Supply Chain Risk Assessment Implementation Using Failure Mode and Effect Analysis (FMEA). Case study on After-Sales Product Support at Heavy Equipment Company

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Abstract

As a leader of heavy equipment company in Indonesia, Company XYZ provides not only products of world-renowned brands but also sold services. One of it is after-sales service namely After-Sales Product Support (ASPS). Based on an interview, 70% of Company XYZ's sales source from ASPS, which mean, ASPS sales level needs to be maintained. This study used Supply Chain Risk Management (SCRM), the SCOR Model, and Failure Mode and Effect Analysis (FMEA) method approach. It has been identified there are 40 risks with 21 risks that needs to be immediately being reviewed and improved. Risk with the highest risk priority number RPN is namely part installation does not match the target from the customer and the risk controls are ensure Job Sheets Schedules (JSS) are tightly controlled every day, fulfilment of manpower according to the competence that needed, and lastly more supervision is improved especially for critical jobs.

Keywords
Heavy equipment company, Supply Chain Risk Management (SCRM), SCOR Model, and Failure Mode and Effect Analysis (FMEA).

1. Introduction

After-sales service is any support provided to a customer after the product or service has already been purchased. Companies use after-sales support as a business strategy as it typically leads to higher customer satisfaction, customer loyalty, and brand loyalty. Company XYZ, as a leading heavy equipment distributor in Indonesia provides not only products of world-renowned brands such as Komatsu and Tadano but also provide services to customers. To always offer the best for their customer, Company XYZ improve the quality of after-sales service called After-Sales Product Support (ASPS).

Based on data obtained from the Company XYZ web portal, it can be concluded that in the construction machinery segment, there are several types of sales that occur, and their performance is measured. One of them is the sales of Parts & Services or we can call that as the sales of ASPS. From this data, it can be concluded that sales for this type have the highest sales than other types of sales in this segment in 2020. Later on, based on an interview that has been conducted with one of the Service Division associates, it is said that of all unit sales made by Company XYZ, there are 70% of sales of product support types. This indicates that ASPS' sales have a high percentage and need to be maintained. There are many things that can be done to maintain and even improve ASPS sales, one of it is by implementing Supply Chain Risk Management (SCRM) because in practice, the ASPS business also consists of supply chain processes where in this case the SCOR Model approach is used.

Supply Chain Risk Assessment needs to be reviewed so that it requires Supply Chain Risk Management (SCRM). SCRM is defined as a risk source management that capable of presenting solutions to avoid, reduce or minimize disruption. SCRM deals with risk management and supply chain, so it can be assumed that this tool is able to manage probabilistic and undesirable situations by identifying sources of risk, analyzing possible risks, and presenting solutions that can be used to avoid, reduce or minimize the effects of risk sources (Shahbaz et al. 2017)

Failure Mode and Effect Analysis (FMEA) is one of many methods that can be used to implement supply chain risk assessment. FMEA is an effective and accepted tool in the application to prevent or reduce the issues (Ariyanti FD & Andika A, 2016). It contains the potential failure mode, causes of failure mode, effects of failure mode and represents RPN form which can be calculated by the product of Severity (S), Occurrence (O), and Detection (D). Once the risk assessment is done, the next step is to find the mitigation action to cope the causes of failure (Wannawiset & Tangjitsitcharoen, 2019). FMEA helps improving product quality and delivery performance by proactively identifying and reducing risks (Ghadge et al. 2017).

1.1 Objectives

The focus of this study is to determine the actions that must be taken to reduce and manage the risks and problems that may and have occurred. In order to fulfil the focus of study following objectives were defined:
Identifying, assessing, implementing, monitoring, and evaluating the risks that occur in the After-Sales Product Support (ASPS) business based on the Failure Mode and Effect Analysis (FMEA) Method.

2. Literature Review

Supply Chain (SC) is a network of organizations and processes where a number of companies (suppliers, manufacturers, distributors, and retailers) collaborate (cooperate and coordinate) along the value chain to obtain raw materials, to convert raw materials into final products or finished goods specified, and to deliver the finished goods to the customer (Ivanov et al. 2019).

