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Operational Risk Management of Feed Industry (Case Study at PT. XYZ)

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Abstract
PT. XYZ is a feed industry company. Potential risk is bound to happen within the company's operational processes. This study aims to analyze problems or risks existed in the plant manufacturing process, assess and evaluate the correlation between risks, its degree and impact on plant manufacturing process activity, as well as creating alternative solutions to mitigate risk in the plant manufacturing process that is appropriate to increase efficiency and effectiveness. The method used is the SCOR model for getting risk event and fuzzy FMEA for risk assessment. Based on the results of operational risk, around 46 risk events were agreed upon by experts as respondents in this study. Risk event assessment was carried out using fuzzy FMEA by calculating the value of FRPN. On fuzzy FMEA, there are three input variables (Severity, Occurence, and Detection). Operational risks categorized as very high (VH) based on a case study in PT. XYZ were (1) the risk of fire plant (M14) FRPN 884.24, (2) the risk of damage to the main engine (M12) FRPN 882.76, (3) the risk of unavailability of raw materials main production (S3) FRPN 880.07, (4) the risk of uncertainty of product sales (P2) FRPN 883.12, and (5) the risk of feed manufacturing process does not conform to standards (M3) FRPN 658.07. Meanwhile, from risk event mapping by SCOR models showed that the highest operational risk and the highest in the feed industry is in the major process make with 14 risk events and the total of its accumulated FRPN is 8,488.13. Mitigation had emphasized more on the very high risk category (VH) with a range of values of RPN 800-1000 assuming that these risks have a significant impact on business processes.
Keywords: process, plant operational manufacturing risk, Fuzzy FMEA

1. Introduction

1.1 Background

Feed company is one of the key chains in the livestock sector which is also part of the agricultural sector. Feed that is produced constantly in Indonesia is chicken feed. Chicken feed demand has the potential to increase significantly in line with the projections of increasing consumption of broiler meat. According to USDA data in 2014, the consumption of chicken meat in Indonesia per capita is still low compared to other ASEAN countries. Indonesia is located on the fourth position with chicken meat consumption level of about 8 kg / year. It is still far short of the ideal set by the United Nations Food and Agriculture organization (FAO) in 2008 that sets international standards of meat consumption as 54 grams per capita per day or equal to 19.71 kg / year. This condition indicates that the consumption of chicken meat in Indonesia needs to be improved.

Based on the forecast of production and consumption of chicken meat, one of which is the meat of broiler chickens in Indonesia, there is a positive trend in the development of consistent increase in population and people awareness to consume animal protein. Increased consumption of chicken meat needs to be supported by the increased production of chicken so that demand can be met. The increase of chicken production is strongly influenced by the consumption of feed and the feed quality.

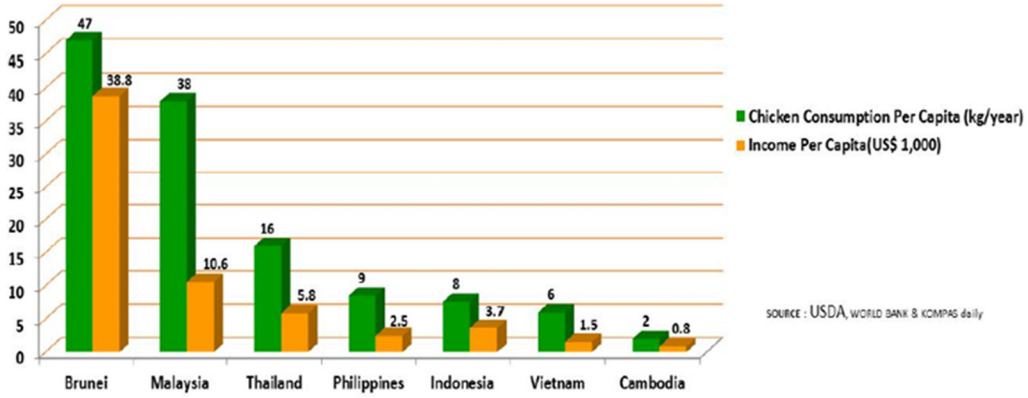

Figure 1. Chicken assumption per capita

(Source: USDA 2014)

