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Seaweed Value Chain Sustainability Assessment in the Kupang Regency, East Nusa Tenggara, Indonesia

A thesis presented in partial fulfilment of the requirements for the degree of
Master of Agribusiness

School of Agriculture and Environment
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Abstract

Value chain study has been crucial in developing the agricultural sector in developing countries, including Indonesia. The study of the value chain in the agricultural sector can present a better understanding of value addition improvements within each stage of the value chain. Indonesia is known as the biggest archipelago country in the world; however, the Indonesian fisheries sector's GDP contribution is relatively low compared to the land agriculture sector, which indicates that it has not reached its full potential in contributing to the country's economy. In the Indonesian fisheries sector, seaweed is considered to be the main commodity of the sector, with an average production of around 10 times greater than other fisheries commodities. This indicates the importance and influence of seaweed commodity to the Indonesian fisheries sector, hence the improvement in the seaweed sector is expected to bring significant implications to the Indonesian fisheries sector moving forward.

However, any development goals must consider sustainability to ensure that the sector's growth does not compromise environmental conditions, social equity, or long-term economic viability. In the seaweed industry, sustainability is essential to maintaining the sector's long-term success and safeguarding the livelihoods of coastal communities. Furthermore, value chain studies in Indonesia are still limited, especially those focusing on the seaweed sector and sustainability assessment. The gap is notable in the Indonesian fisheries sector, where seaweed stands as the most influential commodity based on production volume. Several provinces in Indonesia are known as centers of seaweed production, including East Nusa Tenggara Province, with Kupang Regency being its main contributing area.

The main aim of this study is to comprehensively analyse the seaweed value chain in the Kupang Regency and to assess the sustainability of the seaweed value chain. The findings of this study are invaluable to value chain players, policymakers, and other researchers in the development of the Indonesian seaweed industry in terms of optimizing governance and management of the value chains, ensuring their sustainability, and enhancing their socio-economic contribution.

This study was conducted in the Kupang Regency, East Nusa Tenggara Province. A qualitative approach was used in this study. Primary data was collected using semi-structured interviews

with key players of the seaweed value chain in the region, while secondary data was obtained from the local government database. The findings of this study identified that the seaweed value chain in the Kupang Regency is divided into two types of value chains: unprocessed and processed seaweed, which are performed by smallholder farmers, local intermediaries, inter-island traders, small-scale processors, and carrageenan processor as the value chain players. In terms of sustainability, the study indicated that the seaweed value chain is more prone to negative impact caused by external factors (climate and pollution-related) outside of the seaweed value chain compared to its internal factors, where both factors have historically imposed a critical threat to the sustainability aspect of the seaweed value chain in the Kupang Regency.

Key words: value chain, seaweed, sustainability, Kupang Regency, Indonesia, governance

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List of Abbreviations

ATC	Alkali-Treated Chips
ATCC	Alkali-Treated <i>Cottonii</i> Chips
BLG	<i>Biota Laut Ganggang</i>
BPOM	<i>Badan Pengawas Obat dan Makanan</i> (Indonesian Food and Drug Authority)
CO ₂	Carbon Dioxide
COA	Certificate of Analysis
COGM	Cost of Goods Manufactured
COO	Chief Operating Officer
CSR	Corporate Social Responsibility
GDP	Gross Domestic Product
FAO	Food and Agriculture Organizations
HACCP	Hazard Analysis and Critical Control Points
KOH	Potassium Hydroxide
MD	<i>Makanan Produksi Dalam Negeri</i> (Domestically Produced Food)
MUHEC	Massey University Human Ethics Committee
NGO	Non-Governmental Organization
P2MKP	<i>Pusat Pelatihan Mandiri Kelautan dan Perikanan</i> (Marine and Fisheries Autonomous Training Center)
PLN	<i>Perusahaan Listrik Negara</i> (Indonesian State Electricity Company)
PO	Producer Organisations
PO	Purchase Order
QDA	Qualitative Data Analysis
R&D	Research and Development
RC	Refined Carrageenan
RKN	Rote Karaginan Nusantara
SRC	Semi-Refined Carrageenan
UPI	<i>Unit Pengelohan Perikanan</i> (Fisheries Processing Unit)
USD	United States Dollar
WIP	Work In Progress

Chapter 1: Introduction

1.1 Background

The study of value chains has been pivotal in the development of the agricultural sector in developing countries. The value chain encompasses a series of interconnected activities that contribute to the overall value of products from raw material production to the final delivery of goods or services to customers. Those interconnected activities are governed by multiple actors in different value chain stages with complex relationships and coordination. Therefore, value chain actors have to coordinate accordingly to optimize the value generated within each stage of the value chain and also the overall value generated. In developing countries, the governance of agricultural value chains is mostly identified to be complex, multifaceted, and faced with various challenges. The value chain framework provides a comprehensive approach to analyse each stage and activity within the value chain. As developing countries strive to enhance their economic growth and improve living standards, optimization of value chains is critical for economic development, especially in the agricultural sector which is considered as the backbone sector of most developing countries. Each stage of the value chain presents opportunities for value-addition improvements, which are crucial for sector growth and development in developing countries.

1.2 Problem statement

The above initiative to enhance the study of value chains in developing countries occurred across different agricultural commodities. Indonesia, a country which is known as the biggest archipelago country in the world, consists of 80% of sea territory (Ministry of Foreign Affairs of Indonesia, 2016) and is known for having rich marine biodiversity and favorable oceanographic conditions. However, the fisheries sector only contributed 21% to the total GDP of the agricultural, forestry, and fisheries sectors in 2021 (Ministry of Agriculture of Indonesia, 2022). This indicates that despite Indonesia's vast marine resources, the fisheries sector has not reached its full potential in contributing to the country's economy. In the Indonesian fisheries sector, seaweed is the main commodity with a total average production of approximately 10 million tons per year during 2017-2019, which is around 10 times greater than other fisheries commodities, such as fish or shrimps (Statistics Indonesia, 2020). This data indicates that seaweed has become the most important and influential commodity in the Indonesian fisheries sector; hence the improvement in the Indonesian seaweed sector is expected to bring significant

socio-economic implications on the Indonesian fisheries sector, especially for coastal communities moving forward.

Despite their importance to the agricultural and fisheries sector development, value chain studies in developing countries are still limited. The gap is particularly notable in the Indonesian fisheries sector, where seaweed stands as the main commodity. Studies on the seaweed value chain in Indonesia are scarce, especially those focusing on sustainability factors. Previous research studies have primarily concentrated mostly on the seaweed sector's contribution to community livelihoods (Rimmer et al., 2021, Zamroni, 2021).

Any development goals have to consider sustainability to ensure the growth of the sector does not come at the expense of environmental conditions, social equity, or economic viability in the long term. In the context of the seaweed sector, sustainability is crucial for ensuring the long-term viability of the sector and the well-being of coastal communities. A plethora of studies have outlined the sustainability problem happening in the Indonesian agriculture and aquaculture sector (Henriksson et al., 2022, Kurnia et al., 2022, Syuaib, 2016). However, limited studies are found that directly assess the sustainability aspect of the Indonesian seaweed sector.

1.3 Research aim and objectives

This thesis aims to analyse the seaweed value chain in the Kupang Regency and assess the sustainability factors of the value chain. The primary objectives of this research are as follows:

- To map the seaweed value chain in the Kupang Regency.
- To analyse governance in the seaweed value chain.
- To identify factors affecting the sustainability of the seaweed value chain.

1.4 The implications of the study

As the main commodity in the Indonesian fisheries sector, seaweed farming has become the main source of income for more than 267,000 rural households across Indonesia (Rimmer et al., 2021). Acknowledging the role of the value chain and sustainability studies as one of the foundations to study and practice sustainable development, this research aims to fill the literature gap by being one of the first studies that directly assess the sustainability aspects of the seaweed value chain in Indonesia. This study will analyse the sustainability factors of the seaweed value chain that might be overlooked by stakeholders. Balancing all pillars of

sustainability is critical for achieving sustainable development, which requires more effort by all stakeholders involved.

The findings and recommendations from this study will be invaluable to value chain players, policymakers, and other researchers who are aiming to develop the seaweed industry by implementing strategies that optimise value chains, ensuring their sustainability, and enhancing their existing and future contribution to the regional economy. The overall improvement of the sector is expected to bring significant socio-economic implications for the Indonesian fisheries sector.

1.5 Thesis outline

This thesis is divided into seven chapters. The first chapter is the introduction chapter, which includes background information, problem statement, research objectives, and the implications of the study. Chapter two provides an overview of Indonesia as the study country, specifically regarding the country's economy, fisheries, and seaweed sector. In addition, this chapter also provides an overview of East Nusa Tenggara province as the study region, also regarding seaweed market conditions and trade policies within the region. Chapter three provides reviews regarding relevant theories and concepts from previous literature. Based on the literature review, the conceptual framework of this study is developed. Chapter four provides the methods used in the research. Chapter five presents the results of the collected data. Chapter six includes a discussion of the findings and compares those with previous literature. The final chapter summarises and concludes the thesis with recommendations and further research suggestions.

Chapter 2: Country Background

Introduction

This chapter provides background information regarding Indonesia as the study country and sets up the context of the study. This chapter consists of nine sections. Section one provides an overview of Indonesia as a country. Section two discusses the Indonesian economy based on several economic indicators. Section three presents a brief explanation of the Indonesian agriculture, forestry, and fisheries sectors. Section four briefly discusses the Indonesian fisheries sector. Section five draws more attention to the Indonesian seaweed sector as a whole. Section six provides data regarding seaweed-producing regions in Indonesia. Section seven gives an overview of East Nusa Tenggara region. Section eight discusses the seaweed trade policy in the East Nusa Tenggara region. Section nine summarizes all the key points of this chapter.

2.1 Overview of Indonesia

Indonesia, a country that is considered to be the largest archipelagic country in the world, consists of five main islands, and 30 smaller archipelagoes, with a total of more than 18,110 islands (Ministry of Foreign Affairs of Indonesia, 2016). Geographically, Indonesia is located in Southeast Asia and stretches from 6°8' north latitude to 11°15' south latitude and from 94°45' to 141°65' east longitude (Ministry of Foreign Affairs of Indonesia, 2016). Indonesia has a total area of 9.8 million km², which consists of 7.9 million km² of sea territory and 1.9 million km² of land territory (Ministry of Foreign Affairs of Indonesia, 2016).

The name Indonesia is composed of two Greek words, Indos meaning Indian, and Nesos meaning islands (Ministry of Foreign Affairs of Indonesia, 2016). Indonesia's archipelago is nestled between two oceans (the Indian and Pacific Oceans) and two continents (Asia and Australia) as shown in Figure 2.1 (Central Intelligence Agency, n.d.). Due to its large number of islands, Indonesia is blessed with enormous diversities of cultures, languages, ethnicities, natural resources, and also a great range of biodiversity (Purwanto et al, 2020). The nation is a captivating blend of tradition and modernity, offering a model to the world where ancient traditions thrive alongside modern influences.



Figure 2.1. World map of Indonesia (Central Intelligence Agency, n.d.).

Indonesia has the fourth largest population in the world. As of 2023, the total population was approximately 278 million (Statistics Indonesia, 2023), which comprises approximately 300 ethnic groups across the archipelago (Ministry of Communication and Information Technology of Indonesia, 2017). This diversity extends to 718 languages spoken within the nation; however, Indonesia has Bahasa Indonesia as the official language that unites the multifaceted nation, fostering communication and national identity (Ministry of Education and Culture of Indonesia, n.d). As for religion, the country acknowledges five different religions, which consist of Islam (87.2%), Protestant Christianity (6.9%), Roman Catholic (2.9%), Buddhism (1.7%), Hinduism (0.7%), and Confucianism (0.05%) (Ministry of Foreign Affairs of Indonesia, 2019). Acknowledging the pluralism across the nation, Indonesia has its national motto *Bhinneka Tunggal Ika* which means “Unity in Diversity” (Ministry of Foreign Affairs of Indonesia, 2019).

2.2 Indonesian economy

Indonesia is one of the emerging markets in the world and is also considered the largest economy in Southeast Asia. As of 2022, the GDP of Indonesia was 1.31 trillion USD and the GDP per capita of Indonesia was 4,798 USD (International Monetary Fund, 2023). Both indicators are experiencing an upward trend over the past two decades (International Monetary Fund, 2023). In 2022, the GDP of Indonesia increased by 5.31% growth compared to the previous year (Statistics Indonesia, 2023). The sector that contributed the most to the GDP was the manufacturing industry, which contributed 18.34% of 2022 total GDP, followed by

automotive (12.85%), agriculture, forestry, and fisheries (12.4%), mining (12.22%), and construction (9.77%) as shown in Figure 2.2 (Statistics Indonesia, 2023).

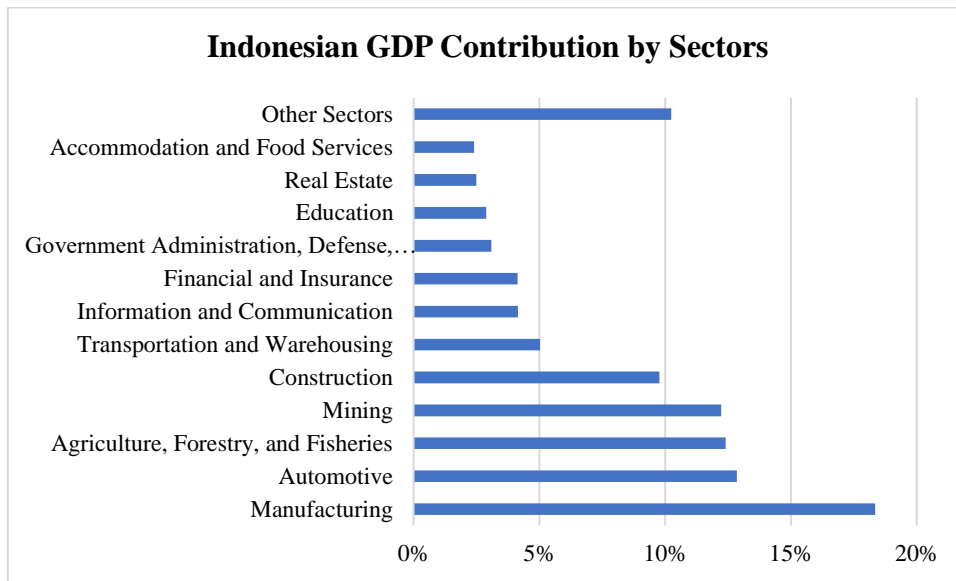


Figure 2.2 Indonesian GDP contribution based on sectors (Statistics Indonesia, 2023).

Despite being only third in the country’s GDP contribution in 2022, data shows that the agriculture, forestry, and fisheries sectors provided the most employment of Indonesian workers, which was 28.61% of the total population of Indonesian workers as shown in Figure 2.3 (Statistics Indonesia, 2022). This figure shows that the agriculture, forestry, and fisheries sectors are considered three of the most fundamental sectors of the Indonesian economy and its people in general.

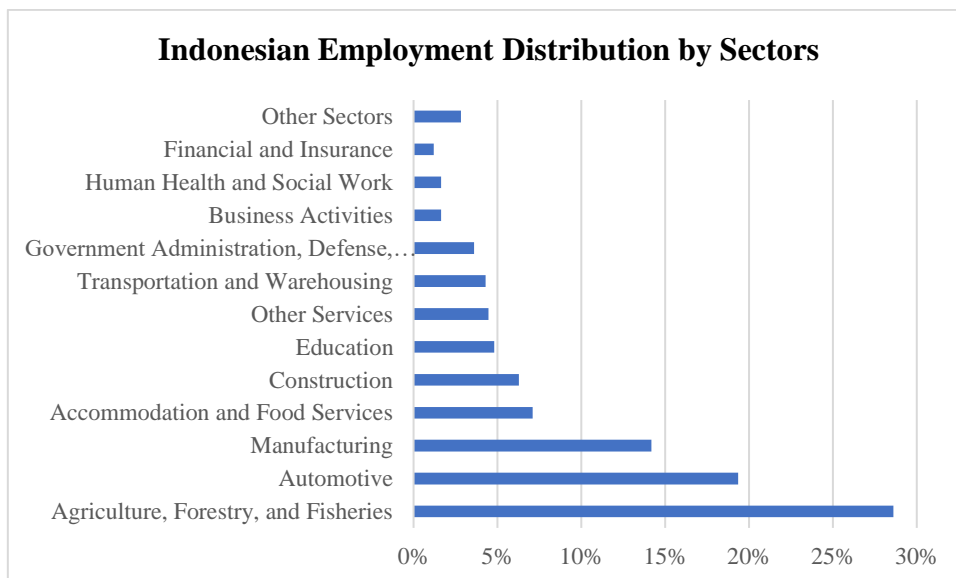


Figure 2.3. Indonesian employment distribution based on sectors (Statistics Indonesia, 2022).

2.3 Indonesian agriculture, forestry, and fisheries sectors

In Indonesia, agriculture, forestry, and fisheries sectors are supervised under three different ministries, which are the Ministry of Agriculture, the Ministry of Environment and Forestry, and the Ministry of Marine Affairs and Fisheries respectively (Ministry of Environment and Forestry of Indonesia, 2019). In 2021, the agriculture sector contributed 146.75 billion US, whereas the forestry sector contributed 7.29 billion USD, and the fisheries sector contributed 30.58 billion USD (Ministry of Agriculture of Indonesia, 2022). From 2018-2021, the trend of GDP contribution from those three sectors has not changed much as shown in Figure 2.4 (Ministry of Agriculture of Indonesia, 2022).

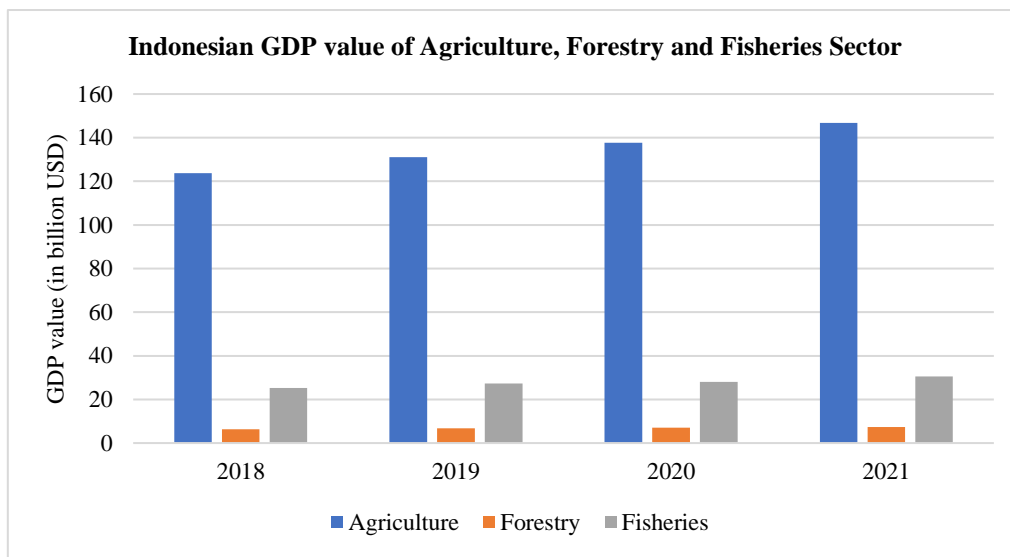


Figure 2.4. Indonesian GDP of agriculture, forestry, and fisheries sector from 2018-2021 (Ministry of Agriculture of Indonesia, 2022).

2.4 Indonesian fisheries sector

Indonesia is considered a maritime nation considering it has the second longest coastline in the world after Canada with a total of 81,290 km length (Mudiastuti et al, 2014, Sulistiyono, 2016). In addition, as the largest archipelago country in the world, Indonesia has a vast ocean with a total area of 5.8 million km² (Mudiastuti et al., 2014). Due to this factor, Indonesia has a high potential for fisheries products. Fisheries products consist of numerous products which originated from ocean and coastal areas; such as fish, squid, shrimp, clam, seaweed, and many more (Mudiastuti et al, 2014). Nevertheless, despite having a vast area of ocean, the fisheries sector only contributed 20.86% of the total GDP contribution of the combined agriculture, forestry, and fisheries sectors or equivalent to 2.77% of the total GDP of Indonesia in 2021 (Ministry of Agriculture of Indonesia, 2022). Numerous studies have highlighted that the

Indonesian fisheries sector has not reached its peak potential yet (Sriwulandari et al, 2020, Teniwut, 2016, Wijayanto, 2016). Therefore, there are plenty of opportunities for improvement in this sector moving forward.

During 2017-2019, seaweed became the largest commodity in the Indonesian fisheries sector compared to other fisheries commodities as shown in Figure 2.5 (Statistics Indonesia, 2020). This data indicates that seaweed has become the most important and influential commodity in the Indonesian fisheries sector, hence the improvement in the Indonesian seaweed sector is expected to bring major benefits on the Indonesian fisheries sector moving forward.

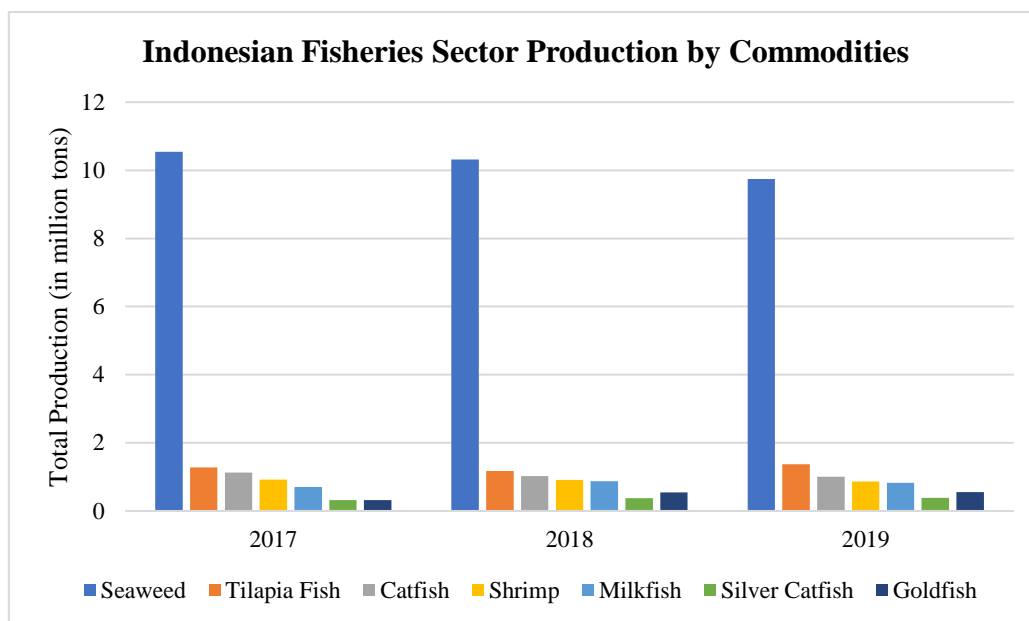


Figure 2.5. Indonesian fisheries sector production from 2017-2019 (Statistics Indonesia, 2020).

2.5 Indonesian seaweed sector

Seaweed is considered one of the emerging commodities in the world due to its diverse uses and applications in various industries (Polat et al., 2023). Global seaweed production has consistently increased since 1950, from 0.56 million tons to 35.82 million tons in 2019 (Figure 2.6). The highest growth of the global seaweed production occurred in the most recent decade, which increased approximately 168% and was dominated by cultivation compared to wild collection (Food and Agricultural Organization, 2021).

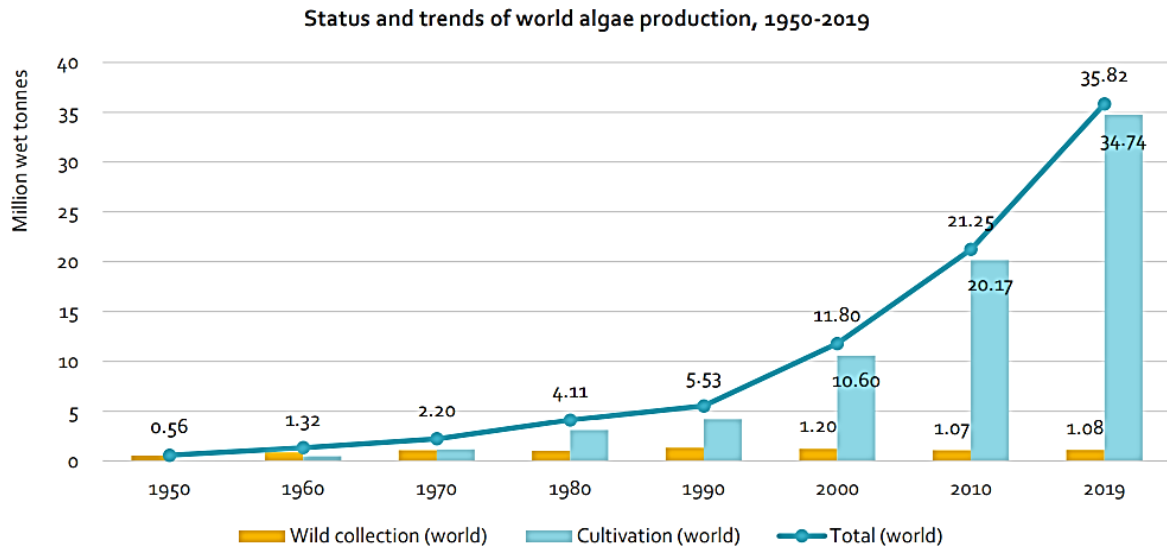


Figure 2.6. Global seaweed production trend from 1950-2019 (Food and Agricultural Organization, 2021).

Seaweeds are generally classified into three different groups based on their colors, which are brown seaweeds (*Phaeophyceae*), red seaweeds (*Rhodophyceae*), and green seaweeds (*Chlorophyceae*) as shown in Figure 2.7 (Cotas et al, 2020, Bhuyar et al, 2021). Brown seaweeds are used for pharmaceuticals, human functional foods, and animal feeds (García-Vaquero & Hayes, 2016). Meanwhile, red seaweeds are commonly used to produce carrageenan (*Eucheuma* species) and agar (*Gracilaria* species) (Rimmer et al, 2021). On the other hand, green seaweeds are commonly used for biomedicine, cosmetics, pharmaceuticals, and food additives (Lomartire et al, 2021).



Figure 2.7. Brown seaweed (a), red seaweed (b), green seaweed (c) (Bhuyar et al, 2021).

Global seaweed cultivation has increased since 1950 from 34 thousand tons to 34.7 million tons in 2019 (Figure 2.8). The growth was dominated by red seaweeds (from 21 thousand tons to 18.25 million tons) and brown seaweeds (from 13 thousand tons to 16.39 million tons),

whereas green seaweeds cultivation fluctuated in every decade (Food and Agricultural Organization, 2021).

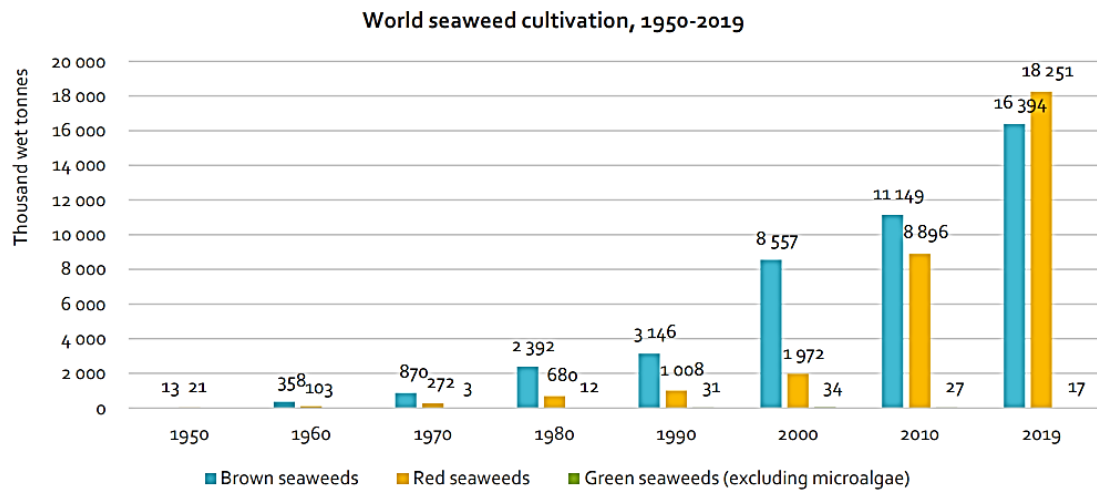


Figure 2.8. Global seaweed cultivation volume based on seaweed classification (Food and Agricultural Organization, 2021).

