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The impact of construction of an integrated shell waste management site on social, economic, and environmental aspects in Cirebon, West Java

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Abstract. The concept of a blue economy encourages business growth and efficient investment while protecting the environment by making the most of spending and financing resources that will increase economic growth and improve people's lives. Crab shell is one of the industrial wastes of the pasteurization of crab meat, which is growing along with the demand for exports. Direct stockpiling of crab shells creates an unpleasant odor and makes access difficult for collectors of crab shells. Therefore an Integrated Shell Waste Treatment Site (ISWTS) is very important to build to support the blue economy principle, where all economic operations are zero-waste, clean, and efficient. The purpose of the study is to examine the impacts of ISWTS development on the social, economic, and environmental aspects in the Cirebon Regency. Data was collected through focus group discussions and interviews with eight miniplant owners and one supplier of crab shells. Qualitative descriptive and triangulation were applied to analyze the increase in earnings in crab industry laborers, the impact of individual and group capabilities, the strength of partnership partners, and labor absorption. The result shows there is an increase in earnings, which can contribute to the fisheries sector to the Gross Regional Domestic Product (PDRB) in Cirebon Regency through the application of the website for making orders operated by laborers and customers. This business makes more strong connections among miniplants, dryer shells, and TPLCT side through labor absorption primarily to involved and utilize at TPLCTThe study findings show that the community supports the construction of the TPLCT because it employs many people, but the building must be carried out far from residential areas.

Keywords: blue swimming crab; crab shell; waste

1. Introduction

The potential utilization of Indonesia's fishery and marine resources has only reached 59% of its total sea area of 5.8 million km^2. In order to effectively manage the utilization of Indonesia's marine environment, it is essential to have a well-defined plan that takes into account all aspects, including economic factors, life expectancy, and education of coastal communities. These communities rely heavily on the sea, and it is important to ensure that their livelihoods are sustainable in the long run. A comprehensive plan that addresses all these factors will help in achieving this goal [1]. The blue economy, is believed to be able to improve economic levels and optimize utilization while still carrying

out sustainable principles [2]. The concept of a blue economy is sustainable development, which means optimizing water resources with the aim of increasing economic growth and people's welfare, but the sky and sea remain blue. Focusing on efficiency to encourage investment and business development while maintaining a sustainable environment. In other words, the blue economy is the concept of pro-ecosystem economic development. The blue economy is prepared to face the challenges of the world economy, which is exploitative and damaging to the environment because it exceeds the capacity or carrying capacity of nature [2].

One of the principles of the blue economy is economic activity that has a clean, efficient production system without waste, is free of pollution, and does not damage the environment [3]. To achieve this efficiency, fisheries and marine economic activities must be directed so that they have a sustainable production cycle system. What is meant is that the waste of one production activity goes through a processing process that makes it an input for other economic activities. All the elements contained in the raw materials are utilized so that they do not go to waste, increasing their economic value, which results in great value as the main raw material. This requires the development of good technological engineering, qualified and professional human resources, and upstream-downstream integration to efficiently use resources so as to be able to provide added value, increase product competitiveness, and increase people's welfare income in an inclusive manner. Input from one production waste that is used for other economic activities is an implementation of increasing added value and servicing a product because it does not require new raw materials [4].

The blue swimming crab commodity (*Portunus pelagicus*) in Indonesia has a potential of 60,489 tons spread over eleven fisheries management areas (FMA), which makes it the fourth exporting country for pasteurized crab meat in the world after Russia, Canada, and China. The United States is the main export destination country, where export demand tends to continue to increase every year, with a percentage increase in volume of 13.25% from 2019–2020. The proportion of crab body parts processed in the industry includes 52.59% shell, 35.68% meat, and 11.73% offal. Along with the increasing demand for exports, the required raw material, namely pasteurized crab meat, is also increasing along with the volume of waste, one of which is shell waste [5]. Shell waste has not been used optimally; [6] stated in his journal that 56,200 tons of crustacean shell waste have not been utilized per year. The handling is just thrown away, sold without being processed, even if it is processed soberly, and then sold to collectors. The sale of unprocessed shells has a very low economic value because there is no public knowledge of how to process crab shells. Discarded crab shells cause complaints from people who feel disturbed by environmental problems such as odor pollution, which has the potential to transmit disease [5]. Even though the shell waste has the potential to be utilized to the maximum, research conducted by Rochima [6] and Azizi *et al.* [7] on the utilization of crab shell waste as chitin chitosan material and Faruqi found that crab shell waste can be processed into paste, broth, and crackers [8].