One of the well-known models to describe the SC processes and measure their performance is SCOR (Supply Chain Operations Reference Model). SCOR consists of 5 processes. Plan is a planning process regarding supply and demand. Source is the process of purchasing goods or services to meet planned or actual demand, which can then be referred to as the purchasing or procurement process. Make process describes all the processes that transform raw materials or sub-assemblies into finished products in order to meet customer demands. The delivery process is a distribution process to the customer. Thus, order management, warehousing and transportation management are also included in this process. Return can be referred as reverse logistic where in this process it is an activity of returning either from the customer to the company or from the company to the supplier (Scott et al. 2018).

SCRM implementation is needed to presenting solutions to avoid, reduce or minimize disruption that may and have occurred. Risk management in the supply chain is one of the most significant challenges facing any organization based on the fact that all organizations are members of at least one and more possibly, several supply chains (Brindley, 2017). The goal of risk management is to find an integrated approach to the evaluation, control, and monitoring the risk. By managing and evaluating the risks, it can increase the company productivity and gain competitive advantage among the other competitor (Hopkin, 2017).

Risk management can be done with using Failure Mode and Effect Analysis (FMEA) method. FMEA is a method that systematically identifies and fully understands potential failures and their causes as well as the impact of failure on a system or end use, for a particular product or process (Carlson, 2012). Liu (2016) explained that FMEA is a systematic methodology designed to identify the potential of failure, and causes and effect of failure on a system. The principle of FMEA risk assessment is to assess risk in terms of severity, occurrence, and detection level with the current method or process. Failure modes are prioritized based on the RPN values. Failure modes with higher RPN values are given higher priority than those with lower RPN values (Chang et al. 2012). In addition to RPN, Risk Score Value (RSV) also being used by several researchers in the FMEA methodology (Anin et al. 2015). The Figure 1 is the rating scale for FMEA (Sinnott & Towler, 2019).

Shirani and Demichela (2015) explained that based on the study they have done, it shows that FMEA appeared to be a valuable tool to identify risks. The steps and risks that were initially neglected or were considered uncritical before performing FMEA turned out to be a major importance.

There are four steps in order to do risk management which are (Ennouri, 2015):

- The first step is the risk identification: allows the detection of risky events,
- The second step is the risk assessment: calculates the probability of occurrence of risks and classify risks based on those probability,
- The third step is the risk management: choice and setting up the corrective strategy,

- The fourth step is the risk monitoring: supervised the efficiency of corrective strategy and detecting the possible other risks.

Table 1. Rating Scale for FMEA

Rating	SEV	OCC	DET
1	Effect is insignificant	Failure is very unlikely	Current safeguards will always prevent failure mode
4	Minor disruption, possible loss of production	Occasional failure possible	High probability that current safeguard will detect or prevent
7	Major disruption, possible damage to local equipment	Infrequent failure is likely	Low probability that current safeguard will detect or prevent
10	Severe disruption, major damage to plant, possible injury to personnel	Failure is very likely to frequent	No current method of detection

A scatterplot is a representation graph of two variables for observing relationships between pairs of variables, wherein the changes in one variable is followed through in the changes in another variable (Samanta, 2019). Scatterplot is graphical display of set of data in Cartesian coordinate, shows the relationship between two variables, one variable represents horizontal distance (independent variable) and second variable vertical distance (dependent variable) of data point from the coordinate axis (Khan & Khan, 2011). In the scatterplot each variable is represented by an axis, independent variable on the x axis and dependent variable on the y axis (Warne, 2020).

3. Methods

The topics on this study is being chose after observing the real situation. There are 8 steps on this study which are: Choosing the topic for this study by observing the real situation, literature review, determine the problem formulations, determine the objectives of the study, conducing a data collection, processing the data, analysis and discussion, and lastly give a conclusion. The data for this study is collected by conducting interviews with the company supervisor and by collecting the dataset. Figure 1 shows a flowchart of 8 steps of completion in this study.

The authors collect the necessary data in order to solve problems and provide solutions. Data collection is done by identifying problems based on the method used, such as risk based on the Failure Mode and Effect Analysis (FMEA) method where risk classification is based on supply chain activities using the SCOR model approach. There are 5 process management core SCOR model and all of them are being used in this study, which is plan, source, make, deliver and return.