Indonesia is the second largest seaweed-producing country in the world behind China (Food and Agricultural Organization, 2021). In 2019, Indonesia contributed approximately 28% proportion of the global seaweed market (Figure 2.9) with a total production of 9.96 million tons (Food and Agricultural Organization, 2021). Indonesia has a strategic geographical location that provides ideal conditions for seaweed farming. In addition, the country also has a vast coastline which serves as a natural habitat for seaweed. Of 9.96 million tons of seaweed produced in Indonesia, 98.8% are *Eucheuma* species and 1.2% are *Gracilaria* species (Food and Agricultural Organization, 2021). This indicates that Indonesia’s seaweed sector has a high potential for carrageenan and agar production.

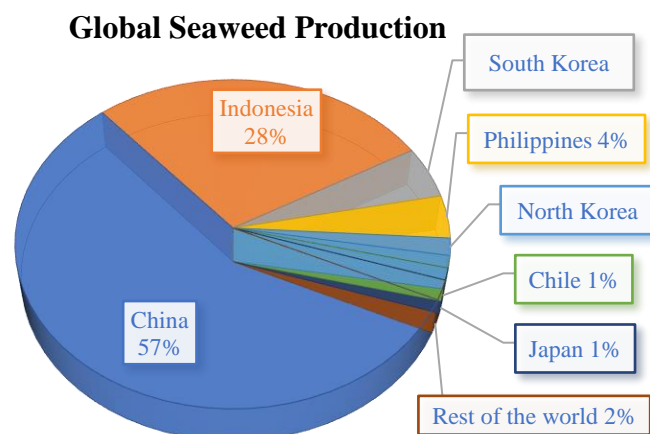


Figure 2.9. Global seaweed production in 2019 (Food and Agricultural Organization, 2021).

In general, seaweeds are considered quite easy to cultivate, it requires approximately only 45 days to harvest the seaweeds after the start of the cultivation (Santika & Ma'ruf, 2014). Most seaweeds are cultivated in the shallow coastal areas at intertidal zones as shown in Figure 2.10. Furthermore, numerous studies in Indonesia have shown that seaweed cultivation in several regions all have a positive value of R/C (revenue/cost) ratio, which means seaweed cultivation is considered a good opportunity for business (Fatony et al, 2023, Nuryanto et al, 2016, Fatmala et al, 2023).



Figure 2.10. Seaweed cultivation in coastal areas in Indonesia (Kasanah et al, 2022).

Indonesia also plays an important role in the global seaweed market. Key export destinations for Indonesian seaweed exports are China, South Korea, Vietnam, and France as shown in Figure 2.11 (Statistics Indonesia, 2023). In 2022, Indonesia exported a total of 232,081 tons of seaweed equivalent to 398 million USD (Statistics Indonesia, 2023).

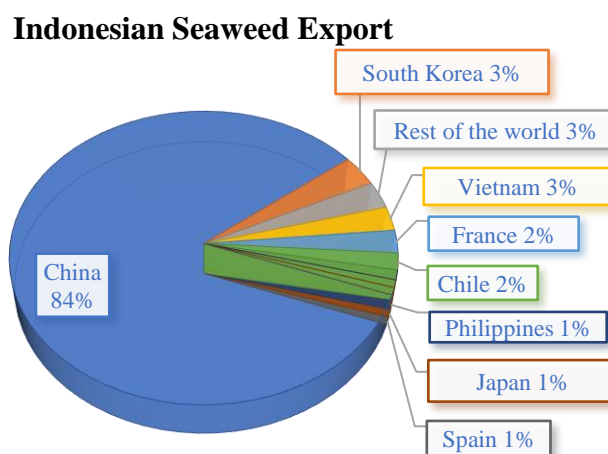


Figure 2.11. Indonesian seaweed export country destinations in 2022 (Statistics Indonesia, 2023).

Other than raw seaweed, Indonesia has also established itself as a major producer of seaweed value-added products such as carrageenan and agar. These value-added products are useful in the food, pharmaceutical, and cosmetics industries, which further improve the potential value of seaweed production and processing. Based on these facts, the Indonesian seaweed sector plays an important role in the nation's economy. It offers employment opportunities and is the main source of income for numerous coastal communities and contributes to rural livelihoods. Furthermore, this sector is dominated by smallholder farmers across regions in Indonesia (Rimmer et al, 2021), which then highlights the importance of the development of this sector to the Indonesian economy moving forward.

In the past decade, the Indonesian government (through the Ministry of Marine Affairs and Fisheries) has proven to fully support the Indonesian seaweed sector by issuing several policies and governmental support to help Indonesian seaweed farmers to develop their businesses. These policies were 1) providing high-quality seeds and developing the local seed banks in designated areas, 2) providing cultivation tools for production and harvesting, 3) developing areas of cultivation, 4) enhancing the fisheries integration system between islands, and 5) promoting and investing in potential lands (Radiarta et al, 2016). Furthermore, recently, the Indonesian government has shifted its focus to the development of the value-adding processing industries for the Indonesian seaweed sector to help get more value out of the Indonesian seaweed products (Ministry of State Secretariat of Indonesia, 2023).

2.6 Seaweed producing regions in Indonesia

In Indonesia, several regions/provinces are known as the major producers of seaweeds, those are South Sulawesi, East Nusa Tenggara, Central Sulawesi, West Nusa Tenggara, Maluku, and East Java. In 2019, South Sulawesi produced a total of 3.4 million tons of seaweed or equivalent to 34.94% of Indonesia total seaweed production, followed by East Nusa Tenggara with 1.6 million tons (16.42%), Central Sulawesi with 0.93 million tons (9.57%), and West Nusa Tenggara with 0.89 million tons (9.2%) as shown in Figure 2.12 (Statistics Indonesia, 2020).

Seaweed Production Based on Regions in Indonesia

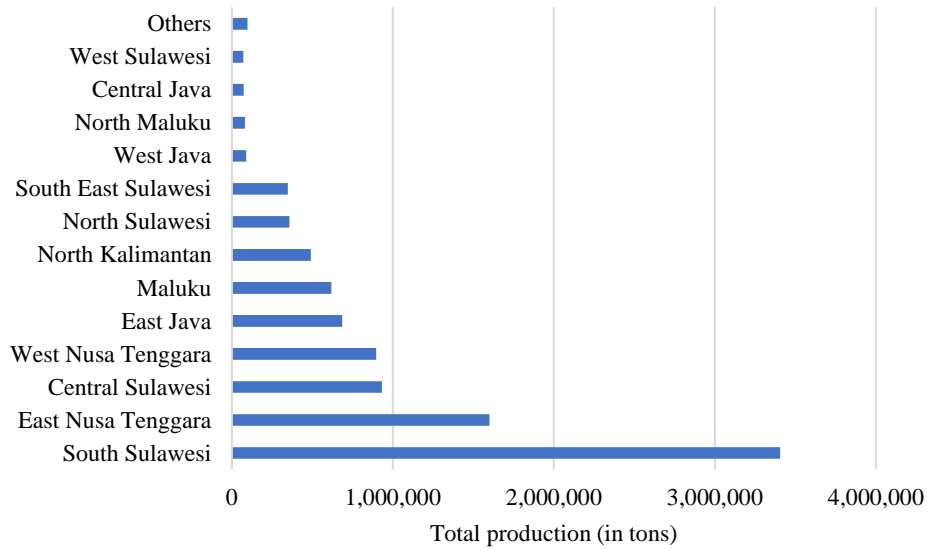


Figure 2.12. Seaweed total production based on regions in Indonesia in 2019 (Statistics Indonesia, 2020).

2.7 Overview of East Nusa Tenggara

East Nusa Tenggara is one of the 38 provinces in Indonesia which is considered the southernmost province in Indonesia. This province consists of a total of 1,192 islands but only 43 are currently inhabited (Ngongo et al, 2021). East Nusa Tenggara has seven main islands which are Timor, Flores, Sumba, Rote, Alor, Lembata, and Sawu (Ngongo et al, 2021). These islands are connected and bordered by the Flores Sea, Sawu Sea, Sumba Sea, Flores Sea, and Indian Ocean (Erb, 2015). The geographic map of East Nusa Tenggara is shown in Figure 2.13 (Erb, 2015).

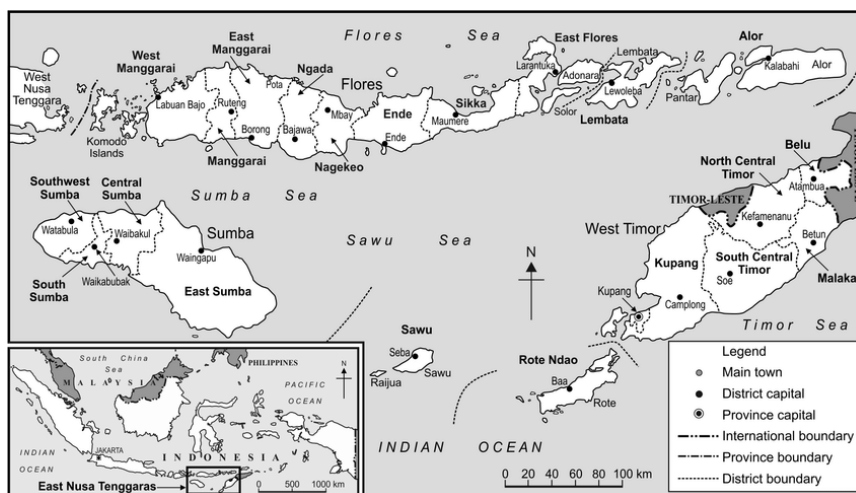


Figure 2.13. Geographic map of East Nusa Tenggara Province (Erb, 2015).

From an economic perspective, East Nusa Tenggara Province heavily relies on the agricultural sector. In 2021, the agricultural sector contributed 29% of the total economy of the province, which was dominated by livestock (10%), crops (8%), and fisheries (6%) (Statistics Indonesia, 2022). Furthermore, in the same year, 50% of the East Nusa Tenggara population were working in the agricultural sector, which implies the importance of the sector for the economy of the province (Statistics Indonesia, 2022).

East Nusa Tenggara territory mainly consists of ocean territory (76%) (Statistics Indonesia, 2022). However, the fisheries sector only contributed 6.15% to the total economy of the province, which indicates that the potential of the fisheries sector of East Nusa Tenggara has not been optimized yet (Statistics Indonesia, 2022). In the fisheries sector, seaweed is the most important commodity for the province. In 2020, East Nusa Tenggara produced 2.1 million tons of seaweed, which by far dominates the province’s fisheries sector as shown in Figure 2.14 (Statistics Indonesia, 2022). This indicates that seaweed is the most significant commodity in the East Nusa Tenggara fisheries sector.

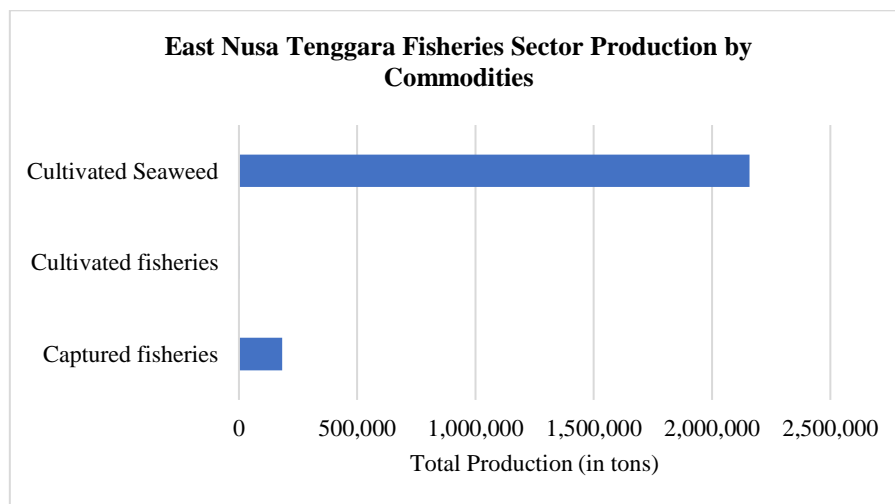


Figure 2.14. East Nusa Tenggara fisheries sector production in 2020 (Statistics Indonesia, 2022).

2.8 East Nusa Tenggara seaweed trade policy

In the Indonesian seaweed sector, 64% of the Indonesian total seaweed production was exported in raw form, whereas the other 36% was absorbed by local processors (Ministry of Trade of Indonesia, 2015). One of the factors that caused this event was seaweed producers tend to sell their seaweed to the international market due to the higher price, compared to the

local processors. This made it difficult for local processors to source raw seaweed at a cheaper price (Ministry of Trade of Indonesia, 2015).

In an effort to limit the export of seaweed in the raw form and to encourage value-adding processes within the country, the Indonesian government planned to issue an export tariff trade policy for raw seaweed. The export tariff would charge 21% for *E. cottonii*, 44% for *Gracilaria*, and 12% for *Spinosum* (Ministry of Trade of Indonesia, 2015). However, this plan has pros and cons even before the implementation, considering an export tariff would raise the price of Indonesian seaweed, which would make Indonesian seaweed less competitive in the international market. Furthermore, local seaweed processors' capacity within the country could only absorb 50% of the country's total seaweed production, which added another concern for Indonesian seaweed industry players (Ministry of Trade of Indonesia, 2015). Other than the export tariff, the Indonesian president also suggested an export ban policy for raw seaweed for the same fundamental reason; however, the implementation has not come to realization on a national level (Ministry of Trade of Indonesia, 2015, Langford et al, 2023).

In August 2022, the East Nusa Tenggara local government implemented a trade policy to ban all exports and inter-island trade transactions of raw dried seaweed. In Indonesia, the local government is given full authority by the central government to create and implement trade policies on their own, as long as the policies do not contradict higher-level regulations (Langford et al, 2023). This trade policy aims to increase the supply of raw seaweeds as materials for local processors within the province to develop value-adding processes for seaweeds. East Nusa Tenggara is the second-largest seaweed-producing province in Indonesia (Statistics Indonesia, 2020). The province has provided most of the seaweed in raw dried form to processors in Java, Sulawesi, and even exported to international markets. Even though this trade policy benefits local processors in terms of raw material price and supply, it brings several disadvantages for the local seaweed producers. The local seaweed farmers are forced to sell their raw seaweeds to three local seaweed processors on the island, hence the farmers are in a low bargaining position and are forced to be the price takers most of the time. Meanwhile, there are plenty of buyers outside of the island who are eager to offer a much higher price for the raw seaweed. Furthermore, local processors do not have the capacity to consistently absorb all the seaweed supplies within the island, especially during peak harvest season. Overall, this regulation implementation has shifted the seaweed's value chain in East Nusa Tenggara province and has implied major effects on its value chain actors (Langford et al, 2023).

Chapter 3: Literature Review

Introduction

This chapter reviews the literature relating to the general value chain theory and agricultural value chain theory, followed by the concept of agricultural value chain analysis with a sustainability approach, which contributes to the development of the theoretical framework of this study. This chapter is divided into six sections. Section one provides definitions and a brief explanation of the general value chain and general value chain analysis. Section two discusses agricultural value chains, agricultural value chain analysis, and its components. Section three focuses on the agricultural value chain in developing countries. Section four discusses the concept of sustainability theory. Section five covers the theory of agricultural value chain with a sustainability approach. Section six outlines the theoretical framework of this study.

3.1 Value chain concept

3.1.1 Value definition

Value is a concept that permeates every facet of our lives, yet its definition remains as elusive as it is essential. Value is a term that holds unique significance for each individual, organization, or society as a whole (Lepak et al., 2007). Value encompasses a diverse layer of meanings, from financial worth to personal appreciation of something (Hinterhuber, 2004, Adler & Fagley, 2005). In products or services, value can take different forms depending on the target market and the specific needs or desires of the customers (Gilaninia et al., 2013).

Anderson & Narus (1998, p.6) stated that value in business markets is “*the worth in monetary terms in terms of the technical, economic, service, and social benefits a customer company receives in exchange for the price it pays for a market offering*”. Whereas, Brandenburger & Stuart Jr (1996, p.8) explained that “*value created = willingness to pay – opportunity cost*”. Meanwhile, rather than defining value directly, Bowman & Ambrosini (2000, p.2-3) first split value into use value and exchange value, which is defined as “*use value is perceived by the customer; exchange value refers to price. It is the monetary amount realized at a single point in time when the exchange of the good takes place*”.

Creating optimum value for a product or service requires a simultaneous design and collaboration within the business actors (Pawar et al., 2009). These sets of collaboration of actions from multiple business actors form a chain of value creation which is called a value chain (Kaplinsky, 2000).

3.1.2 Value chain definition

The value chain concept was first introduced by Michael Porter in 1985 to describe a series of key activities and processes that are performed by an organization to generate value for a product or service, through different phases of production, process, and distribution (Hughes et al., 2014, Kumar & Rajeev, 2016, Zamora, 2016). The value chain allows an understanding of how, where, and how much of the value of the product is created as it is transformed from a set of inputs into finished products or services throughout the supply chain (Hughes et al., 2014).

A value chain is defined as “a systematic way of examining all the activities a firm performs and how they interact” (Porter, 2001, p.50). On the other hand, Kaplinsky (2000, p.4) defined a value chain as “the full range of activities which are required to bring a product or service from conception, through the intermediary phases of production, delivery to final consumers, and final disposal after use”. Whereas, Sturgeon (2001, p.11) proposed a definition for value chain as “the sequence of productive (i.e., value-added) activities leading to and supporting end use”. Moreover, Hughes et al. (2014, p.2) described the value chain as “a chain of key activities performed within an organization that generates value relating to a product (or service)”.

Porter (2001) introduced the value chain as a framework to examine all the activities within a firm to analyze the sources to create a competitive advantage. All the activities are shown in Figure 3.1.

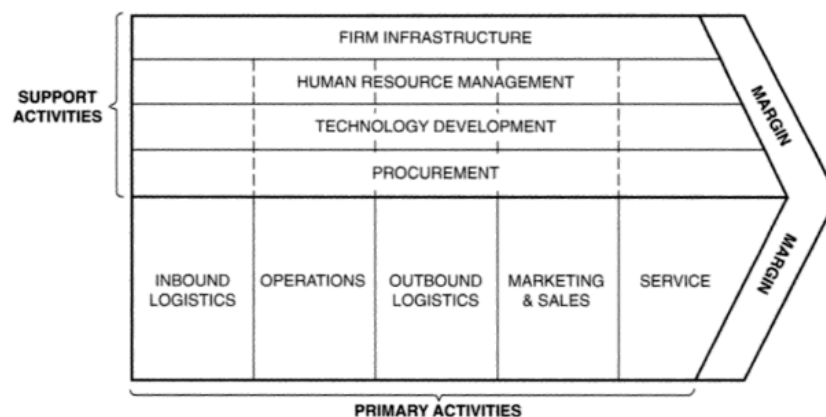


Figure 3.1. Porter’s generic value chain (Porter, 2001).

The value chain depicts a total value, which consists of value activities and margins (Porter, 2001). The value activities are classified into primary activities, which directly contribute to the value-addition of the product, and support activities, which indirectly contribute to the final value of the product (Kumar & Rajeev, 2016). Whereas, the margin is the difference between the final value of the product and the cost of performing the value activities (Porter, 2001). Therefore, competitive advantage can be created when a firm performs activities that create more value in the final product in the most cost-efficient way (Porter 2001, Behesti 2004, Silvi & Cuganesan, 2006).

Although value activities are the components for creating a competitive advantage, the value chain is a system of interdependent activities, hence the linkages or the relationships between each activity are another essential component that contributes to the final value of the products (Ensign, 2001, Ussahawanitchakit, 2017). Linkages can bring optimal value through optimization and coordination (Porter, 2001). Optimization in one process can lead to cost efficiency in another process afterward. Furthermore, the ability to coordinate activities within stages can result in reduced costs and enhance the overall value of the products (Porter, 2001).

However, the use of the value chain framework has been extended to various applications beyond the scope of individual firms (Zamora, 2016). Value chains have been implemented to evaluate entire industries or clusters within certain industries. Moreover, the value chain is also used to study activities involved in the production and distribution of goods and services within and across countries, which are known as the domestic value chains and global value chains (Barrett et al., 2022). Both types of value chains are widely implemented in various sectors of business, such as agriculture, mining, manufacturing, services, and many else (Sanguinet et al., 2023).

3.1.3 Value chain analysis

Value chain analysis refers to “*a managerial process designed to pay proper attention to the possibilities of increasing revenue and cutting costs all along that chain, not just in the process of manufacturing or production*” (Hartley, 2004, p.131). Based on Kaplinsky (2000), there are three key elements in value chain analysis, which are barriers to entry and rent, governance, and systemic efficiency. Whereas, Fearne et al. (2012) took a broader perspective and suggested three dimensions in value chain analysis, which are: 1) boundary of analysis, 2) scope of value considered, and 3) governance. On the other hand, Boehlje (1999) suggested six

dimensions in value chain analysis which are: 1) processes, 2) product flow, 3) financial flow, 4) information flow, 5) incentive systems, and 6) governance. Although there are plenty of value chain analysis theory perspectives; the aim of the value chain analysis can be summarized to understand the behavior of the costs, the sources of differentiation, and the relationships between primary and support activities, so that the value chain players can improve the management of value chain activities, to enable them to determine and gain competitive advantage and larger profit margin out of a business (Kaplinsky, 2000, Porter, 2001).

3.2 Agricultural value chain concepts

3.2.1 Agricultural value chain definition

The agricultural value chain refers to a complex interdependent system that is responsible for the flow of agricultural products from the initial stage of production until the final stage of consumption with value added at each stage of the chain (Wang et al., 2021). Despite coming from the development of the general value chain concept, the agricultural value chain has a unique attribute that differs it from other value chains, which is perishability. Due to this attribute, agricultural value chains are extremely time-sensitive, which emphasizes the need for highly developed coordination between the players within the chain (Trienekens, 2011). Furthermore, as agriculture is a dynamic and complex industry, agricultural value chains require a high level of interaction and coordination among the key players within the stages (Schouten & Bitzer, 2015). According to Cucagna & Goldsmith (2018), the agricultural value chain is generally divided into four main stages, which are inputs, production, processing, and distribution.

3.2.2 Agricultural value chain analysis

Agricultural value chain analysis is an analytical tool to understand the dynamics of inter-linkages within the agricultural productive sector, especially in the way value chain actors are integrated within stages to create value (Kaplinsky & Morris, 2000). One of the strategic tools that can be used to assess the agricultural value chain system practice is value chain mapping. As the agricultural value chain should be perceived as a system, value chain mapping is useful to depict an overview of the value chain's key aspects (Kaplinsky & Morris, 2000). The existing value chain practice should first be scanned to identify the actors and the system to allow further understanding and analysis. Governance and value addition are determined as two critical dimensions in agricultural value chain mapping (Hidayati et al., 2021). These two dimensions describe the key activities within a value chain.

3.2.3 Governance

According to Gereffi (1994, p.97), governance refers to “*authority and power relationships that determine how financial, material, and human resources are allocated and flow within a chain*”. In a value chain, actors within the chain are connected by a variety of complex relationships and interactions, such as transactions and institutions, which are forms of governance (Trienekens, 2011). The governance aspect emphasizes three critical dimensions, which are vertical coordination, horizontal coordination, and information flow (Hidayati et al., 2021). Vertical coordination reflects the relationship between actors at the different stages of the chain link, which includes informal coordination, bilateral contract, and network governance (Trienekens et al., 2018). Whereas, the horizontal dimension reflects the relationships between actors in the same stage of the chain, which includes collaboration between producers or cooperatives (Lazzarini et al., 2001). Moreover, governance is also conducted in the form of information flow, which is crucial in improving value chain performance if executed efficiently (Sjauw-Koen-Fa et al., 2016).

3.2.4 Value addition

Value addition is the amount of increased value of a product in each stage of the chain, created by different actors throughout the value chain (Trienekens, 2011). The amount of value addition is ultimately decided by the end-consumers’ willingness to pay, hence value addition aims to enhance the product in a way that justifies a higher price that meets consumer needs and expectations effectively (Islam et al., 2014). There are three key elements to value addition, which are quality, safety, and value orientation (Hidayati et al., 2021). Value addition should aim to improve the quality and safety of agricultural products. Whereas, value orientation portrays the activities and treatments which contribute to the final value of the products. These two critical dimensions of the value chain can be used to serve as analytic tools to assess the agricultural value chain, which is illustrated in the following conceptual framework (Figure 3.2).

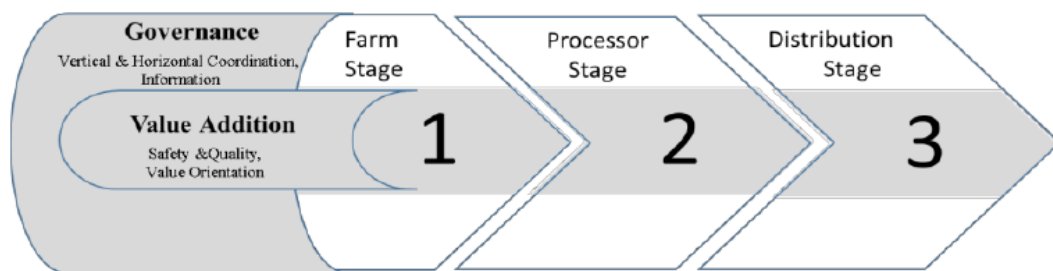


Figure 3.2. Agricultural value chain mapping framework (Hidayati et al., 2021).

3.3 Agricultural value chain in developing countries

In developing countries, the agricultural sector is often characterized by small-scale and subsistence farming (Morton, 2007, Onakuse, 2012). Small-scale actors mostly face barriers such as the lack of institutional and infrastructural support, lack of resources, technologies, and capital, and inefficient or ineffective coordination in the value chains (Trienekens, 2011). Globalization and the expansion of international markets offer opportunities for developing countries to emerge in national and international markets (Pingali, 2007, Trienekens, 2011). However, in order to be competitive with other existing and emerging players, players in developing countries need to gain better control and coordination over their production, trade, and distribution to optimize the value added to their products in the most cost-effective way (Swinnen & Maertens, 2007). As the agricultural sector is considered one of the backbone sectors for most developing countries' economies (Mkuna & Wale, 2022), the urgency to develop value chains in the agricultural sector has risen in recent decades. However, the development of an agricultural value chain in developing countries is hindered by many constraints to implement.

Mishra & Dey (2018) stated in their findings, that in developing countries, the governance of value chains is mostly conducted in an informal way, hence creating further complexity within the value chain. Furthermore, smallholders generally lack bargaining power, which suggests a power asymmetry in vertical coordination and also low horizontal coordination level between the smallholders themselves. These dynamics bring several challenges to governance which is specific in the developing countries.

In terms of value addition, Nugroho et al. (2021) stated that in most developing countries, value addition for raw agricultural products is still rare to be found, whether in terms of quality or safety value addition. Several issues such as the lack of capital resources, the lack of knowledge and skilled labor, the lack of experts, and the lack of infrastructure and technology prevent developing countries' smallholders from applying value-addition processes to their agricultural products.

Due to its distinct characteristics, agricultural value chains in developing countries encounter different problems compared to the value chains in developed countries. Therefore, addressing the challenges also requires different knowledge and actions from value chain actors and policymakers. However, in recent years, a number of studies have been conducted to fill the

gap in value chain knowledge in developing countries, which is critical for the development of the agricultural sector in those particular developing countries.

3.4 Sustainability Concept

Sustainability, as defined by Liu et al. (2019) is a concept in which its development meets the needs of the present without compromising the future generations to meet their needs. On the other hand, Ben-Eli (2018) emphasized more on the relationship with the environment as he defined sustainability as a dynamic equilibrium of interaction between a population and the environment to develop its full potential without causing irreversible adverse effects to the environment. Whereas, Ukko et al. (2019) took a more holistic view and defined sustainability as a systematic encouragement and exploration of internal and external sources in the development of technologies, services, business models, and other initiatives that are environmentally, socially, and economically sustainable.

The idea of sustainability has served as a response to declining resources (Purvis et al., 2019). Sustainability is a contrasting approach to the neoliberal socio-economic view, which is more focused on short-term gain, whereas sustainability is more focused on long term economic, environmental, and social gain (Lozano et al., 2015). Sustainability refers to an endpoint of a process called sustainable development (Gray, 2010). In 1987, The World Commission on Environment and Development released a report named *Our Common Future* or also known as the Brundtland Report, where sustainability emerged as its focal point of discussion and also emphasized the importance of sustainable development as a process towards sustainability.