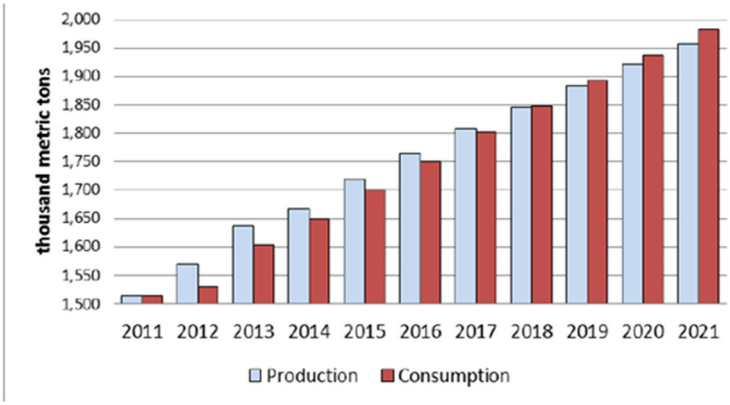

Figure 2. Chicken meat production and consumption planning in Indonesia

(Source: USDA 2014)

Indonesia currently has 56 large-scale feed mills and 14 mini feed mill sites. These 56 large-scale factories are spread across eight provinces. XYZ is one of the 56 large-scale plant with a production capacity of around 1 million tons per year. Along with the increase in consumption of chicken meat, the feed industry is growing and so there is competition. It needs a strategy to win the competition. One of it is by minimizing the risks involved in plant manufacturing process. The possibility of deviation from expectations may result in losses. Since risk might appear in the manufacturing process at the plant, the risk management is essential to maintain the activity of the business process. Chapman et al. (2002) stated that the identification and assessment of risks is the most important in the whole process of risk management and that the results of an analysis depends entirely on the process of identification and assessment. According to Darmawi (2007), risk management is an attempt to identify, analyze and control risks in every activity of the company in order to gain higher effectiveness and efficiency.

1.2 Research Objective

This research is expected to provide benefits to minimize their failures and prevent the risks that may occur from a plant manufacturing process, namely by:

a. Analyze problems or risks contained in plant manufacturing process.
b. Assess and evaluate the relationship of risk and the risk level and its impact on the activity of plant manufacturing process.
c. Make alternative risk mitigation solutions in a manufacturing plant the right process to improve efficiency and effectiveness.

1.3 Scope

The scope of the study is limited to the XYZ include plant manufacturing process on the types of operational risk, include Sales Forecast, Material Requirement, Inventory Control, Purchase Order, Raw Material, Incoming Material, Material Storage, Feed Production, Receiving Finished Goods, Finished Goods Storage, and Finished Goods Loading.

2. Research Methodologies

2.1 Types and Source of Data

The data used in this study are primary data and secondary data related to the research topic. Primary data were obtained from questionnaires and structured interviews directly to related parties. While the secondary data obtained through different sources of literature, such as books, journals, and reports issued from the agency or agencies, as well as some of the Internet literature associated with this research.

In this study, the questionnaires are divided into three stages, namely:

a. Questionnaires Phase 1 : Identification of the operational risk
b. Questionnaires Phase 2 : Assessment of operational risk
c. Questionnaires Phase 3 : Mitigation of operational risk

To determine the sample that will be used in this study, purposive sampling technique was used. It is based on the consideration that the respondent is the person or people who know and understand the conditions of PT. XYZ, especially Production & Operations Department. Person or party who became the respondents came from internal sources. Respondents to the questionnaire stage 1 amounted to 15 people consisting of Head of the Plant, General Manager of Quality Control, PPIC Senior Manager and Manager of each Department. As for the questionnaire phase 2 and 3 consists of three respondents, Head of the Plant, General Manager of Quality Control, and Senior Manager of PPIC.

2.2 Data Analysis

2.2.1 First Objective

Preliminary studies was conducted to determine the activity and potential operational risks in plant manufacturing process. The results of risk identification then determined subject incidence of risk (risk event). The determination of this subject is based on SCOR models. SCOR model based on Pujawan (2009) divides five types of areas.