The data that has been collected is processed using the methods that have been studied and determined which in this case is the FMEA method and the SCOR model approach. FMEA uses the RPN to determine the risk priorities of failure modes (Wang et al. 2009). RPN is calculated with this formula:

$$RPN = S \times O \times D \qquad (1)$$

Risk Score Value (RSV) used in the FMEA methodology is calculated with formula:

$$RSV = S \times O \qquad (2)$$

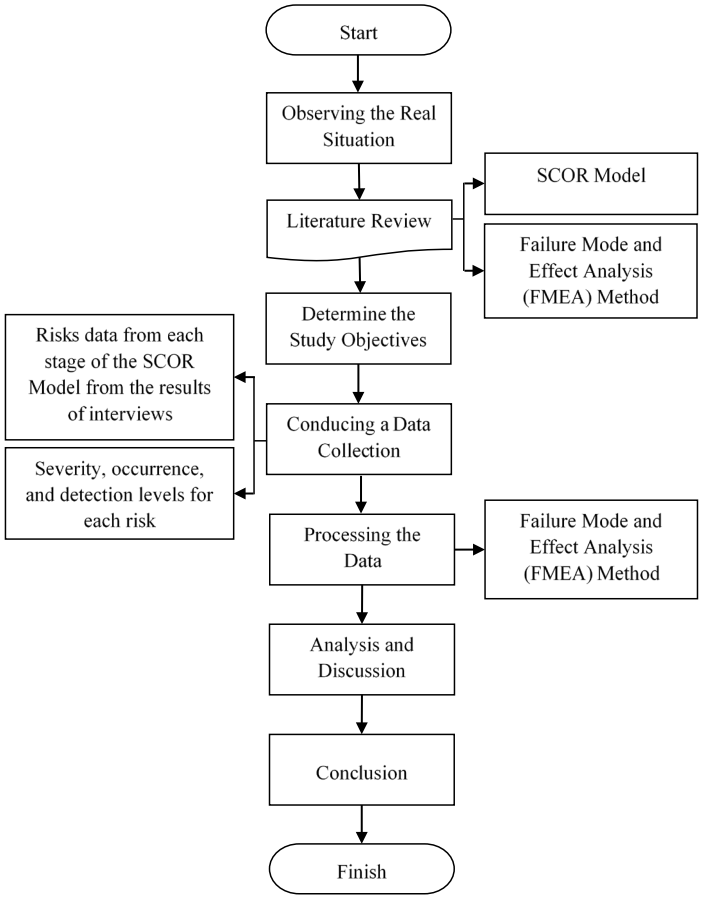

Figure 1. Flowchart of the Study Completion Stage

The data was processed using Microsoft Excel and Minitab software. From the data that has been processed, it can be seen what risks need to be prioritized in determining risk control strategies. The outcome of processing data are RPN and RSV value for every risk, the Pareto chart analysis, and a scatterplot for risk clustering. From the Pareto chart analysis and the scatterplot, risk profiles and mitigation strategies are developed.

4. Data Collection

The risks that may and have occur in the After-Sales Product Support (ASPS) are obtained based on the results of interviews and discussions with one manager and two associates from service division at Company XYZ. There are 40 identified risks which will then be determined by the severity, occurrence, and detection level by them. The assessment obtained by the three sources are different, so that the maximum value is taken for each level of severity, occurrence, and detection. Table 2 and Table 3 shows the risks that have been classified based on supply chain activities with the SCOR Model approach.

Table 2. After-Sales Product Support (ASPS) Risk Identification for Plan Process

Process	***Code***	***Risks***
Plan	E1	The volatile and uncertainty (VUCA) macro business conditions affect the accuracy of demand forecasting
	E2	Government policy changes (apbn, licensing, etc.)
	E3	Lost coverage (customer/demand is not detected)
	E4	Business competition activities by competitors
	E5	Product engine new model/upgrade parts are not available and mechanics are not yet competent
	E6	Sudden additional requests from customers
	E7	Customer is doing cost reduction program

Table 3. After-Sales Product Support (ASPS) Risk Identification for Source, Make, Delivery, and Return Process