In recent decades, the sustainability concept has been studied and developed in various aspects of study, but the wide use of the word sustainability in different studies creates ambiguity and lack of clarity regarding the definition and the concept of sustainability (Salas-Zapata, & Ortiz-Muñoz, 2019). However, in an effort to move beyond the ambiguity of the sustainability concept, scholars have developed theories on the pursuit of sustainable development. Studies identified that sustainability cannot be achieved through an isolated approach, but rather requires an integrated holistic approach of three dimensions, comprising financial, environmental, and social (Figure 3.3) (Purvis et al., 2019).

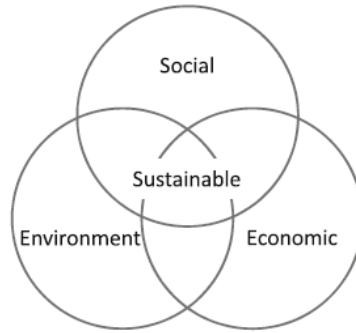


Figure 3.3. Three dimensions of sustainability (Purvis et al., 2019).

Economic sustainability refers to the long-term viability and stability of an economy (Latruffe et al., 2016). It is also defined as the ability of an economic system or organization to maintain its operations over the long term (Latruffe et al., 2016). It involves managing economic resources and activities in a way that ensures present and future generations can meet their stability and prosperity goals without depleting resources or causing harm to future generations. Economic sustainability is also aligned with creating a competitive advantage to improve profits and maintain the financial situation (Aidara et al., 2021).

Environmental sustainability refers to responsible use and management practices in a way that preserves the natural environment for future generations. It involves taking actions that minimize harm to the environment, ecosystems, and natural resources. It is considered a critical aspect of addressing the global challenges caused by environmental degradation, climate change, and resource depletion (Zaman et al., 2017).

Social sustainability refers to the capacity of a society to maintain and improve the well-being of its members in the long term. Efforts to achieve social sustainability often involve collaboration between government, business organizations, society organizations, and individuals. Social sustainability aims to ensure that society's well-being is not compromised by the pursuit of economic growth or environmental protection, and also to ensure the benefits of sustainable development are distributed fairly across society (Eizenberg & Jabareen, 2017).

3.5 Sustainable Agricultural Value Chain

The rapid growth of industrialization and globalization in recent decades pose challenges for the agricultural sector in terms of the exploitation of natural resources and negative environmental impact for production purposes (Hassan et al., 2019, Vroegindewey & Hodbod,

2018). In addition, population growth and market competition create pressure on farmers to increase their production rate and efficiency to supply global market demand (Vroegindewey & Hodbod, 2018). These issues impose high pressure on agricultural players to not only focus on the economic value of their production but also focus on environmental and social values in an effort to establish more sustainable value chain practices (Liu et al., 2019).

The FAO (2014) defined sustainable value chains as a full range of coordinated value-adding activities within farms and firms that produce raw agricultural materials and transform them into particular products that are sold to the end-consumers, which is considered profitable, bring benefits for society, and not permanently deplete natural resources. Sustainable value chains are considered an ideal approach to run an agricultural business based on its long-term impact. However, due to persistent challenges, especially in developing countries, sustainable value chains might be more difficult to achieve. Hence, the focus on achieving sustainability in the agricultural value chain has been critical in developing countries.

In the sustainability dimension, a value chain is considered economically sustainable when each stage's activities generate value that leads to profit that is distributed fairly among the value chain players based on their economic contribution (Mefford, 2011, Sulewski et al., 2018). In terms of environmental sustainability, a value chain has to have minimized negative environmental impacts and responsible waste management (Sulewski et al., 2018). On the other hand, being socially sustainable is the least explicit dimension in comparison to economic or environmental sustainability (Toussaint et al., 2022). Some studies focused on labor and work conditions (Agyemang et al., 2022, Mefford, 2011), others focused on community development and ethical issues (Barin Cruz & Boehe, 2008), while others also focused on the relationship between the upstream and downstream partners in the value chain (Toussaint et al., 2022).

3.5.1 Sustainability indicators in agricultural value chain

As sustainability is considered an endpoint of the sustainable development process, sustainability requires some indicators to measure the performance of a system or an organization. These indicators help gauge progress towards sustainability as a goal and serve as a way to track the impact and effectiveness of current sustainable practices.

Economic sustainability is generally considered economic viability, which refers to the ability to survive in the long term within a changing economic context (Latruffe et al., 2016). The

main indicator to measure economic sustainability is profitability (income, efficiency, and productivity) (Lebacqz et al., 2013, Latruffe et al., 2016). However, Lebacqz et al. (2013) suggested three other indicators that can be used to measure economic sustainability, which are autonomy, diversification, and durability (Figure 3.4). Profitability refers to the ability of a business to generate revenues that exceed all costs, generally indicated by income, efficiency, and productivity (Lebacqz et al., 2013). Autonomy refers to an independence factor, generally used for external inputs and external subsidies, which means a business that is less dependent on external inputs is less sensitive to input availability and price fluctuations, and subsidy policy reforms (Latruffe et al., 2016). Diversification refers to the heterogeneous sources of income in a business. In terms of agriculture, agricultural income can be diversified by implementing non-agricultural activities, such as agritourism or on-farm processing (Latruffe et al., 2016). Durability refers to the ability of a business to survive over time, which is mainly related to the succession and transmission of a business to newer generations (Lebacqz et al., 2013). Economic sustainability is closely linked to social sustainability as income level is one of the critical elements of social life (Van Cauwenbergh et al., 2007).

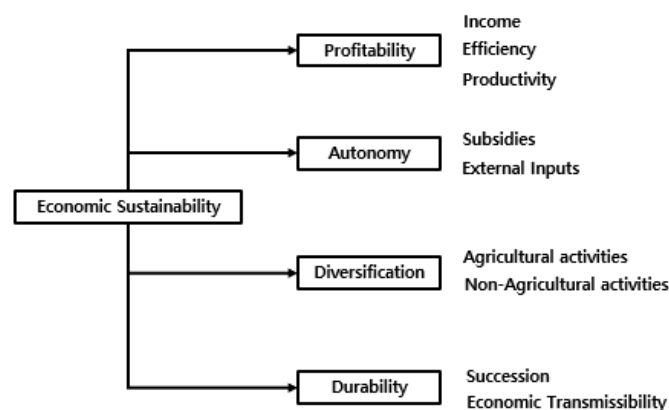


Figure 3.4. Economic sustainability indicators (adapted from Lebacqz et al., 2013).

Social sustainability is defined at two levels, which are internal social sustainability and external social sustainability. Internal social sustainability is related to the well-being of the agricultural business actor, which consists of education, working conditions (working time, workload, workforce), and quality of life (isolation and social involvement) (Figure 3.5) (Lebacqz et al., 2013). On the other hand, external social sustainability is related to the well-being of the society, which consists of quality of products (food safety and quality processes), acceptable practices (environmental impacts and ethical issues), and multifunctionality (cultural goods, contribution to employment and ecosystem) (Van Cauwenbergh et al., 2007, Lebacqz et al., 2013).

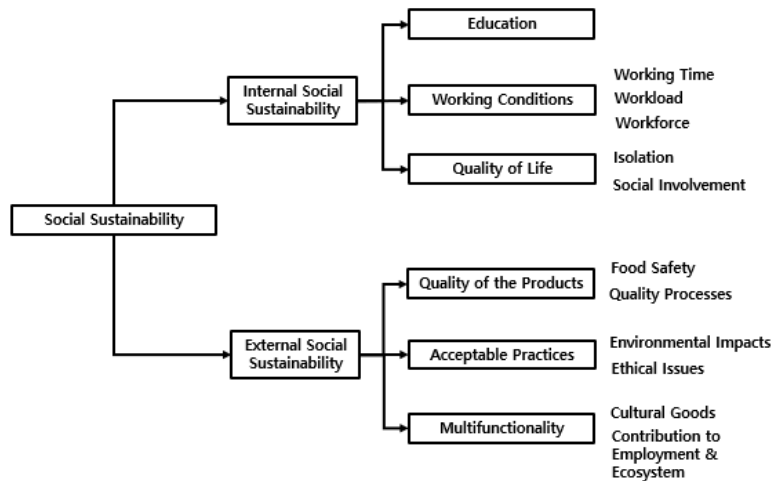


Figure 3.5. Social sustainability indicators (adapted from Lebacqz et al., 2013).

Environmental sustainability indicators are grouped into input management and quality of natural resources (Lebacqz et al., 2013). Input management relates to land management and the use of non-renewable sources, such as energy and water (Lebacqz et al., 2013, Gebre & Rik, 2016). Whereas, the quality of natural resources relates to the emission of air pollutants, waste management, and biodiversity impact (Figure 3.7) (Gebre & Rik, 2016).

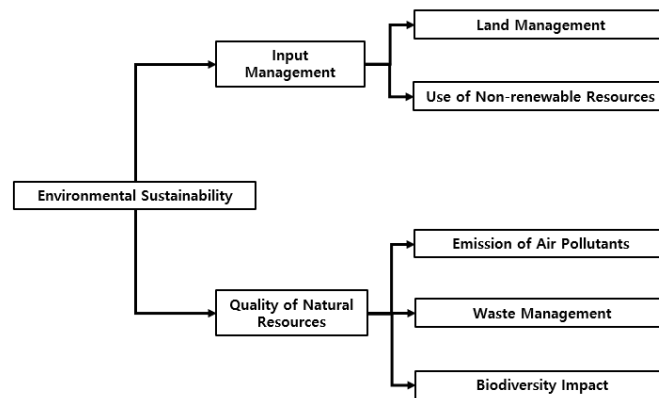


Figure 3.6. Environmental sustainability indicators (adapted from Lebacqz et al., 2013, Gebre & Rik, 2016).

3.6 Theoretical framework of the study

Based on the literature review, the agricultural sector in developing countries, including Indonesia might face several barriers that hinder their development. As globalization and the expansion of the international markets offer opportunities to emerge in the national and international markets, the assessment of the agricultural value chain becomes one of the tools for the development of the sector. In Indonesia's case, seaweed has become the main

commodity of the Indonesian fisheries sector and is considered one of the products that has high potential and implications to develop in terms of its value creation. To assess the existing seaweed value chain, value chain mapping can provide an overview of the value chain's key aspects and identify the key players, allowing for a deeper understanding and analysis of the value chain. Literature highlights the use of governance and value addition as the critical dimensions of value chain analysis. The governance dimension involves coordination and relationship between players, whereas the value addition dimension involves the value enhancement of a product through various activities and processes.

Value chain analysis has been widely used as one of the tools for sector development. However, awareness to consider sustainability is essential to ensure that development is both sustainable and responsible. The literature emphasizes three dimensions of sustainability, which are economy, environment, and social. Incorporating those sustainability dimensions into value chain analysis can help in identifying practices that affect environmental health, social equity, and economic viability in the longer term.

Several studies have been conducted on the contribution of the seaweed sector to Indonesian coastal communities (Rimmer et al., 2021, Zamroni, 202); however, there are still limited studies focusing on the analysis of the Indonesian seaweed value chain, especially that directly assess its sustainability aspect. This study combines analysis of the Indonesian seaweed value chain and the assessment of its sustainability factors. The theoretical framework of this study is presented in Figure 3.7.

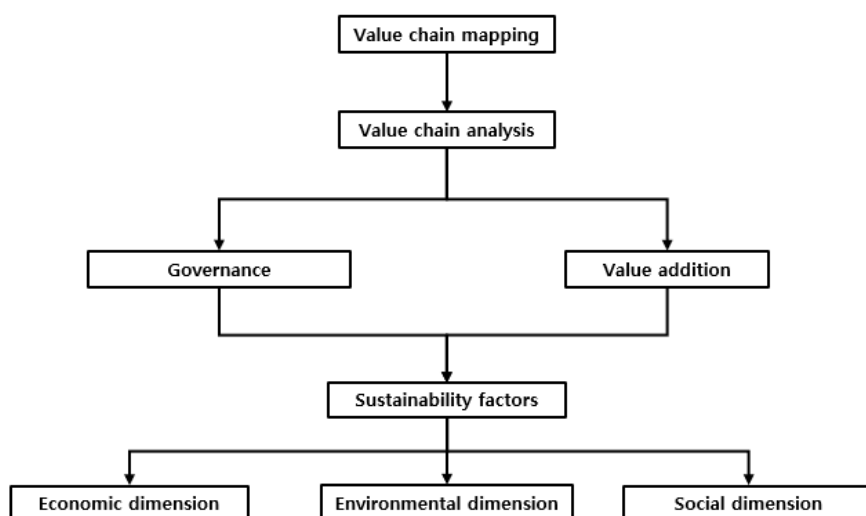


Figure 3.7. Theoretical framework of the study (source: author).

Chapter 4: Research Methods

Introduction

This chapter explains the methodology employed in this study. Section one presents the aim and objectives of this research. Section two explains the research design. Section three outlines how the study area was selected. Section four provides the methods for data collection and questionnaire design. Section five explains the sampling methods for the targeted respondents. Section six covers the respondents' descriptive information. Section seven describes the data analysis methods. The last section presents the ethical considerations of the research.

4.1 Research aim and objectives

This research aims to analyse the seaweed value chain in the Kupang Regency and assess the sustainability factors of the value chain. To achieve this aim, this study has the following objectives:

- To map the seaweed value chain in the Kupang Regency.
- To analyse governance in the seaweed value chain.
- To identify factors affecting the sustainability of the seaweed value chain.

4.2 Research design and method

To be able to achieve the research aim and objectives above, this study uses a qualitative method as the research method. The qualitative approach emphasises words rather than the quantification of numbers for data collection and analysis (Mohajan, 2018). The qualitative approach focuses on interpretivism and constructivism which aim to understand the meanings and experiences of participants within their specific contexts (Lee, 2012). This method enables the researcher to gain an in-depth understanding of the Indonesian seaweed value chain by conducting data collection by interviewing key players of the seaweed value chain. Other studies such as Sørensen et al., 2021, Ansari et al., 2016, and Roudgarmi, 2011 demonstrated the use of qualitative methods in their agricultural studies, which involved the collection of qualitative data through case studies and in-depth interviews to understand the related phenomenon based on the participants' point of view.

4.3 Study area selection

This study will be held in the three top seaweed-producing villages, which are (Tablolong Village, Lifuleo Village, and Tesabela Village), located in West Kupang Subdistrict, Kupang

Regency, East Nusa Tenggara Province. In Indonesia, East Nusa Tenggara Province is the second largest-producer province which accounted for 16% of Indonesian total seaweed production in 2019 (Statistics Indonesia, 2020). Furthermore, in the 3-year report that was published by the Statistics of East Nusa Tenggara Province (2022), Kupang Regency contributed 84% of the total seaweed production in East Nusa Tenggara during 2019-2021. There are four top seaweed-producing subdistricts in the Kupang Regency, which are Semau Subdistrict, South-Semau Subdistrict, West Kupang Subdistrict, and Sulamu Subdistrict. However, due to limited transportation, Semau and Sulamu Subdistrict are difficult to access, as Semau Subdistrict is located on a different island, whereas Sulamu Subdistrict is located 70 km away from the center of the Kupang city. Furthermore, the West Kupang Subdistrict is known to be the focus of the seaweed trading flow in the Kupang Regency as most of the traders and processors are settled in the region (Langford et al., 2023). Consequently, due to the above several reasons, the West Kupang Subdistrict is selected to be the focus study area of this research.

4.4 Data collection methods

This study uses both primary and secondary data as the data sources. Primary data will be obtained by conducting semi-structured interviews. Semi-structured interviews with open-ended questions are intended to allow participants to provide more detailed and expressive opinions and responses (Adeoye-Olatunde & Olenik, 2021). This method also provides flexibility for the questions to obtain more in-depth explanations regarding the respondent's experiences, their thoughts, and their opinions (Busetto et al, 2020). Semi-structured interviews also allow an iterative process between the interviews, where the insights gained from earlier interviews can be used to refine interview questions to provide more opportunities for further exploration (Adeoye-Olatunde & Olenik, 2021). The secondary data collection includes collecting documents, reports, published, and unpublished materials from the regional government database. These relevant documents are essential to help the researchers to gather data based on previous events which might not be discussed in the interview (Baskarada 2014).

4.5 Sampling methods

This study used purposive sampling as the sampling method. The purposive sampling method is a non-probability sampling technique where the researcher selects respondents based on specific characteristics or criteria that are relevant to the study. This method is used to acquire

data from respondents who are considered qualified to give more reliable and accurate information. In this study, purposive sampling method is used to gain information from experienced seaweed industry stakeholders (Etikan et al, 2016) with at least a minimum of three years of working experience, which brings advantages in terms of getting more reliable and accurate data from experienced players in the sector (Nyimbili & Nyimbili et al., 2024). On the contrary, unfiltered participants might provide misleading information due to their lack of experience (Nyimbili & Nyimbili et al., 2024). A total of 24 interviews were conducted, including interviews with 14 seaweed farmers, six intermediaries, and four processors.

4.6 Respondents' descriptive

This study was conducted by interviewing the 24 seaweed value chain players in the three seaweed-producing villages in West Kupang Subdistrict, Kupang Regency. The details of the respondents are presented in Table 4.1.

Table 4.1 Total number of respondents based on their role

Respondent role	Number of respondents
Smallholder farmer	14
Local intermediary	2
Inter-island trader	4
Small-scale processor	2
Processor	2

Most of the seaweed farmers interviewed in this study are senior seaweed farmers aged between 40 and 75 years old with more than 20 years of seaweed farming experience, except for one seaweed farmer who is the second generation of the seaweed farmers family. He has three years of experience in seaweed farming, planning to continue his father's profession. Most of the farmers' educational backgrounds are between six to twelve years of education.

The seaweed farmers in the region are considered smallholder farmers. Most of the farmers have a similar size of sea area (approximately one hectare) because they divide the available seaweed cultivation area between themselves. In addition, most of the farmers work individually; therefore, having a larger area than one hectare requires more labor as the cultivation activities are done manually. The area of one hectare is considered able to be

effectively handled by one farmer. However, the only exception is when a new seaweed farmer started seaweed farming activities recently. Due to their lack of skill and experience, usually they start with a smaller area at first, then gradually increase their cultivation area when they gain more skill and experience.

One of the seaweed farmers is a key informant because he also works as the official seaweed cultivation trainer of P2MKP (*Pusat Pelatihan Mandiri Kelautan dan Perikanan* meaning Marine and Fisheries Autonomous Training Center). He has 10 years of experience coaching and training seaweed farmers across the region regarding general seaweed farming knowledge, accurate cultivation techniques, and quality harvest standards. P2MKP is an organisation that was created in 2011 by the Indonesian Ministry of Marine Affairs and Fisheries. The organisation is intended to provide training and guidance for the communities involved in the marine and fisheries sectors. The main goal of this organisation is to improve the skills, knowledge, and independence of the players working in those sectors.

Six intermediaries were interviewed for this research, which consisted of two local intermediaries and four inter-island traders. The two local intermediaries are representatives from Tablolong Village and Tesabela Village, while Lifuleo Village has no local intermediaries. The local intermediaries are senior seaweed traders aged between 45-50 years old with more than 20 years of seaweed trading experience. The educational backgrounds of the local intermediaries are between six to twelve years of education.

The four inter-island traders are the representative of eight inter-island traders in the region. Four of them lived in Lifuleo Village, and the other four lived in the central city near the trade harbor location. The four inter-island traders who participated in this study are experienced seaweed traders aged between 27-47 years old with more than 7 years of seaweed trading experience. Some of them were working as local intermediaries first before becoming inter-island traders. The educational background of the inter-island traders varies between six to sixteen years of education (university level). This indicates that some of the inter-island traders have a higher level of education compared to most of the value chain players.

In terms of small-scale processors, the two respondents are the co-owners of the business in Tablolong Village. Both are 50 years old with 22 years of seaweed processing experience. One of them is also working as the official seaweed processing trainer of P2MKP. She has 10 years

of experience in coaching and training households (usually housewives) in the coastal villages inside and also outside of the region regarding seaweed processing techniques and procedures.

There is only one carrageenan processing factory in the Kupang Regency. The respondents are the COO (Chief Operating Officer) and the Head of the R&D (Research and Development) Department of the company. They are originally from the Philippines and have been assigned to their positions since the company was built in 2017. The COO is 52 years old, and the R&D Manager is 50 years old. Before coming to Indonesia, the Head of R&D had 20 years of experience in carrageenan manufacturing in the Philippines.

4.7 Data analysis methods

This study uses qualitative data analysis (QDA) for the data analysis method. The method was first introduced by Dey (2003) and provides a framework to examine non-numerical data, which emphasizes the importance of context, meaning, and subjective experiences of participants. Dey's (2003) framework involves the process of breaking the gathered data into pieces, and then proceeding by connecting the pieces together. The method involved three main data processing tasks, which are describing, classifying, and connecting (Figure 4.1).

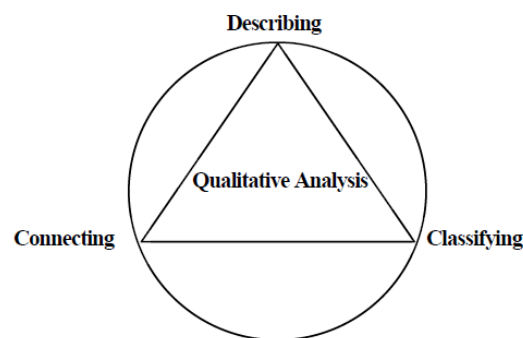


Figure 4.1. Qualitative data analysis process (Dey, 2003).

The describing process involves the transcription of important information from interviews into written form (Maxwell & Chmiel, 2014). Classifying involves organising the transcribed data into different themes or categories (Maxwell & Chmiel, 2014). Connecting involves finding associations between different themes or categories into connections or relationships that have meaning (Maxwell & Chmiel, 2014). These three processes are repeated several times until the researcher is able to capture a clearer understanding regarding the information gained from the data collection to achieve the research aim and objectives (Li & Zhang, 2022). In this study, all

the raw data from the interviews are transcribed into written transcripts. From these written transcripts, the information is then classified based on the categories (material flows, value chain analysis, or sustainability). After that, the connecting process is done by finding relationships between the classified data, which will provide a comprehensive understanding of how material flows, value chain dynamics, and sustainability factors are interconnected within the seaweed sector.

4.8 Ethical considerations

Ethics are norms and behaviours that are expected to guide moral choices in our interactions with other people. In the research context, ethical consideration is critical to ensure that the study is not causing any physical or mental harm, discomfort, embarrassment, or privacy loss to any of the participants involved in the research study. In this study, the research is guided by ethical principles and requirements of the Massey University Human Ethics Committee (MUHEC). Before conducting any of the interviews, the researcher is responsible for clearly explaining to the respondents regarding the purpose of the research and the benefits of the participants involved in the study. The researcher is also required to inform the rights of participation, where the participants have the right to decline to become respondents or to decline to answer any sensitive questions. In addition, the researcher also needs to ensure that the participants' information and answers would be kept confidential and only used for research purposes. Subsequently, the participants were provided with a consent form to be signed by either oral or written evidence as a sign that the respondents agreed to be part of the research.

Chapter 5: Results

Introduction

This chapter presents the results from the data collected in Kupang Regency, East Nusa Tenggara, Indonesia. This chapter consists of four sections. Section one explains the material flow of the seaweed. Section two provides the seaweed value chain mapping in the regency. Section three covers value addition and governance aspects of the value chain. Section four identifies the sustainability factors within the value chain.

5.1 Material flow of seaweed

This section will discuss the seaweed material flow from raw seaweed to products purchased by the consumers. This section will also explain the activities done by the value chain actors and how those activities change the products.

5.1.1 Types of cultivated seaweed

In Kupang Regency, seaweed farmers only cultivate two types of seaweed; which are *Eucheuma cottonii* (*Kappaphycus alvarezii*), locally called “Sakol” and *Eucheuma spinosum*, locally called “Sp”. The term “Sakol” is named after “kol”, which is the Indonesian term for cabbage. This term is given by the local people because of its round shape similar to cabbage as shown in Figure 5.1.



Figure 5.1. Sakol (green color, round shape) and Sp (brown color, root shape) ¹(source: author).

Both seaweeds are classified in the red algae division. Both types of seaweed are also well known as two of the main sources of carrageenan production. Carrageenan is widely used in the food, pharmaceutical, and cosmetic industries as a thickening, gelling, and stabilizing agent.

¹ All figures are sourced by author, unless otherwise noted.

5.1.2 Seaweed cultivation

In seaweed cultivation, generally, there are three main production methods, which are 1) bottom, 2) longline, and 3) raft. The bottom cultivation method is used in water areas with low depths (less than 3 metres). With this method, the seaweed farmers would not need to go further away from the coast. However, the risk of pests consuming the seaweed is high; therefore, only a few farmers in certain sea areas that are not inhabited by potential pests use this method. Longline and raft cultivation methods are both used in areas with water depths of more than 3 metres. However, the raft cultivation method is not used in the area due to its high cost and high intensity of waves within the coastal sea, which would make the raft easily capsized. Farmers have tried to implement the method, but it did not work well. Therefore, longline is the most used cultivation method in the area, because it is considered the most suitable cultivation method to be applied in the area.

“Most of us use the longline method. The bottom method is risky because many of our seaweed get eaten by fish and turtles. Meanwhile, the raft method is expensive and waves would easily tilt the raft.” (Respondent 3).

Three main tools are used in the longline cultivation method, which are ropes, empty bottles, and stones (Figure 5.2).



Figure 5.2. Tools used for the longline cultivation method.

Seaweed seeds are tied with the nodes on the rope. The distance between each node is approximately 20 cm. This distance is considered the most efficient by the farmers as it gives an appropriate space for the seaweed to grow and at the same time utilizes the length of the rope with the optimal quantity of seaweed seeds being cultivated. Empty bottles are also tied across the rope as the floating agents for the cultivation. It is important to keep seaweed cultivation floating in the sea because seaweed also needs a certain amount of sunlight exposure

to grow. If the cultivation is placed too deep in the sea, the sunlight will not be able to penetrate through the depth of the sea and seaweed will not be able to grow. In addition, seaweed farmers also use stones as the anchor for the ropes, which will keep the ropes steady on the sea. The longline cultivation method layout is presented in Figure 5.3.

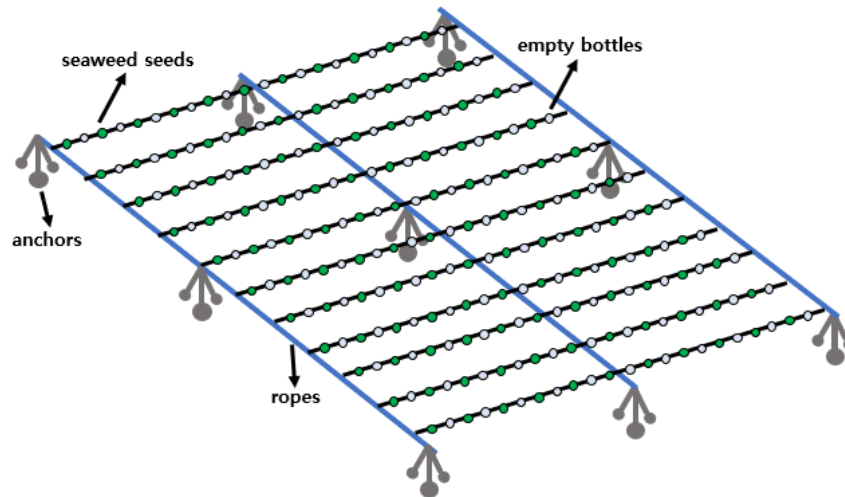


Figure 5.3. Longline cultivation method layout.

Seaweed farmers in the region usually start their cultivation in March and finish in December. They do not cultivate seaweed in January – February due to high wind and wave intensity in the area, which is caused by the west monsoon wind that occurs from late December to late February. During this period, seaweed farmers usually focus more on seed cultivation which will be used for the March cultivation period, as seaweed farmers do not regularly purchase new seeds for the seaweed.