Based on research conducted by Amalia *et al*, the supply chain of crab shell waste starts with fishermen, baskets, and miniplants, where the miniplants act as crab peelers [5]. There are various ways to treat crab shells that a mini plant decides to dispose of in the environment. Second, miniplants sell crabs shell to collectors, and collectors have to visit the miniplants one by one. Miniplants selling crabs shells do not know the purpose of buying shells. Third, miniplant throws away and sells the crab shells. Fourth, miniplants utilize crab shells. There are many studies that use crab shell waste as the subject; based on journals on the utilization of crab shell waste during 2007–2020, four large groups of shell waste utilization were obtained, including industrial raw materials (chitosan), animal feed, food products, and fertilizers [5]. The industry requires large volumes of raw material for crab shells. The data shows that if the shells are sold casually, an added value of Rp. 2,000/kg is obtained, while if they are used as chitosan, an added value of Rp. 18,000/kg is obtained. Utilization of crab shell waste can increase added value, supported by a high volume of shells.

Based on these conditions, the Indonesian Crab Management Association (APRI) in collaboration with the Bogor Agricultural Institute decided to make a prototype business for managing crab shell waste called the Crab Shell Waste Management Site (TPLCT) which is planned to be established in the Mertasinga Village area, Gunung Jati District, Cirebon Regency. where TPLCT implements

management that is technical and integrated with the aim of facilitating the collection of crab shells, implementing handling and processing in accordance with standards, producing quality shells that are hygienic and have been sorted according to industrial needs, making it easier for the industry to obtain raw materials for crab shells. Of course, the development of the TPLCT business will generate various kinds of responses from the local community.

2. Methods

2.1. Study Area

The research took place from April to June 2023 in Grogol Village and Mertasinga Village, Gunung Jati District, Cirebon Regency (Figure 1).

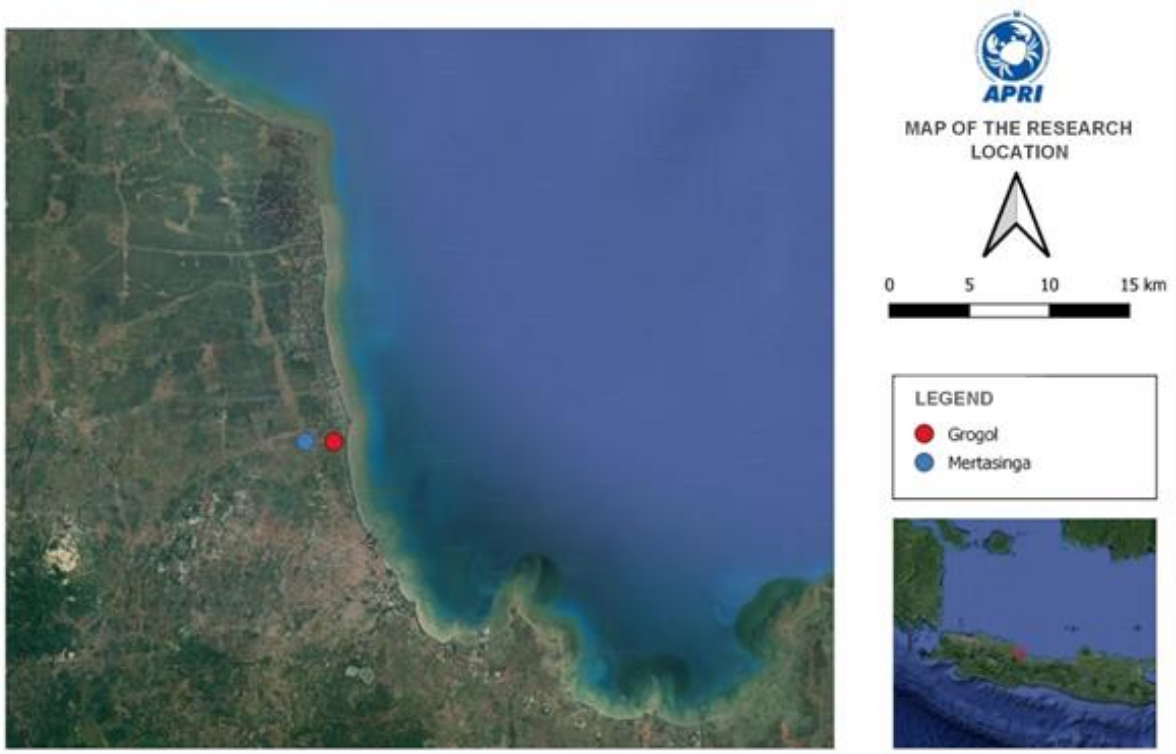

Figure 1. Map of research locations in Grogol and Mertasinga Village, Cirebon Regency.