According to Pujawan (2009), five processes contained in the SCOR model works as follows:

a. *Plan*, is a process that balances demand and supply to meet the needs of providing. This process includes the assessment of the needs of the distribution, production planning, material planning, capacity planning, and supply chain adjustment plan and financial plan.
b. *Source*, is the procurement of goods or services to meet the demand. This process includes scheduling of deliveries from suppliers, receive, check and authorize payment for delivered goods suppliers, select suppliers, and evaluate supplier performance.
c. *Make*, is the process of transforming raw materials into finished materials according to customer demand. This activity is carried out based on forecast (make to order), order. Make to stock or engineer to order. These processes include production scheduling, production activities, quality testing, to manage semi-finished goods, and maintains production facilities.
d. *Deliver*, is the process of fulfilling the demand for goods or services. These processes include order management, transportation, and distribution. The process involved, among others handle orders from customers, choose the delivery service company, handling the finished product warehousing activity, and send the bill to the customer.
e. *Return*, is the process of placing or receiving a refund for a variety of reasons. The activities involved include the identification of the condition of the product, request a return authorization smallpox, rescheduling returns and making repayments. Post-delivery-customer support is also a part of the return.

2.2.2 Second Objective

Assessment of the operational risks identified assessed on the basis of three parameters in accordance with the approach to the concept of fuzzy failure mode and effect analysis (Fuzzy-FMEA), the input fuzzy as a value-level severity (S), the incidence occurrence (O), and the level of detection (D). Assessment is done using a Linkert scale of 1-10 with a description of the criteria approved by experts. Criteria impact (S) shown in Table 1, the impact (O) in Table 2, and detection (D) in Table 3.

Table 1. Scale of Severity (S)

Rank	Effects	Criteria
10	Hazardous without warning	May endanger the plant operation itself without warning
9	Hazardous with warning	May endanger the plant operation itself with warning
8	Very high	Failure disrupts the entire production
7	High	Failure disrupts 50% of plant performance
6	Moderate	Failure disrupts 25% of plant performance
5	Low	Failure disrupts 10% of plant performance
4	Very Low	Failure affects plant performance
3	Minor	Failure is causing minor effect on plant
2	Very Minor	Failure is causing ignorable effect
1	None	Failure does not cause any impact

(Source: Aldridge & Dale 2003)

Results of the assessment S, O, and D are grouped into five categories linguistic levels, then applied by Fuzzy using membership functions to determine the degree of membership of each input. Membership function parameters input variables shown in Table 4.

Output of Fuzzy FMEA as value Fuzzy risk priority number (FRPN) used to represent the priority of corrective action to the rating scale of 1-1,000. Output in the form FRPN value is categorized into 9 class intervals, see Table 5.

Table 2. Scale of Occurrence (O)

Rank	Probability of Occurrence	Rating	Probability/year
10	Very High	>1 in 2	> 500
9	Very High	1 in 3	366-500
8	High	1 in 8	300-365
7	High	1 in 20	250-300
6	Medium	1 in 80	150-249
5	Medium	1 in 400	50-149
4	Medium	1 in 2,000	10-49
3	Low	1 in 15,000	5-9
2	Low	1 in 150,000	1-4
1	Very small	< 1 in 150,000	< 1

(Source: Aldridge & Dale 2003)

Table 3. Scale of Detection (D)

Rank	Detection	Criteria
10	Absolute Uncertainty	There are no control to detect failure
9	Very Remote	Very remote control to detect failure
8	Remote	Remote control to detect failure
7	Very low	Very low to detect failure
6	Low	Low control to detect failure
5	Moderate	Moderate control to detect failure
4	Moderate High	Moderate - high control to detect failure
3	High	High control to detect failure
2	Very High	Very high control to detect failure
1	Almost Certain	Almost certainly to detect failure

(Source: Aldridge & Dale 2003)