Process	*Code*	*Risks*
Source	E8	Changes in government regulations regarding the procurement of goods
	E9	PO does not reach pic related
	E10	Error number and specification of units and parts in order
	E11	Leadtime stock fulfillment is not OTIF (On Time In Full)
	E12	Delay in production implementation at the vendor
	E13	Parts and components that are suppliers responsibility are not available
	E14	The number and types of units and parts received do not match the request
	E15	There is a delay when receiving units/components/parts if the person incharge is infected, backup PIC is required
	E16	Units, components, and parts received are missed for quality control by the Part Distribution Center (PDC)
	E17	Units and parts received are classified as poor durability
Make	E18	Available supplies cannot be used because they are damaged
	E19	Available supplies cannot be used because of old model units/scrap units
	E20	Mechanic availability is not as needed
	E21	Access to the customer area and the number of people is limited, the installation process can be delayed due to following the COVID-19 protocol
	E22	Part installation does not match the target of the customer
	E23	There is a delay if the person incharge is infected COVID-19, need pic backup
	E24	No quality control is performed during the production process
	E25	Decrease in unit /component/part quality
Delivery	E26	Storage and maintenance process of units/components/parts is not good
	E27	Check and commissioning before delivery is incomplete
	E28	There is a delay if the person incharge is infected COVID-19, need pic backup
	E29	Delay in delivery of units/components/parts
	E30	There is an accident at the time of delivery
	E31	Unit /components/parts are damage when received by customer
	E32	Access to the customer area and the number of people is limited, due to following the COVID-19 protocol
	E33	There is fatigue material
	E34	Broken support equipment (forklifts, cranes, etc.)
	E35	System shutdown
	E36	*Over stock capacity*
	E37	Discrepancies between recorded and available stocks
Return	E38	Delay in return process from customer
	E39	Delay in return process to supplier
	E40	Unit/component/part damaged during warranty period

5. Results and Discussion

5.1 Numerical Results

The risks that have been identified and assessed based on their severity, occurrence, and detection level are then calculated to obtain the Risk Priority Number (RPN) and Risk Score Value (RSV) using formula (1) and (2). The results of these calculations are described in Table 3.

Table 3. RPN and RSV Score

Process	*Code*	S	O	D	RPN	RSV	*Process*	*Code*	S	O	D	RPN	RSV
Plan	E1	7	3	9	189	21	Make	E21	6	1	9	54	6
	E2	6	3	8	144	18		E22	8	8	7	448	64
	E3	7	4	7	196	28		E23	8	1	9	72	8
	E4	8	7	7	392	56		E24	7	5	5	175	35
	E5	5	3	6	90	15		E25	7	2	7	98	14
	E6	6	8	7	336	48	Delivery	E26	6	5	4	120	30
	E7	8	6	4	192	48		E27	6	5	4	120	30
Source	E8	8	3	8	192	24		E28	5	1	9	45	5
	E9	6	9	5	270	54		E29	6	6	4	144	36
	E10	6	4	7	168	24		E30	8	3	9	216	24
	E11	6	6	6	216	36		E31	5	3	7	105	15
	E12	4	5	3	60	20		E32	5	1	9	45	5
	E13	6	6	6	216	36		E33	5	2	8	80	10
	E14	4	5	3	60	20		E34	5	6	7	210	30
	E15	8	4	9	288	32		E35	6	6	9	324	36
	E16	8	5	3	120	40		E36	7	6	4	168	42
	E17	8	5	7	280	40		E37	6	7	7	294	42
Make	E18	7	3	6	126	21	Return	E38	5	4	7	140	20
	E19	7	4	4	112	28		E39	4	4	7	112	16
	E20	6	6	5	180	36		E40	5	6	8	240	30

5.2 Graphical Results

Furthermore, to be able to identify and evaluate potential product and process failures, a Pareto Chart and Scatterplot is needed from the calculated RPN and RSV values. The Pareto Chart was created using Minitab software and will form the basis for using the 80/20 rules. Scatterplots are created using Minitab software by entering all the RPN, RSV values, and calculating the interpolated values from the Pareto Chart that have been created to determine the reference lines. From Figure 2 it can be seen that there are 21 risks on Quadrant 1 that needs to be prioritized when it comes to develop the mitigations and risk controls.