2.2. Data collection

The data used in this study are primary data obtained through observation, in-depth interviews, and focus group discussions (FGD) with miniplant owners spread across Grogol Village and Mertasinga Village, Gunung Jati District, Cirebon Regency. After conducting a location survey, it was found that 8 miniplants were willing to carry out discussions. Secondary data is needed to complete the unavailability of information from sources, including data needed from agencies, reports, journals, and articles related to research locations and topics. Data analysis is by using a qualitative descriptive method by reducing data, namely choosing the main points, simplifying, and focusing on important things, in this case recording the results of interviews and documentation from informants, presenting data in tables and graphs, and drawing conclusions. The triangulation method is used to avoid misinterpretation of data. Data obtained from one source was confirmed by another source [5, 9, 10, 11].

2.3. Data Analysis

The focus of this research is by analyzing the TPLCT development on the socio-economic conditions of coastal communities where this program is implemented by APRI in collaboration with IPB students as an effort to implement a blue economy, protect the environment, and empower local communities. The aspects analyzed include:

1. Increasing income from existing crab industrial activities
2. Recruitment of workers from several groups of people in Grogol Village and Mertasinga Village, Gunung Jati District, Cirebon Regency
3. Impact on individual and group capabilities to support operations if the TPLCT is built
4. Land use
5. Minimize waste
6. Strengthen partnership patterns

3. Results and Discussion

3.1. Flow process of integrated crab shell waste management (TPLCT)

The work process at the miniplant as the initial supplier of raw material for crab shells includes a series of activities. After stripping the crab shells, which are still in wet conditions, they undergo a sorting process (separating each part between full-blooded, swimming, and walking legs, claws, and other parts) (Figure 2). Sorting is carried out by staff or peeler groups in miniplants; sorted shells are grouped in different containers per part. Then the shells are weighed, and the results of the shell weighing are inputted to a special website featuring the miniplant database so that TPLCT, as the buyer of shell raw materials, knows the quantity of shell availability and current prices and facilitates ordering. There are two options for shell distribution to TPLCT, the first is that the miniplants are willing to deliver it to TPLCT, or the second is that TPLCT will take it directly to each miniplant. The selection of distribution options is done through the website.

After arriving at TPLCT, the shells are reweighed to input the data to the special website for the TPLCT database feature. After the data is input, the miniplant will receive a receipt that TPLCT has purchased the shells. The shell will then undergo a drying process using a tray, and other parts, such as the abdomen, will then go through a pressing process. After going through the drying and pressing processes then the shells are packed according to their parts and then put into the storage warehouse. Prior to being purchased by the buyer, the shells will go through an inspection process.

Figure 2. Crab shell from drying process.
(Source: Indonesian Blue Swimming Crab Association)

The buyer, namely the industry, is provided with access by TPLCT to visit the website, where the industry creates an account and password to log in. Before making a purchase, the industry can see data on the availability of the number and price of shells per part. If buyers want to make a purchase, the industry enters the order menu and then makes the transaction as desired. The industry has the right to re-check the shells it wants to buy, and if it is appropriate, the industry will confirm the order and get a digital order sign. Then TPLCT received the order and sent the shells according to the order.

3.2. Increased income from crab industry and utilization of crab shell waste

Income refers to the remuneration individuals receive for their contributions to the production factors in creating a product during a specific time frame. Income is divided into three categories: money income, namely regular income as remuneration or counter-performance; goods income, namely regular income in the form of remuneration received in the form of goods and services; and income that is not income, namely receipts that are redistributive transfers and make changes in household finances [12]. The variables that affect income include working hours, working capital, business location, and product type [13].

Regional income in Cirebon Regency comes from potential agriculture, forestry, and fisheries, with an average of 17.38%, according to Cirebon Regency GRDP Distribution Data Based on Current Prices (Table 1). According to Business Fields in 2010–2016, it is still lower than the processing industry sector, with an average of 21.42%.

Table 1. Distribution of gross regional domestic product (GRDP) (%) of cirebon utara regency by current prices based on the field of business (2010-2016).