“We do not need to purchase seeds in routine, we just use the seeds from our previous cultivation. Unless if our harvest is all failed, we buy from other farmers, usually from Semaui Island.” (Respondent 2)

Sakol is required to be cultivated at least for 45 days, lesser harvest time will result in a lower quantity of carrageenan content in *Sakol*, which lowers the quality of the harvested *Sakol*. Meanwhile, *Sp* has a shorter standard cultivation period, which is 30 days. After those standard cultivation days, the carrageenan content of the seaweed will not increase, hence 45 days and 30 days are considered the optimal cultivation period for the seaweed. Considering the length of the cultivation period, the seaweed farmers can harvest *Sakol* up to 6 times per year.

5.1.3 Seaweed harvesting

In terms of harvesting, seaweed farmers in the region use their boats to collect their seaweed. They collect both the seaweed and the ropes, then put them on their boats to bring to the coast (Figure 5.4).



Figure 5.4. Seaweed harvesting process.

Once they arrive on shore, before proceeding to the drying process, the seaweed farmers will sort and tie the seeds from the harvested seaweed so that they can directly continue the cultivation (Figure 5.5). The criteria for ideal seaweed seeds are the ones that have a good amount of thallus (plant vegetative body) and are healthy (meaning no diseases and contamination).



Figure 5.5. Seaweed seeds sorting and tying process.

After finishing with the sorting and tying process of the seaweed seeds, the seaweed farmers will go to the cultivation area during the morning to start planting the next cultivation of seaweed (Figure 5.6).



Figure 5.6. Seaweed farmers preparing for new cultivation.

5.1.4 Seaweed drying

Meanwhile, the rest of the harvested seaweed will be directly dried by the farmers. This process is essential to be done by the farmers because the only form of seaweed that is acceptable for the trading process is the raw-dried form. The drying process is done near the shore using sunlight. However, the drying process of the seaweed needs to be done with the help of a one-metre-height wooden rack (Figure 5.7).



Figure 5.7. One-metre-height wooden racks for drying process.

“We need to dry our seaweed on these racks. We made these on our own, because the racks have to be at least one-metre height. If not, the sand below will be blown by the wind and contaminate our seaweed.” (Respondent 10)

Generally, it requires 3-5 days to dry the seaweed when the intensity of sunlight is high. But when the intensity of sunlight is low, generally it requires 1-2 weeks for the drying process to

be completed. Furthermore, the length of the drying process also depends on the thickness of the seaweed layer being dried. A thicker seaweed layer requires a longer drying period, hence the farmers tend to spread their seaweed on the wooden racks and avoid stacking them against each other to accelerate the process. The drying process is finished when the seaweed reaches approximately 38% water content. Farmers do not have any tools to measure the water content of the dried seaweed, instead, they measure based on the visual and texture of the seaweed. Seaweed that is well-dried will have a rough texture as shown in Figure 5.8.



Figure 5.8. Raw-dried Sakol after drying process.

5.1.5 Seaweed storage

If the seaweed has dried properly, it has a long shelf life due to its low water content. Farmers generally can store them in their houses for months if stored properly. The farmers do not need to pack the dried seaweed in bags; however, they need to avoid any contact with fresh water. Fresh water can dissolve the carrageenan in the seaweed, hence will make the seaweed crumble. Contact with floor tile also needs to be avoided due to the characteristics of floor tile that tend to absorb water molecules from surroundings. The packing process of the dried seaweed to the bags is generally done when the dried seaweed is traded to the local intermediaries or the inter-island traders. This is intended to make it easier for handling and transport purposes.

5.1.6 Seaweed processing

In the Kupang Regency, due to limited seaweed processing in the region, only approximately 10% of raw-dried seaweed produced in the region is allocated for further processing, while the other 90% is exported predominantly by the inter-island traders to other provinces in Indonesia,

such as Surabaya and Makassar. In the region, there are two ways of processing the seaweed, which are to process it into ready-to-eat snacks and to process it into carrageenan. The ready-to-eat processed seaweed snacks are produced by the two well-known seaweed small-scale processors (home industries) located in Tablolong Village and Sulamu Village. There are five types of ready-to-eat snacks produced by the home industries, which are dodol, pilus, tortile, sticks, and biscuits as shown in Figure 5.9.



Figure 5.9. Ready-to-eat snack (stick and dodol) from processed seaweed.

“We (small-scale processors) used to use cottonii for our raw materials, but because as of now the type is rare to be found, so we use Sakol for our raw materials. We only use Sakol, because its gel strength (carrageenan) is suitable for our snack products.” (Respondent 21)

The flow process of transforming raw dried seaweed into ready-to-eat snacks includes six main steps which are sorting, washing, cooking, sun-drying (only applied for dodol production), packing, weighing, and delivery. Sorting is a process to check and separate the good quality and the low-quality seaweed based on the quality standard of the processors. The quality standard includes texture, visuals, color, dryness, and impurities level. This process is also important to remove impurities such as sand and stones from the seaweed. Washing is a process to clean up all the remaining impurities within the seaweed and to ensure the hygiene of the seaweed. Cooking includes processes of boiling, frying, and adding other ingredients and seasonings. This process is the main process to transform raw inedible seaweed into ready-to-eat snacks. Sun drying is an additional process that is specifically done for dodol production. This sun drying process is essential for the dodol to reach a certain water content that is important to create its solid form and chewy texture. The process usually takes up to three days. Packing is a process to pack the goods with standardized packaging. Weighing is a process to

ensure each product is packed with its standard weight. Delivery involves a process of sending the finished products to the selling destinations.

On the other hand, the other way to process seaweed is to transform raw-dried seaweed into carrageenan, which is done by a processor (carrageenan factory) located near Tablolong Village. The factory produces carrageenan in two forms, SRC (semi-refined carrageenan) in the form of powder and ATC (alkali-treated chips) in the form of chips as shown in Figure 5.10.



Figure 5.10. SRC (semi-refined carrageenan) in powder form and ATC (alkali-treated chips) in chips form.

Carrageenan is widely used in the food, pharmaceutical, and cosmetic industries as a thickening, gelling, and stabilizing agent. Carrageenan will dissolve during heat treatment and form a thermally reversible gel during the cooling process, it will bind water molecules and provide texture for the products. Generally, carrageenan is produced in three forms, which are ATC (alkali-treated chips), semi-refined carrageenan (SRC), and refined carrageenan (RC).

ATC (alkali-treated chips) or sometimes also called ATCC (alkali-treated *cottonii* chips) is one type of carrageenan product in the form of chips. Compared to semi-refined carrageenan and refined carrageenan, alkali-treated chips require the simplest production procedure and are also used as the intermediate product for carrageenan powder production. Due to its simple production method, the cost-effectiveness of alkali-treated chips is the main advantage of being used by various processing companies.

Semi-refined carrageenan is produced from alkali-treated chips that are milled into powder with 40-60 mm particle size, while refined carrageenan undergoes further processing to increase its purity level. Semi-refined carrageenan contains more impurities or residual cellulose (8-15%) compared to refined carrageenan (< 2%). Refined carrageenan will give a clear solution and exhibit a high level of gel strength, hence suitable for high-quality food, pharmaceutical, and cosmetic applications with strict quality requirements. Meanwhile, semi-refined carrageenan gives a more cloudy solution, which is suitable for dairy and meat industries where clarity is not a requirement. However, refined carrageenan requires further technology to produce, thus relatively higher cost compared to semi-refined carrageenan. Semi-refined carrageenan is more suitable for bulk production of products with simpler coarse processing, which offers good cost-effectiveness in general food production.

Furthermore, they also produce two types of carrageenan products, which are kappa-carrageenan (produced from *Sakol/Eucheuma cottonii*) and iota-carrageenan (produced from *Sp/Eucheuma spinosum*). Kappa-carrageenan provides a rigid gel which shows a strong level of gel strength, meanwhile, iota-carrageenan produces a soft and elastic gel which shows a weaker level of gel strength.

Some processes are required to be done to transform raw-dried seaweed into alkali-treated chips. Firstly, raw-dried seaweed has to be washed to remove impurities (sand and salt). Then, the cooking process is carried out by boiling the seaweed with a potassium hydroxide (KOH) solution. The alkali solution is used to dissolve soluble matter (protein, carbohydrate, and salt) in the seaweed and leave carrageenan and other insoluble matter as residue. The insoluble residue (primarily carrageenan and cellulose) is then sun-dried to take out the remaining water from the product. Finally, the chopping, weighing, and packing process will be done to finish the production of alkali-treated chips. For semi-refined carrageenan production, the alkali-treated chips will be milled into powder form, then the weighing and packing process is carried out to finish the production of semi-refined carrageenan.

5.2 Seaweed value chain mapping

Based on the information collected from interviews, the seaweed value chain in Kupang Regency can be classified into two types of value chains, which are: 1) unprocessed raw-dried seaweed value chain for the domestic (inter-provincial) market and 2) processed seaweed (ready-to-eat snacks and carrageenan) value chain for the local and export market.

5.2.1 Unprocessed raw-dried seaweed value chain

The first type of seaweed value chain in Kupang Regency is the unprocessed raw-dried seaweed value chain, which contributes to 90% of the seaweed production in the region. This value chain includes three main actors; which are the smallholder farmers, local intermediaries, and inter-island traders. The mapping of the value chain is presented in Figure 5.11.

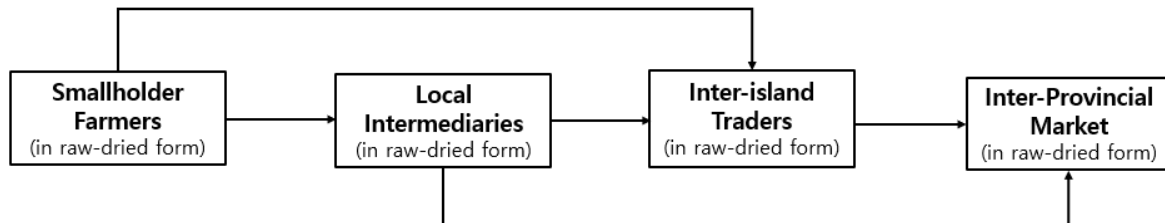


Figure 5.11. Unprocessed raw-dried seaweed value chain for the domestic (inter-provincial) market.

Smallholder Farmers

Seaweed farming activity in the Kupang Regency started in 1999 when the local government first introduced seaweed cultivation of *Eucheuma cottonii* to the people living in the villages near the coastal area. Twenty-five years later, seaweed farming has become the main source of income for hundreds of families in Tablolong, Lifuleo, and Tesabela villages.

Based on interviews, all farmers claim that being a seaweed farmer is their main occupation. Some of them are only working as seaweed farmers, and some are also working as fishermen as their secondary occupation. Three main motivations for them to become seaweed farmers are; 1) geographical advantage as they live in villages near the coastal area, 2) low capital and operation costs, and 3) seaweed is considered a high-value commodity.

The capital and operation costs needed for the occupation are relatively small compared to becoming land farmers. Seaweed farmers are not required to buy their seaweed cultivation area. Due to the sea area being owned by the government, the sea area is eligible for any people living in the villages nearby to start cultivating their seaweed for free. Generally, a new seaweed farmer needs approximately USD 1,000 – USD 1,600 capital to buy ropes, seeds, and a boat. Furthermore, they also do not need any routine operational costs unless in some rare cases, the farmers intend to buy more cultivation ropes (for expansion purposes), buy seeds (usually because previous cultivation failed), and buy a new boat (usually can be used up to 3-5 years).

Compared to becoming land farmers, the land farmers need significantly higher capital to start. Land-based farmers need to own land and machinery for farming activities. Furthermore, land farming also requires routine operational costs, such as buying seeds, fertilizers, and other farming materials, equipment, and maintenance.

“Becoming seaweed farmers is easier for us. We usually only need Rp 15,000,000 to Rp 25,000,000 (USD 1,000 – USD 1,600) for the first capital. Usually to buy ropes, seeds, and a boat. We collect empty bottles and stones nearby so they are free. After that, we do not need to spend our money again. But, if we do land farming, we need to buy land, seeds (in every cultivation), fertilizers, and machinery. Furthermore if there is a pest, we need to spend high cost for its maintenance. None of those are needed in seaweed farming.” (Respondent 6)

Seaweed is considered a high-value commodity in the area. During 2018-2021, the price of raw-dried seaweed ranged between USD 1.1 – USD 1.9 per kg at the farmer level. Moreover, the price of raw-dried seaweed continually increased during the first half of the year 2022. In July 2022, the price of raw-dried *Sakol* seaweed reached its peak at USD 2.4 per kg. Farmers were gaining significant profits during that time. However, in August 2022, the local government implemented a governor decree (Governor Decree Number 39 Year 2022 for Fisheries Commodity Trading Administration) that banned all shipments of raw-dried seaweed outside of the East Nusa Tenggara Province. This decree was originally intended to push the value-adding activities inside the province. Besides the shipment ban, the government also implemented a minimum price regulation, which provided a market price floor for raw-dried seaweed bought from farmers. This regulation was intended to guarantee a reasonable price for the seaweed farmers. The regulation introduced a minimum price of USD 1.9 per kg, a significant drop from the price in July 2022.

However, the decree implementation impacted the farmers in a negative way. Due to the shipment ban of raw-dried seaweed outside of the province, demand significantly decreased. In addition, there were not many processing players and facilities for value-adding activities for seaweed in the region, hence creating an excess supply of raw-dried seaweed in the province. The excess supply of raw-dried seaweed led to a significant decrease of its market price. At the end of 2022, the price of raw-dried seaweed dropped to USD 1.6 per kg.

Many farmers and other chain players have demonstrated their demand to the local government to cancel the decree. Based on the interview with a local government representative, the decree has been revised since November 2023, which already allows raw-dried seaweed to be shipped to other provinces. However, in 2023, the global market price of raw-dried seaweed also experienced a significant decline to only USD 1 per kg. Many respondents indicated this price decline was the result of the influence of Chinese companies as they are the main players in the seaweed sector. Due to the series of these events, farmers had to experience a decline from USD 2.4 per kg to USD 1 per kg in just less than two years.

“Rp 15,000 (USD 1) is the current minimum price for the seaweed if farmers want profits, barely enough for our daily needs. Before the implementation of the governor decree, all farmers here were wealthy. We can build our houses, buy motorbikes, and send our children to universities. But as of now, our income is only enough for our daily needs.” (Respondent 3)

Despite having 2 types of cultivated seaweeds, *Sakol* dominates the overall seaweed cultivation in the region because of the price discrepancy between *Sakol* and *Sp*. In December 2023, the price of *Sakol* at the farmer level was around USD 1 per kg; meanwhile, the price of *Sp* at the farmer level was only around USD 0.2 per kg. Although *Sp* is more resistant to diseases and has a shorter harvest period, the farmers are still reluctant to cultivate *Sp* and much prefer to cultivate *Sakol*.

“Sp is easier for us to grow and resistant to diseases, but the price is so low. Sakol has a way better price and brings more profits to us.” (Respondent 1)

The area of seaweed cultivation varies between farmers, ranging from 50-100 metres in length and 30-150 ropes/lines in width. Nowadays, one seaweed farmer can only produce approximately 1 ton of wet seaweed per harvest (100 kg of dried seaweed). Originally, one farmer could produce up to 10 tons of wet seaweed harvest (1 ton of dried seaweed); however, due to the Montara oil spill incident back in 2009, and other various environmental problems in recent years, the outcome of seaweed farming has been significantly decreased by approximately 90%. Due to the Montara oil spill incident, all the farmers' seaweed cultivation at the time was polluted and failed to grow. After the incident, the original *cottonii* species could not survive due to the polluted water environment, farmers have tried to cultivate this

species multiple times but always failed. Months after the incident, two cool boxes (8 kg) of *Sakol* seeds were brought by the local government for the farmers to cultivate. The *Sakol* species survive and become the main cultivated seaweed species in the region until now.

Other than cultivating and harvesting, the seaweed farmers are also in charge of the drying process of the harvested seaweed. After the drying process is finished, the farmers usually temporarily store their dried seaweed in their own houses until the traders buy and pick up the seaweed. In terms of doing all the work from cultivating until drying, most of the farmers are getting help from their families and even their neighbors. They tend to help each other without pay and rely much on their relationship with the people from the same village.

Seaweed farmers in the region are generally selling their raw-dried seaweed to local intermediaries in their villages. However, in some cases, they can also sell their seaweed directly to inter-island traders, usually when the local intermediaries do not exist in the particular village. Generally, farmers tend to supply their hometown intermediaries whom they already know well. However, the opportunities for the other traders are still open, but they usually have to offer a higher price compared to how much the local intermediaries have offered.

Local Intermediaries

Local intermediaries play a role in collecting raw-dried seaweed from the farmers and selling those again mainly to inter-island traders. However, in rare cases, local intermediaries can also directly sell the dried seaweed to other provinces in Indonesia, usually when they have market channels outside of the province. Based on interviews, there are two local intermediaries in Tablolong Village, three in Tesabela Village, and none in Lifuleo Village. Due to the nonexistence of local intermediaries in Lifuleo Village, the seaweed farmers in Lifuleo Village sell their seaweed directly to the inter-island traders in the village.

The amount of seaweed traded by the local intermediaries ranges between 3-15 tons of dried seaweed per month. When buying dried seaweed from the farmers, the traders will be responsible for the transportation fees in this case. Generally, they rent a pick-up car to visit the farmers' houses and buy their dried seaweed. Besides providing collection services, local intermediaries also provide loan support for the farmers. The local intermediaries are willing

to give loans to the farmers because of trust between the village residents and also to encourage the farmers to sell their seaweed to them and not to other people.

Inter-island Traders

Inter-island traders are traders in the region that play a main role in collecting raw-dried seaweed from local intermediaries, and in some cases directly from the farmers, then selling it to other provinces in Indonesia. There are a total of eight active inter-island traders in the region. Four of them are living in Lifuleo Village, while the other four are living in the central city near the trade harbor location. The amount of seaweed traded by the inter-island traders ranges between 30-150 tons per month. Due to the limitation of the value-adding processors in the seaweed sector within the region, the inter-island traders play an important role in selling the majority (approximately 90%) of the raw-dried seaweeds from the Kupang Regency to other provinces in Indonesia, dominantly to Surabaya (East Java) and Makassar (South Sulawesi).

When selling raw-dried seaweed, local intermediaries are the ones who are responsible for the transportation fees from their warehouses to either the container loading point or to the inter-island traders' warehouses. Hence, the price paid by the inter-island traders to the local intermediaries usually includes transportation fees. In some cases, inter-island traders also provide fund support to the local intermediaries. The intention is to give more capital for the local intermediaries to purchase more raw-dried seaweed from the farmers to fill all the container capacity for shipping purposes. In terms of inter-provincial transportation, the inter-island traders are usually in charge of the container transportation fees.

5.2.2 Processed seaweed value chain

The second type of seaweed value chain in Kupang Regency is the processed seaweed value chain, which contributes only 10% of the seaweed flow in the region. Due to the scope of this value chain study being only at the province level, this value chain includes five main actors; which are smallholder farmers, local intermediaries, inter-island traders, small-scale processors, and a processor. The mapping of the value chain is presented in Figure 5.12.

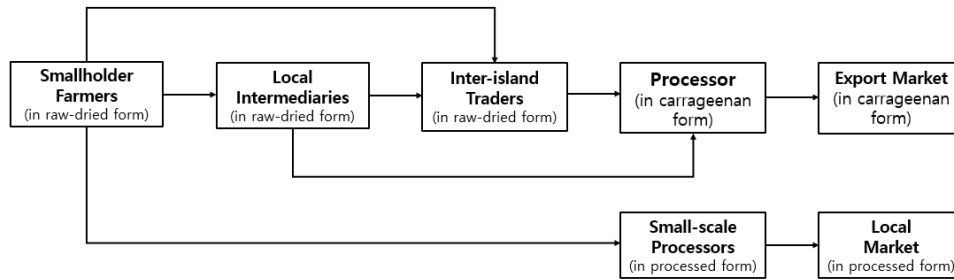


Figure 5.12. Processed seaweed (ready-to-eat snacks and carrageenan) value chain.

Small-scale Processors

In the Kupang Regency, there are two well-known seaweed small-scale processors, one is located in Tablolong Village, and the other one is located in Sulamu Village. Small-scale processors produce ready-to-eat snacks with seaweed as the main ingredient under the brand name *Tresha Food*. In Tablolong Village, the small-scale processor first operated in 2001. Originally, the processor used fish and seaweed as the main ingredients; but since 2009, the processor decided to completely focus on seaweed processing. Acknowledging the impact of the processor on the seaweed sector in the region for more than a decade, in 2014, the Indonesian Ministry of Marine Affairs and Fisheries gave support by giving a license to the processor to operate under the name of UPI Mina Usaha Bersama Tablolong (UPI is the acronym of *Unit Pengelohan Perikanan* or Fisheries Processing Unit). The government also gave operational and marketing support such as certifications and market channel recommendations to the processor.

The process takes place in the production house located approximately only 50 metres away from the owner's house in Tablolong Village. The house is specifically for production to ensure the hygiene of the production site and also to fulfill all the certification requirements (Figure 5.13). They also ensure the use of masks, hairnets, and gloves by the employees on the production site to ensure the quality of the products. The processor has qualified for a patent right certificate, MD certificate from BPOM (MD means *Makanan Produksi Dalam Negeri* or domestically produced food, BPOM means *Badan Pengawas Obat dan Makanan* or Indonesian Food and Drug Authority), and Halal certificate.



Figure 5.13. Tablolong small-scale processor production house.

The processor gets the seaweed by buying it directly from the seaweed farmers. They collaborate with three seaweed farmers in Tablolong Village to supply their raw-dried seaweed. However, in some rare cases, they also buy seaweed from Lifuleo Village when they need more supply of raw-dried seaweed because of increased production demand. The processor does not buy from traders because the price of the raw-dried seaweed at the trader level will be more expensive than at the farmer level. For transportation, they usually use a motorcycle to pick up the seaweed from the farmers' houses if the quantity is small (only two or three sacks). If they are buying 100-200 kg or buying from other villages, they will use a small truck.

The processor has 6 employees with the production capacity of 30 packs of finished goods per day. The processing from start to finish is done manually. Due to limited resources, the maximum the processor can produce per day is 30 packs.

“Our production capacity is at 30 packs per day. Last time, there was a high demand for 3,000 packs for special event, and we had to finish those within 15 days. Hence, we had to recruit 10 other daily workers to help us finish the order within the given time.”

There are five types of ready-to-eat snacks produced by the processor, which are dodol, pilus, tortile, stick, biscuit. All five products are sold at the same price (USD 1 per pack), the only difference is the weight of the product per packaging. Out of the five products, dodol is the one product that brings more profits; however, it is also the product that requires longer processing

time (four days) compared to the rest of the products (only one day). These products are sold in several well-known centers of souvenirs in East Nusa Tenggara, named *Ibu Soekiran*, *Dekranasda*, and *Exotic*. The processor has signed a partnership agreement with those centers of souvenirs based on the recommendation from the Indonesian Ministry of Marine Affairs and Fisheries. Their production type is pre-order based, which means they will produce based on the demand from those centers. For centers of souvenirs located in the city center (*Ibu Soekiran* and *Dekranasda*), the processor delivers the products by car to the shop location. Whereas, for delivery to the center of souvenirs located on a different island (*Exotic*, which is located in Labuan Bajo), they use a courier package delivery service. They charge no delivery fees in this case because it is already included in the selling price.

Processor

In the Kupang Regency, there is only one carrageenan factory in the region. The factory is located near Tablolong Village, under the name of PT Rote Karaginan Nusantara (RKN). The company conducted its first production in September 2017 and had its first local shipment in December 2017. In 2019, RKN entered the international market for the first time by exporting carrageenan to Argentina and became the first East Nusa Tenggara company to export processed seaweed. After 2019, the company decided to not conduct any local shipments, mainly due to the Indonesian government's new tax policy increase (from 10% to 11%). In addition, the Indonesian government imposes no tax on exports, hence the profit margin is larger in doing export than local shipments.

The company produces two types of carrageenan products, which are kappa-carrageenan (produced from *Eucheuma cottonii* / *Sakol*) which contributes to 90% of the total sales, and iota-carrageenan (produced from *Eucheuma spinosum*) which contributes only 10% of the total sales. The demand for iota-carrageenan is relatively low due to its limited use for dairy products; meanwhile, kappa-carrageenan demand is significantly higher because it has wider use for industrial applications. Both products are sold in two forms, which are ATC (alkali-treated chips) and SRC (semi-refined carrageenan). Most of the buyers who buy carrageenan in the form of chips (ATC) usually have their own grinding facility and decided to buy in chip form due to its lower price compared to the powder form.

The company has a production capacity of 150 tons per month; however, the company was not able to optimize capacity, mainly due to the high price of raw materials. In 2016, before the

factory was built, the market price of raw-dried seaweed was only around USD 0.6 per kg. However, the price went up to USD 1 per kg at the time the factory finished being built in 2017. This event alone has affected the company's financial cash flow. Moreover, the price of raw-dried seaweed kept increasing until it reached USD 2.4 per kg in 2022. Due to this issue, the company could only export less than five containers in one year. In addition, the negotiation with potential buyers also took a longer time (two to six months) because the company was still considered a new and relatively small player in the industry compared to the other large existing carrageenan companies. This issue created another problem due to the market price volatility of the raw-dried seaweed when the price at the beginning of the negotiation is different compared to when the PO (purchase order) was released. For context, the cost of raw materials contributes 70% of the total cost of the product, hence the fluctuation of the raw-dried seaweed price will significantly affect the final price of the finished product.

“I can say RKN during that time was still small, and our role in the carrageenan industry was small as well, so the big players can monopolize everything. Since we were still small, we had to introduce ourselves (to the potential buyers) for setting samples and trying to introduce our capacity and everything. So the discussion will take from two months up to six months. Then finally, when we already got the order, the price (of the raw material) went up, and could not support our operation anymore. During our discussion, the price was around Rp 25,000 (USD 1.6), and when they already released the PO, the price became Rp 33,000 (USD 2.1).”

Originally, the processor owned its own seaweed cultivation area in several regions such as Alor, Rote, Semaun, and Tablolong, but all cultivations failed due to human error. Therefore, to avoid any further losses, the company decided to stop cultivating and sign a contract with the traders in the regions to buy the seaweed from them. The company is also not allowed to buy directly from the farmers, due to the government decree and also it is extremely difficult for them to bypass the traders in the region. The company was on contract with approximately 30 traders from different regions of East Nusa Tenggara and Maluku. RKN bought seaweed from Maluku due to its low price, the seaweed price in Maluku can be half the seaweed price in East Nusa Tenggara. However, since the government decree was implemented in 2022, the company has stopped buying from outside East Nusa Tenggara Province and focused only on buying from the traders in the region. In terms of transportation, the party who pays for the

cost is dependent on the agreement with the intermediaries. In some cases, the transportation cost is already included in the selling price, and in some other cases, it is not included.

Furthermore, the company is helped significantly by the government decree. Because the price of raw-dried seaweed is relatively cheap compared to recent years, the company can now export up to one container per month. One container of finished carrageenan product needs approximately 90 tons of raw materials. Hence, the amount of raw-dried seaweed bought from the traders per month is around 90 tons. As of now, the company is consistently exporting carrageenan products to several countries such as Argentina, Brazil, Chile, Spain, Russia, Germany, the United Kingdom, China, and the Philippines.

The company is applying a traceability system, that can trace every production run from the finished goods to the incoming of the raw material. Every production run will have a specific batch production number. All materials used in that particular batch number will be documented. Furthermore, the company also has a specific supplier code and delivery number for each incoming material. The company is also attributed with various certifications; such as HACCP certificate, Halal certificate, Kosher certificate, COA certificate, phytosanitary certificate, health certificate, certificate of origin, packaging certificate, and also other certificates depending on the buyers' request. The company is also maximizing automatization in the production process to avoid direct contact with products, coupled with strict quality checking (heavy metal and microbiology test) in the raw material incoming and finished goods level. These actions are important to ensure no contamination of the product since the product produced by the company is a certified food-grade labeled product.

5.3 Governance and value addition

5.3.1 Governance

In terms of governance, three critical dimensions are being analysed, which are vertical coordination, horizontal coordination, and information flow.

Vertical coordination

Most of the transactions at the farmer level are spot transactions, short-term, price-based, and mostly without negotiation. They rely much on local intermediaries and inter-island traders to sell their seaweed. For the context, most of the local intermediaries and inter-island traders are local people. During the early years of seaweed trading in the region, there were not many

traders from the local people. In the past, many farmers got scammed by external traders, which caused trust issues among the farmers to external parties. Those events also encouraged local intermediaries and inter-island traders to become traders to help the local farmers market their seaweed. Therefore, the farmers tend to coordinate with the traders informally and use trust as the main value of the relationship. The trust between the farmers and the traders extends to situations where the traders are willing to provide loans without any contractual agreement.