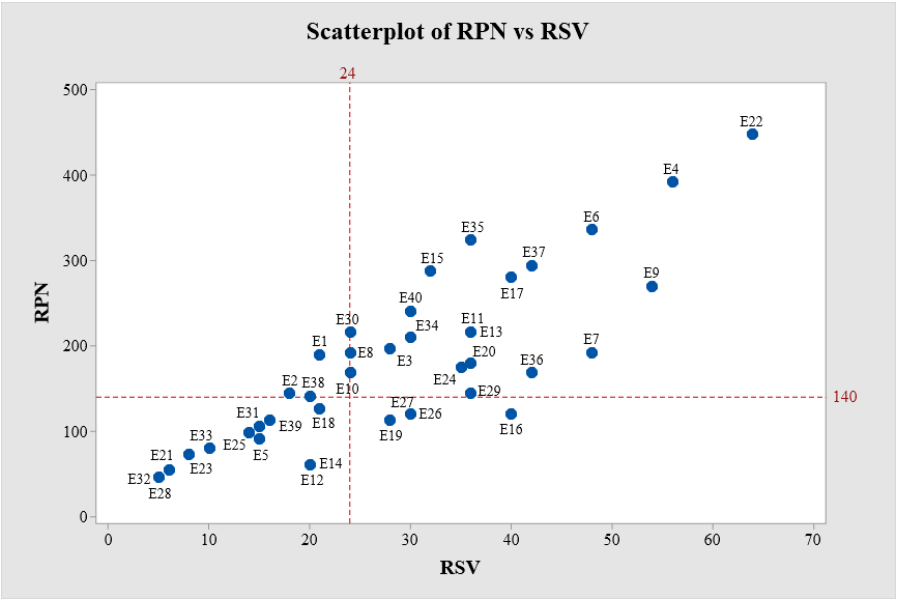

Figure 2. RPN vs RSV Scatterplot

The first quadrant consists of 21 risks consisting of every supply chain process that occurs, for example the risk in the make process with code E22 regarding the installation of parts that are not in accordance with the target from the

customer. The next example is the risk from the plan process with code E4 regarding business competition activities by competitors. The risks above are sorted by the largest RPN value, so risk control starts from code E22, E4, E6, E35, E37, E15, E17, E9, E40, E11, E13, E30, E34, E3, E7, E8, E20, E24, E10, E36, and E29.

The second quadrant located at the top left represents a problem that has often occurred but does not interfere with the company's activities, therefore the risks contained in the second quadrant do not need to be prioritized. The second quadrant consists of three risks in the plan process, namely the risk of volatile macro business conditions and uncertainty (VUCA) affecting the accuracy of demand forecasting with code E1 and changing government policies (APBN, licensing, etc.) with code E2. If sorted by the largest RPN value, then risk control starts from code E1, E2, and E38.

The third quadrant located at the bottom left represents a problem that does not often occur so that companies will tend to ignore the risks contained in the third quadrant. The third quadrant consists of 12 risks consisting of every supply chain process that occurs, for example the risk in the source process with E12 code, namely delays in the implementation of production at the vendor. The next example is the risk of the delivery process with code E31 regarding damage to the unit / component / part when it is received by the customer. The risks above are sorted by the largest RPN value, so risk control starts from code E18, E39, E31, E25, E5, E33, E23, E12, E14, E21, E28, and E32.

The fourth quadrant which is located at the bottom right represents a problem that rarely occurs, but if it occurs it has a big impact on the company, then the company needs to prepare the right risk control for the risks contained in the fourth quadrant. The fourth quadrant consists of 4 risks in the source, delivery, and make processes. The risk in the source process is that the units, components, and parts received are missed for quality control by the Part Distribution Center (PDC) with code E16. Furthermore, one of the risks in the delivery process is that the storage and maintenance process for units/components/parts is not good. The risks in this quadrant are sorted by the largest RPN value, so risk control starts from code E16, E26, E27, and E19.

