Risk Appetite

	Risk level			
Scale	low risk	Medium Risk	High Risk	Extreme Risk
Severity	Severity Scale <= 2	3 <= Severity Scale <=4	5 <= Severity Scale <= 7	8 <= Severity Scale <= 10
Occurance	Occurace Scale <= 2	3 <= Occurance Scale <=4	5 <= Occurance <= 7	8 <= Occurance Scale <= 10
Detection	Detection Scale <= 2	3 <= Detection Scale <=4	5 <= Detection Scale <= 7	8 <= Detection Scale <= 10
Risk Appetite Range	Risk Priority Number (RPN) <= 8	9 <= Risk Priority Number (RPN) <= 64	65 <= Risk Priority Number (RPN) <= 343	Risk Priority Number (RPN) >= 344

Table 9.
Risk Level Identification example for several risk description.

Risk Description	Risk Effect	Risk Effect Code	RPN Highest to Lowest	Risk Level
Weather uncertainty	Less productivity when harvest time is come	EF1	384	Extreme Risk
Unrecognize pest that is occur in the farm	Plants broken and cannot be distributed to the market	EF2	98	High Risk
Unsafe act by the farmers while using machine	Workers injured	EF3	90	High Risk
Stake not strong enough to hold plants from winds and extream weather	Lower productivity for luffa commodities	EF6	56	Medium Risk
Take commodities that are not ready for harvest	lower harverst quantity and productivity	EF7	48	Medium Risk

Table 10.
Investment Summary

Project Investment for Luffa and Giinger in 5000 sqm Land		
	Description	Total Invesment
1	Material Investment	Rp54.440.000
2	Labor Investment	Rp50.250.000
3	Land Rent	Rp5.000.000
4	Tools Asset	Rp18.830.000
	Total Investment	Rp128.520.000

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 Prioriy Number (RPN) consist of severity, probability of occurance 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 the occurance 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 activites are 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 occurance 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, occurance, 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 percetange 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

Table 11.
Monte Carlo Simulation

No	Productivity			Price			Revenue
	Luffa (1)	Luffa (2)	Ginger	Luffa Price (1)	Luffa Price (2)	Ginger Price	
1	1,7	1,2	2,4	Rp6.769	Rp4.719	Rp20.014	Rp263.594.571
2	1,6	1,0	2,5	Rp6.673	Rp5.760	Rp20.403	Rp269.124.910
3	1,7	1,3	2,7	Rp4.974	Rp6.400	Rp23.372	Rp316.538.909
4	1,6	1,1	2,2	Rp5.350	Rp6.929	Rp17.499	Rp220.384.977
5	1,7	1,2	2,3	Rp5.892	Rp5.738	Rp18.403	Rp235.124.052
6	1,7	1,0	2,2	Rp6.925	Rp5.378	Rp20.121	Rp247.250.456
7	1,6	1,0	2,3	Rp6.669	Rp3.827	Rp20.658	Rp251.596.414
8	1,6	1,3	2,8	Rp2.646	Rp7.611	Rp30.560	Rp399.717.697
9	1,7	1,0	2,2	Rp5.128	Rp2.859	Rp23.926	Rp260.322.982
10	1,5	1,2	2,4	Rp6.185	Rp4.070	Rp26.008	Rp311.185.244

the base of RPN. Each risk level has their own proportion, Figure 5 present a chart are the risk level 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 percetange 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 identified 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 intercopping 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.

$$\boldsymbol{n = \frac{N}{1 + Ne^2}} \quad (1)$$

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 intercopping 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 intercopping 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

Table 12.
Return on Investment Calculation Result Example

No	Revenue	Investment	PV Revenue	ROI
1	Rp263.594.571	Rp 128.520.000	Rp152.512.902,03	19%
2	Rp269.124.910	Rp 128.520.000	Rp155.712.694,99	21%
3	Rp316.538.909	Rp 128.520.000	Rp183.145.909,93	43%
4	Rp220.384.977	Rp 128.520.000	Rp127.512.308,99	-1%
5	Rp235.124.052	Rp 128.520.000	Rp136.040.174,49	6%

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 market and operational excellence at the farm to produce a quality and high productivity crops.

Furthrmore, Author need to calculate the ratio of potential lossess 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. 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 occurance 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 lossess 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%.

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