Supply Chain Risk Management Design for U-Hansa Product in Relation to Covid-19 Pandemics

(*Perancangan Manajemen Risiko Rantai Pasok untuk Produk U-Hansa terkait Pandemi Covid-19)*

Freisca Erwan[1#)], Prima Denny Sentia[1,2], Rizki Agam Syahputra[1], Zaty Fadhilla[1], Raihan Dara Lufika[1], Didi Asmadi[1]

[1]Industrial Engineering Department, Universitas Syiah Kuala, Banda Aceh, Indonesia
[2] Center for Artificial Intelligent Technology, Universiti Kebangsaan Malaysia
[2] Industrial Engineering Department, Universitas Teuku Umar, Meulaboh, Indonesia

[#)]Corresponding author: friesca_erwan@unsyiah.ac.id

Received 25 May 2022, Revised 6 August 2022, Accepted 7 September 2022, Published 15 September 2022

Abstract. The recent Covid-19 pandemics situation has brought a lot of discussion on how to manage a supply chain in uncertainty since the dynamic of pandemics risk has altered the way a supply chain is organized. This research aims to identify, asses and manage the possible risks on supply chain that may occur in relation to production process of U-Hansa (USK Hand Sanitizer) following a high demand of hand sanitizer during the pandemics. This research performed risk breakdown structure to identify risks, evaluated the risks using risk matrix 5x5 (MIL-STD-882B) and create risk mapping using the big picture approach. This research revealed that there are 15 risks involved in U-Hansa production process that can potentially disrupt the whole supply chain process of U-Hansa. Factors such as raw material shortage during the Covid-19 lockdown, insufficient production capacity and the limitation of machinery and equipment to support the production contributes to the noticeable risk potential in the overall U-Hansa supply chain network. The overall findings of this research are expected to help the decision-making process that can be utilized in the post-Covid-19 pandemics setting.

Keywords: supply chain risk management, Covid-19, hand sanitizer, risk matrix.

Abstrak. *Pandemi Covid-19 yang terjadi pada akhir 2019 membawa topik Manajemen Risiko Rantai Pasok semakin banyak dibahas karena membawa perubahan pada tatanan kebiasaan professional dan sosial kemasyarakatan, sehingga industri terdampak mulai dari segi pasokan bahan baku maupun distribusi permintaan. Penelitian ini bertujuan untuk mengidentifikasi, menilai dan mengelola risiko rantai pasok yang terjadi pada proses produksi U-Hansa (USK Hand Sanitizer) sehubungan dengan tingginya permintaan akan produk hand sanitizer. Pada penelitian ini, identifikasi risiko dilakukan menggunakan pendekatan Risk Breakdown Structure, penilaian risiko dilakukan menggunakan matriks risiko 5x5 (MIL-STD-882B) dan pemetaan risiko dilakukan menggunakan pendekatan The Big Picture. Dari hasil pengolahan data, diperoleh 15 risiko yang berpotensi terjadi pada proses produksi U-Hansa. Beberapa faktor yang berkontribusi pada potensi risiko proses produksi dan keseluruhan jaringan rantai pasok U-Hansa berdasarkan hasil penelitian adalah kelangkaan bahan baku akibat Pembatasan Sosial Berskala Besar (atau lockdown), kapasitas produksi yang tidak mencukupi dan keterbatasan mesin dan peralatan untuk mendukung proses produksi. Hasil penelitian ini secara umum diharapkan dapat membantu proses pengambilan keputusan dalam rantai pasok proses produksi untuk situasi pandemik.*

Keywords: manajemen risiko rantai pasok, Covid-19, hand sanitizer, risk matrix.

1 Introduction

Supply chain risk management (SCRM) is a strategic management tools that involves the process of mapping the supply chain process of a firm. This process concerns on the activity of identifying, measuring, and assessing risks that may occur in an industry and developing strategic decisions to control and mitigate the risks (Tummala & Schoenherr, 2011). SCRM aims to discover the

probability of risk occurrence within an industry and to develop a mitigation strategy as a plan to avoid the disruption to the overall supply chain process (Munir et al., 2020). In its practice, SCRM consists of several processes, methods and techniques that help to maximise the probabilities and the impact of positive events and minimise the probabilities and the consequences of a disruptive event (Purnama, 2014; Syahputra et al., 2022). This method is essential for a company to increase the security and safety of the supply chain. Figure 1 shows the scope of risk management which adopted by supply chain management to perform the supply chain risk management (Ganji & Hayati, 2016). By monitoring the supply chain, organizations have more capability to explore company's vulnerabilities and to be more adaptive to anticipate the problem.