Category	2010	2011	2012	2013	2014	2015	2016	Avg. 7 years
Agricultural, Fisheries, Forestry	18,99	18,37	17,74	17,55	16,76	15,97	16,30	17,38
Manufacturing industry	21,68	21,83	21,31	21,23	21,15	21,29	21,42	21,42

Source: [14]

The income of the communities in Mertasinga and Grogol Villages largely comes from activities related to the crab processing industry. The series of crab processing activities starts with the catching process, which involves the use of traps and rakes as fishing gear. This process incurs various costs, such as purchasing boats, machinery, fuel, gas (for boiling crabs), feed, boat and machinery repairs, and non-routine fishing equipment. The selling price of crabs caught using traps in 2022 ranged from Rp100,000 to Rp130,000 per kilogram, whereas in 2021, it was in the range of Rp70,000 to Rp100,000 per kilogram. Crabs caught using rakes were sold at a price of Rp20,000 per kilogram. Subsequently, the crabs are boiled and peeled by fishermen's families or a group of about 10–20 workers in a miniplant. The miniplant then sends the crab meat to the main plant or factory for further processing, usually canned for export to various countries [15]. The financial aspects of the crab processing activities are shown in Table 2.

Table 2. Financial aspects of crab processing industry in cirebon regency, 2022.

Cost components	Fishing gear	
	Kejer	Garuk
Inverstment (Rp)	46.443.696	33.025.000
Total annual costs (Rp)	54.951.565	34.258.000
Total annual revenue (Rp)	100.991.304	117.000.000
Annual boat business profit (Rp)	46.039.739	82.742.000

Source: [15]

The development of constructing TPLCT (Temporary Processing and Waste Management Center) is an effort to provide a solution for handling crab waste through utilization activities, adding value to the crab waste, specifically crab shells, and enabling commercialization. This is expected to increase the income of miniplant owners who are engaged in the crab processing industry (Table 3).

Table 3. Financial aspects of integrated crab shell waste management facility (TPLCT).

Cost components	Amount (Rp)
Inverstment	667.060.620
Total Annual Production Costs	222.122.674
Annual revenue	288.759.477

Source: Primary data processing, 2023

The TPLCT (Integrated Crab Shell Waste Management Facility) purchases sorted crab shells (separated into pincers, swimmerets, walking legs, claws, and other parts, which are pre-sorted by the miniplant) at the following prices: pincers are bought at Rp4,526/kg, swimmerets and walking legs at Rp3,480/kg, claws at Rp3,480/kg, and other parts at Rp5,343/kg. Upon arrival at the TPLCT, the crab shells are weighed, and then they are dried using trays, while other parts are pressed using a pressing tool before weighing. Each part of the crab shell is then individually packaged and stored in the storage warehouse until it is sent to industries (buyers) where it will be utilized according to their needs, such as raw material for chitin chitosan, animal feed, fertilizer, restaurants, frozen food, etc. [5]. The total income from the sale of crab shells by TPLCT in Cirebon Regency reaches Rp552,878,963 per year (Table 4).

Table 4. Annual financial aspects of tplct prototype development in cirebon regency.

Product	Total weight production (kg)	Total pieces production (pcs)	Price (Rp)	Total sales
totok / pincers	25.860	206.880	1.336	276.439.481
swimmerets and walking legs	19.884	-	6.951	138.219.741
claws	19.884	-	3.476	69.109.870
others	30.540	-	2.263	69.109.870
	Total			552.878.963

Source: Primary data processing, 2023

The financial details exclude the production costs amounting to Rp425,291,510. Based on the interviews, there are seven miniplants and one temporary shell dryer willing to collaborate and supply crab shell raw materials to TPLCT, while one miniplant is not willing to collaborate. Among the seven miniplants willing to collaborate, six are willing to sort the crab shells by parts, while one temporary shell dryer is not willing to sort. Five out of the seven miniplants anticipate an increase in income due to the collaboration, as they believe TPLCT offers a new program that addresses the technical handling of crab shell waste and provides commercial opportunities. On the other hand, two miniplants, willing to collaborate, have decided to provide crab shells for free without expecting an increase in income. They view the benefit as merely reducing crab shell waste and improving the hygienic conditions of their miniplants. Based on these factors, it is expected that the percentage contribution of the fisheries sector to the Gross Regional Domestic Product (PDRB) in Cirebon Regency will surpass that of the manufacturing industry.