5.3 Proposed Improvements

The risks involved in the flavor supply chain of the After-Sales Product Support (ASPS) were identified and assessed. The risks should be treated by determining what will be done in response to the identified risk. Based on scatterplot above, it can be concluded that risks on Quadrant 1 need to be prioritize and have to be mitigate and control. The following risk control strategies were developed in a group discussion between the authors and the manager and the associate. Company past risk control strategies were taken into consideration in the discussion. Table 4 and Table 5 shows risk control for 15 risks with the highest RPN.

Table 4. Risk Control for Risk with Code E3 – E11

Code	Risk Control
E3	1. Increasing territory coverage, involving sales, supervisors, mechanics etc 2. Involving X Call to target customer cluster C (Retail) 3. Optimization of the digital system to detect the location of the unit, unit utilization, and the condition of the customer's heavy equipment unit
E4	1.Continuous product improvement is more intended to meet customer needs 2.Maintaining employee competence in the face of competition 3.Monitor the development of competitor level and prepare strategies in competition
E6	1.Monitoring the availability of parts 2.Daily coordination with customers related to current activities 3.Educate the customer to improve the ability to analyze parts needs 4.For impromptu needs where the partsare not available then sourcing is being done at the nearest branch UT
E7	1. Management of distribution costs, 2. Weekly review
E9	Reconciliation with customers related to orders periodically so that if anything is missed can be corrected immediately
E11	1. Monitoring the availability of parts 2. Daily coordination with customers regarding ongoing activities 3. Educate customers to improve the ability to analyze parts needs

Table 5. Risk Control for Risk with Code E13 – E40

Code	Risk Control
E13	1. Regularly review the parts/component requirement plan with the vendor 2. Monitoring the movement / readiness of stock at the vendor according to the purchase plan from the customer
E15	1.Prevent the spread of the virus by implementing covid protocol 2.Appointment of other PIC by superiors 3.Coordination with the nearest branch if necessary
E17	1.Conduct data collection and periodic reviews related to the quality issue of each parts 2.Coordination with the suplyer for prevention and curative 3.Backup stock and acceleration improvement quality parts
E22	1.Ensure Job Sheets Scheduled (JSS) are tightly controlled every day 2.Fulfillment of man power according to competence 3.More supervision is improved especially for crtitical jobs
E30	1. Carried out by a third party for component and parts forwarder process 2. Monitoring the delivery process and active communication with the PIC forwarder to monitor its movement
E34	1. Coordination with vendors related to plan needs and supply plans on a regular basis 2. Make an accuracy plan at the customer so that it is in accordance with the production schedule at the vendor
E35	1. Preparing SOP for manual material production 2. Run SOP production material manual 3. Perform recovery system when it is back to normal
E37	1.Stock taking regularly every day using barcode system 2.Create event news and reset stock accuracy
E40	1.Analyze material damage 2.Acceleration of the repair process of warranty parts so that the unit does not break down too long 3.Complete the administration of claims with customer and principle

Supply Chain Risk Management (SCRM) implementation using FMEA method along with SCOR Model approach has been done and with this method, Company XYZ can classify risks based on supply chain processes that occur and make it more convenient for the company to identify what risks need to be prioritized, how risks need to be handled, and prepare the mitigations or risk control. Risks that need to be prioritized can be determined based on the scatterplot in Figure 2. Not only that, the company also can gain the information about the profile of each risk from how it being mapped in scatterplot, it can help the company to prepare more strategies according to it.

6. Conclusion

After-Sales Product Support (ASPS) business risk management related to the supply chain process has been carried out using the SCOR Model approach to identify risks in each process. The method used for risk management is the Failure Mode Effect Analysis (FMEA) method to identify potential failures for certain units, components, parts and processes. Risks that need to be prioritized can be identified by using the Pareto Chart which applies 80/20 rules wherein these risks can then be mapped based on the RPN and RSV values in the scatterplot. The risks in quadrant 1 have high RPN and RSV values or have RPN values above 140 and RSV above 24 need to be prioritized in determining and implementing risk control so as not to cause losses to the company. Risks in quadrant 1 consist of every supply chain process that occurs.