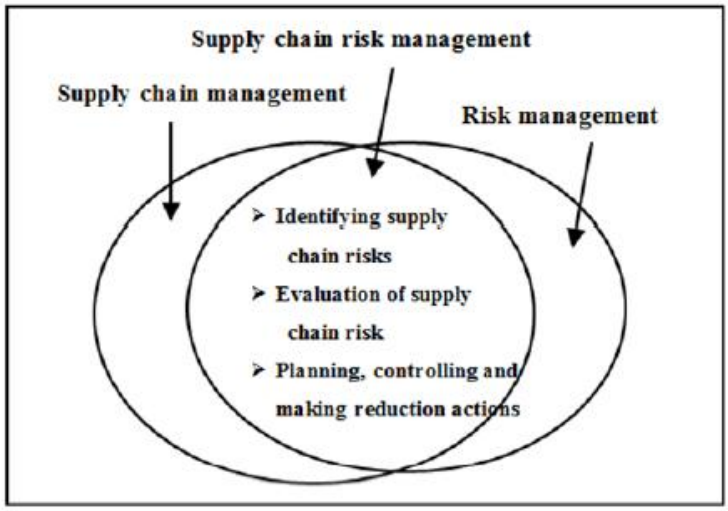

Figure 1 Supply chain risk management (Ganji & Hayati, 2016).

Given the Covid-19 pandemics situation, SCRM has become one of the most critical tools for a company to maintain business performance, competitiveness, and survival of the firm (Hohenstein, 2022). However, witnessing the impact of Covid-19 to economic stability (Astuti & Mahardhika, 2020; Gandasari & Dwidienawati, 2020), it's clear that the pandemics has brought an imbalance between consumer demand and the steady supply of raw materials for production, which cause unavoidable delays in all aspect of the supply chain. Therefore, the role of SCRM requires massive adjustment in order for the company to survive in the next phase of the pandemics (Sharma et al., 2020).

The impact of the pandemics on the firm supply chain is also experienced by the Atsiri Research Centre (ARC) of Universitas Syiah Kuala (USK). ARC USK is a centre of excellence for Aceh patchouli research and development, which concern on improving the value of patchouli oil to be innovative products. During the early Covid-19 pandemics, ARC USK took part on supporting government appeal towards the use of hand sanitizer as one of health protocols. ARC USK developed research-based hand sanitizer and disinfectant products using light fraction of patchouli oil and registered its product as U-Hansa (USK Hand Sanitizer). However, the lockdown and pandemics situation has taken a toll on the production line of U-Hansa. Major distribution lines for the raw material were congested with reefer containers that faced a delay in shipment due to several trade restrictions. Consequently, ARC USK was facing difficulty in raw material procurement resulting in a massive delay in the production process and hampering the distribution to the costumer.

Therefore, this research aims to analyse the supply chain risk management at producing ARC hand sanitizer product and capture the pandemics impact on the firm operating in restricted operation. In this study, we identified the risk factors from open-ended interviews with experts combined with relevant literature using Risk Breakdown Structure (RBS). RBS is a tool which widely used to identify risks and multicriteria decision making (Hillson, 2003; Mehdizadeh et al., 2012) and effectively grouping risks in a composition (Ganji & Hayati, 2016). Further, this study analysed each risks using risk matrix 5x5 (MIL-STD-882B) and created the big picture of U-Hansa SCRM. Risk matrix 5x5 (MIL-STD-882B) is one of the most popular forms of risk matrix, particularly in the field of re-engineering (Huihui, 2010). Risk matrix 5x5 added "Negligible" category on the lowest level of severity (Figure 2) which states that the hazard could be ignore as it will not cause

serious injury or illness or high probability of damage (Huihui, 2010). The result of this study is expected to assist practitioners and decision-makers to develop a long- and short-term strategic plan for a company operating in a pandemics situation in the future.

2 Methods

This research employs a case study analysis to study situations, processes, or events due to the Covid-19 situation in depth. Data observation and case study analysis were conducted in Atsiri Research Centre (ARC) of Universitas Syiah Kuala (USK), which was one of the leading research centres in, Banda Aceh, Indonesia. This study used qualitative and quantitative data, which was gathered through direct observation, open-ended interviews with the key stakeholders of the research center, and relevant literatures to describe supply chain processes and associated risk in the system. The data processing analysis in this study is outlined in several steps:

Mapping the Supply Chain Activities

The supply chain activity was structured and mapped according to business process of the firm. The mapping is carried out by describing the supply chain flow starting from suppliers of raw materials for hand sanitizers, production processes, and hand sanitizer distribution activities. This supply chain mapping serves as a basis for describing the risk sources and the next stage of the risk process.