3.3. Impact on individual and group capabilities

The economic development of communities is influenced by global economic advancements. Therefore, efforts are made to keep up with and adapt to global economic trends, focusing on knowledge-based aspects of the economy and utilizing knowledge and innovation to manage available natural resources. The implementation of knowledge and innovation in community economic development involves collaboration with academics and the implementation of appropriate technology to compete with larger or more advanced businesses [16]. During its operations, TPLCT collaborates with local miniplants, involving individuals and community groups in the collection and delivery of crab shells.

TPLCT provides a website for the miniplants, serving as a platform to collect data on the availability and prices of crab shells, as well as options for delivering the shells to TPLCT, allowing miniplants to choose whether they deliver the shells or have TPLCT pick them up. The website is managed by individuals or groups working at the miniplants, such as the crab peelers' groups in Mertasinga and Grogol Villages, as well as individual owners and staff of the miniplants. Through the TPLCT website, miniplant owners, staff, and crab peelers' groups gain new skills and knowledge, learning how to navigate and use the website's features, input crab shell data, and track the availability of shells. Based on interviews, six miniplants and one shell dryer find the website's interface appealing, and they find the data input process for updating easy to understand, leading them to commit to regularly inputting data. They also appreciate the real-time data input as it facilitates tracking and historical data since the shell data is stored on the website. On the other hand, two miniplants are not willing to input data, with one miniplant refusing to collaborate with TPLCT and the other not familiar with website usage.

3.4. Strengthening Partnership Patterns

Adriyani *et al.* states that communities need effective solutions amidst confusion when facing challenges [17]. They would greatly benefit from programs or business activities that generate income, even if small, but are sustainable, thus increasing their primary income. This phenomenon can influence the strengthening of partnership patterns between the local community and other parties willing to collaborate with or empower the local community.

TPLCT serves as a solution to the problems faced by Mertasinga Village. Until now, the community has not found an effective solution for handling crab shell waste. TPLCT has discovered a utilization opportunity in this issue, where the main waste problem of crab shells becomes raw material for production. TPLCT does not compete with other fishing-related activities as it does not utilize fish catches as raw material, which is common in Mertasinga Village's crab processing industry. The decision of TPLCT to collaborate with local miniplants creates a business relationship that does not involve competition and ultimately increases the income of miniplant owners and the community members who will directly engage in TPLCT's operations. The utilization of crab shells as raw material for TPLCT follows sustainable principles, as there is no waste from the crab processing industry, resulting in a cleaner production system and reduced pollution.

Based on interviews, seven miniplants and one shell dryer are willing to collaborate with TPLCT. The reasons for miniplant owners wanting to collaborate are that TPLCT will handle the crab shell waste issue, for which they do not have an effective solution, and TPLCT will purchase crab shells, thus increasing the income of miniplant owners. From the perspective of the shell dryer, they are willing to collaborate to enhance the value of the processed crab shells. Currently, the shell drying facility only produces crab shells for animal feed. On the other hand, two miniplants are not willing to collaborate, with one refusing to work with TPLCT and the other having family relations with someone who regularly takes crab shells for personal animal feed.

3.5. Labor absorption

Industrial development aims to achieve the main objective of community welfare, not just for the sake of development itself but through independent activities [18]. According to research conducted by Prabawa and Budhi [18], labor absorption is influenced by capital and labor wages. Capital significantly and positively affects production results, as indicated by the research, where a higher capital investment leads to higher production outcomes. Efficient capital involves a quick turnover of working capital elements. Labor wages are affected by capital, and wage levels increase if other variables related to capital, such as the use of technology, remain unchanged, as industries depend on labor in their operations.

During TPLCT's operations, two people will be recruited, with an estimated wage of Rp150,000 per month (based on interviews with miniplant owners as wage providers for consideration). The working hours will be 1 month, 16 days, 8 hours per day, and their tasks include data input, weighing, drying, and re-weighing the crab shells. The technology used is limited to a hydraulic pump for pressing parts, while the drying process relies on manual labor to move trays to ensure even drying of the shells.

4. Conclusion

The development of TPLCT had a positive impact on the social and economic conditions in Cirebon Regency. It has led to increased income, stronger partnerships, mastery of technology, and job creation opportunities. Furthermore, the TPLCT has helped in effectively managing the disposal of crab shell waste, which has prevented environmental pollution. These benefits are crucial for the community to develop blue economy-based businesses in the local environment.

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