“Sometimes we (local intermediaries) provide funding for the farmers if they asked, usually around Rp 1 million – Rp 2 million (USD 63 – USD 126). We do this to gain their trust so they will sell their seaweed to us at harvest time. However, we cannot force low prices on them, they still have the freedom to sell their seaweed to anyone. But, of course, they still need to pay their loans on time.” (Respondent 15)

At the small-scale processor level, most of their transactions are also spot transaction-based, short-term, price-based, and mostly without negotiation. Because the owners of the small-scale business are also local people, the coordination with the farmers is mostly informal and also uses trust as the main value of the relationship.

Contractual coordination is built between the traders and the processor. Most of the transactions at the processor level are in the form of bilateral contracts, periodical terms, and mostly with negotiation. The contract with the traders is essential for the processor to ensure the traders supply seaweed with the quality standard.

“The main reason why we have a contract is for them to follow the quality standard, which is 45 days, the moisture content is supposed to be 38% (or less), the impurities have to be at maximum 2%, the color is supposed to be lighter, the goods (seaweed) not supposed to be exposed with (fresh) water, especially rain.”

When a violation of quality standards happens, the contract has the power for the processor to do a price deduction based on the calculation. The contract is periodic (one to three years period), but there is no price agreement stated in the contract because the price of raw-dried seaweed highly fluctuates.

Horizontal coordination

In terms of horizontal coordination, most of the seaweed farmers in the region are working individually. There are several seaweed farmer groups formed among the seaweed farmers; however, the groups only serve as channels to receive external governmental support and funding. For context, the Indonesian government through the Ministry of Marine Affairs and Fisheries allocates a certain amount of annual budget as part of the governmental programs to provide support for seaweed farmers and fishermen to support their production and to increase their welfare. Governmental support is varied in the form of cash or farming tools and materials. However, most of the support and funding to be distributed to the farmers can only be in the form of farmer groups and not individuals. Several farmers stated that they have tried to work collectively as groups; however, all groups failed to operate effectively.

“We have tried to work as groups, but it failed. It was difficult to distribute responsibilities between the members of the group. Some might work more and some might work less. So, we decided to just work individually. The group is only used for support distribution from the government, and not for our daily operation.”
(Respondent 3)

In terms of the traders and the processors, they are all operating individually. There is no horizontal coordination identified between those players as there are limited players within the region. The traders do have social media groups consisting of the traders in the particular region. They usually share information regarding market prices, market conditions, and other important updates regarding the seaweed sector. However, the informal groups only used as information-sharing media, and not as media to coordinate with each other.

Information flow

The two value chains, which are the unprocessed seaweed value chain and the processed seaweed value chain, have slightly different flows of information within the chain. In the unprocessed seaweed value chain, farmers gain information from the local intermediaries or inter-island traders (in some cases) regarding the prices and quality standards (as mentioned before) of the seaweed. Farmers do not gain any information regarding the quantity required by the traders, instead, they produce seaweed based on their cultivation capacity. Due to the high demand and long shelf life of raw-dried seaweed, farmers are not afraid of overproduction

of seaweed. Based on the farmers' experience, their seaweed is traded relatively fast to the traders, generally within one or two weeks post-harvesting, or at the latest within a month.

As for the local intermediaries, they gain information about price, quality, and quantity mainly from the inter-island traders. Generally, the inter-island traders will give the target quantity for the local intermediaries to fulfill. The target quantity given to the local intermediaries is important because the inter-island traders have to fulfill the maximum capacity (around 12 tons of raw-dried seaweed) of one container load (usually a 20 ft container) before the container is shipped out. The longer the time required to fulfill one container load, the more risk of weight loss faced by the inter-island traders. The weight loss of the raw-dried seaweed is approximately 1% per month, which is a relatively large amount considering the total amount of the seaweed being traded by the inter-island traders. Therefore, inter-island traders always prefer fast and direct shipping to avoid weight loss and price fluctuations.

“Sometimes we need to add more fund support to our local intermediaries to buy more seaweed from the farmers to speed up the process of fulfilling one container load. Sometimes they have limited capital to buy additional seaweed from the farmers.” (Respondent 19)

In the unprocessed seaweed value chain of the Kupang Regency, the inter-island traders are the source of information regarding the quantity, quality, and price of the raw-dried seaweed, as they are the main players that sell the unprocessed seaweed in the Kupang region to the buyers located in other provinces in Indonesia, such as Surabaya and Makassar.

In the processed seaweed value chain, both the small-scale processors and the carrageenan processor are the source of information. The small-scale processors provide information regarding the quality of the seaweed (as mentioned before). However, they do not provide information regarding quantity, because the farmers are producing based on their optimum capacity regardless of the quantity demanded by the small-scale processors. Moreover, they also do not provide information regarding price, as they follow the current market price set by the traders in the region.

The carrageenan processor provides information regarding quality, quantity, and price to the traders. The quality of the seaweed has to be raw-dried with > 45 cultivation days, < 38%

moisture content, and < 2% impurities. As for the quantity, the processor will give a target quantity for the traders to supply; however, historically the traders have no problem in supplying to the processor, as their demand is lower than the amount of seaweed that the traders can afford to supply. As for the price, in the region, the processor has to compete with the inter-island traders regarding the price of the seaweed. They compete with each other by offering higher prices to the local intermediaries. Some of the inter-island traders have collectively tried to negotiate with the processor to buy seaweed from them; however, due to several internal reasons, the negotiation has failed to succeed. Therefore, both parties have decided to be competitors to buy seaweed from the local intermediaries. However, some inter-island traders who were not part of the negotiation team, have established a good relationship with the processor. They are the ones who consistently supply to the processor, compared to numerous other local intermediaries.

5.3.2 Value addition

Quality

In terms of value addition, two dimensions are being analysed, which are quality and safety. The seaweed material flow includes activities of cultivating, harvesting, drying, storing, quality checking, and processing. At the farmer level, the cultivating and harvesting activities are essential to allow several qualities that farmers have to add to their harvested seaweed. Firstly, the seaweed has to be cultivated for a minimum of 45 days for *Sakol* and 30 days for *Sp*. Any shorter harvest time will result in a lower quantity of carrageenan content, which lowers the quality of the harvested seaweed. The shorter-period cultivated seaweed can be identified by the traders based on the seaweed's appearance and solidity. Generally, seaweed will have smaller thallus size and the seaweed will more easily crumble compared to normal. If the traders found this when they did the quality checking onsite, they would either refuse to continue the transaction or ask for the farmers to lower the price of the seaweed depending on the conditions of the seaweed.

Furthermore, the farmers have to proceed with the drying activity, because the only tradeable form of seaweed is in the raw-dried form. Although, there are a few cases where wet seaweed is traded, but mainly for research and educational purposes, and not for business purposes. In December 2023, the price of raw-dried *Sakol* was at USD 1 per kg, whereas the price of wet *Sakol* was only around USD 0.1-0.2 per kg. Moreover, the seaweed has to be dried until it reaches < 38% moisture content as the standard for most carrageenan manufacturers. If the

traders found the seaweed was not dried properly when they did the quality checking onsite, they will ask the farmers to dry the seaweed again until it reaches the standard. But, if the traders find the issue after the transaction is done, usually they will do the drying process on their own, then the weight loss will be calculated and the price of the next purchase will be cut based on it.

In addition, seaweed has to contain < 2% impurities such as sand, stones, or other foreign objects. Therefore, seaweed farmers need to ensure their seaweed is free from those impurities. Generally, seaweed farmers would use wooden racks to avoid sand blown onto the seaweed when the drying process takes place. If the traders found the seaweed was not dried properly when they did the quality checking onsite, they will ask the farmers to clean the impurities before continuing the transaction or ask for the farmers to lower the price of the seaweed depending on the amount of the impurities found.

Storing activity is also important to maintain the value of dried seaweed. Dried seaweed is extremely sensitive to fresh water. Any contact with fresh water (rain or tap water) will crumble the seaweed apart as its carrageenan will be dissolved in fresh water. Generally, dried seaweed will be packed in bags and stored in a room inside the house or storage facility. Therefore, a proper storing activity is essential to be done at either the farmer or trader level.

At the trader level, local intermediaries and inter-island traders are doing quality checking of seaweed they bought. This activity is important to maintain the overall quality of the seaweed that will be sold to the processors and the inter-island buyers so that only seaweed with the agreed standards will be sent to them.

“We do quality control before the shipping process, the seaweed that does not meet the quality standard are sent to the warehouse for further sorting and re-drying process.” (Respondent 17)

Generally, the processors or the inter-island buyers have a signed agreement regarding the quality standard of the seaweed that has to be fulfilled by the traders. Any deviation from the agreed quality standard will result in a reduced price from the original agreed price. The value addition of the seaweed itself is not existent at the trader level; however, they provide value in

terms of collecting the seaweed from several farmers which would be difficult for the processors or the inter-island buyers to do.

The highest value addition in the quality aspect of the value chain occurs at the processing stage, which comprises two types of processing (ready-to-eat snacks processing and carrageenan processing). At the small-scale processor stage, the raw-dried seaweed is processed into certified and branded products for direct consumption. Meanwhile, at the processor stage, the raw-dried seaweed is processed into certified and branded products (kappa-carrageenan and iota-carrageenan) for various industrial uses.

Safety

In terms of safety, there is no value addition traced at the farmer and trader level. The safety aspect of value addition is only found at the processing stage. At the small-scale processor stage, the production can be traced from finished goods to raw materials. The small-scale processors use the production code printed on the packaging of the finished goods, which is connected to the production batch code. The production batch code is then also connected to the list of raw material incoming code, hence the traceability can be performed from finished goods down to raw materials. Moreover, the small-scale processor is also equipped with certifications such as MD certificate (from the Indonesian Food and Drug Authority) and Halal certificate which help ensure the safety and quality of the products. Furthermore, the small-scale processors also save “retain samples” for every production batch as part of the quality control procedure. They set three months expiry date for all their products, despite their historical retain samples which can last for approximately four to five months to enhance the safety of the products.

At the processor stage, the processor also uses production codes similar to codes that are used by the small-scale processors to allow traceability from finished goods down to raw materials. Furthermore, the processor is also certified with several certifications such as HACCP certificate, COA certificate, phytosanitary certificate, health certificate, certificate of origin, and packaging certificate. The processor also provides regional certificates such as Halal certificate and Kosher certificate. All these certifications provide more safety value for the products.

5.4 Sustainability

This section will discuss the assessment of the sustainability aspect of the seaweed value chain in the Kupang Regency, which consists of environmental, economic, and social dimensions.

5.4.1 Environmental sustainability

The results of this study suggested there are four factors affecting the environmental sustainability aspect of the seaweed value chain, which consists of external factors, and three internal factors, which are the use of fuel and energy, the use of chemical inputs, and waste management.

External factors

External factors include factors from outside the seaweed value chain system which have an impact on the system. Based on the environmental sustainability assessment results, external factors have the highest impact on the environmental aspect of the seaweed value chain, as seaweed cultivation is the one that is more prone to external environmental issues. Generally, seaweed cultivation does not require any additional nutrients or fertilizers, it is extremely dependent on environmental conditions to grow.

Historically, seaweed cultivation in the region has experienced several significant impacts due to various external environmental issues. The first major environmental issue affecting seaweed cultivation in the Kupang region was the Montara oil spill incident in 2009. Due to the incident, spilled oil polluted the seawater in the region and caused all the seaweed grown by the farmers to fail. After the incident, the existing seaweed species cultivated in the region, *Eucheuma cottonii*, could not survive due to the polluted water. A few months later, the local governor brought two cool boxes of *Sakol* (*Kappaphycus alvarezii*) seeds to the farmers in Tablolong Village to cultivate. The *Sakol* species survived and become the main cultivated seaweed species in the region until now. However, the incident still affected the quality of the seawater in the region even years after the incident happened. The output of seaweed farming has significantly decreased by approximately 90% after the incident.

“Before the incident (2009 Montara oil spill), one farmer could produce up to 1 ton of dried seaweed on average per month. But after the incident, we can only produce up to 100 kg of dried seaweed on average per month, sometimes even lower than that.” (Respondent 4)

The other major environmental issue affecting seaweed cultivation in the Kupang region is climate. The most destructive climate phenomenon occurring in the Kupang Regency was Cyclone Seroja which occurred in 2021. The cyclone destroyed all existing seaweed cultivations, the seaweed farmers' boats, and the farmers' ropes used for seaweed cultivation. Due to this incident, all seaweed farmers in the region that were affected by the cyclone had to start from the beginning again. They had to spend capital to buy new seaweed seeds, ropes, and boats, which took months for them to fully recover. Based on the data collected from the Kupang Regency local government database, production of seaweed in the region decreased significantly from 1.16 million tons in 2021 to 150 thousand tons of wet seaweed in 2022.

The most recent major environmental issue affecting seaweed cultivation in the Kupang region was the Steam Fired Power Plant waste disposal issue in 2023. For context, the PLN (*Perusahaan Listrik Negara* or the Indonesian State Electricity Company) launched a new Steam Fired Power Plant located in Lifuleo Village. The power plant ran its first operation in mid-2023. However, months after the power plant began operation, farmers found out their seaweed was polluted and failed to grow. They also found out the sea water turned darker in color and had a strange odor every time the power plant was operating. Tesabela Village, which is one of the three main seaweed-producing villages in the region, located in the same bay, has been affected the most by this issue. The bay is known as the place where the ocean waves all end up, which makes the pollution concentrated more in that particular part of the sea. None of the seaweed planted could survive the polluted water in the area. The seaweed farmers in the region have stopped seaweed cultivation activities for nearly seven months, which forces them to shift their occupation to become fishermen. Other seaweed farmers in Tablolong and Lifuleo Villages also experienced the effect of the power plant waste mistreatment, although the effect is not as bad as what happened to the seaweed farmers in Tesabela Village.

The use of fuel and energy

The main internal factor affecting the environmental sustainability aspect of the seaweed value chain identified in this study is the use of fuel and energy. The activities of cultivating and harvesting seaweed are all done manually by the farmers. The drying activity does not use any electricity and only uses sunlight as its natural energy. In terms of fuel, the farmers are still using petroleum. Petroleum is used as the fuel for the boats for transport to and from the cultivation area. However, the use of petroleum-fueled boats is only applied to some of the seaweed farmers who also work as fishermen. Fishing activities require the fishermen to go

further away from the coast, hence they require boats with fuel energy to help them in fishing activities. Meanwhile, approximately half of the seaweed farmers who do not have any other jobs are mostly using boats that are manually driven by paddles as seaweed farming is being done near the coastal area. At the trader level, they require the use of fossil fuel for trucks for transportation to transfer their seaweed from one place to another. However, at this point, there are no other options for transport fuel available in the country.

At the small-scale processor level, they use kerosene for the cooking process. For context, the majority of households in the regions are still using kerosene for cooking purposes. Other than cooking, small-scale processors are also required to do the drying process, specifically for *dodol* production. In the drying process, small-scale processors use natural sunlight, which is considered more environmentally friendly and free of cost. Moreover, the sunlight intensity in coastal areas is relatively high compared to other areas in the region.

At the processor level, the factory implements a 24-hour nonstop production for the boiling machine to reduce the power usage for the starting phase (the starting phase generally consumes more power compared to the running phase). The factory uses electricity from the national electricity company, which is mainly produced from steam and gas-fired powered plant. Production will only stop when there is no production scheduled or when cleaning or maintenance are scheduled. In addition, the factory also uses a technology called a circular drier system for energy efficiency purposes. However, sometimes the circular drier system is not capable enough to dry the entire WIP (work in progress), then the company also uses natural sunlight as an additional option for the drying process.

“... We also implemented a technology for our energy efficiency named circular drier system. The system utilizes hot vapor taken from our boiling process, then (the system) will circulate it as a heater for the drying process at a later stage. This technology can save us a large amount of electricity.”

The use of chemical inputs

Aside from the use of fuel and energy, the use of chemical inputs is also identified as an internal factor affecting the environmental sustainability of the seaweed value chain. The use of the chemical-inputs factor indicates the use of chemical materials in seaweed value chain activities which are potentially harmful to the environment. At the farmer level, there are no chemicals

used by the seaweed farmers whether in cultivating, harvesting, or drying activities. Seaweed cultivation does not require any fertilizers to grow. After the seaweed seeds are placed in the sea, no treatments are required to be done to the seaweed until the day of harvest. Seaweed only needs sunlight and nutrients from seawater to grow. However, seaweed farmers are using ropes made from polyethylene material and empty plastic bottles as tools for seaweed cultivation, which might release microplastics into the sea.

At the trader level, there are no chemical inputs used in their trading or storing activities. At the small-scale processor level, there are also no chemical inputs used in their processing activities. However, at the processor level, in the process of transforming raw-dried seaweed into carrageenan, the seaweed has to be cooked with an alkaline solution, in this case, potassium hydroxide (KOH), which after the process will be discharged and become liquid waste.

Waste management

Another critical internal factor that affects the environmental sustainability aspect of the seaweed value chain identified in this study is waste management. The waste management factor indicates the treatment and disposal management of waste or pollutants produced in seaweed value chain activities. At the farmer level, the only waste produced at the farmer level is the discharge of the lubricant waste used for the petroleum boats to the sea by the seaweed farmers. However, seaweed farmers themselves have been highly aware of the environmental impact of their actions, and are urging each other to do better waste management by not discharging the lubricant waste into the sea. At the trader level, the only pollutant is the carbon emission of the trucks used for the raw-dried seaweed transport. However, at this point, there are no other options for transport fuel available in the country. In terms of waste, there are no wastes identified in any of the traders' activities.

At the small-scale processor level, there are two types of waste produced as the byproduct of seaweed processing, which are liquid waste and solid waste. The liquid waste originates from the water used to wash and clean the raw-dried seaweed before proceeding to the cooking process. The liquid waste is then managed by throwing it into a septic tank to avoid contaminating the environment. Whereas, the solid waste originates from the leftover or below-standard seaweed and WIP (work in progress) due to the sorting and quality control processes. The solid waste is burned to avoid contaminating the soil and water nearby.

The only waste produced as the byproduct of carrageenan processing is liquid waste. The liquid waste originates from the alkaline solution (KOH) used for the cooking process. The liquid waste is collected in four ponds made of coral stones near the facility, which is located far enough from the ocean and the village residents.

“We do have four ponds which have never been fully filled throughout six years of our production. The liquid part of the waste will evaporate due to the high sunlight intensity, and some are absorbed by the coral stones within the ponds.”

The evaporation and the absorption of the liquid part of the waste will leave only a small volume of waste sediments in the ponds, hence the four ponds have never fully filled. This liquid waste has the potential to pollute the environment; however, it is claimed to be handled well with proper waste management. Moreover, throughout the six-year period, there have been no complaints filed by other parties in regards to the waste.

5.4.2 Economic sustainability

The results of this study suggested there are four factors affecting the economic sustainability aspect of the seaweed value chain, which consists of external and internal factors. External factor consists of price stability, while internal factors consist of profitability, economic independence, and diversification.

Price Stability (external factor)

The price stability factor indicates the overall consistency level of seaweed prices over time. Based on the economic sustainability assessment results, price stability has the most impact on the economic aspect of the seaweed value chain. From an economic perspective, the seaweed sector is considered a high-profitable sector, especially in regions where the sea area is suitable for seaweed to grow. Seaweed has been the main source of income for people living in the three villages (Tablolong, Lifuleo, and Tesabela) for more than two decades, which emphasizes the economic importance of the sector to the region. However, despite being the main sector in the region, seaweed has one major weakness in terms of the economic aspect, which is its price instability. The market price of raw-dried seaweed fluctuates significantly compared to other commodities.

All respondents in the study pointed out how unstable the seaweed price is. The price instability of seaweed is one of the reasons that traders and processors could not fix a price in their long-term contracts with their external buyers. Once the traders agree on one price with their inter-island buyers, they will immediately fill up containers so they can be shipped on time. There were cases where they could not fill the container load on time (usually within one week) and at that time the price of the raw-dried seaweed went up. In that case, the traders had to cover up the price differences and ended up losing profits.

There were also cases where the processor faced difficulties reaching an agreement on their carrageenan product price with their international buyers, as the negotiation with them might take a longer time to settle. As the price of a carrageenan product is highly dependent on the price of its raw material, slight changes in raw material price will affect the profit margin of the carrageenan product.

Even though traders and processors are troubled by this issue, they can adjust their selling price to maintain their profit margin. The much bigger effect of this issue might be felt by the farmers because their whole income is entirely dependent on the market price of seaweed. When prices are high, seaweed farmers can live with their families in a comfortable way. However, when the prices are low, their income is only sufficient for daily needs. In some cases, they would ask to borrow some money from the local traders and guaranteed to sell them their seaweed once harvest comes.

To reduce the impact of this issue, small-scale processors and the carrageenan processor have tried several hedging strategies to reduce the negative impact caused by the seaweed price instability, such as mass-buying raw-dried seaweed only when the prices are low to create a buffer stock or implementing a fixed production cost strategy. Fixed production cost is a strategy used to maintain the price of finished goods without decreasing any profit margin even when the cost of production is increased.

“To reduce price instability risk, we deliberately use a fixed production cost strategy. We put the price of raw dried seaweed at 1.5 USD/kg in our production cost calculation even though the real market price is only 1 USD/kg. We do this to protect our profit margin when the real market price of the seaweed is going up. We

do not want to change our finished goods prices too often, because it will negatively affect our market sales.”

Profitability

Another critical factor that is affecting the economic sustainability of the seaweed value chain identified in this study is the profitability of the businesses. The profitability factor indicates the capacity of the seaweed value chain players to generate profits or financial gains after accounting for all expenses and costs. At the farmer level, the average capital to start a seaweed farming business is approximately 1,680 USD, and the useful life of those assets is around four years. Seaweed farming activities do not require any operational costs, assuming all assets are well maintained. However, if farming tools or materials are broken or go missing, seaweed farmers have to replace those with new ones. Assuming the market price of raw-dried seaweed is 1 USD/kg (the actual market price when the data collection was conducted), and the average production of one seaweed farmer is 500 kg/month, the average revenue that a seaweed farmer can get is 500 USD/month. If we divide the capital cost (1,680 USD) by 48 months, we can assume the average capital cost that a seaweed farmer spends is 35 USD/month.

At the local intermediary level, the cost of the business is the cost of raw-dried seaweed purchased from the farmers and transportation costs. The average amount of seaweed traded at the local intermediary level is 10 tons/month. Assuming the market price of raw-dried seaweed is 1 USD/kg, the total cost of the purchased seaweed is 10,000 USD/month. Meanwhile, the average cost of transportation is 330 USD/month. Hence, the average total cost for the local intermediaries is 10,330 USD/month. The local intermediaries set a price of 1.083 USD/kg for raw-dried seaweed sold to the inter-island traders. Hence, the average revenue of the local intermediaries is 10,830 USD/month.

At the inter-island trader level, the cost of the business is the cost of raw-dried seaweed purchased from the local intermediaries and transportation costs. The average amount of seaweed traded at the inter-island trader level is 100 tons/month. The average market price of raw-dried seaweed at the local intermediary level is 1.083 USD/kg, therefore the total cost of the purchased seaweed is 108,300 USD/month. Meanwhile, the average cost of transportation is 3,300 USD/month. Hence, the average total cost for the inter-island traders is 111,600 USD/month. The inter-island traders set a price of 1.167 USD/kg for raw-dried seaweed sold

to the processor or external buyers. Therefore, the average revenue of the inter-island traders is 116,700 USD/month.

At the small-scale processor level, the average production capacity for one day is 116 packs. However, the small-scale processor only operates twice a week; hence, the overall production capacity is 928 packs/month. One kg of raw-dried seaweed can be processed into up to 156 packs of ready-to-eat snacks. The average cost per day of production (including all the operational costs and labor costs) is 100 USD/day or 800 USD/month. Each pack of snacks is sold with at the price of 1 USD/pack. Therefore, the average revenue of the small-scale processor is 928 USD/month. The average revenue of the small-scale processor is considered low compared to the other seaweed value chain players. There are several limitations faced by small-scale processor to increase their overall profits; such as limited consumer demand and short product shelf life, which causes them to produce less to avoid oversupply.

At the processor level, the average production volume of the factory is one container/month, where one container consists of 30 tons of carrageenan powder. The production of one kg of carrageenan powder requires three kg of raw-dried seaweed. The average market price of raw-dried seaweed purchased by the processor is 1.167 USD/kg. In addition, the cost of the raw material is 70% of the total cost of carrageenan production, whereas the 30% consists of other operational and labor costs. Hence, the total cost of carrageenan powder production is 1.667 USD/kg or 150,030 USD/month. The market price of the carrageenan powder at that time was 7 USD/kg, therefore, the average revenue of the processor is 210,000 USD/month. However, it is important to note that when the study was conducted, the raw-dried seaweed price was at the lowest point (1 USD/kg at the farmer level) in recent years. Due to the low price of the raw material, the company was able to secure a higher profit margin. In 2022, the price of raw-dried seaweed in the Kupang Regency was 3 USD/kg at the farmer level, which caused the company to struggle financially because they could not afford enough profit margin to support their operational costs.

Economic independence

Another factor affecting the economic sustainability aspect of the seaweed value chain identified in this study is economic independence. Economic independence factor indicates the ability of the seaweed chain players to support themselves financially without relying on external support (financial or non-financial support) or sources of income. At the farmer level,

farmers do not regularly receive external subsidies from the government or NGOs, hence they are not economically dependent on those external parties. However, in some cases, when they need urgent money, they usually ask for some money from traders and then promise the traders to sell the seaweed to them at harvest time. This event also happens at the trader level, where local intermediaries in some cases ask for more funds from the inter-island traders to buy more seaweed as requested.

At the small-scale processor and processor level, there is no regular external funding or subsidies from external parties. However, their business is highly dependent on governmental regulations. For example, the governor's decree in 2022 initiated the external shipment ban of raw-dried seaweed resulting in an excess supply of raw-dried seaweed within the region. This excess supply caused a significant price drop of the raw-dried seaweed, which favored the processors because they could reduce the COGM (Cost of Goods Manufactured) of their products.

Diversification

The last factor affecting the economic sustainability aspect of the seaweed value chain identified in this study is diversification. The diversification factor indicates the ability of the seaweed value chain players to spread their business across different products and sources of income to reduce risks and optimize returns. In terms of income diversification, approximately half of the seaweed farmers are also working as fishermen. Generally, they start working on seaweed farming from dawn to noon, then continue fishing from afternoon until night. However, they claimed that seaweed farming is still the main source of their income, and fishing is considered their additional source of income. They decide to have a secondary occupation because seaweed market prices fluctuate, hence they feel like they need to have another source of income, especially when the seaweed market price is relatively low compared to its normal market price.

The decision of having a secondary occupation as fishermen by the seaweed farmers is affected by geographical aspect. The seaweed farmers who are also working as fishermen are only living in the villages that have strong waves in its sea area, which are the Tablolong and Tesabela Villages. Meanwhile, seaweed farmers in Lifuleo Village are all only working as seaweed farmers. They claimed that the low intensity of waves in their sea area cannot support their fishing activities; hence, they decided to only work as seaweed farmers.

At the trader level, some of them also have a secondary occupation as their other source of income. Some traders are working as regular employees in private companies, and some are even working as seaweed farmers. At the small-scale processor and processor level, both players do not have any income diversification as they only focus on their seaweed processing activities.

“I (inter-island trader) also work as an employee in one private company. I do this for additional income. My main source of income is still from my seaweed trading. But, we never know what will come in the future, so for me, it is important to have more than one source of income.” (Respondent 13)

In terms of product diversification, the diversification of the seaweed business at all levels of the seaweed value chain is still limited due to only one species (*Sakol*) that is dominantly cultivated in the region. Hence, if there were any specific diseases or fluctuating market prices of *Sakol*, the seaweed farmers would not have any other option to run with. Although there is *Sp* species option which is more resistant to environmental pollution compared to *Sakol*; however, the low market price of *Sp* makes it not viable to depend on it economically. In fact, the situation right now where the price of *Sakol* has reached its lowest point in recent years, and also the water pollution problem causes seaweed farmers to struggle in their farming activities. However, there is an ongoing plan where the local government is in the process of finding another species option for seaweed cultivation, but the research has not generated any results yet.

5.4.3 Social sustainability

The results of this study suggested there are four factors affecting the social sustainability aspect of the seaweed value chain, which are 1) society contribution, 2) quality of life, 3) working conditions, and 4) training and education.