Table 4. Parameter of input variable membership functions

Category	Curve type	Parameter
Very Low (VL)	Trapezoidal	[0 0 1 2.5]
Low (L)	Triangle	[1 2.5 4.5]
Medium (M)	Trapezoidal	[2.5 4.5 5.5 7.5]
High (H)	Triangle	[5.5 7.5 9]
Very High (VH)	Trapezoidal	[7.5 9 10 10]

(Source: Nastiti 2013)

Table 5. FRPN value category

Output value	Category
1-49	Very Low (VL)
50-99	Very Low-Low (VL-L)
100-149	Low (L)
150-249	Low-Medium (L-M)
250-349	Medium (M)
350-449	Medium-High (M-H)
450-599	High (H)
600-799	High-Very High (H-VH)
800-1,000	Very High (VH)

(Source: Marimin, *et. al*., 2013)

In the assessment factors in the FMEA failure mode in the form of fuzzy, then do the steps as follows:

a. Determine the value of S, O, D based on Table 1, 2, and 3.
b. Perform calculations aggregation fuzzy rating of the factors S, O, and D by Equation (1)

$$N_{crips} = \sqrt[3]{\overline{B}\overline{B} * \overline{B}\overline{T} * \overline{B}\overline{A}} \quad (1)$$

c. Determine the fuzzy risk priority number (RPN) for each model of failure (failure) based on the Equation (2)

$$FRPN_i = (\tilde{R}_i^O)\overline{\tilde{w}^O + \tilde{w}^S + \tilde{w}^D} \times (\tilde{R}_i^S)\overline{\tilde{w}^O + \tilde{w}^S + \tilde{w}^D} \times (\tilde{R}_i^D)\overline{\tilde{w}^O + \tilde{w}^S + \tilde{w}^D} \quad (2)$$

The calculation of the value of fuzzy RPN in this research is done by using Matlab, follows previous research by Nastiti (2013).

d. Ranking of FRPN value, where the value of the largest FRPN a top ranking.

2.2.3 Third Objective

Risk mitigation is done to reduce the risk based on the circumstances and the ability of the company at the time of decision making. Based on the assessment result of potential operational risks that can occur in the plant manufacturing process activity, then created the step of risk mitigation measures which become the priority to be addressed. Risk mitigation is focused to a very high risk (based on the recommendation of experts) that could potentially occur in every major process (*Plan*, *Source*, *Make*, *Deliver*, and *Return*).

3. General Overview Plant Manufacturing Process

The production is a process that is concerned with the conversion of input into the services or goods. Manufacturing is the production process to produce physical products. At present, manufacturing is seen as a process that integrates the activities of the three parties *i.e.* the material suppliers (suppliers), the processing plant (manufacturing plants) and customers (costumers). PT. XYZ is one of manufacturing company which engaged in feed industry. The products produced by the company are fodder in the form of breeder feed, feed layer, broiler feeds and others. While the products produced by the type of physique that are complete pellet, crumble, complete mash, and concentrate.

PT. XYZ business process starts with Sales Forecast mentioned the selling target of product which is predicted by the Marketing Department, the demand for material (material requirement) by Formulators Department coordinated with the departments of Production Planning and Inventory Control (PPIC). Purchase of materials or raw materials is done by the Purchasing Department by opening a purchase order to Suppliers, when the material or the raw material comes, quality inspection conducted by the Department of Quality Control (QC). Quality inspection done from start to stage of the materials or raw materials arrival, raw material storage warehouse (material storage), *hand-add* preparation, feed production, receiving finished goods, finished goods storage, and a finished goods loading. Products produced and then shipped to the Customer's hands. Flow chart of manufacturing process plant in XYZ can be seen in Figure 3.