Risk Assessment

The risk assessment process in this study is achieved in several procedure: First, Risk Identification is carried out by validating the supply chain risk data based on a literature study. The data will be validated directly by the ARC stakeholder as the expert judgments of the study. Furthermore, the validated risk report was organized by using Risk Breakdown Structure (RBS) methods. RBS aims to organize each risk factors according to supply chain activities based on the hierarchical structure of the potential risk sources. Secondly, Risk analysis is conducted to visualize the extent and severity on the impact of the risk to the company. In this step, Risk Matrix methodology is applied. Risk matrix aims to compare the probability of a risk occurring (likelihood) and the impact (severity) that may occur to the firm. Risk Matrix accumulates expert's judgment results based on a scale of 1-5 (Figure 2), in which 1 indicates that no action is required to handle the risk, while 5 indicates that immediate action is required (Landell, 2016).

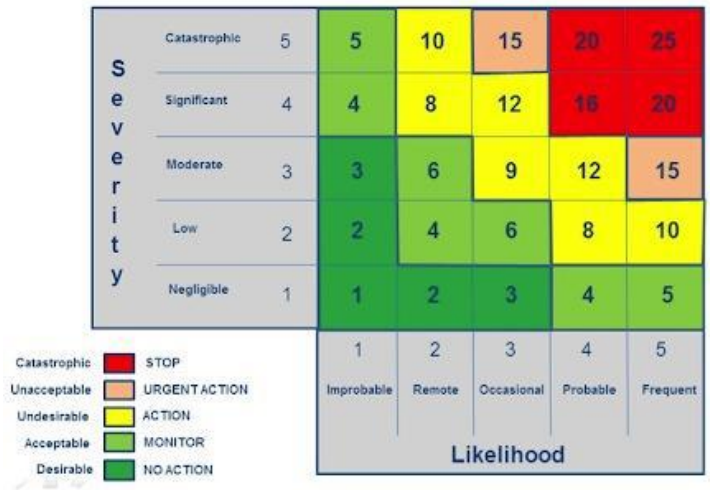

Figure 2 Risk matrix 5x5 (Huihui, 2010).

Thirdly, the risk that has been ranked is then evaluated to determine the probability of the risk, so that it can be used as a reference for determining treatment actions. The risk management strategy is determined based on the result of multiplying the probability and severity values generated from the risk analysis. The risk values interprets treatment actions which consist of (PMBOK 6th Ed, 2017):

1. Escalate risk, applied when the proposed response of risk would exceed the project manager's authority, therefore project manager would nominate the risk to be managed at the program level, portfolio level, or other relevant part of the organization, and not on the project activities level.
2. Avoid risk, applied when risk needs to be eliminated to protect the activities from risk's impacts. Avoid may be appropriate for high-priority threats with a high probability of occurrence and a large negative impact.
3. Transfer risk, involves shifting risk to a third party to manage the risk and its impact. Transfer can be achieved by a range of actions, which include but are not limited to the use of insurance, performance bonds, warranties, guarantees, etc.
4. Mitigate risk, taken to reduce the probability of risk occurrence and/or impact. Early mitigation action is often more effective than trying to repair the damage after the risk has occurred.
5. Accept risk, acknowledges the existence of a risk, but no proactive action is taken. This strategy may be appropriate for low-priority threats, and it may also be adopted where it is not possible or cost-effective to address a threat in any other way.

Risk Register

After assessing the risk within the firm supply chain, the risk is then registered in a log document scheme to determine the treatment actions. The risk register or risk table is an assessment of risk and documentation of information which covers identification of sources and risks, risk analysis, risk evaluation, and handling actions (Uzulāns, 2015; Dunovic & Radujkovic, 2013). All information is presented in a table to make it easier to carry out the next step. The risk register contains details of individual project risks that have been identified and prioritized, and for which risk responses are required. The priority level for each risk can help to guide the selection of appropriate risk responses (PMBOK 6th Ed, 2017). The risk register may provide other data on identified risks that can assist in planning risk responses, including root causes, risk triggers and warning signs, risks requiring responses in the near term, and risks where a need for additional analysis has been identified (PMBOK 6th Ed, 2017).

The Big Picture

The risk management process that has been determined is then translated into the Big Picture. Big picture is a tool used to describe the system as a whole and the values contained in the flow. Big picture serves to identify waste and show the relationship between information and material flows (Hines & Taylor, 2000).

