A conceptual mitigation model for asymmetric information of supply chain in seaweed cultivation

Wellem A. Teniwut¹, Kamilius D. Betaubun¹, Marimin², Taufik Djaña²

¹Fisheries Agribusiness Study Program, Tual State Fisheries Polytechnic, Langgur, Indonesia, 97611
²Department of Agroindustrial Technology, Faculty of Agricultural Technology, Bogor Agricultural, Indonesia, 16680

Email: wateniwut@polikant.ac.id

Abstract. Seaweed cultivation has a better advantage over other fisheries activity in terms of easiness on conducting the production and multiplier effect on coastal community welfare. The effect of seaweed farming on the prosperity of coastal community in Southeast Maluku started to take place in 2008, although in 2012 either number of production and workforce is declining rapidly. By solving this problem, this article also provided with identifying and analyzing the supply chain of seaweed cultivation in Southeast Maluku. Based on this analysis we have found that one of the main reasons of declining seaweed production and the number seaweed farmers was asymmetric information that occurred on seaweed supply chain in Southeast Maluku. The component of asymmetric risk was the quality of the seeds, price, information and technology and the knowledge of actual market of seaweed, especially by seaweed farmers. Therefore, it is essential to make a conceptual model on mitigation of asymmetric information on the supply chain of seaweed production. We proposed a conceptual model based on four perspectives, first was goal, criteria and sub-criteria, actor and the solution to mitigate asymmetric information supply chain on seaweed cultivation.

1. Introduction

An efficiency of a supply chain is one of the keys to the success of modern business sector especially in this century, although, the higher efficiency of supply chain also tend to increase the complexity of supply chain risks [1]. To optimize supply chain, every member needs to consider supply chain risks. Studies showed by [13] that each it's necessary to put supplier failure risks into consideration, while [14] stated that distributor needs to act accordingly to face the growing of product cycle. The risks in the supply chain could be the result of a natural disaster [15] bad demand forecasting and price fluctuation [16-17] and inaccurate of supplier quantity [18].

[19] proposed supply and demand-based of supply chain risk, related to potential disruptive on supply chain from downstream to upstream, where normal information flow would play a key factor in this matter. Information disruption in the supply chain is one of the risks may occur in a supply chain, thus integration information concept proposed by experts to address asymmetric information problem in supply chain [2]. Rapid competition, instability in internal of each business, the change in the environment caused by nature or human-made and high volatile politic situation are sources of risk that every business sector needs to deal with recently [3]. The risk of information from original supplier to final user is known as information risk [4]. Therefore, it's necessary to provide a model on mitigation risk on asymmetric information in the supply chain.
The mitigation model on asymmetric information in the supply chain in this study adopted studies by [5-6] with their concept of "pre-disruption" and "post-disruption" or also known as "prevention" and "Responses." This approach also means that mitigation model in supply chain risk on the occurring of asymmetric information refers to every effort to identify risks and manage to prevent from happens and if distortion in information already happens then take a necessary action to make sure this situation handled. [33] stated that to avoid the risk in a supply chain to happen there were three steps to take which first was risks identification, risks assessment and risks mitigation following in that order accordingly.

This concept pointed of view also shared by [7] although, in addition to those three steps, their study expands "to-do list" for risk mitigation in supply chain into few more detail steps include risk estimation and risk control. The actor who also responsible and have the resources to influence the risk and distortion that already happen also take an essential part of mitigation model of asymmetries information supply chain. Studied from [20] showed that sharing information among supply chain members could reduce risk.

Seaweed cultivation in Southeast Maluku Regency, Indonesia, face a significant challenge started from 2012 where selling price of seaweed dropped from IDR 12.000 – IDR 15.000 /Kg to IDR 5.000/Kg. Several main reasons for this to happen was the incidence of ice-ice disease at seaweed farms that caused massive crop failure that also had an influence on the price of seaweed because of the declined on the quality on seaweed. The other reason was the behavior of local distributor related to an effort to influence the price of seaweed by holding the information on the quantity of demand of seaweed to the farmers so they could dictate the selling price [8]. Recently, in addition to those two factors, farmers also face the problem with a supplier of seeds, where farmers have found significant difficulties on the search for high quality on seaweed’s seed, this due to the lack of basic knowledge by farmers. This situation indicated that the problem on seaweed cultivation in Southeast Maluku occurred because of there is an asymmetric information on the supply chain of seaweed in this area, from farmers to distributor and supplier and farmers. Based on the description above, this study aimed to provide a conceptual mitigation model on asymmetric information of seaweed cultivation in Southeast Maluku. Therefore the purpose of this study was first, to identify the risks in asymmetric information on supply chain especially in seaweed cultivation. Second, to determine and analyze the actor and the solution on the possible risk that been identify and third, was to build a conceptual model to mitigate asymmetric information on the supply chain in seaweed cultivation.