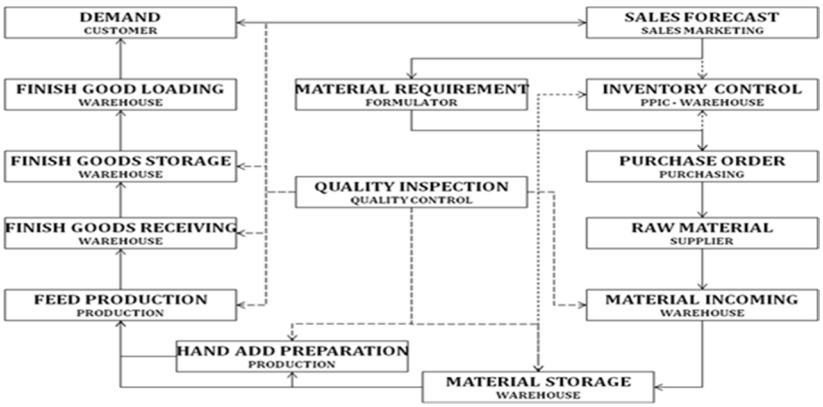

Figure 3. Plant Manufacturing Process Flow at PT XYZ

4. Result and Discussion

4.1 Operational Risk Identification Feed Industry in PT XYZ

Determination of operational risk based on the literature study and brainstorming as well as in-depth interviews with experts. Specialists in this case is a person who has the ability and a deep understanding of everything that happens in the activity of plant manufacturing process, has the authority in decision-making, and has over 10 year experiences in the company. The resulting risk is not only a risk that once or often occur in XYZ, but also risks that might arise in the future. The results of operational risk identification is then mapped by SCOR models to gain a risk event of the risks that exist in the plant manufacturing process XYZ. In the operational risks that exist in XYZ earned 46 risk event agreed upon by experts as respondents in this study.

Out of the 46 risk event is mapped. Major process *Make* has the highest number of risk event which is 14 risk event, followed by the major process *Source* with 12 risk event process, *Deliver* with 9 major risk event, 7 major risk event for *Plan* and the least is the process of *Return* with 4 major risk event. In the study by Ulfah, M. (2013) in identifying risks in the sugar supply chain activities also gained the most on the major risk event of the *Make* process. The amount of risk event on the major process *Make* can be due to the activity on the process more than the others, it is in line with what is stated by Handayani, D.I. (2013) showed that the peak activity in the

business process based on the SCOR model is a activity of *Make*, which is a transformation process of raw materials into finished materials according to customer demand. These processes include production scheduling, production activities, quality testing, to manage semi-finished goods, and maintains production facilities.

Table 6. Risk Event on Operational Risk of Feed Industry

Process	*Sub-Process*	*Risk Event*	*Code*
Plan	Forecast of distribution needs	Unmatched production *forecast*	P1
		Product sales uncertainty	P2
	Production planning	Unachieved production target(s)	P3
		Accidental change of production plan	P4
	Material planning	Imprecision on the fulfillment of material requirements	P5
	Capacity planning	Warehouse limited capacity	P6
		The use of the production capacity is not optimal	P7
Source	Scheduling of deliveries from suppliers	Delays in delivery of raw materials	S1
		Interruptions in the supply of raw materials	S2
		Unavailability of main raw materials for production	S3
	Material check	Delivered material is not inspected	S4
		Incoming raw material quality yang does not meet standard	S5
		The quality of raw material is fluctuating/unstable	S6
	Material receiving	Plant limit to empower local commodities	S7
		The slow process of raw materials loading	S8
		Quality incident when receiving raw materials	S9
	Supplier	Dependence on certain suppliers	S10
		Chosen the wrong supplier	S11
	Supplier performance evaluation	Supplier does not fulfill the quality and quantity mentioned in the contract	S12
Make	Production schedule	Delays on production schedule	M1
	Production activity	Raw material preparation process is not standardized	M2
		The process of making feed does not meet the standard	M3
		Man power deficiency for production	M4
		Unable to meet the production demand	M5
	Quality testing	Not done according to the standard product quality testing throughout the process	M6
		Feed product does not comply with standards	M7
	Managing intermediate product	The incidence of quality raw materials in warehouse	M8
		S*hort/over* of raw material	M9
	Maintaining production facilities	Production engine failure	M10
		Production machines' capacity	M11
		Machinery main failure	M12
		Partial fire	M13
		Plant on fire	M14
Deliver	*Order management*	Unsold feed product(s)	D1
		S*tock out* product	D2
	Transportation	Delays on deliveries to customers	D3
		Product damage during shipping	D4
		Product lost during shipping	D5
	Order handling from customers	Changes in feed by customer order	D6
		Errors delivery of products to customers	D7
	Choosing a delivery service company	Difficulties to find expedition	D8
	Finished product handling and warehouse activities	Product damage during storage	D9
Return	Product identification	Delay of proposing a complain to *supplier*	R1
		Unmatched product and packaging	R2
		Customer complain	R3
	Product recall	Feed is to be returned by customers	R4