Society contribution

Society contribution factor indicates the activities, efforts, or resources provided by the seaweed value chain players to benefit the broader community or society as a whole. The seaweed sector has been the main source of income for people living in the three villages (Tablolong, Lifuleo, and Tesabela) for more than 20 years. Seaweed production has become the identity of those villages for decades. Acknowledging that they have the same main source

of income, as a society, the seaweed farmers are regularly helping each other in their activities. Although they are not working in the form of a farmers group, they collaborate to help each other for greater benefits.

“We (seaweed farmers) regularly help our neighborhood when we can. Sometimes we even ask our wives to help other farmers tie the seaweed seeds to the ropes. There are hundreds of ropes to finish, it would be hard to finish those alone. We are all doing without any pay because we consider everyone here a family.”
(Respondent 6)

The traders regularly provide money to the farmers when they need it. In addition, they also provide more transactional safety to the farmers, because the farmers do not have to deal with external traders, where many of them were scamming the farmers in the past. As for small-scale processors, they contribute by buying seaweed from the farmers and also provide employment for their processing activities.

At the processor level, the company has tried several actions to also contribute to society. One of the actions the company focused on doing is to conduct several CSR (Corporate Social Responsibility) activities. The CSR is intended specifically for seaweed farmers by donating capital, farming tools, and farming materials. Moreover, the company also collaborated with Nusa Cendana University to provide farming training for seaweed farmers. The company also collaborated with East Nusa Tenggara Bank to provide credit to the seaweed farmers.

“... We are aware that we as a company need to also contribute to society. Our CSR and all other programs are designed to help the society here, especially the seaweed farmers. We acknowledge that their existence is important to us and we also want to build a good relationship with them.”

Quality of life

Another critical factor affecting the social sustainability aspect of the seaweed value chain identified in this study is quality of life. The quality of life factor indicates the overall well-being and satisfaction experienced by the seaweed value chain players. At the farmer level, all the farmer respondents claimed that their overall quality of life has increased because of their work in the seaweed sector, especially when seaweed prices are high.

“Seaweed is our (seaweed farmers) main job. Our daily needs and our children’s educational fees are all from seaweed. We can also build our houses, buy motorcycles, and many else.” (Respondent 7)

At the trader level, all the trader respondents also claimed that their overall quality of life has increased because of their work in the seaweed sector. They also can build houses, buy motorcycles, and pay tuition fees for their children because of the money from seaweed trading activities. At the small-scale processor and processor level, they ensure they always pay their employees on time and in a fair amount based on every employee’s skills and capabilities.

Working conditions

Another factor affecting the social sustainability aspect of the seaweed value chain identified in this study is working conditions. The working conditions indicator indicates the environment and circumstances in which the seaweed value chain players and their employees perform their jobs. At the farmer level, the farmers admit that the job requires physical strength, but they do not complain about it, as they understand they need to make an effort to get income. They feel that they forget their fatigue when they see their cultivation succeed and are able to get money from it. They generally work for 8 – 10 hours from early in the morning (between 4 am – 5 am) to noon (12 pm to 3 pm) depending on the situation. However, they point out the flexibility of the job, where they can freely manage their own working time and not be pressured by any other party. Hence, they can freely take a day off whenever they feel tired or unhealthy. In terms of safety, although the farmers go to the sea area without any safety equipment, they claim that most of them are able to swim and also due to the distance between the coast and the cultivation area is not too far, hence they feel quite safe when they are doing their seaweed farming activities.

At the trader level, they do not have a regular working time as most of their work is based on the orders from their buyers. They do not need to do any physical activities in their job, but they are mostly feeling stressed mentally due to issues in their trading business.

“Actually, we (inter-island traders) are not that tired. However, we need to think a lot. We need to move one step ahead of everybody. We need to contemplate our strategy because this seaweed sector has numerous players in it. Therefore we need to be always one step ahead to survive in this sector.” (Respondent 19)

At the small-scale processor level, there are no serious issues identified related to working conditions. The working hours for the employee are normal working hours (8 hours). The small-scale processor does not regularly ask the employees to do overtime. When the demand is high (usually due to preorders from large events), the small-scale processor would hire more daily workers from the neighbourhood. Although the processing activities are mostly done manually; however, there are not many physical activities involved throughout the process.

At the processor level, they admit that they are currently asking their employees to work overtime (12 hours a day). This is due to financial issues where they can not add more employees. The factory has to continuously run for 24 hours, and they only have 8 workers available. However, they ensure that they always conduct safety protocol training and provide complete PPE (boots and masks) to ensure the safety of their employees.

Training and education

The last factor affecting the social sustainability aspect of the seaweed value chain identified in this study is training and education. In terms of informal education such as farmer training, the farmers do not regularly receive training either from the government or non-governmental organizations. Most of them claimed that they received official training only at the beginning when seaweed cultivation was introduced to the people in the region in 1999. While a few of them claimed that they received official training regarding seaweed cultivation knowledge and techniques once in a while. However, the trainings are considered ineffective as the farmers claimed that it could not help them solve their main problems.

“We sometimes receive training from the government; however, it did not resolve our problems. We have been asking for solutions regarding the seaweed disease and seawater pollution issues, but they could not give us any.” (Respondent 2)

Most of the farmers learn and try to minimize the problems by themselves as they have more than 20 years of seaweed farming experience. At the small-scale processor and processor level, they ensure that they conduct consistent training for their employees. The trainings cover the daily operation procedures and safety protocols within the processing sites.

In terms of formal education, most of the farmers, local intermediaries, and small-scale processors' educational backgrounds are between six to twelve years of education. On the other

hand, The educational background of the inter-island traders varies between six to sixteen years of education (university level), which indicates that most of the inter-island traders have a higher level of education compared to most of the other value chain players. Most of the value chain players are already at working age, hence they do not consider continuing their formal education. They tend to be the ones who provide education fees for their children. All farmer and trader respondents claimed that they can provide good education to their children because of their work in the seaweed sector. Some of them even can support their children to master degree level. However, the data shows that the inter-island traders have a higher level of education compared to the local intermediaries and the seaweed farmers.

5.5 Summary

The finding of this study reveals there are two types of seaweed value chains in the Kupang Regency, which are unprocessed and processed. In addition, there are five main players within both types of seaweed value chains: smallholder farmers, local intermediaries, inter-island traders, small-scale processors, and carrageenan processor.

Regarding vertical coordination, most of the transactions at the farmer, local intermediary, and small-scale processor level are informal transactions. Meanwhile, contractual coordination is used at the inter-island trader and processor level. In terms of horizontal coordination, all the value chain players are operating individually. In terms of the information flow of the unprocessed seaweed value chain, the farmers and the local intermediaries gain information (price, quality, quantity) from the inter-island traders as the source. Whereas, small-scale processors and carrageenan processor are the sources of information in the processed seaweed value chain. The highest value addition in the quality aspect of the seaweed occurs at the processing stage. Small-scale processors and carrageenan processor transform raw-dried seaweed into certified and branded products. Regarding safety, the aspect is only found at the processing stage, using a product traceability system and equipped with various certifications.

The findings of this study reveal there are four factors affecting the environmental sustainability aspect of the seaweed value chain: external factors (climate and pollution related), use of fuel and energy, use of chemical inputs, and waste management. Four factors affecting the economic sustainability aspect: price stability, profitability, economic independence, and diversification, and four factors affecting the social sustainability aspect: society contribution, quality of life, working conditions, and training and education.

Chapter 6: Discussion

Introduction

This chapter discusses the research findings about the seaweed value chain analysis and sustainable assessment with previous studies. The chapter is divided into four sections. Section one discusses the seaweed value chain mapping in the Kupang Regency. Section two discusses the governance in the seaweed value chain. Section three provides a discussion about sustainability assessment of the seaweed value chain. The final section summarises the overall main points of the chapter.

6.1 Seaweed value chain mapping in the Kupang Regency

The findings of this study indicate that there are two types of seaweed value chains in the Kupang Regency which are: 1) unprocessed raw-dried seaweed value chain for the domestic (inter-provincial) market and 2) processed seaweed (ready-to-eat snacks and carrageenan) value chain for the local and export market. There are also other studies that found an agricultural product with multiple value chains, such as citrus value chains in Pakistan (Siddique & Garnevska, 2018) and cashew nut value chains in Tanzania (Krepl et al., 2016), that consist of two types of value chain, unprocessed and processed. Multiple value chains of a product in one region usually exist when a product is involved in different pathways and processes that are executed by different value chain players within the same geographical area.

The unprocessed seaweed value chain dominates with approximately 90% of total seaweed flow in the region, while only 10% of the seaweed goes to processors. This finding is aligned with previous studies that suggest there is a large discrepancy between seaweed production volume and seaweed processing capacity in the East Nusa Tenggara Province (Wabang et al., 2022, Langford et al., 2023). The large discrepancy between seaweed production volume and seaweed processing capacity in the region means the majority of the seaweed in the region is shipped to other regions in Indonesia, such as Makassar and Surabaya (Wabang et al., 2022).

In terms of the main players in the both unprocessed and processed seaweed value chain, this study reveals five main players in the seaweed value chain in the Kupang Regency: seaweed farmers, local intermediaries, inter-island traders, small-scale processors, and carrageenan processor. Two previous studies regarding seaweed market potential (Wabang et al., 2022) and seaweed industry policy issue (Langford et al., 2023) also highlighted seaweed farmers, local

intermediaries, inter-island traders, and carrageenan processor as the main players of the seaweed value chain in the region. However, both of these studies did not specifically mention small-scale processors as one of the main players in the seaweed value chain. This is probably due to the low impact of the small-scale processors in terms of trade volume compared to the overall flow of the seaweed in the region. Despite that, other studies (Poeloengasih et al., 2014, Tangguda et al., 2022) have mentioned the importance of the small-scale processors' role in the seaweed sector. The studies highlighted the significance of the small-scale processors for the community empowerment aspect in the region.

6.2 Governance in seaweed value chain

In terms of vertical coordination of the seaweed value chain, this study indicates that most of the transactions between farmers, local intermediaries, and small-scale processors are done informally and use trust as the main value of the relationship. This situation where the value chain players (especially farmers and local traders) are regularly undertaking informal transactions was also identified in other studies such as in the tuna value chain in East Java (Satria & Li, 2017) and the coffee value chain in South Sumatera (Fauzi et al., 2023). Both these studies identified the common practice of informal transactions between value chain players in these regions. Furthermore, Sahban (2018) and Ferris et al. (2014) also highlighted the importance of informal transactions in developing countries, where informal markets are the main distribution channels for farmers and traders who are currently not able to compete in modern markets.

The findings of this study also indicate that most transactions between inter-island traders and the carrageenan processor are contractual transactions, with a duration of one to three years. This situation is also identified in other studies such as the study of the vegetable value chain in Central Java (Widadie et al., 2021), where contracting mechanisms are essential to create stronger coordination between players who operate in high-value markets.

In terms of horizontal coordination of the seaweed value chain, the findings of this study point out that there is no observed coordination between the chain players at the same level. Due to the non-existence of any producer organisations, seaweed farmers have a relatively low ability to find other market channels and totally rely on local traders to buy their seaweed. This situation puts the seaweed farmers in a position where they have relatively low bargaining power against the local traders. Literature on vegetable producer organisations (PO) in East

Java and rice PO in Sri Lanka (Fernando et al., 2021) mentioned that strong horizontal collaboration between the smallholder farmers can help the PO have more power to negotiate with other market channels, which ultimately will give smallholder farmers more bargaining power in their transactions (Widadie et al., 2021).

In terms of information flow, this study shows that farmers and local intermediaries gain information (price, quality, and quantity) from the inter-island traders (in the unprocessed seaweed value chain), and from the processors (in the processed seaweed value chain). In addition, this study also shows that the information flow between the players is relatively well executed. This is demonstrated by how well the value chain players are educated regarding the quality standards required by the processors and external buyers. This situation is quite different from most of the literature (Nakasone et al., 2014, Jouzi et al., 2017), where usually smallholder farmers in developing countries are struggling with accessing information due to ineffective information flow down the value chain. Other studies (Otsuka et al., 2016) also emphasize the situation in developing countries where smallholder farmers are generally not aware of the quality standards required by external buyers.

6.3 Sustainability

This section will discuss the assessment of the environmental, economic, and social sustainability aspects of the seaweed value chain in the Kupang Regency in relation to the previous studies.

6.3.1 Environmental sustainability

The results of the current study revealed that seaweed farming activities have a relatively low negative impact on the environment. In general, agricultural activities have the highest environmental impact at the farming level in the value chain compared to the processing level (Boye & Arcand, 2013). However, seaweed farming operates differently than other agricultural systems. Seaweed farming does not have any major environmental impact at the farmer level. In fact, many recent studies have identified the high potential of carbon capture by seaweed farming activities (Mashoreng et al., 2019, Jones et al., 2022, Johnston et al., 2023). Carbon capture refers to the process of trapping carbon dioxide (CO₂) emissions by taking advantage of the ability of plants to utilize CO₂ in photosynthetic processes (Mashoreng et al., 2019). The carbon capture ability of seaweed can help reduce the CO₂ content of seawater. The lack of CO₂ level in seawater will cause the seawater to draw more CO₂ from the atmosphere into the

water to maintain equilibrium, which will indirectly reduce the CO₂ level in the atmosphere. (Hurt et al., 2022).

Other studies have also identified the role of seaweed farming as the biofilters. Seaweed can absorb excess nutrients such as nitrogen and phosphorus from the seawater, which helps mitigate eutrophication and improve the overall quality of the seawater (Kang et al., 2021, Duarte et al., 2022), which emphasizes how seaweed farming can positively impact the environment.

In this study, seaweed farming uses tools that are made of polyethylene material and empty plastic bottles which potentially release microplastics into the sea. The practice of using these materials is still considered a common practice in seaweed farming activities, especially in Indonesia. Nonetheless, the real impact of this practice may not yet be fully understood and could worsen if it continues for many years. A recent study has raised awareness of this issue and suggests a shift from polyethylene ropes to wool ropes to reduce plastic use in the seaweed sector. However, the viability and durability of this alternative material should be further evaluated before fully replacing plastic ropes (Drury & Crotty, 2022).

This study also reveals that seaweed farming is more prone to the negative impact caused by external factors (climate and pollution) outside of the seaweed value chain compared to its internal factors as shown in Table 6.1. The external factors that historically impact seaweed farming identified in this study are sea pollution (Montara oil spillage and power plant waste mistreatment) and *force majeure* (Cyclone Seroja). Those incidents were also pointed out by several previous studies; such as Spies et al. (2017) and Ryan & Parry (2021), that discussed severe the impact of the 2009 Montara oil spillage on seaweed farming around the Timor Sea. Spies et al. (2017) reported that a well on the Montara platform near Australia blew out in August 2009 and spilled oil into the Timor Sea (Figure 6.1) for as long as 74 days. The oil was spread over a large area of the Timor Sea and eventually into Indonesian sea regions. Ryan & Parry (2021) reported the oil spill affected around 81 villages in the East Nusa Tenggara Province, killing seaweed cultivated by more than 15,000 seaweed farmers in the region. Even worse, the effect of the Montara oil spillage also caused a significant decline in seaweed production for many years even after the incident occurred.

Table 6.1. Sustainability assessment of the seaweed value chain.

Sustainability factor	Sustainability performance assessment
Environmental	
External factors (climate & pollution)	○ ○ ○ ○ ○
The use of fuel and energy	★ ★
The use of chemical inputs	★ ★
Waste management	★ ★
Economic	
Price Stability	○ ○ ○ ○ ○
Profitability	★ ★ ★ ★
Economic independence	★ ★ ★
Diversification	★ ★ ★
Social	
Society contribution	★ ★ ★ ★ ★
Quality of life	★ ★ ★ ★ ★
Working conditions	★ ★ ★
Training and education	★ ★

Note. More points represents more frequency of critical impact identified from the respondents in the study.

○ represents negative impact, ★ represents positive impact.

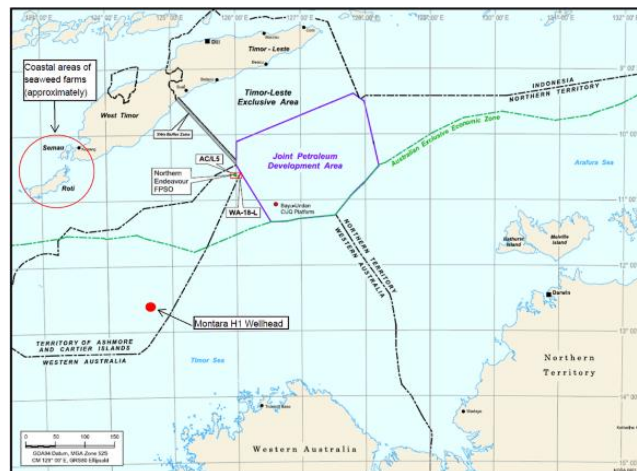


Figure 6.1. The location map of the 2009 Montara oil spillage incident (Ryan & Parry, 2021).

Other studies pointed out the effect of Cyclone Seroja on seaweed farming in the Kupang region. Sekaranom et al. (2021) reported that the destruction caused by Cyclone Seroja and the loss of seaweed farming was estimated at more than USD 400,000 USD. Langford et al. (2023)

also reported there was a decline in seaweed trade volumes from 6.93 kT (2020) to 4.36 kT (2021), which was likely due to the impact of Cyclone Seroja in April 2021. Seaweed farmers claimed that the cyclone had destroyed their seaweed cultivations, boats, and farming tools. Hence, they had to start their business from the beginning again.

6.3.2 Economic sustainability

From an economic perspective, the outcomes of this study reveal that the business in the seaweed sector is considered profitable for its players. This is shown by the amount of income generated by the value chain players, which is mostly greater than the average wage within the region. In addition, the seaweed sector has been sustained as the main source of income for the majority of people living in the coastal villages for over two decades. Several previous studies on the Indonesian seaweed sector have also indicated positive economic impacts of seaweed farming on the coastal communities (Wijayanto et al., 2020, Rimmer et al., 2021, Jibreal & Nursafitri, 2023). A study in North Sulawesi revealed that 73% of participating seaweed farmers claimed their economic aspect of life was getting better due to seaweed farming (Rimmer et al., 2021). The results of a study in Karimunjawa Islands (Central Java) claimed that the revenue-to-cost ratio for seaweed farming is 6.04, which was considered high (Wijayanto et al., 2020). There was also a study conducted in Luwu Regency, South Sulawesi, which stated that seaweed cultivation has a significant impact on people's income within the region (Jibreal & Nursafitri, 2023). A study in the Philippines also suggested that seaweed farming has a high potential to generate revenue for coastal communities (Alin et al. 2015). All studies also agreed that one of the major factors why the seaweed sector is considered profitable is due to how cost-friendly seaweed farming is compared to other agricultural products.

Despite its profitability, the outcome of this study also revealed that the economic sustainability of the seaweed value chain is also greatly affected by external factors outside the system, such as price instability. Price instability of seaweed is caused either by government policies or fluctuations in the seaweed market price in China, which is the most dominant player in the global seaweed industry (Avila-Peltroche & Villena-Sarmiento, 2022). The results of this study also correspond to several previous studies on the seaweed sector. Langford et al. (2023) reported that the seaweed prices in Kupang have dropped significantly from 2.2 USD/kg in July 2022 to 1.2 USD/kg in November 2022. The significant price decrease was strongly influenced by the implementation of the governor's decree which regulates the external shipment ban of raw-dried seaweed in August 2022 (Figure 6.2). Due to the new regulation,

traders were not able to sell seaweed from the region to external buyers. In addition, the lack of processing capacity within the region made seaweed produced by the farmers become stockpiled. The excess supply of seaweed resulted in a decrease in seaweed prices and seaweed leftover within the region (Langford et al., 2023).

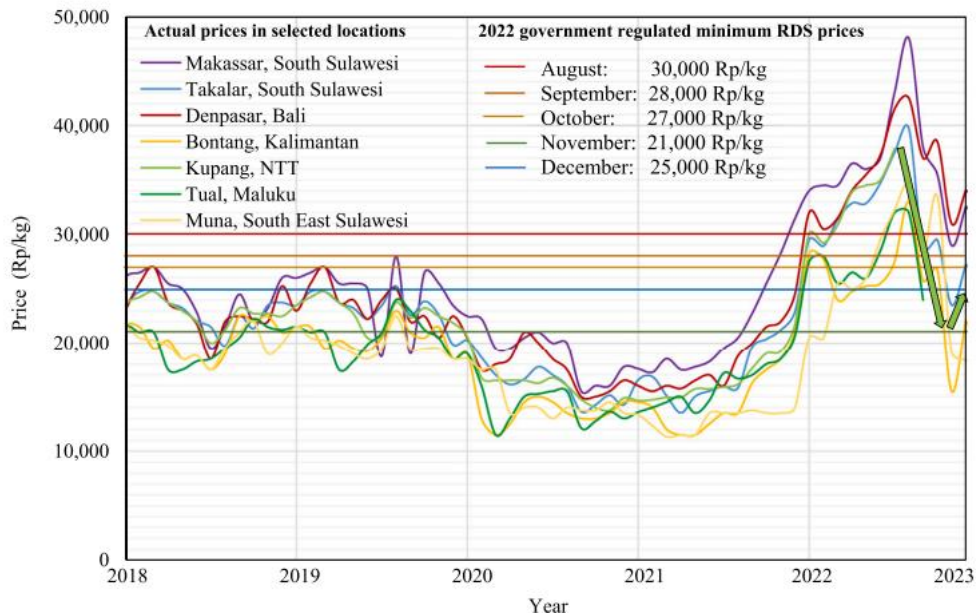


Figure 6.2. Seaweed prices in the Kupang region, represented by green line (Langford et al., 2023).

Another factor that is causing price instability of seaweed is the domination of the Chinese seaweed market. This result corresponds with other previous literature, such as the study on Peru's seaweed sector stated that volumes and prices of seaweed in the region are mostly dictated by the Chinese seaweed market (Avila-Peltroche & Villena-Sarmiento, 2022). China dominated the seaweed market in Peru by importing approximately 90% of the total seaweed produced from Peru, hence the Chinese seaweed importers had a large influence on the prices of seaweed in Peru. When the demand from Chinese buyers is high, the prices will increase; but when the demand is low, the prices will drop (Avila-Peltroche & Villena-Sarmiento, 2022).

Another study also examined the influence of the Chinese seaweed market on the Indonesian seaweed sector. Zhang et al. (2023) reported that China's influence on the Indonesian seaweed sector started growing since the introduction of major investments by the three largest Chinese carrageenan producers, named Shanghai Brilliant Gum (under the name BLG or *Biota Laut Ganggang* in Indonesia), Greenfresh, and Longrun Newstar. Several drivers that encourage Chinese companies to invest in Indonesia are 1) the reliance on imported raw materials (raw-

dried seaweed), 2) minimizing any trade disruption risks, 3) lower energy and labor costs, and 4) more loose environmental regulations. The Chinese-invested companies have emphasized their influence on the Indonesian seaweed sector. The high demand from the Chinese carrageenan companies is one of the reasons why 80% of the Indonesian exported seaweed is going to China. The introduction of BLG in 2017 and Greenfresh China in 2021 have increased the demand for raw-dried seaweed, especially in the South Sulawesi region, which also increased its price significantly (Figure 6.3).

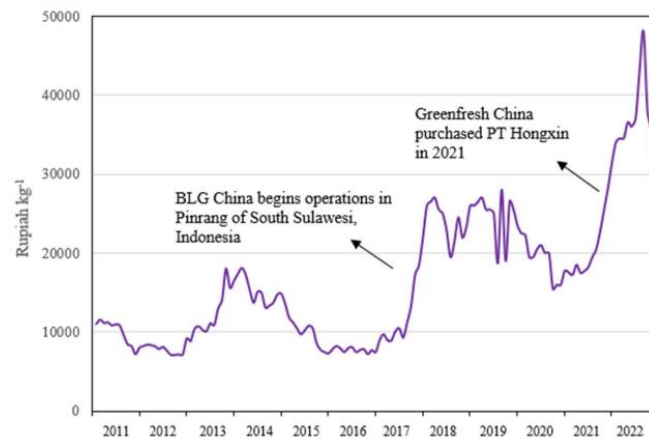


Figure 6.3. Seaweed prices in the South Sulawesi region (Zhang et al., 2023).

Despite the positive influence on raw-dried seaweed prices for the farmers, the existence of the Chinese carrageenan processors has put immense competition for the local carrageenan processors. Furthermore, the study also reported that industry actors stated that, BLG and Greenfresh set the prices for raw-dried seaweed at the beginning of every week because of their dominance in the seaweed market (Zhang et al., 2023). Therefore, Indonesian seaweed value chain players have limited power to control the prices of seaweed, and mostly rely on the prices set by the Chinese seaweed companies and markets.

6.3.3 Social sustainability

From the social perspective, the results of this study indicate that the seaweed value chain in the Kupang Regency is considered socially sustainable. Quality of life and society contribution (collaboration and employment) aspects are two main factors that socially sustain the seaweed sector in the region for approximately 25 years (see Table 6.1). The findings of this study correspond with other studies on the seaweed value chain in the South Sulawesi region. The study indicated that seaweed farming positively impacts the seaweed value chain players' well-being. It helps provide transport, housing, basic and secondary needs fulfillment, and also

education. In addition, the study also revealed that community satisfaction also increased with the existence of seaweed farming activities, which suggested the growth of the sector in the region is perceived to grow relatively fair and supported by the community as a whole (Larson et al., 2021). The study of the seaweed sector in Rote Island, East Nusa Tenggara, also revealed that the coastal community has benefited from seaweed farming in many social aspects, such as education and other basic needs. The study also claimed that similar results have been found in other seaweed sector studies in different countries, such as Tanzania, India, and the Philippines (Mariño et al., 2019).

The study in the South Sulawesi region also stated that seaweed farming has a positive impact on the social aspect of the coastal communities (Rimmer et al., 2021). Other than improving the life quality of its players, the seaweed sector is also perceived as complementary and compatible with other activities within the communities, such as land farming and fishing (Rimmer et al., 2021). Due to its impact on the community, the response from the community is relatively positive towards the seaweed sector in the region. Another study on the seaweed sector in Kepulauan Seribu Regency, Jakarta, pointed out the collaboration between the seaweed farmers in doing their seaweed farming activities. They share equipment and help each other as a society, which is one of the main reasons why the seaweed sector in the region is considered socially sustained and resilient despite external stress and disruptions (Rahatiningtyas, 2019).

Chapter 7: Conclusion

Introduction

This chapter summarises the key results of the study and provides recommendations to different stakeholders. The chapter consists of four sections. Section one summarises the key results of the study. Section two provides recommendations from the study. Section three outlines the limitations of the study. The final section provides suggestions for future research in relation to this topic.

7.1 Summary of key results

Seaweed value chain mapping

The result of this study shows there are two types of seaweed value chains in the Kupang Regency, which are unprocessed and processed. The unprocessed seaweed value chain dominates with approximately 90% of total seaweed flow in the region, while only 10% of the seaweed goes to processors. In addition, there are five main players in both types of seaweed value chains: smallholder farmers, local intermediaries, inter-island traders, small-scale processors, and carrageenan processor. In the unprocessed seaweed value chain, seaweed is cultivated, harvested, dried, and stored by seaweed farmers, which then are traded to local intermediaries and inter-island traders. In the processed seaweed value chain, seaweed are further processed by small-scale processors and carrageenan processor. However, due to limited processing facilities in the region, only 10% of raw-dried seaweed produced in the region is allocated for further processing, while the other 90% is exported predominantly by inter-island traders to other provinces in Indonesia.

Governance and value addition

The seaweed value chain is analysed based on two dimensions: governance (vertical coordination, horizontal coordination, and information flow) and value addition (quality and safety). Regarding vertical coordination, most of the transactions at the farmer, local intermediary, and small-scale processor level are informal transactions, while contractual coordination is mostly used at the inter-island trader and processor level. In terms of horizontal coordination, all the value chain players are operating individually. The information flow of the unprocessed seaweed value chain involves farmers, local intermediaries, and inter-island traders, where farmers and local intermediaries gain information (price, quality, quantity) from the inter-island traders as the source. On the other hand, the information flow of the processed

seaweed value chain involves small-scale processors and carrageenan processor as the source of information.