Determination of risk control for each risk is carried out by brainstorming with resource persons in order to determine the optimal risk control. There are several risk controls related to the After-Sales Product Support (ASPS) business that already exist and are implemented, but there are also risks that have not been identified as risk controls or can be added to other risk controls for some risks so it is necessary to determine the appropriate risk control. One of the risks that risk control has not yet been identified is material fatigue with code E33. The risk control proposed by the author is to provide a colored label for each material that arrives based on the date of arrival and the optimal age of the material. This is so that the age of the material can be grouped and viewed without the aid of a tool in order to make it easier to determine the use of the material.

References

Ariyanti, F.D., & Andika, A., (2016). Supply Chain Risk Management: Case Study from a Multinational Flavour Company in Indonesia, Proceeding of 6th IEOM Conference, Kuala Lumpur Malaysia, 396-400

Brindley, C., *Supply Chain Risk*, 1st Edition, New York, Routledge, 2017.

Carlson, S. C., *Effective FMEAs: Achieving Safe, Reliable, and Economical Products and Processes using Failure Mode and Effects Analysis,* 1st Edition, New Jersey, John Wiley & Sons, 2012.

E.K. Anin, O.F. Alexander, and D.E. Adzimah, Managing Supply Chain Risks: A Perspective of Exportable Pineapple Fresh Fruits in Ghana, *European Journal of Business and Management*, vol. 7, no. 3, pp. 59-71, 2015.

Ennouri, W., Risk Management Applying FMEA-STEG Case Study, *Polish Journal of Polish Study,* vol. 11, no. 1, pp. 56-67, 2015.

Ghadge, A., Fang, X., Dani, S., and Antony, J., Supply Chain Risk Assessment Approach for Process Quality Risks. *International Journal of Quality & Reliability Management,* vol. 34, no. 7, pp. 940-954, 2017.

Hopkin, P., *Fundamentals of Risk Management: Understanding, Evaluating and Implementing Effective Risk Management*, 4th Edition, New York: Kogan Page Publishers, 2017.

Ivanov, D., Tsipoulanidis, A., and Schönberger, J, *Global Supply Chain and Operations Management.* Switzerland: Springer, 1st Edition, 2019.

K.H. Chang, Y.C. Chang, T.C. Wen, and C.H. Cheng, An Innovative Approach Integrating 2-Tuple and LOWGA Operators in Process Failure Mode and Effects Analysis, *International Journal of Innovative Computing, Information and Control*, vol. 8, no. 1B, pp. 747-761, 2012.

Khan, M., and Khan, S. S., Data and Information Visualization Methods, and Interactive Mechanisms: A Survey. *International Journal of Computer Applications,* vol. 34, no. 1, pp. 0975-8887, 2011.

Liu, H.-C., *FMEA Using Uncertainty Theories and MCDM Methods,* 1st Edition, Singapore, Springer Nature, 2016.

Samanta, M., *Lean Problem Solving and QC Tools for Industrial Engineers.* 1st Edition, New York: Taylor & Francis Group, 2019.

Scott, C., Lundgren, H., and Thompson, P., *Guide to Supply Chain Management,* 2nd Edition, Berlin, Springer, 2018.

Shahbaz, M. S., Rasi, R. Z., Bin Ahmad, M. F., & Rehman, F., What is Supply Chain Risk Management? A Review. *Advance Science Letters,* vol. 23, no. 9, pp. 9233-9238, 2017.

Shirani, M., and Demichela, M., Integration of FMEA and Human Factor in the Food Chain Risk Assessment. *International Scholarly and Scientific Research & Innovation,* vol. 9, no. 12, pp. 4247-4250, 2015.

Sinnott, R., and Towler, G., *Chemical Engineering Design: SI Edition.* 5th Edition, Cambridge, Elsevier, 2019.

Wannawiset, S., and Tangjitsitcharoen, S., Paper Machine Breakdown Reduction by FMEA and Preventive Maintenance Improvement: A Case Study. *IOP Conf. Series: Materials Science and Engineering*, July, 2019.

Warne, R. T., *Statistics for the Social Sciences: A General Linear Model Approach.* 1st Edition, Cambridge, Cambridge University Press, 2020.

Y.M. Wang, K.S. Chin, G.K.K. Poon, and J.B. Yang, Risk Evaluation in Failure Mode and Effects Analysis Using Fuzzy Weighted Geometric Mean, *Expert Systems with Applications*, vol. 36, pp. 1195-1207, 2009.

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