4.2 Assessment and Evaluation of Operational Risk in PT XYZ

Event risk assessment carried out using fuzzy FMEA by calculating the value of FRPN. On fuzzy FMEA, there are three input variables (severity, occurrence and detection) with five levels of language linguistics ranging from Very Low (VL) to Very High (VH), so that would be obtained the number of 125 (5x5x5) combinations of base fuzzy rules (Wang *et. al.* 2009). Value FRPN then processed using Pareto diagram as used by Suhartini and Ziko (2013) also analyzed the risk of failure of the production process in the taps, Pareto diagram is used to see any risks that need to be prioritized.

From the FRPN calculation of operational risk to feed industry, the results obtained from the 46 risk there are 34 risks that go into the 80% value of Pareto. Five top value of FRPN fit into the category of Very High (VH). FRPN greatest value, or those under the main sequence showed that the risk is a potential risk that need attention from PT. XYZ. Operational risks are categorized as very high (VH) based on a case study in PT. XYZ are *(1)* the

risk of fire plant (M14) FRPN 884.24, *(2)* the risk of damage to the main engine (M12) FRPN 882.76, *(3)* the risk of unavailability of raw materials main production (S3) FRPN 880.07, *(4)* the risk of uncertainty of product sales (P2) FRPN 883.12, and *(5)* the risk of feed manufacturing process does not conform to standards (M3) FRPN 658.07.

While mapping risk event by SCOR models showed that operational risk tallest and largest at the feed industry are on *(1)* the major process of *Make* with 14 risk event and the total accumulated FRPN 8,488.13, *(2) Source* with 12 risk event and the total accumulated FRPN 6,942.04, *(3) Deliver* to the 9 risk event and the total accumulated FRPN 4,519.85, *(4) Plan* with 7 risk event and the total accumulated FRPN 4,012.68, and *(5) Return* with 4 risk event and the total accumulated FRPN 2,144.33. From the above discussion it is known that the highest operational risk and the highest in the feed industry is on the major process of *Make*, while the *Return* and *Deliver* are less risky in the feed industry for the case study at PT. XYZ. It can be caused by the policy of business processes at PT. XYZ where the distribution system is not considered an important issue due to the sales applied loco factory system. Also the ability of PT. XYZ in producing high standard quality so that the major risk in the *Return* process is not perceived to be quite high. A similar study by Ulfah (2013) in his research entitled "Risk Identification to improve the Performance of Supply Chain Approach House of Risk" mentioned that the process of *Make* major risk event has the most that 15 risk event.

Table 7. FRPN value on *failure mode*

Code	FRPN	Rank	Category	Code	FRPN	Rank	Category
P1	533.53	26	High (H)	M5	509.06	30	High (H)
P2	833.12	4	Very high (VH)	M6	643.58	8	High-Very High (H-VH)
P3	533.33	27	High (H)	M7	618.83	14	High-Very high (H-VH)
P4	487.62	36	High (H)	M8	580.06	21	High (H)
P5	640.80	10	High-Very High (H-VH)	M9	539.82	24	High (H)
P6	505.31	31	High (H)	M10	647.60	7	High-Very high (H-VH)
P7	478.97	38	High (H)	M11	425.58	42	Medium-High (M-H)
S1	588.37	18	High (H)	M12	882.76	2	Very High (VH)
S2	625.69	13	High-Very High (H-VH)	M13	581.93	19	High (H)
S3	880.07	3	Very High (VH)	M14	884.24	1	Very High (VH)
S4	640.41	11	High-Very High (H-VH)	D1	581.93	20	High (H)
S5	563.47	23	High (H)	D2	639.48	12	High-Very High (H-VH)
S6	570.70	22	High (H)	D3	505.31	32	High (H)
S7	488.78	35	High (H)	D4	522.84	28	High (H)
S8	426.55	41	Medium-High (M-H)	D5	466.16	39	High (H)
S9	486.20	37	High (H)	D6	420.81	43	Medium-High (M-H)
S10	538.58	25	High (H)	D7	594.02	17	High (H)
S11	490.52	34	High (H)	D8	368.33	45	Medium-High (M-H)
S12	642.7	9	High-Very High (H-VH)	D9	420.76	44	Medium-High (M-H)
M1	514.52	29	High (H)	R1	495.45	33	High (H)
M2	648.35	6	High-Very High (H-VH)	R2	436.40	40	Medium-High (M-H)
M3	658.07	5	High-Very High (H-VH)	R3	599.52	16	High (H)
M4	353.75	46	Medium-High (M-H)	R4	612.95	15	High-Very High (H-VH)