In terms of quality, seaweed farmers have to ensure their harvested seaweed meets the standard quality set by the traders and processors. The seaweed has to be cultivated for a minimum of 45 days, contains < 38% of moisture content, and < 2% of impurities. After harvesting, the seaweed has to be properly stored to maintain its quality, mainly by avoiding contact with fresh water. This storing activity is done at either the farmer or trader level. The traders are also doing quality checking of seaweed they bought, to ensure the overall quality of the seaweed that will be sold to the processors and the inter-island buyers. The highest value addition in the quality aspect occurs at the processing stage. Small-scale processors transform raw-dried seaweed into certified and branded ready-to-eat snack products, while the carrageenan processor transforms raw-dried seaweed into certified and branded carrageenan products. Regarding safety, the aspect is only found at the processing stage, using a product traceability system and equipped with various certifications, such as HACCP certificate, COA certificate, phytosanitary certificate, health certificate, certificate of origin, and packaging certificate.

Sustainability factors in the value chain

The findings of this study reveal there are four factors affecting the environmental sustainability aspect of the seaweed value chain: external factors (climate and pollution-related), use of fuel and energy, use of chemical inputs, and waste management. Four factors affecting the economic sustainability aspect: price stability, profitability, economic independence, and diversification, and four factors affecting the social sustainability aspect: society contribution, quality of life, working conditions, and training and education. This study also finds that the seaweed business is more prone to the negative impact caused by external factors rather than internal factors, whether in the environmental aspect (climate and pollution-related) or economic aspect (price instability).

7.2 Recommendations from the study

Through qualitative analysis, this study provides an assessment of the seaweed value chain and its sustainability. This assessment can provide critical insights and recommendations for the seaweed value chain stakeholders to develop the Indonesian seaweed industry by implementing strategies that optimise value chains, ensuring its sustainability, and enhancing its existing and future contribution to the regional economy. The recommendations are provided as follows:

7.2.1 Recommendations for farmers

This study indicates that farmers are facing some constraints such as low bargaining power, limited market information and access, and the risk of external factors (environment and price-related). The following solutions are recommended to address these issues:

Horizontal coordination

The study finds out that most of the seaweed farmers in the region are working individually. Although they have previously failed to work as groups; the importance of horizontal coordination should be highly considered for greater benefits. Seaweed farmers can coordinate in the form of cooperatives or farmer organisations. The purpose of these groups is to create a stronger bargaining power for the seaweed farmers and to provide more market channels for them. As farmer groups, the seaweed farmers can scale up their production and sales, which enables them to have stronger negotiation power. By coordinating and working together, seaweed farmers can access larger markets that may be inaccessible to individual small-scale farmers. Currently, the farmers are solely dependent on the local traders to buy their seaweed; hence their bargaining power is relatively low. Additionally, the establishment of farmer groups can also provide them a platform for advocacy, allowing them to collectively address issues such as pricing, policy support, and credit access.

Risk mitigation improvement

This study also finds out that seaweed farming is prone to external factors, whether environment (climate and pollution related) or economy (price-related). Based on the interviews, most of the farmers do not have any risk mitigation towards these issues. When the Montara oil spill and Cyclone Seroja incident happened, seaweed farmers were severely losing their whole cultivation material and tools, which forced most of them to start again from the beginning. Considering this issue, it is crucial for seaweed farmers to have insurance for assets with high value (such as boats), and to provide backup farming tools and materials in case incidents happen. Although those options might cost them some money; however, it would be extremely helpful for them to recover after incidents happen.

7.2.2 Recommendations for traders

This study indicates that traders are experiencing problems such as instability of seaweed business and capital issues. The following solution is recommended to address the issue:

Product or income diversification

The seaweed sector is considered to be a profitable business for the traders in the region. However, several external factors can significantly impact the sector's trading activities. For example, when the governor's decree in 2022 was implemented, traders were prohibited from shipping their seaweed to the outside of the province. As a result, traders were losing their main source of income, as most of their transactions were done with buyers from outside of the province. In another case, when Cyclone Seroja destroyed the seaweed farmers' cultivations in 2021, there was a period when traders were not able to do their business due to no supply of seaweed. Therefore, it is suggested that traders to have product or income diversification as an alternative source of income whenever unforeseen situations happen in the seaweed sector. In addition, the traders (local intermediaries and inter-island traders) are also sometimes facing a capital issue, which hinders them from purchasing more seaweed when the demand is high. With product or income diversification, traders would have other sources of capital, which can reduce their dependency on lending capital from other sources.

7.2.3 Recommendations for processors

This study indicates that processors are experiencing issues such as price instability of seaweed as the main raw material of their products. The following solution is recommended to address the issue:

Purchasing strategy implementation

As previously indicated, the price instability of seaweed is causing significant challenges for processors in managing their business. Given that the seaweed market is largely controlled by Chinese market, implementing purchasing strategies could help reduce the risk of price volatility in the future. One potential strategy is to purchase larger quantities of seaweed when prices are relatively low and store it for several months. A convenient aspect of seaweed trading is that once dried, seaweed can last for several months if stored properly. However, the risk of weight loss must also be considered, as storing seaweed for too long could result in losses rather than increased profits. Another strategy is to implement a price hedging strategy through future contracts. This approach allows processors to reduce the risk of future price volatility. While there are some risks, such as the possibility of prices decreasing instead of rising, this hedging strategy provides greater certainty and clarity for long-term business planning.

7.2.4 Recommendations for government or policy makers

This study also finds that the seaweed sector in this region is significantly reliant on governmental regulations. The governor's decree in 2022, which banned the shipment of seaweed outside of the East Nusa Tenggara Province, has predominantly caused a negative impact on the seaweed sector in the region. The main purpose of the policy is to improve the value-adding activities inside the province; however, the implementation of the decree did not consider the imbalance between the seaweed production capacity and processing capacity within the region. This imbalance created an oversupply of seaweed, which led to a significant decrease in seaweed prices in the region. While the decree had a positive impact on processors; the majority of the players in the seaweed value chain, primarily the farmers, were adversely affected. The seaweed farmers, who are the backbone of the seaweed industry, saw their income drop as a result of the falling prices. The following solution is recommended to address the issue:

Regulation formulation improvement

The government or policymakers ideally have to create regulations that support the certainty, stability, and continuity of the commodity products in the market. In the case of the 2022 governor's decree implementation, the negligence of considering the balance between seaweed production and processing capacity within the region has led to the uncertainty and instability of seaweed prices, especially at the farmer level. In addition, the government also could not provide any effective price protection policy for the seaweed farmers, which allowed a significant decrease in seaweed prices in the region. The local government (regency level) claimed that they do not have any power to intervene with the policy set by the provincial government, although they are aware of the negative effect caused by the policy implementation. Therefore, it is suggested that the provincial government have to carefully consider all the upcoming implications caused by the new policies. Additionally, the role of the local government (regency level) can also be improved; because most of the time, the local government has a more technical understanding of the reality on the field, which allows them to understand what policies are effective to be implied.

7.3 The limitations of the study

Due to financial and time constraints, this research was conducted in only one subdistrict area in the Kupang Regency, East Nusa Tenggara, Indonesia. In addition, a relatively small number of respondents were interviewed. Furthermore, some of the additional data lacked reliability

because they were not properly recorded by the local government, which creates more barriers to accurately analysing some aspects of the study. The lack of previous academic research on the seaweed value chain in the region and other regions in Indonesia also hinders the availability of reliable secondary data. Therefore, the findings of this study are explanatory and limited in providing more generalised results and may not fully represent the seaweed value chain dynamics in the region or country as a whole.

7.4 Future research recommendations

This study is one of the first studies that directly assess the sustainability aspects of the seaweed value chain in Indonesia, with Kupang Regency as the study region. However, Indonesia is a big and diverse country, one part of the region might have significant differences with another region. Further research could aim to cover a larger study area with more respondents in the sample or to compare the sustainability assessments of seaweed value chains in different parts of Indonesia, thereby players from one region might get better insights from players from other areas and vice versa. Another interesting future research recommendation is to develop a seaweed value chain sustainability transformation framework that should be useful to realistically illustrate methods to address sustainability issues in the seaweed value chain or as a comparison to other agricultural sectors, especially in developing countries such as Indonesia.

References

- Adeoye-Olatunde, O. A., & Olenik, N. L. (2021). Research and scholarly methods: Semi-structured interviews. *Journal of the American College of Clinical Pharmacy*, 4(10), 1358-1367.
- Adler, M. G., & Fagley, N. S. (2005). Appreciation: Individual differences in finding value and meaning as a unique predictor of subjective well-being. *Journal of Personality*, 73(1), 79-114.
- Agyemang, M., Kusi-Sarpong, S., Agyemang, J., Jia, F., & Adzanyo, M. (2022). Determining and evaluating socially sustainable supply chain criteria in agri-sector of developing countries: insights from West Africa cashew industry. *Production Planning & Control*, 33(11), 1115-1133.
- Aidara, S., Mamun, A. A., Nasir, N. A. M., Mohiuddin, M., Nawi, N. C., & Zainol, N. R. (2021). Competitive advantages of the relationship between entrepreneurial competencies and economic sustainability performance. *Sustainability*, 13(2), 864.
- Alin, J. M., Eranza, D. R. D., Bahron, A., & Mahmud, R. (2015). Profit and loss analysis of Eucheema seaweed farming in Green Island, Palawan, Philippines. *Mediterranean Journal of Social Sciences*, 6(5), 125-128.
- Aminah, L. N., Qurniati, R., & Hidayat, W. (2014). Kontribusi hutan rakyat terhadap pendapatan petani di desa buana sakti kecamatan batanghari kabupaten lampung timur. *Jurnal Sylva Lestari*, 1(1), 47-54.
- Anderson, J. C., & Narus, J. A. (1998). Business marketing: understand what customers value. *Harvard Business Review*, 76, 53-67.
- Ansari, M. T., Armaghan, N., & Ghasemi, J. (2016). Barriers and solutions to commercialization of research findings in schools of agriculture in Iran: A qualitative approach. *International Journal of Technology*, 1, 5-14.
- Avila-Peltroche, J., & Villena-Sarmiento, G. (2022). Analysis of Peruvian seaweed exports during the period 1995–2020 using trade data. *Botanica Marina*, 65(3), 209-220.
- Barin Cruz, L., & Boehe, D. M. (2008). CSR in the global marketplace: Towards sustainable global value chains. *Management Decision*, 46(8), 1187-1209.
- Barrett, C. B., Reardon, T., Swinnen, J., & Zilberman, D. (2022). Agri-food value chain revolutions in low-and middle-income countries. *Journal of Economic Literature*, 60(4), 1316-1377.
- Baskarada, S. (2014). Qualitative case study guidelines. *The Qualitative Report*, 19(40), 1-25.
- Beheshti, H. M. (2004). Gaining and sustaining competitive advantage with activity-based cost management system. *Industrial Management & Data Systems*, 104(5), 377-383.
- Ben-Eli, M. U. (2018). Sustainability: definition and five core principles, a systems perspective. *Sustainability Science*, 13(5), 1337-1343.
- Bhuyar, P., Sundararaju, S., Rahim, M. H. A., Unpaprom, Y., Maniam, G. P., & Govindan, N. (2021). Antioxidative study of polysaccharides extracted from red (*Kappaphycus alvarezii*), green (*Kappaphycus striatus*) and brown (*Padina gymnospora*) marine macroalgae/seaweed. *SN Applied Sciences*, 3, 1-9.
- Boehlje, M. (1999). Structural changes in the agricultural industries: how do we measure, analyze and understand them? *American Journal of Agricultural Economics*, 81(5), 1028-1041.
- Bowman, C., & Ambrosini, V. (2000). Value creation versus value capture: towards a coherent definition of value in strategy. *British Journal of Management*, 11(1), 1-15.
- Boye, J. I., & Arcand, Y. (2013). Current trends in green technologies in food production and processing. *Food Engineering Reviews*, 5, 1-17.
- Brandenburger, A. M., & Stuart Jr, H. W. (1996). Value-based business strategy. *Journal of Economics & Management Strategy*, 5(1), 5-24.

- Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice*, 2, 1-10.
- Cavallo, G., Lorini, C., Garamella, G., & Bonaccorsi, G. (2021). Seaweeds as a “palatable” challenge between innovation and sustainability: A systematic review of food safety. *Sustainability*, 13(14), 7652.
- Central Intelligence Agency. (n.d.). Indonesia - details. <https://www.cia.gov/the-world-factbook/countries/indonesia/map>
- Cotas, J., Leandro, A., Pacheco, D., Gonçalves, A. M., & Pereira, L. (2020). A comprehensive review of the nutraceutical and therapeutic applications of red seaweeds (Rhodophyta). *Life*, 10(3), 19.
- Cucagna, M. E., & Goldsmith, P. D. (2018). Value adding in the agri-food value chain. *International Food and Agribusiness Management Review*, 21(3), 293-316.
- Dey, I. (2003). *Qualitative data analysis: A user friendly guide for social scientists*: Routledge.
- Drury, K. E., & Crotty, F. V. (2022). Developing the Use of Wool Rope within Aquaculture— A Systematic Review. *Sustainability*, 14(15), 1-17.
- Duarte, C. M., Bruhn, A., & Krause-Jensen, D. (2022). A seaweed aquaculture imperative to meet global sustainability targets. *Nature Sustainability*, 5(3), 185-193.
- Eizenberg, E., & Jabareen, Y. (2017). Social sustainability: A new conceptual framework. *Sustainability*, 9(1), 68.
- Ensign, P.C. (2001) Value Chain Analysis and Competitive Advantage: Assessing Strategic Linkages and Interrelationships. *Journal of General Management*. 27(1): 18–42.
- Erb, M. (2015). Sailing to Komodo: Contradictions of tourism and development in eastern Indonesia. *Advances in Southeast Asian Studies*, 8(2), 143-164.
- Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4.
- Fauzi, D., Purnamasari, U., Wicaksono, S. A., & Maharani, C. (2023). When local customs meet the market: an analysis of coffee value chain in Tebat Benawa customary community, Indonesia. *International Journal of Agricultural Sustainability*, 21(1), 1-18.
- Fearne, A., Martinez, M. G., & Dent, B. (2012). Dimensions of sustainable value chains: implications for value chain analysis. *Supply Chain Management: An International Journal*, 17(6), 575-581.
- Fernando, S., Garnevska, E., Ramilan, T., & Shadbolt, N. (2021). Organisational attributes of cooperatives and farmer companies. *Journal of Co-operative Organization and Management*, 9(1), 100132.
- Ferris, S., Robbins, P., Best, R., Seville, D., Buxton, A., Shriver, J., & Wei, E. (2014). Linking smallholder farmers to markets and the implications for extension and advisory services. *MEAS Brief*, 4(10), 13-14.
- Fatmala, W., Sari, M., Yunarsi, Y., & Rahman, N. (2023). Pengembangan ekonomi lokal melalui budidaya rumput laut sebagai sumber pendapatan masyarakat. *Jurnal Maksipreneur: Manajemen, Koperasi, dan Entrepreneurship*, 12(2), 471-485.
- Fatonny, N., Nuralina, R., & Fariyanti, A. (2023). Analisis Sistem Agribisnis Rumput Laut di Kabupaten Takalar Provinsi Sulawesi Selatan. *Forum Agribisnis*, 13(1), 35-49.
- Food and Agricultural Organization. (2014). *Developing sustainable food value chains: Guiding principles*. FAO. <http://www.fao.org/3/i3953e/i3953e.pdf>
- Food and Agricultural Organization. (2021, May 28). *Global status of seaweed production, trade and utilization*. <https://www.competecaribbean.org/wp-content/uploads/2021/05/Global-status-of-seaweed-production-trade-and-utilization-Junning-Cai-FAO.pdf>
- Food and Agricultural Organization. (2021, June). *Global seaweeds and microalgae production, 1950–2019*. <https://www.fao.org/3/cb4579en/cb4579en.pdf>

- García-Vaquero, M., & Hayes, M. (2016). Red and green macroalgae for fish and animal feed and human functional food development. *Food Reviews International*, 32(1), 15-45.
- Gebre, G. G., & Rik, E. (2016). Sustainability assessment of a banana value chain: The case of Arba Minch, Ethiopia. *Journal of Agribusiness*, 34(2), 1-13.
- Gereffi, G. (1994), "The organization of buyer-driven global commodity chains: how US retailers shape overseas production networks", in Gereffi, G. and Korzeniewicz, M. (Eds), *Commodity Chains and Global Capitalism*, Greenwood Press, Westport, CT, pp. 95-122.
- Gilaninia, S., Taleghani, M., & Aziz, N. (2013). Marketing mix and consumer behavior. *Kuwait Chapter of Arabian Journal of Business and Management Review*, 2(12), 1-6.
- Gray, R. (2010). Is accounting for sustainability actually accounting for sustainability... and how would we know? An exploration of narratives of organisations and the planet. *Accounting, Organizations and Society*, 35(1), 47-62.
- Hartley, J. (2004). The 'value chain of meaning' and the new economy. *International Journal of Cultural Studies*, 7(1), 129-141.
- Hassan, S. T., Xia, E., Huang, J., Khan, N. H., & Iqbal, K. (2019). Natural resources, globalization, and economic growth: evidence from Pakistan. *Environmental Science and Pollution Research*, 26, 15527-15534.
- Henriksson, P. J. G., Tran, N., Mohan, C. V., Chan, C. Y., Rodriguez, U. P., Suri, S., & Phillips, M. J. (2017). Indonesian aquaculture futures—Evaluating environmental and socioeconomic potentials and limitations. *Journal of Cleaner Production*, 162, 1482-1490.
- Hidayati, D. R., Garnevska, E., & Childerhouse, P. (2021). Agrifood value chain assessment in developing countries: a case of Indonesia's cashew sector. *E3S Web of Conferences* 306, 1-9.
- Hidayati, D. R., Garnevska, E., & Childerhouse, P. (2021). Sustainable agrifood value chain - transformation in developing countries. *Sustainability*, 13(22), 1-20.
- Hidayati, D. R., Garnevska, E., & Childerhouse, P. (2021). Transforming developing countries agrifood value chains. *International Journal on Food System Dynamics*, 12(4), 358-374.
- Hinterhuber, A. (2004). Towards value-based pricing - An integrative framework for decision making. *Industrial Marketing Management*, 33(8), 765-778.
- Hughes, N. M., Shahi, C., & Pulkki, R. (2014). A review of the wood pellet value chain, modern value/supply chain management approaches, and value/supply chain models. *Journal of Renewable Energy*, 2014, 1-14.
- Hurd, C. L., Law, C. S., Bach, L. T., Britton, D., Hovenden, M., Paine, E. R., & Boyd, P. W. (2022). Forensic carbon accounting: Assessing the role of seaweeds for carbon sequestration. *Journal of Phycology*, 58(3), 347-363.
- International Monetary Fund. (2023). *Indonesia: Datasets*. <https://www.imf.org/external/datamapper/profile/IDN>
- Islam, K. K., Fujiwara, T., Tani, M., & Sato, N. (2014). Marketing of agroforestry products in Bangladesh: a value chain analysis. *American Journal of Agriculture and Forestry*, 2(4), 135.
- Jibreál, A. A., & Nursafitri, N. (2023). Seaweed Cultivation for Community Income in Indonesia. *Patikala Journal of Sustainable Business & Entrepreneurship*, 1(1), 59-71.
- Johnston, K. G., Abomohra, A., French, C. E., & Zaky, A. S. (2023). Recent Advances in Seaweed Biorefineries and Assessment of Their Potential for Carbon Capture and Storage. *Sustainability*, 15(17), 1-32.

- Jones, A. R., Alleway, H. K., McAfee, D., Reis-Santos, P., Theuerkauf, S. J., & Jones, R. C. (2022). Climate-friendly seafood: The potential for emissions reduction and carbon capture in marine aquaculture. *BioScience*, 72(2), 123-143.
- Jouzi, Z., Azadi, H., Taheri, F., Zarafshani, K., Gebrehiwot, K., Van Passel, S., & Lebailly, P. (2017). Organic farming and small-scale farmers: Main opportunities and challenges. *Ecological Economics*, 132, 144-154.
- Kang, Y. H., Kim, S., Choi, S. K., Lee, H. J., Chung, I. K., & Park, S. R. (2021). A comparison of the bioremediation potential of five seaweed species in an integrated fish-seaweed aquaculture system: implication for a multi-species seaweed culture. *Reviews in Aquaculture*, 13(1), 353-364.
- Kaplinsky, R. (2000). Globalisation and unequalisation: what can be learned from value chain analysis? *Journal of Development Studies*, 37(2), 117-146.
- Kaplinsky, R., & Morris, M. (2000). *A handbook for value chain research* (Vol. 113). Brighton: University of Sussex, Institute of Development Studies.
- Kasanah, N., Ulfah, M., Imania, O., Hanifah, A. N., & Marjan, M. I. D. (2022). Rhodophyta as potential sources of photoprotectants, antiphotaging compounds, and hydrogels for cosmeceutical application. *Molecules*, 27(22), 1-26.
- Kidd, C. V. (1992). The evolution of sustainability. *Journal of Agricultural and Environmental Ethics*, 5, 1-26.
- Krepl, V., Kment, P., Rajdlova, G., & Kapila, P. F. (2016). African countries' agricultural trade value chain assessment case study: Tanzania (cashew nut exports). *AGRIS on-line Papers in Economics and Informatics*, 8(1), 45-55.
- Kumar, D., & Rajeev, P. V. (2016). Value chain: a conceptual framework. *International Journal of Engineering and Management Sciences*, 7(1), 74-77.
- Kurnia, G., Setiawan, I., Tridakusumah, A. C., Jaelani, G., Heryanto, M. A., & Nugraha, A. (2022). Local wisdom for ensuring agriculture sustainability: A case from Indonesia. *Sustainability*, 14(14), 8823.
- Langford, A., Turupadang, W., & Waldron, S. (2023). Interventionist industry policy to support local value-adding: Evidence from the Eastern Indonesian seaweed industry. *Marine Policy*, 151, 1-11.
- Larson, S., Stoeckl, N., Fachry, M. E., Mustafa, M. D., Lapong, I., Purnomo, A. H., & Paul, N. A. (2021). Women's well-being and household benefits from seaweed farming in Indonesia. *Aquaculture*, 530, 1-8.
- Latruffe, L., Diazabakana, A., Bockstaller, C., Desjeux, Y., Finn, J., Kelly, E., & Uthes, S. (2016). Measurement of sustainability in agriculture: a review of indicators. *Studies in Agricultural Economics*, 118(3), 123-130.
- Lazzarini, S., Chaddad, F., & Cook, M. (2001). Integrating supply chain and network analyses: the study of netchains. *Journal on Chain and Network Science*, 1(1), 7-22.
- Lebacqz, T., Baret, P. V., & Stilmant, D. (2013). Sustainability indicators for livestock farming. A review. *Agronomy for Sustainable Development*, 33, 311-327.
- Lee, C. J. G. (2012). Reconsidering constructivism in qualitative research. *Educational Philosophy and Theory*, 44(4), 403-412.
- Lepak, D. P., Smith, K. G., & Taylor, M. S. (2007). Value creation and value capture: A multilevel perspective. *Academy of Management Review*, 32(1), 180-194.
- Li, Y., & Zhang, S. (2022). Qualitative data analysis. In *Applied research methods in urban and regional planning* (pp. 149-165). Cham: Springer International Publishing.
- Liu, Y., Eckert, C., Yannou-Le Bris, G., & Petit, G. (2019). A fuzzy decision tool to evaluate the sustainable performance of suppliers in an agrifood value chain. *Computers & Industrial Engineering*, 127, 196-212.

- Lomartire, S., Marques, J. C., & Gonçalves, A. M. (2021). An overview to the health benefits of seaweeds consumption. *Marine Drugs*, 19(6), 341.
- Lozano, R., Carpenter, A., & Huisingh, D. (2015). A review of 'theories of the firm' and their contributions to Corporate Sustainability. *Journal of Cleaner Production*, 106, 430-442.
- Mariño, M., Breckwoldt, A., Teichberg, M., Kase, A., & Reuter, H. (2019). Livelihood aspects of seaweed farming in Rote Island, Indonesia. *Marine Policy*, 107, 1-9.
- Mashoreng, S., La Nafie, Y. A., & Isyrini, R. (2019). Cultivated seaweed carbon sequestration capacity. *IOP Conference Series: Earth and Environmental Science* 370(1), 1-9.
- Maxwell, J. A., & Chmiel, M. (2014). Notes toward a theory of qualitative data analysis. *The SAGE handbook of qualitative data analysis*, 21-34.
- Mefford, R. N. (2011). The economic value of a sustainable supply chain. *Business and Society Review*, 116(1), 109-143.
- Ministry of Agriculture of Indonesia. (2022). *Analisis PDB sektor pertanian tahun 2022*. https://satudata.pertanian.go.id/assets/docs/publikasi/Analisis_PDB_Sektor_Pertanian_2022.pdf
- Ministry of Communication and Information Technology of Indonesia. (2017). *Suku bangsa*. <https://indonesia.go.id/profil/suku-bangsa/kebudayaan/suku-bangsa>
- Ministry of Education and Culture of Indonesia. (n.d.). *Data Bahasa di Indonesia*. <https://petabahasa.kemdikbud.go.id/databahasa.php>
- Ministry of Environment and Forestry of Indonesia. (2019, January 16). *RUU konservasi sumber daya alam hayati dan ekosistemnya masih perlu pendalaman*. https://ppid.menlhk.go.id/berita_foto/browse/1633
- Ministry of Foreign Affairs of Indonesia. (2016). *Indonesia at a glance*. https://kemlu.go.id/vancouver/en/pages/indonesia_at_a_glance/2016/etc-menu
- Ministry of Foreign Affairs of Indonesia. (2019). *Bhinneka Tunggal Ika*. <https://kemlu.go.id/download/L1NoYXJlZCUyMERvY3VtZW50cy9icnVzc2VsL0Jvb2tsZXQlMjBIYXJt255JTIwb2YIMjBmRvbmVzaWEIMjBpbiUyMFBpY3RlcmVzLnBkZg==>
- Ministry of State Secretariat of Indonesia. (2023, June 23). *Pemerintah terus berupaya kembangkan hilirisasi rumput laut*. <https://www.presidentri.go.id/siaran-pers/pemerintah-terus-berupaya-kembangkan-hilirisasi-rumput-laut/>
- Ministry of Trade of Indonesia. (2015). *Info komoditi rumput laut*. https://bkperdag.kemendag.go.id/media_content/2017/08/Isi-BRIK_Rumput_Laut.pdf
- Mudiastuti, R. D., Nur, T., & Sudirman, S. (2014). Strategi kebijakan industri marine politan untuk mendukung konsep mamminasata: Model konseptual dengan pendekatan sistem dinamik. *Journal of Engineering & Management in Industrial System*, 2(2), 20-27.
- Ngongo, Y., Kotta, N., & Matitaputty, P. R. (2021). Strengthening archipelago food security and food sovereignty in ENT-Indonesia. *IOP Conference Series: Earth and Environmental Science*, 803(1), 1-11.
- Mishra, P. K., & Dey, K. (2018). Governance of agricultural value chains: Coordination, control and safeguarding. *Journal of Rural Studies*, 64, 135-147.
- Mkuna, E., & Wale, E. (2022). Explaining Farmers' Income via Market Orientation and Participation: Evidence from KwaZulu-Natal (South Africa). *Sustainability*, 14(21), 14197.
- Mohajan, H. K. (2018). Qualitative research methodology in social sciences and related subjects. *Journal of Economic Development, Environment and People*, 7(1), 23-48.
- Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences*, 104(50), 19680-19685.
- Nakasone, E., Torero, M., & Minten, B. (2014). The power of information: The ICT revolution in agricultural development. *Annual Review of Resource Economics*, 6(1), 533-550.