3 Result and Discussion

Mapping the Supply Chain Activities

Generally, there are three mains actor on the overall supply chain line of U-Hansa, ARC as the producer and distributor of the product and suppliers. U-Hansa is a new research-based product which was developed by ARC USK in response to high demand of hand sanitizer during the early Covid-19 pandemics. To produce U-Hansa, ARC USK experienced massive delayed of raw material and bottles packaging due to government lockdown policy in the entire area of Indonesia. The mapping of the U-Hansa supply chain activities can be observed in Figure 3.

In this process, inspection one of the essential processes to make sure all the required material and the products from the supplier to the consumer are according to the standard of the company. The raw materials that are not in accordance with U-Hansa's production standards are returned to the supplier and replaced with the required raw materials. The raw materials that pass the inspection stage are then used for the hand sanitizer production process, the hand sanitizer that has been produced is filled into several package sizes, and after that the packaging and the labelling process is carried out. Products that have been produced are then subjected to further inspection before being sent to consumers who have placed an order and products that are not

suitable/damaged will be discarded. Hand sanitizer products that reach consumers in a damaged condition will be returned and replaced with new products.

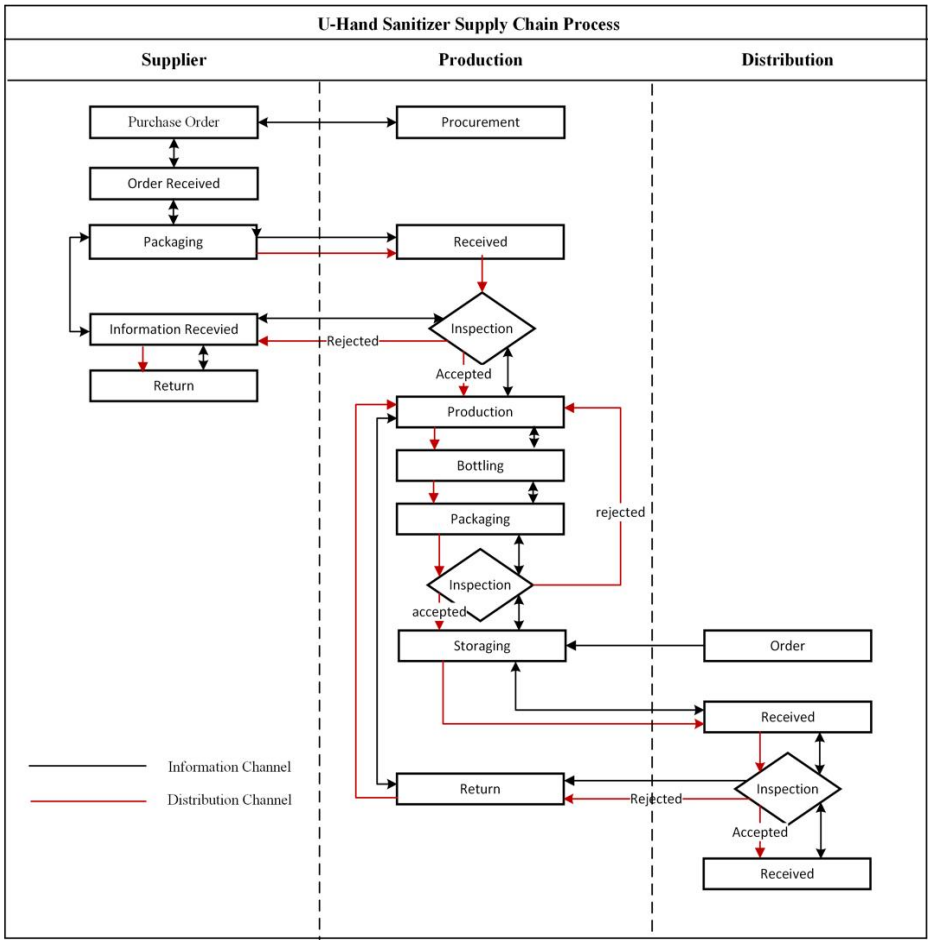

Figure 3 U-Hansa SCM mapping scheme.

Risk Assessment

Risk management is a planning and decision-making activity in dealing with uncertainty to minimize risks in the future (Lufika et al., 2022). Managing the risk consists of several stages including the risk identification, analysis of the potential risks, and evaluation of the potential risks. The assessment of U-Hansa supply chain risk is organized as follow:

Risk Identification

The first step of risk assessment is performing risk identification. In this study, the risk identification process is organized based on open-ended interviews with experts (Table 1) and the relevant literatures. Once the risk variables collected, this study concludes 15 potential risks that can possibly disrupt the supply chain activities of U-Hansa production process and classified into RBS compositions: supplier, factory and logistic (Figure 2). Each risk in Level 3 was given an ID (R) to represent its name. The validity of the identified risks is validated by using a check-sheet technique filled out by the expert judgment of the study. Furthermore, in order to present a hierarchical deconstruction of the risk, the potential risks in this study are organized by the type of risk structure by using the RBS Framework.