2. Methodology
In this study, we used an integrated approach to manage the distortion on asymmetric information in seaweed cultivation by identifying the possible risks that can occur and how to deal with the risks when it happens (Figure 1). This study took a case study of seaweed cultivation in Southeast Maluku, Indonesia.

2.1. Identification of risks in asymmetric information on supply chain
Based on the study by [9] that to identify risks in the supply chain, the commonly used of methodology was experts interview, where in this case, we have interviewed with experienced practitioners of seaweed cultivation from Southeast Maluku. We also interviewed with bureaucrats and academician who have in-depth knowledge of what happened in seaweed cultivation in this area. Also, we also conducted focus group discussion in two of the largest production of seaweed in this area. To enrich the data, we also used survey which also proposed by [5] where we surveyed villages that have seaweed cultivation in last three years to have comprehensive information regarding the problems occurred in seaweed cultivation. We also added all the empirical data with a literature review to compare sources and the risks, also review on similar cases in other countries. The summary of the methodology showed in Figure 1.
2.2. Identification solution on the possible risk in asymmetric information on supply chain

Failing on providing any related and sufficient information among member of the supply chain can increase the possibility of risks [11]. [10] Stated the strategies to mitigate risks where its approaches that every business sector can utilize to manage the possible risk and reduce the effect on supply chain were avoidance; control; cooperation and flexibility. For better formulation on mitigation model on asymmetric information in seaweed cultivation in Southeast Maluku, it is important to identify and analyze the supply chain in this area. Identify the supply chain stream, determine the condition of all members related to this supply chain and analyze the product and production of seaweed. On figure 3, the method for identifying the solution on the risks in the occurrence of asymmetric information in seaweed supply chain, started by identify supply chain of seaweed cultivation and analyze the constraints factor that keeps this supply chain to be optimum.

2.3. Conceptual mitigation model on asymmetric information of seaweed cultivation

In dealing with many factors that have to be considered in better decision making when many factors have to be weighed in against competing priorities then Multi-Criteria Decision-Making (MCDM) can be the solution. Many studies have used MCDM for risk mitigation [21-23]. One of the most extensively used approaches of MCDM is AHP (Analytical Hierarchy Process). AHP has been widely used for risk mitigation in supply chain [24-26, 31]

The AHP approach, developed by Satty. AHP integrates measures into one overall score to have a ranking of decision alternatives result usually provides a simplifying in multiple criterion problems by decomposing it into a multilevel hierarchical structure. [12] Pointed out that AHP is a useful tool for the understanding decision-making process that been provided because it can be view in hierarchical graphical form.

Therefore, to build a conceptual mitigation model on asymmetric information in seaweed cultivation in Southeast Maluku, we used AHP approach, to select the best alternative to mitigate the asymmetric information in the supply chain of seaweed farming. The risk factors and the solutions include key elements to manage the risks along with the actor that have resources to do so are combine to select the best alternative on mitigating asymmetric information on seaweed cultivation supply chain (Figure 2).
3. Results and Discussion

3.1. Risks on seaweed farming supply chain in Southeast Maluku

In supply chain of seaweed cultivation in this area, three main risks have occurred since the declining of seaweed production in 2012. First, the lack of trust between supply chain members is the reason each of them behaviors differently to maximize their profitability [28]. With more trust among members in the supply chain, the responsiveness as the result supply chain will function dynamically [29]. On the relationship between supplier and farmers, both parties want to seize the opportunity to gain the most each other. Farmers want a high-quality seed with a lower price or with a lower price they can have more quantity of the seeds. In the other hand suppliers also want farmers to pay more for seeds and with the lack of information that farmers do not have on the supply and availability of high quality of seeds. While at the same time the relations between farmers and distributors also have a lack of trust among them, farmers want their product to be pay in a competitive price and with a hope that distributor willing to buy their product immediately without any waiting time. Whereas, distributor used the lack of knowledge of farmers on demand and price that available in the market outside the area by offering noncompetitive price.

Second, on the risk of seaweed, cultivation supply chain was fluctuation on the selling price in this area [8]. Due to the geographical condition of Southeast Maluku that considered as an archipelagic region, the distance between this area and areas in Maluku Province is significant; besides, there is no end user of seaweed product in this area. In this condition, the distributor has more power on influencing the selling price of seaweed product than farmers, because they are the only buyers available in the area. Distributor in some cases forced to buy seaweed from farmers in early period before the selling price and demand of seaweed increased there are using information that they have to control the price. Farmers also take part of fluctuation on selling price. They sell their unqualified seaweed, to get fast money, they conducted an early harvest, which is not accordingly the suitable with time for the crop. Therefore, the quality of seaweed is low, and that implied on the selling price of seaweed.