- Nugroho, A. D., Bhagat, P. R., Magda, R., & Lakner, Z. (2021). The impacts of economic globalization on agricultural value added in developing countries. *PloS One*, *16*(11), 1-23.
- Nuryanto, N., Sasongko, L. A., & Nurjayanti, E. D. (2016). Analisis kelayakan usaha budidaya rumput laut (*Eucheuma cottonii*) (studi kasus di Desa Karimun Jawa Kecamatan Karimun Jawa Kabupaten Jepara). *Mediagro*, *12*(2), 56-64.
- Nyimbili, F., & Nyimbili, L. (2024). Types of Purposive Sampling Techniques with Their Examples and Application in Qualitative Research Studies. *British Journal of Multidisciplinary and Advanced Studies*, *5*(1), 90-99.
- Onakuse, S. (2012). The future of subsistence agriculture in the rural community of Uzanu, Edo state, Nigeria. *Journal of Agriculture, Food Systems, and Community Development*, *3*(1), 61-71.
- Otsuka, K., Nakano, Y., & Takahashi, K. (2016). Contract farming in developed and developing countries. *Annual Review of Resource Economics*, *8*, 353-376.
- Pawar, K. S., Beltagui, A., & Riedel, J. C. (2009). The PSO triangle: designing product, service and organisation to create value. *International Journal of Operations & Production Management*, *29*(5), 468-493.
- Pingali, P. (2007). Agricultural growth and economic development: a view through the globalization lens. *Agricultural Economics*, *37*, 1-12.
- Polat, S., Trif, M., Rusu, A., Šimat, V., Čagalj, M., Alak, G., & Özogul, F. (2023). Recent advances in industrial applications of seaweeds. *Critical reviews in food science and nutrition*, *63*(21), 4979-5008.
- Porter, M. E. (2001). The value chain and competitive advantage. *Understanding Business Processes*, *2*, 50-66.
- Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustainability science*, *14*, 681-695.
- Purwanto, Y., Sukara, E., Ajiningrum, P. S., & Priatna, D. (2020). Cultural diversity and biodiversity as foundation of sustainable development. *Indonesian Journal of Applied Environmental Studies*, *1*(1), 2-10.
- Radiarta, N., Erlania, E., Haryadi, J., & Rosdiana, A. (2016). Analisis pengembangan budidaya rumput laut di Pulau Sebatik, Kabupaten Nunukan, Kalimantan Utara. *Jurnal Kebijakan Perikanan Indonesia*, *8*(1), 29-40.
- Rimmer, M. A., Larson, S., Lapong, I., Purnomo, A. H., Pong-Masak, P. R., Swanepoel, L., & Paul, N. A. (2021). Seaweed aquaculture in Indonesia contributes to social and economic aspects of livelihoods and community wellbeing. *Sustainability*, *13*(19), 1-22.
- Poeloengasih, C. D., Bardant, T. B., Rosyida, V. T., Maryana, R., & Wahono, S. K. (2014). Coastal community empowerment in processing *Kappaphycus alvarezii*: a case study in Ceningan Island, Bali, Indonesia. *Journal of Applied Phycology*, *26*, 1539-1546.
- Rahatiningtyas, N. S. (2019). Social and ecological resilience in coastal livelihood (case study: Kepulauan Seribu Regency Jakarta Province and Takalar Regency South Sulawesi Province Indonesia). *IOP Conference Series: Earth and Environmental Science*, *338*(1), 1-9.
- Rimmer, M. A., Larson, S., Lapong, I., Purnomo, A. H., Pong-Masak, P. R., Swanepoel, L., & Paul, N. A. (2021). Seaweed aquaculture in Indonesia contributes to social and economic aspects of livelihoods and community wellbeing. *Sustainability*, *13*(19), 1-22.
- Roudgarmi, P. (2011). Qualitative research for environmental sciences: A review. *Journal of Food, Agriculture & Environment*, *9*(3&4), 871-879.

- Ryan, R. & Parry, E. (2021). The Montara class action decision and implications for corporate accountability for Australian companies. *Business and Human Rights Journal*, 6(3), 599-606.
- Sahban, H. (2018). Empowerment of traders and traditional market potential development in Indonesia. *Journal of Innovative Science and Research Technology*, 3(1), 428-436.
- Salas-Zapata, W. A., & Ortiz-Muñoz, S. M. (2019). Analysis of meanings of the concept of sustainability. *Sustainable Development*, 27(1), 153-161.
- Sanguinet, E. R., Atienza, M., Azzoni, C. R., & Alvim, A. M. (2023). Linking Brazilian regions to value chains: is there a potential for regional development? *Economies*, 11(7), 199.
- Santika, L. G., & Ma'ruf, W. F. (2014). Karakteristik agar rumput laut *Gracilaria Verrucosa* budidaya tambak dengan perlakuan konsentrasi alkali pada umur panen yang berbeda. *Jurnal Pengolahan dan Bioteknologi Hasil Perikanan*, 3(4), 98-105.
- Saputro, M. G. S., Nuryartono, N., Arifin, B., & Zulfainarni, N. (2021). A Bibliometric Analysis of Study on Seaweed Industry for Strengthening Regional Competitiveness in Indonesia. *European Journal of Business and Management*, 13(6), 64-72.
- Satria, D., & Li, E. (2017). Contract engagement in the small-scale tuna-fishing economies of East Java. *Bulletin of Indonesian Economic Studies*, 53(1), 27-54.
- Schouten, G., & Bitzer, V. (2015). The emergence of Southern standards in agricultural value chains: A new trend in sustainability governance? *Ecological Economics*, 120, 175-184.
- Sekaranom, A. B., Putri, N. H., & Puspaningrani, F. C. (2021). The impacts of Seroja Tropical Cyclone towards extreme weather in East Nusa Tenggara. *E3S Web of Conferences*, 325, 1-6.
- Siddique, M. I., & Garnevska, E. (2018). Citrus value chain (s): A survey of Pakistan citrus industry. *Agric. Value Chain*, 37, 37-58.
- Silvi, R., & Cuganesan, S. (2006). Investigating the management of knowledge for competitive advantage: A strategic cost management perspective. *Journal of Intellectual Capital*, 7(3), 309-323.
- Siswadarma, A. B., & Burhanuddin, N. F. (2022). Analisis subsektor unggulan pertanian di Sulawesi Selatan. *Jurnal Ekonomika dan Dinamika Sosial*, 1(1), 18-40.
- Sjauw-Koen-Fa, A. R., Blok, V., & Omta, S. W. F. (2016). Critical Success Factors for Smallholder Inclusion in High Value-Adding Supply Chains by Food & Agribusiness Multinational Enterprise. *International Food and Agribusiness Management Review*, 19(1030), 83-112.
- Sørensen, L. B., Germundsson, L. B., Hansen, S. R., Rojas, C., & Kristensen, N. H. (2021). What skills do agricultural professionals need in the transition towards a sustainable agriculture? A qualitative literature review. *Sustainability*, 13(24), 1-17.
- Spies, R. B., Mukhtasor, M., & Burns, K. A. (2017). The montara oil spill: a 2009 well blowout in the Timor Sea. *Archives of Environmental Contamination and Toxicology*, 73, 55-62.
- Sriwulandari, S., Widjaja, S. M., Wahyono, H., & Utomo, S. H. (2020). Enhancement of market opportunities for seaweed farmers: East Java in Indonesia. *Utopía y Praxis Latinoamericana*, 25(6), 114-121.
- Statistics Indonesia. (2020). *Produksi perikanan budidaya menurut komoditas utama (ton), 2019*. <https://www.bps.go.id/indicator/56/1513/1/produksi-perikanan-budidaya-menurut-komoditas-utama.html>
- Statistics Indonesia. (2020). *Produksi perikanan budidaya menurut komoditas utama (ton), 2017*. <https://www.bps.go.id/indicator/56/1513/3/produksi-perikanan-budidaya-menurut-komoditas-utama.html>
- Statistics Indonesia. (2020). *Produksi perikanan budidaya menurut komoditas utama (ton), 2018*. <https://www.bps.go.id/indicator/56/1513/2/produksi-perikanan-budidaya-menurut-komoditas-utama.html>

- Statistics Indonesia. (2020). Produksi perikanan budidaya menurut komoditas utama (ton), 2019. <https://www.bps.go.id/indicator/56/1513/1/produksi-perikanan-budidaya-menurut-komoditas-utama.html>
- Statistics Indonesia. (2022, September 28). *Statistik pertanian Nusa Tenggara Timur 2021*. <https://ntt.bps.go.id/publication/2022/09/28/9616c86ea35747335d2da8cb/statistik-pertanian-nusa-tenggara-timur-2021.html>
- Statistics Indonesia. (2022, December 7) *Keadaan Angkatan kerja di Indonesia Agustus 2022* <https://www.bps.go.id/publication/2022/12/07/a64afccf38fbf6deb81a5dc0/keadaan-angkatan-kerja-di-indonesia-agustus-2022.html>
- Statistics Indonesia. (2023). *Jumlah penduduk pertengahan tahun (ribu jiwa), 2021-2023*. <https://www.bps.go.id/indicator/12/1975/1/jumlah-penduduk-pertengahan-tahun.html>
- Statistics Indonesia. (2023, February 6) *Ekonomi Indonesia tahun 2022 tumbuh 5,31%*. <https://www.bps.go.id/pressrelease/2023/02/06/1997/ekonomi-indonesia-tahun-2022-tumbuh-5-31-persen.html>
- Statistics Indonesia. (2023, July 25). *Ekspor rumput laut dan ganggang lainnya menurut negara tujuan utama, 2012-2022*. <https://www.bps.go.id/statictable/2019/02/25/2025/ekspor-rumput-laut-dan-ganggang-lainnya-menurut-ne>
- Statistics of East Nusa Tenggara Province. (2022). *Produksi rumput laut (ton), 2019-2021*. <https://ntt.bps.go.id/indicator/56/601/1/produksi-rumput-laut.html>
- Sturgeon, T. J. (2001). How do we define value chains and production networks? *IDS Bulletin*, 32(3), 9-18.
- Sulewski, P., Kłoczko-Gajewska, A., & Sroka, W. (2018). Relations between agri-environmental, economic and social dimensions of farms' sustainability. *Sustainability*, 10(12), 4629.
- Sulistiyono, S. T. (2016). Paradigma maritim dalam membangun Indonesia: Belajar dari sejarah. *Lembaran Sejarah*, 12(2), 81-108.
- Swinnen, J. F., & Maertens, M. (2007). Globalization, privatization, and vertical coordination in food value chains in developing and transition countries. *Agricultural Economics*, 37, 89-102.
- Syuaib, M. F. (2016). Sustainable agriculture in Indonesia: Facts and challenges to keep growing in harmony with environment. *Agricultural Engineering International: CIGR Journal*, 18(2), 170-184.
- Tando, E. (2019). Pemanfaatan teknologi greenhouse dan hidroponik sebagai solusi menghadapi perubahan iklim dalam budidaya tanaman hortikultura. *Buana Sains*, 19(1), 91-102.
- Tangguda, S., Siahaan, I. C., Hariyadi, D., & Valentine, R. (2022). Pengolahan Rumput Laut *Eucheuma Sp.* Bagi Kelompok Masyarakat Desa Tablolong, Kupang Barat, NTT. *Indonesian Journal of Fisheries Community Empowerment*, 2(2), 87-92.
- Teniwut, W. A. (2016). For sustainable revenue of fisheries sector in small islands: evidence of Maluku, Indonesia. *Aquaculture, Aquarium, Conservation & Legislation*, 9(3), 722-732.
- Toussaint, M., Cabanelas, P., & Muñoz-Deñas, P. (2022). Social sustainability in the food value chain: what is and how to adopt an integrative approach? *Quality & Quantity*, 1-24.
- Trienekens, J. H. (2011). Agricultural value chains in developing countries a framework for analysis. *International Food and Agribusiness Management Review*, 14(2), 51-82.
- Trienekens, J., van Velzen, M., Lees, N., Saunders, C., & Pascucci, S. (2018). Governance of market-oriented fresh food value chains: Export chains from New Zealand. *International Food and Agribusiness Management Review*, 21(2), 249-268.

- Ukko, J., Saunila, M., Rantala, T., & Havukainen, J. (2019). Sustainable development: Implications and definition for open sustainability. *Sustainable Development*, 27(3), 321-336.
- Ussahawanitchakit, P. (2017). Value chain costing, competitive advantage and firm success: Evidence from Thai auto parts manufacturing businesses. *International Journal of Business*, 22(3), 230-250.
- Van Cauwenbergh, N., Biala, K., Biolders, C., Brouckaert, V., Franchois, L., Ciudad, V. G., & Peeters, A. (2007). SAFE - A hierarchical framework for assessing the sustainability of agricultural systems. *Agriculture, Ecosystems & Environment*, 120(2-4), 229-242.
- Vroegindewey, R., & Hodbod, J. (2018). Resilience of agricultural value chains in developing country contexts: A framework and assessment approach. *Sustainability*, 10(4), 916.
- Wabang, I. L., Plaimo, P. E., Hendrizal, A., Alelang, I. F., & Peny, T. L. L. (2022). Mapping study on market potential and market chain for seaweed in Alor Regency, East Nusa Tenggara Province. *IOP Conference Series: Earth and Environmental Science* 1038(1):1-15.
- Wang, H., Wang, X., Sarkar, A., & Qian, L. (2021). Evaluating the impacts of smallholder farmer's participation in modern agricultural value chain tactics for facilitating poverty alleviation—A case study of kiwifruit industry in Shaanxi, China. *Agriculture*, 11(5), 462.
- Widadie, F., Bijman, J., & Trienekens, J. (2021). Value Chain upgrading through producer organisations: linking smallholder vegetable farmers with modern retail markets in Indonesia. *International Journal on Food System Dynamics*, 12(1), 68-82.
- Wijayanto, D. (2016). Fisheries development strategies of Biak Numfor Regency, Indonesia. *Aquatic Procedia*, 7, 28-38.
- Wijayanto, D., Bambang, A. N., Nugroho, R. A., & Kurohman, F. (2020). Financial analysis of seaweed cultivation in Karimunjawa Islands, Indonesia. *Aes Bioflux*, 12(1), 1-10.
- Yuliyanto, I., Utoyo, B., & Riniarti, D. (2016). Karakteristik cendawan mikoriza arbuskula (CMA) pada beberapa rhizosfer tanaman perkebunan. *Jurnal Agro Industri Perkebunan*, 4(2), 97-105.
- Zaman, K., Abdullah, I., & Ali, M. (2017). Decomposing the linkages between energy consumption, air pollution, climate change, and natural resource depletion in Pakistan. *Environmental Progress & Sustainable Energy*, 36(2), 638-648.
- Zamora, E. A. (2016). Value chain analysis: A brief review. *Asian Journal of Innovation and Policy*, 5(2), 116-128.
- Zamroni, A. (2021). Sustainable seaweed farming and its contribution to livelihoods in Eastern Indonesia. *IOP Conference Series: Earth and Environmental Science*, 718, 1, 1-10.
- Zhang, J., Waldron, S., Langford, Z., Julianto, B., & Komarek, A. M. (2023). China's growing influence in the global carrageenan industry and implications for Indonesia. *Journal of Applied Phycology*, 36, 1-22.

Appendices

Appendix 1: Research questionnaire for farmers

Farmer Characteristics

1. Can you please tell me about your personal details? (Name, age, educational background, seaweed farming experience, reason on seaweed farming, main job)

Farm Characteristics

2. Can you please tell me about your seaweed farm? (Size, ownership status, seaweed types and reason behind it, production volume)

Production

3. What inputs do you use for your seaweed farming? (Where to buy, why use it)
4. What production practices you have for your seaweed farming? (Methods and why, tools, labor)

Harvesting and Post-harvesting

5. What do you do after the production of the seaweed? (Frequency of the harvest, when, harvesting methods and why, loss and waste, storage (time and perishability), transportation and why, additional processes and why, safety, quality control, certification)

Marketing

6. Where do you sell your seaweed? (Who are the buyers and why, market percentages and why, relationships, transportation and why, volume, price, apply these questions to each type of seaweed)
7. How does the transaction arrangement work? (Contract term and why, negotiation for price, price setting, payment method, quality standard, traceability)
8. How do you access market information? (Price, quality, challenges, coordination among players)

Institution

9. How do you connect with other farmers? (Why)
10. Is there any other institutions or producer groups related to the seaweed production

activities?

Economic Sustainability

11. How about your seaweed farming business in terms of economy? (Revenue, price conditions, sales volume, cost efficiency, financial support)

Social Sustainability

12. How does your social life conditions? (Quality of life, social impact, training, education, lifestyle improvement)
13. How does your working conditions? (Working time, workload, workforce, work safety)

Environmental Sustainability

14. What do you do regarding the environment? (Non-renewable resources such as energy/fuel, air/water pollutions, waste, biodiversity impact)

Additional Questions

15. What do you think about the future in the seaweed sector? (Opportunities, challenges, plans in five years)

Appendix 2: Research questionnaire for traders

Intermediaries Characteristics

1. Can you please tell me about your personal details? (Name, age, educational background, seaweed trading experience, reason on seaweed trading, main job, position)

Company Characteristics

2. Can you please tell me about your seaweed trading business? (Size, ownership status, seaweed types and reason behind it, trading volume)

Seaweed Sourcing Activities

3. How do you buy your seaweed? (Who are the sellers and why, market, relationships, transportation and why, volume, price, apply these questions to each type of seaweed)
4. How does the transaction arrangement work? (Contract term and why, negotiation for price, price setting, payment method, quality standard, traceability)
5. How do you access market information? (Price, quality, challenges, coordination among players)

Seaweed Processing/Storage Activities

6. What do you do after buying the seaweed? (Storage, time and perishability, transportation and why, additional processes and why, safety, quality control, certification)

Marketing

7. Where do you sell your seaweed? (Who are the buyers and why, market percentages and why, relationships, transportation and why, volume, price, apply these questions to each type of seaweed)
8. How does the transaction arrangement work? (Contract term and why, negotiation for price, price setting, payment method, quality standard, traceability)
9. How do you access market information? (Price, quality, challenges, coordination among players)

Institution

10. How do you connect with other intermediaries? (Also, farmers, processors and why)

Economic Sustainability

11. How about your seaweed trading business in terms of economy? (Revenue, price conditions, sales volume, cost efficiency, financial support)

Social Sustainability

12. How does your social life conditions? (Quality of life, social impact, training, education, lifestyle improvement)
13. How does your working conditions? (Working time, workload, workforce, work safety)

Environmental Sustainability

14. What do you do regarding the environment? (Non-renewable resources such as energy/fuel, air/water pollutions, waste, biodiversity impact)

Additional Questions

15. What do you think about the future in the seaweed sector? (Opportunities, challenges, plans in five years)

Appendix 3: Research questionnaire for processors

Identity

1. Can you please tell me about your personal details? (Name, age, position in the company, seaweed sector experience, reason on entering seaweed sector)

Company Characteristics

2. Can you please tell me about the company's seaweed processing? (Size, ownership status, seaweed types and reason behind it, volume)

Seaweed Sourcing Activities

3. How does the company buy the seaweed? (Who are the sellers and why, market, relationships, transportation and why, volume, price)
4. How does the transaction arrangement work? (Contract term and why, negotiation for price, price setting, payment method, quality standard, traceability)
5. How does the company share information to the sellers? (Why, price, quality, challenges, coordination among players)

Seaweed Processing/Storage Activities

6. What does the company do after buying the seaweed? (Storage, time and perishability, transportation and why, additional processes and why, safety, quality control, certification)

Marketing

7. Where does the company sell the processed seaweed? (Who are the buyers and why, market percentages and why, relationships, transportation and why, volume, price)
8. How does the transaction arrangement work? (Contract term and why, negotiation for price, price setting, payment method, quality standard, traceability)

Economic Sustainability

9. How about the company seaweed processing business in terms of economy? (Revenue, price conditions, sales volume, cost efficiency, financial support)

Social Sustainability

10. How about the social conditions related to the company? (Social impact, training and education, lifestyle improvement)

11. How about the working conditions of the company's employees? (Working time, workload, workforce, work safety)

Environmental Sustainability

12. What do you do regarding the environment? (Non-renewable resources such as energy/fuel, air/water pollutions, waste, biodiversity impact)

Additional Questions

13. What do you think about the future in the seaweed sector? (Opportunities, challenges, plans in five years)

Appendix 4: Research ethics approval



Dear:

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our database for inclusion in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Dr Brian Finch, Director - Ethics, telephone 06 3569099 ext 86015, email humanethics@massey.ac.nz.

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Dr Brian Finch Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

Research Ethics Office, Research and Enterprise
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand T 06 951 6841; 06 95106840
E humanethics@massey.ac.nz; animalethics@massey.ac.nz; gtc@massey.ac.nz

Appendix 5: Research information letter



Seaweed Value Chain Sustainability Assessment in the Kupang Regency, East Nusa Tenggara, Indonesia

Information Sheet for Stakeholders

Who am I?

My name is Angelo Luigi Mario, I am originally from Jakarta, Indonesia, and I am currently studying as a Masters Student at Massey University in the School of Agriculture and Environment, New Zealand.

What is the aim of the project?

Agricultural value chains have been increasingly studied in developing countries, including Indonesia, to help respond to the changes and challenges of the global development of agricultural products with high-value standards. However, value chain studies are still limited in Indonesia. One of the value chains that has not been studied in much depth is the seaweed value chain. Therefore, this study aims to assess the seaweed value chain in the Kupang Region, which can potentially provide insights into the sector development in the future.

If you agree to be part of this research, what will you be requested to do?

The study employs semi-structured interviews with the key stakeholders involved in the seaweed value chain. If you choose to participate in this study, there will be an interview that will approximately last up to one hour. The interview will be based on the issues which focuses on your experiences and insights regarding the seaweed value chain. The questionnaire will not include any personal topics that could cause discomfort, and you are free to decline to answer any questions that make you uncomfortable.

Withdrawing from the study?

Your participation is entirely voluntary, and you are free to withdraw at any point without any negative consequences.

Possible risks and benefits

The study poses minimal potential risks. Participating in this study will not directly benefit you. However, your involvement will provide valuable insights into the development of the seaweed value chain in Indonesia, especially in the Kupang Region.

What are your rights if you participate in this research?

You are under no obligation to accept this invitation. If you decide to take part, you have the right to:

- decline to answer any question(s)
- provide information anonymously
- request to turn off the recorder at any point during the interview
- ask questions and seek clarifications about research study at any point during the participation
- obtain a summary of the project findings once the study is completed

Thank you for your cooperation.

Kind Regards,

Angelo Luigi Mario

Who can you speak to if you have any questions?

If you have any questions regarding the study, please don't hesitate to contact either:

Researcher

Angelo Luigi Mario

Email: angelo.luigi23@gmail.com, School of Agriculture and Environment

Supervisors

Dr. Elena Garnevska

Email: E.V.Garnevska@massey.ac.nz, School of Agriculture and Environment

Prof. Peter Tozer

Email: P.Tozer@massey.ac.nz, School of Agriculture and Environment

Appendix 6: Participant consent form

Title of the project: Seaweed Value Chain Sustainability Assessment in the Kupang Regency, East Nusa Tenggara, Indonesia

Please Initial box

1. I confirm that I have read, or, had read to me, and understand the information sheet for the above-mentioned study. I have been given a chance to inquire about any concerns and they have been addressed fully to my satisfaction.
2. I understand that my participation is entirely voluntary, and I am free to withdraw at any time, without any consequence.
3. I understand that the researcher may request access to relevant records, such as production and inventories.
4. I understand that all the information collected in the study will remain confidential and personal and identifiable information will be anonymized.
5. I understand that I can decline to answer if it makes me uncomfortable.
6. I agree to the photo documentation as required.
7. I agree for my interview to be taped and transcribed.

I consent to provide access and authorize the research team to collect and examine data for the study. I also agree to participate in a research interview, as detailed in the information sheet.

Participant's Name: _____

Participant's Signature: _____

Date: _____

Appendix 7: Translated research information letter



Kajian Rantai Nilai Rumput Laut Keberlanjutan di Kabupaten Kupang, Provinsi Nusa Tenggara Timur, Indonesia

Lembar Informasi untuk Partisipan

Siapakah saya?

Nama saya adalah Angelo Luigi Mario, saya berasal dari Jakarta, Indonesia. Saya sekarang sedang mendalami studi sebagai pelajar S2 di Departemen Pertanian dan Lingkungan, Universitas Massey, Selandia Baru.

Apakah tujuan dari studi ini?

Rantai nilai pertanian semakin banyak dipelajari di negara-negara berkembang, termasuk Indonesia, untuk membantu merespons perubahan dan tantangan perkembangan global produk pertanian dengan standar bernilai tinggi. Namun studi rantai nilai masih terbatas di Indonesia. Salah satu rantai nilai yang belum banyak dikaji secara mendalam adalah rantai nilai rumput laut. Oleh karena itu, studi ini bertujuan untuk mengkaji rantai nilai rumput laut di wilayah Kupang, yang berpotensi memberikan wawasan mengenai pengembangan sektor ini di masa depan.

Jika Anda setuju untuk menjadi bagian studi ini, apa yang diharapkan untuk Anda lakukan?

Studi ini menggunakan wawancara semi-terstruktur dengan para partisipan yang terlibat dalam rantai nilai rumput laut. Jika Anda memilih untuk berpartisipasi dalam penelitian ini, akan ada wawancara yang berlangsung kurang lebih satu jam. Wawancara akan didasarkan pada isu-isu yang berfokus pada pengalaman dan wawasan Anda mengenai rantai nilai rumput laut. Pertanyaan tidak akan memuat topik pribadi apa pun yang dapat menyebabkan

ketidaknyamanan, dan Anda bebas menolak menjawab pertanyaan apa pun yang membuat Anda tidak nyaman.

Mengundurkan diri dari partisipasi studi?

Partisipasi Anda sepenuhnya bersifat sukarela, dan Anda bebas untuk mengundurkan diri kapan saja tanpa konsekuensi negatif apa pun.

Kemungkinan risiko dan manfaat

Studi ini memiliki potensi risiko minimal. Berpartisipasi dalam studi ini tidak akan memberikan manfaat langsung bagi Anda. Namun keterlibatan Anda akan memberikan wawasan berharga terhadap pengembangan rantai nilai rumput laut di Indonesia, khususnya di wilayah Kupang.

Apa saja hak Anda jika berpartisipasi dalam studi ini?

Anda tidak berkewajiban untuk menerima undangan ini. Jika Anda memutuskan untuk ikut serta, Anda berhak untuk:

- menolak menjawab pertanyaan apa pun
- memberikan informasi secara anonim
- meminta untuk mematikan perekam kapan saja selama wawancara
- mengajukan pertanyaan dan mencari klarifikasi tentang studi kapan saja selama partisipasi
- memperoleh ringkasan temuan studi setelah studi selesai

Terima kasih untuk kerja sama Anda,

Salam Hormat,

Angelo Luigi Mario

Dengan siapa Anda dapat berbicara jika Anda memiliki pertanyaan?

Jika Anda memiliki pertanyaan lebih lanjut mengenai studi ini, Anda dapat menghubungi:

Peneliti

Angelo Luigi Mario

Email: angelo.luigi23@gmail.com, Departemen Pertanian dan Lingkungan

Pembimbing

Dr. Elena Garnevska

Email: E.V.Garnevska@massey.ac.nz, Departemen Pertanian dan Lingkungan

Prof. Peter Tozer

Email: P.Tozer@massey.ac.nz, Departemen Pertanian dan Lingkungan

Appendix 8: Translated participant consent form

Formulir Persetujuan

Judul studi: Kajian Rantai Nilai Rumput Laut Keberlanjutan di Kabupaten Kupang, Provinsi Nusa Tenggara Timur, Indonesia

Isi Kotak	Silahkan
1. Saya menyatakan bahwa saya telah membaca, atau, telah dibacakan untuk saya, dan memahami lembar informasi untuk studi ini. Saya telah diberi kesempatan untuk menanyakan kekhawatiran apa pun dan hal itu telah ditangani sepenuhnya demi kepuasan saya.	<input type="checkbox"/>
2. Saya memahami bahwa partisipasi saya sepenuhnya bersifat sukarela, dan saya bebas untuk mengundurkan diri kapan saja, tanpa konsekuensi apa pun.	<input type="checkbox"/>
3. Saya memahami bahwa peneliti dapat meminta akses ke catatan yang relevan, seperti produksi dan inventaris.	<input type="checkbox"/>
4. Saya memahami bahwa semua informasi yang dikumpulkan dalam studi ini akan tetap rahasia dan informasi pribadi serta identitas akan dianonimkan.	<input type="checkbox"/>
5. Saya memahami bahwa saya dapat menolak menjawab jika hal tersebut membuat saya tidak nyaman.	<input type="checkbox"/>
6. Saya menyetujui dokumentasi foto sesuai kebutuhan.	<input type="checkbox"/>
7. Saya setuju wawancara saya direkam dan ditranskrip.	<input type="checkbox"/>

Saya setuju untuk memberikan akses dan memberi wewenang kepada tim peneliti untuk mengumpulkan dan memeriksa data untuk studi ini. Saya juga setuju untuk berpartisipasi dalam wawancara studi, sebagaimana dirinci dalam lembar informasi.

Nama Partisipan: _____

Tanda Tangan Partisipan: _____

Tanggal: _____