Table 1 Expert judgment

No.	Name (initial)	Duty
1	NI	Manager
2	IF	Production team
3	SK	Production team

Risk Analysis

The second stage in the risk assessment is the analysis of potential supply chain risks at U-Hansa. To better understand the intensity of the risk, the analysis of potential risk and risk ranking was carried out cumulatively by using risk matrix, where the value of probability and severity was obtained from the results of expert judgment (Table 1) of the study. The results of probability and severity values is presented in Table 2.

Table 2 Risk Breakdown Structure (RBS)

Level 0	Level 1	Level 2	Level 3
Supply Chain Risk	Supplier	Supplier risk	Supplier financial instability (R1)
			Uncertainty in raw material cost (R2)
		Risks in the supply activities	Misinformation in raw material procurement (R3)
			High dependencies on the supplier (R4)
			Lack information in demand (R5)
		Risks in affecting production activities	Defect in raw material received (R6)
			Delay in receiving raw materials (R7)
	Factory	Production risk	Raw materials inadequacy (R8)
			Raw materials are mixed with other materials (R9)
			Damage to machinery and equipment (R10)
			Insufficient production capacity (R11)
			Production activities stop (R12)
		Marketing risk	Competitive rivalry in hand sanitizer product (R13)
	Logistic	Distribution risk	Defect in distribution process (R14)
			Lack of facilities and logistics workers (R15)

Table 3 Risk values

ID	Risk Event(s)	Probability Value	Severity Value	Risk Value
R7	Delay in receiving raw materials	5	5	25
R8	Raw materials inadequacy	4	4	16
R5	Lack information in demand	4	4	16
R2	Uncertainty in raw material cost	4	4	16
R13	Competitive rivalry	4	4	16
R12	Production activities stop	4	3	12
R10	Damage to machinery and equipment	3	3	9
R11	Insufficient production capacity	3	3	9
R3	Misinformation in raw material procurement	3	2	6
R6	Defect in raw material received	2	2	4
R14	Defect in distribution process	2	2	4
R1	Supplier financial instability	2	2	4
R4	High dependencies on the supplier	2	2	4
R15	Lack of facilities and logistics workers	1	2	2
R9	Raw materials are mixed with other materials	2	1	2

Note: Catastrophic: STOP, Undesirable: ACTION, Acceptable: MONITOR, Desirable: NO ACTION

Based on the severity and occurrence values on Table 3, each risk was colour coded according to 3 risk area. Green area indicates that no to minimum corrective action is required, yellow area

indicates that corrective action is needed to be considered, while red area indicates that immediate corrective action should prioritized.

Risk Evaluation

The risk evaluation stage is the last stage of a risk assessment framework. The evaluation of the potential risks is carried out through potential risks that have been sorted by risk rating, then evaluated to see the causes of the occurrence of risks and decide on strategies to be carried out to eliminate these priority risks. Treatment option only provided for the catastrophic (red), undesirable (yellow) and acceptable (light green) risks based on the treatment actions introduced by PMBOK 6th Ed (2016) (see in Table 4). While, the desirable (dark green) risks do not need any treatment action since it will not cause any impact on the production process activities.

Table 4 Risk evaluation

ID	Risk Event(s)	Probable Cause(s)	Treatment Option
R7	Delay in receiving raw materials	Pandemics lockdown restriction	Avoid
R8	Raw materials inadequacy	Lack of information on production capacity	Avoid
R5	Lack information in demand	Improper bookkeeping process	Avoid
R2	Uncertainty in raw material cost	The increasing demand for hand sanitizers during the Covid-19 pandemics resulted to the higher price of raw material	Avoid
R13	Competitive rivalry	Abundant similar products in the marketplace	Avoid
R12	Production activities stop	Limited raw material and low workforce available	Mitigate
R10	Damage to machinery and equipment	No routine maintenance and lack of workers' understanding of the condition of the engine and equipment	Mitigate
R11	Insufficient production capacity	Insufficient machineries for larger-scale production	Mitigate
R3	Misinformation in raw material procurement	Error in documentation of request info from consumers	Accept
R6	Defect in raw material received	Error in material handling	Accept
R14	Defect on distribution process	Packaging process that are not according to the standard	Accept
R1	Supplier financial instability	The cost of processing raw materials rose during the pandemics period	Transfer
R4	High dependencies on the supplier	Lack of suppliers who have appropriate standard raw materials	Accept

Risks with catastrophic (red) category need to be avoided since it will cause a large negative impact on the activities being carried out in the production process of U-Hansa. According to PMBOK 6th Ed (2017), avoiding risk may involve changing some aspect of the production plan or the objective in order to eliminate the entire risk and reducing its probability of occurrence to zero. Some risks can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise (PMBOK 6th Ed, 2017).