The third risk on seaweed supply chain was decreasing on the profitability of seaweed. Lack of basic and applied knowledge on seaweed cultivation by farmers makes their profits are not sustainable. Aside from the knowledge the lack of ability on their part to obtain information regarding demand and selling price in seaweed, which it will cause declining on the profit [30]. Southeast Maluku has the marine resources and due to the characteristic of this area provide a perfect area for seaweed cultivation, though a significant number of farmers in this region who conducted seaweed cultivation have small access in information technology available related on seaweed farming.

In the other hand, the supplier in this region also faced the same problem on decreasing on their profitability, because the number of seaweed farmers is also decreasing since 2012, the demand for seeds also declining. For the distributor, they found some difficulties on supply seaweed to market outside the area, because the production of seaweed in this area keep dropping. Distributors also take a necessary action to dealing with this problem by providing tools and seeds to farmers with an incentive to pay seaweed in certain price, but in these circumstances, for other farmers will gain the loss because it narrowed their market since distributor provide their supply. Therefore, it’s necessary to exchange sufficient information among members of the supply chain to increase profitability and manage the uncertainty to have successful supply chain [32].
3.2. A conceptual mitigation model on seaweed cultivation supply chain based on AHP approach

Figure 2. Hierarchy of AHP Model on mitigation asymmetries information on seaweed cultivation supply chain
4. Conclusion

Three risks occurred in the supply chain of seaweed cultivation. Trust among supply chain members, fluctuation on selling price of seaweed, declining on the profit. Key factors that can mitigate the risks to happen are information sharing, reputation, behavior for trust among supply chain members; demand, supply, government policy for fluctuation on selling price and knowledge on science and technology, quality, quantity for declining in profit. Actors that can help to mitigate the asymmetric information that occurred in the seaweed supply chain are local government, farmer distributors, higher education, and research institution. Based on all aspects considered, we proposed alternatives of mitigating asymmetric information in seaweed cultivation supply chain Southeast Maluku. First, create the community of seaweed farmers in the area. Second, create the information center related to seaweed farming. Third, use of information technology to access information and communicate with farmers and distributor outside the area and forth, create a cluster based on the productivity of villages in the area to easier the coordination among farmers, supplier, and distributors.

References

[1] Behdani, Behzad and Adhitya, Arief and Lukszo, Zofia and Srinivasan, Rajagopalan, 2012 How to Handle Disruptions in Supply Chains – An Integrated Framework and a Review of Literature Available at SSRN: https://ssrn.com/abstract=2114201 or http://dx.doi.org/10.2139/ssrn.2114201
[2] Kulp, S. C., Lee, H. L., and Ofek, E 2004 Manufacturer benefits from information integration with retail customers. Management science, 50(4), 431-444.
[3] Nyoman Pujawan, I., and Geraldin, L. H 2009 House of risk: a model for proactive supply chain risk management. Business Process Management Journal, 15(6), 953-967.
[4] Juttner, U., Peck, H. and Christopher, M 2003 Supply chain risk management: outlining an agenda for future research, International Journal of Logistics: Research and Application, Vol. 6 No. 4, pp. 197-210.
[5] Thun, J. and Hoenig, D 2009 An Empirical Analysis of Supply Chain Risk Management in the German Automotive Industry, International Journal of Production Economics 131(1): 242-249.
[6] Dinis, N. M. M. T 2010 Impact of Demographics on Supply Chain Risk Management Attitudes: Prevention Vs Response (Doctoral dissertation, Massachusetts Institute of Technology, Engineering Systems Division).
[7] Adhitya, A., Srinivasan, R. and Karimi, I.A 2009 Supply chain risk identification using a HAZOP-based approach, AIChE Journal 55(6): 1447-1463.
[8] Teniwit W. A dan Kabalma. J 2014. Studi Empiris: Evaluasi Usaha Budidaya Rumput Laut Di Kabupaten Maluku Tenggara. Prosiding Seminar ilmiah Tahunan ke-2. Langgur, Indonesia. 16 Desember 2014 [in Indonesian].
[9] Yang, Y.C 2010 Impact of the container security initiative on Taiwan's shipping industry, Maritime Policy and Management 37(7): 699-722.
[10] Miller, K. D 1992 A framework for integrated risk management in international business. Journal of international business studies, 23(2), 311-331.
[11] Van der Vorst, J. G., and Beulens, A. J 2002 Identifying sources of uncertainty to generate supply chain redesign strategies. International Journal of Physical Distribution & Logistics Management, 32(6), 409-430.
[12] Marimin. 2004 Teknik dan Aplikasi Pengambilan Keputusan Kriteria Majemuk. Gramedia Widiasarana Indonesia. Jakarta [In Indonesian].
[13] Lee, T.Y.S 2008 Supply Chain Risk Management, *Int. J. Information and Decision Sciences* 1: 98–114.