Table 8. Degree of SCOR risk model based on the accumulated value of FRPN

Major Process	*Risk Event*	FRPN Accumulation	*Rank*
Plan	7	4,012.68	4
Source	12	6,942.04	2
Make	14	8,488.13	1
Deliver	9	4,519.85	3
Return	4	2,144.33	5

5. Managerial Implication

The discussion within the managerial implications of a greater emphasis on risk mitigation operations conducted by PT. XYZ. Mitigation done more emphasis on the very high risk category (VH) with a range of values RPN 800-1,000. Very high-risk category (VH) have a significant impact affecting business processes. The risks of operating in a risk event caused by multiple risk agents. In this study carried out risk mitigation outcome expert recommendations based on risk agents that cause the occurrence of a risk (risk event) is.

At the risk of fire plant (M14) handling alternative risk transfer is taken which is to transfer the risk to other parties which in this case is the insurer. But before it happens, the company may take other steps such as reduce risk by establishing a Committee of Occupational Safety and Health (P2K3) where in one work program is the manufacture of Hazard Identification Risk Assessment and Control (HIRAC). At the risk of damage to the main engine (M12) mitigation is done by reducing the risk, which is to undertake a program of machine maintenance/preventive maintenance on production machines, especially the main engine. At the risk of unavailability of key raw materials for the production of (S3), in this case the main raw materials for the purpose are corn, because the raw material of corn has the highest proportion of feed that can reach about 50-60%. Alternative undertaken to mitigate the risk retention is, by substituting corn with alternative raw material. At the risk of uncertainty of product sales (P2), mitigation is taken in the form of risk retention, namely the improvement of the sales forecast. At the risk of feed manufacturing process does not satisfy the standards (M3), mitigation of the risks taken is reduce risk by making standard operation procedure of (SOP).

6. Conclusions and Recommendations

6.1 Conclusions

According to results shown in this research, it can be concluded that there are 46 operational risks in plant manufacturing process.

Based on the risk assessment, fire risk is a risk that potentially cause the highest losses compared to risk of damage to the main engine, risk of unavailability of production main raw materials, risk of uncertainty of product sales, and risk of feed production that does not meet standards. The highest and largest operational risk in feed industry is caused by the *Make* process, followed by risks from the *Source*, *Delivery*, *Plan*, and *Return*.

Mitigation that can be done is transferring risk to the insurer and the formation of P2K3 team (fire risk mill), a preventive maintenance program (risk of damage to the main engine), the substitution of the main raw material (risk of unavailability of main raw materials), improvement on sales forecasting (risk of uncertainty product sales), and the establishment of SOP (risk of feed manufacturing process not meeting the standards).

6.2 Recommendations

Recommendations for further research in the same or directly related to this research for both the topics and methods used are as follows:

a. Further research done for the completion of this research should identify risks and not to be restricted solely by the classification of operational risks but all kinds of other risks such as the strategic risk type.
b. Advanced research is needed for the improvement of this study by identifying risks in operational activities more specifically so that the identification, assessment and mitigation can be optimized.
c. Further research is needed to create operational risk mitigation modeling in feed industry to make it easier to address problems or risks that may occur.

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