Risks with undesirable (yellow) category determine that action is needed. Therefore, the risks are mitigated by adopting less complex processes and conducting more tests prior to conduct the production process of U-Hansa (PMBOK 6th Ed, 2017). While, risks with acceptable (light green) category determine that it needs to be monitored. In the case of the production process of U-Hansa, the monitoring activities are divided into accept and transfer. Risk acceptance can be either active or passive. The most common active acceptance strategy is to establish a contingency reserve, including amounts of time, money, or resources to handle the threat if it occurs (PMBOK 6th Ed, 2017).

Risk Register

Risk register at Table 5 provides the documentation process of all information gained form risk management process. The risk register includes all risk detail gained from risk assessment stages to collectively track the highest potential risk scenario in the overall supply chain process.

Table 5 Risk register (in order ID)

ID	Risk Factor Category(es)	Risk Event(s)	Probable Cause(s)	Severity	Probability	Risk Value	Treatment option
R1	Supplier	Supplier financial instability	The cost of processing raw materials rose during the pandemics period	2	2	4	Transfer
R2		Uncertainty in raw material cost	The increasing demand for hand sanitizers during the Covid-19 pandemics resulted to the higher price of raw material	4	4	16	Avoid
R3		Misinformation in raw material procurement	Error in documentation of request info from consumers	3	2	6	Accept
R4		High dependencies on the supplier	Lack of suppliers who have appropriate standard raw materials	2	2	4	Accept
R5		Lack information in demand	Improper bookkeeping process	4	4	16	Avoid
R6		Defect in raw material received	Error in material handling	2	2	4	Accept
R7		Delay in receiving raw materials	Pandemics lockdown restriction	5	5	25	Avoid
R8	Factory	Raw materials inadequacy	Lack of information on production capacity	4	4	16	Avoid
R9		Raw materials are mixed with other materials	Packing from the Supplier Party is less secure	1	2	2	No action needed
R10		Damage to machinery and equipment	No routine maintenance and lack of workers' understanding of the condition of the engine and equipment	3	3	9	Mitigate
R11		Insufficient production capacity	Insufficient machineries for larger-scale production	3	3	9	Mitigate
R12		Production activities stop	Limited raw material and low workforce available	4	3	12	Mitigate
R13		Competitive rivalry in hand sanitizer product	Abundant similar products in the marketplace	4	4	16	Mitigate
R14	Logistic	Defect in distribution process	Packaging process that are not according to the standard	2	2	4	Accept
R15		Lack of facilities and logistics workers	U-Hansa does not use third parties in distribution activities	2	1	2	No action needed

Big Picture of U-Hansa SCRM

The overall supply chain risk management process from the identification stage to the risk evaluation is then translated into a Big Picture Framework. Big Picture displays each supply chain network in the U-Hansa production and describe the data that related to the information and material network. Figure 4 visualizes the big picture framework for U-Hansa supply chain risk management.

As shown in Figure 4, the distribution of risk in the U-Hansa production process can be found in all aspect of supply chain activities, starting from the supply processes up to the distribution activities. Based on the overall framework, the production activities show the highest level of potential risk compared to the supply and distribution process. Factors such as raw material shortage during the Covid-19 lockdown, insufficient production capacity and the limitation of machinery and equipment to support the production contributes to the noticeable risk potential in the overall U-Hansa supply chain network.