[14] Mills, J. F., and Camek, V 2004 The risks, threats and opportunities of disintermediation: A distributor's view. *International Journal of Physical Distribution & Logistics Management*, 34(9), 714-727.

[15] Martha, Joseph and Sunil Subbakrishna 2002 Targeting a Just-in-Case Supply Chain for the Inevitable Next Disaster, *Supply Chain Management Review*, Vol. 6, No. 5, pp. 18-23.

[16] Christopher, M. and Lee, H 2004 Mitigating supply chain risk through improved confidence, *International Journal of Physical Distribution & Logistics Management*, Vol. 34 No. 5, pp. 388-96.

[17] Juan Yang, Haorui Liu, Xuedou Yu, and Fenghua Xiao 2016 Emergency Coordination Model of Fresh Agricultural Products’ Three-Level Supply Chain with Asymmetric Information. *Mathematical Problems in Engineering*, vol. 2016, Article ID 2780807, 9 pages, 2016.

[18] Zsidisin, G.A 2003 Managerial perceptions of supply risk *Journal of Supply Chain Management*, Vol. 39 No. 1, pp. 14-25.

[19] Jüttner, U 2005 Supply chain risk management: Understanding the business requirements from a practitioner perspective. *The International Journal of Logistics Management*, 16(1), 120-141.

[20] Frazier, G. L., Maltz, E., Antia, K. D., and Rindfleisch, A 2009 Distributor sharing of strategic information with suppliers. *Journal of Marketing*, 73(4), 31-43.

[21] Enyinda, C. I., Mbah, C. H., & Ogbuehi, A. 2010 An empirical analysis of risk mitigation in the pharmaceutical industry supply chain: A developing-country perspective. Thunderbird International Business Review, 52(1), 45-54.

[22] Levy, J. K 2005 Multiple criteria decision making and decision support systems for flood risk management. Stochastic *Environmental Research and Risk Assessment*, 19(6), 438-447.

[23] KarimiAzari, A., Mousavi, N., Mousavi, S. F., and Hosseini, S 2011 Risk assessment model selection in construction industry. *Expert Systems with Applications*, 38(8), 9105-9111.

[24] Aminbakhsh, S., Gunduz, M., and Sonmez, R 2013 Safety risk assessment using analytic hierarchy process (AHP) during planning and budgeting of construction projects. *Journal of safety research*, 46, 99-105.

[25] Gaudenzi, B., and Borghesi, A. 2006 Managing risks in the supply chain using the AHP method. *The International Journal of Logistics Management*, 17(1), 114-136.

[26] Zayed, T., Amer, M., and Pan, J 2008 Assessing risk and uncertainty inherent in Chinese highway projects using AHP. *International journal of project management*, 26(4), 408-419.

[27] Chan, F. T., and Kumar, N 2007 Global supplier development considering risk factors using fuzzy extended AHP-based approach. *Omega*, 35(4), 417-431.

[28] Kwon, I. W. G., and Suh, T 2004 Factors affecting the level of trust and commitment in supply chain relationships. *Journal of supply chain management*, 40(1), 4-14.

[29] Handfield, R. B., and Bechtel, C 2002 The role of trust and relationship structure in improving supply chain responsiveness. Industrial marketing management, 31(4), 367-382.
[30] Hallikas, J., Virolainen, V.M. and Tuominen, M 2002 Risk analysis and assessment in network environments: a dyadic case study, *International Journal of Production Economics*, Vol. 78, pp. 45-55.

[31] Septiani, W., Marimin, M., Herdiyeni, Y., and Haditjaroko, L 2016 Method and approach Mapping for Agri-food Supply Chain Risk Management: A literature review. *International Journal of Supply Chain Management*, 5(2), 51-64.

[32] La Londe, B 2002 Who Can You Trust These Days? *Supply Chain Management Review*, May-June 2002, pp. 9-10.

[33] Oehmen, J., Ziegenbein, A., Alard, R. and Schönsleben, P 2009 System-oriented supply chain risk management. *Production Planning and Control*, 20(4), pp.343-361.