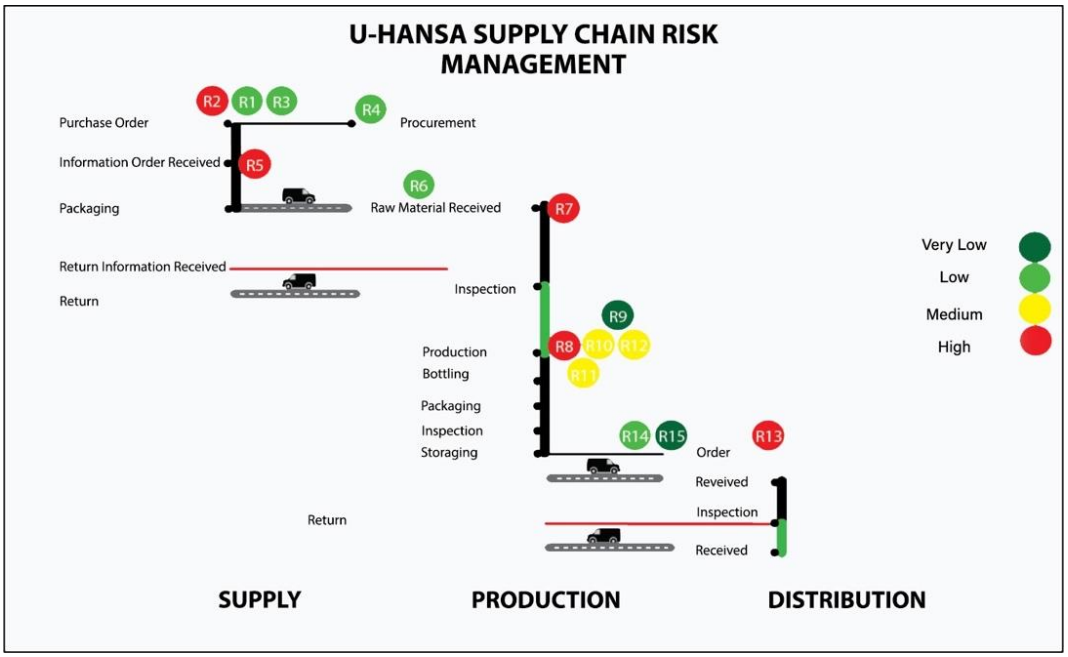

Figure 4 Big picture of U-Hansa SCRM.

4 Conclusion

The Covid-19 pandemics crisis has forced industries all over the world to be more adaptive to resilient changes in the business process. An effective supply chain risk management has now become more importance attributes for a company to survive to the potential consequences of a significant supply chain disruption. Based on the current state of the supply chain risk in the U-Hansa production process at Atsiri Research Centre of the Universitas Syiah Kuala, this study observed 15 potential risk that can possibly disrupt the overall supply chain system of the company. Based on the risk assessment processes, there are 4 risks which are categorized into high risk (catastrophic) and need to be avoided, 4 risks are categorized as medium risk (desirable), 5 risks are categorized as low risk (acceptable), and 2 risks can be escalate since it will not cause any impact on the production process activities of U-Hansa. Risk such as delay in raw material arrival to disruption in production equipment capacity contribute as the highest potential risk for the industry.

This research is expected to develop a useful insight for a related company to develop a strategic plan operating in pandemics situation. Risk management is expected to assist stakeholders to different recognize threats in different or specific supply chain industries. Therefore, we hope that future research can incorporate greater coverage of risk in the identification process, since different industries may have different type of risk that may be classified to the specific industry.

References

Ale, B., & Slater, D. (2012). *Risk Matrix Basics*. *August*, 1–23.

Astuti, P. B., & Mahardhika, A. S. (2020). COVID-19: How Does It Impact To The Indonesian Economy? *Jurnal Inovasi Ekonomi*, *5*(02). https://doi.org/10.22219/jiko.v5i3.11751

Cagliano, A. C., De Marco, A., Grimaldi, S., & Rafele, C. (2012). An Integrated Approach To Supply Chain Risk Analysis. In *Journal of Risk Research* (Vol. 15, Issue 7). https://doi.org/10.1080/13669877.2012.666757

Chen, W., Li, C., Yang, Y., & Du, Z. (2012). Transmission Model of Risk Breakdown Structure in Engineering Project-Chain based on Entropy Risk Element. *Systems Engineering Procedia*, *4*(2011), 268–274. https://doi.org/10.1016/j.sepro.2011.11.075

Duijm, N. J. (2015). Recommendations on The Use and Design of Risk Matrices. *Safety Science*, *76*(December), 21–31. https://doi.org/10.1016/j.ssci.2015.02.014

Gandasari, D., & Dwidienawati, D. (2020). Content Analysis Of Social And Economic Issues In Indonesia During the COVID-19 Pandemics. *Heliyon*, *6*(11), e05599. https://doi.org/10.1016/j.heliyon.2020.e05599

Ganji, S. M., & Hayati, M. (2016). Identifying and Assessing the Risks in the Supply Chain. *Modern Applied Science*, *10*(6), 74. https://doi.org/10.5539/mas.v10n6p74

Hillson, D. (2003). Using a Risk Breakdown Structure in Project Management. *Journal of Facilities Management*, *2*(1), 85–97. https://doi.org/10.1108/14725960410808131

Hines, P., & Taylor, D. (2000). Going lean. *Lean Enterprise Research Centre Cardiff Business School*, 1, 528-534, Cardiff, UK

Hohenstein, N.O. (2022). Supply Chain Risk Management in the COVID-19 Pandemics: Strategies and Empirical Lessons for Improving Global Logistics Service Providers' Performance. *The International Journal of Logistics Management*. https://doi.org/10.1108/IJLM-02-2021-0109

Holzmann, V., & Spiegler, I. (2011). Developing Risk Breakdown Structure for Information Technology Organizations. *International Journal of Project Management*, *29*(5), 537–546. https://doi.org/10.1016/j.ijproman.2010.05.002

Huihui, N., An. C., & Ning., C. (2010). Some Extensions on Risk Matrix Approach. *Safety Science*. 48 (10): 1269–1278. doi:10.1016/j.ssci.2010.04.005.

Jiantong, Z., Zhuoqi, G., & Xiaodong, C. (2016). Evaluation of Automotive Supply Chain Risks: An Empirical Research. *2016 13th International Conference on Service Systems and Service Management, ICSSSM 2016*. https://doi.org/10.1109/ICSSSM.2016.7538472

Landell, H. (2016). *The Risk Matrix as a Tool For Risk Analysis*. 1–3.

Lufika, R.D., Sentia, P.D., Ilyas, Erwan, F., Andriansyah., & Muthmainnah. A. (2022). Risk Mitigation Design in the Production Process of Packaged Fruit Juice Drinks Using a Fuzzy Based House of Risk (HOR) Approach. *Jurnal SIstem Teknik Industri*, 24(2), 245 – 253. DOI 10.32734/jsti.v24i2.8498

Mehdizadeh, R., Franck, T., Denys, B., & Halidou, N. (2012). Methodology and Tools for Risk Evaluation in Construction Projects using Risk Breakdown Structure. *European Journal of Environmental and Civil Engineering*, 16(SUPPL. 1)

Munir, M., Shakeel, M., Jajja, S., Ali, K., & Farooq, S. (2020). Supply Chain Risk Management and Operational Performance : The Enabling Role of Supply Chain Integration. *International Journal of Production Economics*, *227*(March 2019), 107667. https://doi.org/10.1016/j.ijpe.2020.107667

Project Management Body of Knowledge (PMBOK) 6th Edition. (2017). *A Guide to the Project Management Body of Knowledge*. Project Management Institute.

Purnama, M. (2014). Analisis Penerapan Manajemen Risiko Pada Perusahaan Eksportir Yang Menggunakan Metode Pembayaran Letter Of Credit (Studi Pada PT. Inti Luhur Fuja Abadi Pasuruan). *Jurnal Administrasi Bisnis S1 Universitas Brawijaya*, *16*(1), 85003.

Qazi, A., & Akhtar, P. (2020). Risk Matrix Driven Supply Chain Risk Management: Adapting Risk Matrix Based Tools to Modelling Interdependent Risks and Risk Appetite. *Computers and Industrial Engineering*, *139*(August 2018), 105351. https://doi.org/10.1016/j.cie.2018.08.002

Sharma, R., Shishodia, A., Kamble, S., Gunasekaran, A., & Belhadi, A. (2020). Agriculture Supply Chain Risks and COVID-19: Mitigation Strategies and Implications for the Practitioners.

International Journal of Logistics Research and Applications, 1–27. https://doi.org/10.1080/13675567.2020.1830049

Syahputra, R. A., Sentia, P. D., Arifin, R., & Zubir, A. A. (2022). *System Analysis and Design of Fishery Supply Chain Risk in Aceh: A Case Study*. https://doi.org/10.2991/aer.k.220131.038

Tummala, R., & Schoenherr, T. (2011). Assessing and Managing Risks using the Supply Chain Risk Management Process (SCRMP). *Supply Chain Management*, *16*(6), 474–483. https://doi.org/10.1108/13598541111171165

Uzulāns, J. (2015). Project Risk Register Analysis and Practical Conclusions 1. PM World Journal. IV(Vi), 1–9

Zsidisin, G. A., Melnyk, S. A., & Ragatz, G. L. (2005). An Institutional Theory Perspective Of Business Continuity Planning for Purchasing and Supply Management. *International Journal of Production Research*, *43*(16), 3401–3420. https://doi.org/10.1080/00207540500095613