

ANALYSIS OF VALUE-ADDED PRODUCT MAPPING FROM SHELLFISH WASTE IN COASTAL AREAS



Reiga Ritomiea Ariescy

Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia
reiga.mnj@upnjatim.ac.id

Egan Evanzha Yudha Amriel

Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia
reiga.mnj@upnjatim.ac.id

Arief Budiman

Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia
reiga.mnj@upnjatim.ac.id

Laksamana Aditya Hanif Rabbani

Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia
reiga.mnj@upnjatim.ac.id

Abstract

Coastal areas are one of the areas that currently have many problems, such as environmental problems and community welfare. One of the areas that has problems with these issues is Gisik Cemandi, Sedati, and Sidoarjo. One of the problems in the coastal area is the pile of shells that make the residential environment look dirty, smelly, and even become a nest for dangerous animals. The purpose of this research is to map the benefits that can be taken from shell waste so that the community can take opportunities of economic value, both as industrial activities, helping to reduce waste, and empowering coastal communities. This research uses a qualitative method with the Snowball Sampling Technique. Based on the results of the study, shell waste can be reduced to several products, namely fertilizer materials, chemical mixtures (calcium carbonate and metal adsorbents), handicrafts, animal feed mixtures, chitin-chitosan, and building material mixtures. Each of these products has its own benefits and selling value. However, this research only focuses on innovation in mapping waste products. This can be a potential opportunity for local communities to provide value to waste and improve welfare.

Keywords: Innovation, Entrepreneurship, Shellfish Waste

INTRODUCTION

Indonesia is an archipelago with almost two-thirds of its land area covered by oceans. The vast ocean area has great fisheries potential for the people of Indonesia, especially those living in coastal areas (Firdaus, et. al; 2018). As a strategic area and rich in biodiversity, coastal areas are often the center of trade, fisheries, and agricultural activities that depend on the marine environment (Firdaus, et. Al; 2018). However, coastal communities are also faced with various challenges. Seawater pollution, coral reef damage, and decreased seawater quality are some of the environmental issues that can affect the sustainability of coastal communities (Yani, et.al; 2021).

One of the coastal communities with environmental problems is Gisik Cemandi Village, Sedati, Sidoarjo, East Java. Some community groups in the village work as laborers separating/shelling shells with fairly low wages (Nisa, et al., 2021). Meanwhile, the shells from the separation become waste and have no market value. This shell waste is a problem that exists at the location, not only damaging the scenery but also has an impact on public health, including reducing the quality of life of the community (Ismail, et.al; 2022), public health (A'yuni, et al., 2019), and other organic waste problems (Nika, Anisah, & Musalamah, 2019). Thus, it is necessary to protect the marine environment so that coastal and marine resources can be utilized sustainably, including waste treatment. Protection of coastal and marine ecosystems is still lacking compared to land (Subekti, 2020). Solving this problem will help in realizing the welfare and environmental cleanliness of local coastal communities.

In entrepreneurship, problems that exist in society can usually be the basis for business startups to create an opportunity (Trott, P. 2017). Solving this problem requires innovation so that it will result in what solutions can be created (Bojoaga and Petrisor, 2013). Moreover, nowadays many people are aware of the importance of sustainability in the environment, both for business and environmental management (Ariescy & Amriel, 2019). Therefore, it is important to understand the problems that exist in coastal communities as a basis for designing sustainable development policies that take into account their needs and local wisdom. Not only designing policies but also involving coastal communities in the decision-making process and empowering them to manage natural resources sustainably are important aspects in promoting the sustainability and welfare of coastal communities.

Based on the above background, the formulation of the problem is what products can be produced from shell waste so that the waste can provide added value to improve the economy of coastal communities. Researchers take economic potential from a business and management point of view, so that technical matters are not examined in detail and in-depth.

This research aims to find and map product innovations derived from clamshell waste. The benefit of this research is to provide alternative solutions to the community through the utilization of clamshell waste to empower and improve the welfare of coastal communities. This is also very helpful for the government and supports achieving SDGs pillar 1 (No Poverty) and 14 (Marine Ecosystems).

REVIEW OF LITERATURE

Sustainable Entrepreneurship

Sustainable entrepreneurship is essentially the embodiment of sustainable innovation aimed at the mass market and providing benefits to the wider community (Lüdeke-Freund, F, 2020). Sustainable entrepreneurs link the success of their businesses directly to achieving a positive impact on the natural environment and humanity, and thus also to the creation of value for various stakeholders (Freudenreich, Lüdeke-Freund, & Schaltegger, 2019).

Business Innovation

Innovation is the management of all activities involved in the process of generating ideas, developing technology, manufacturing, and marketing new (or better) products or manufacturing processes or equipment (Trott, P. 2017). So, it does not rule out the possibility that the formation of a business idea is due to the role of science and technology. However, innovation must also have an impact on both the company and society (Hererra, 2016).

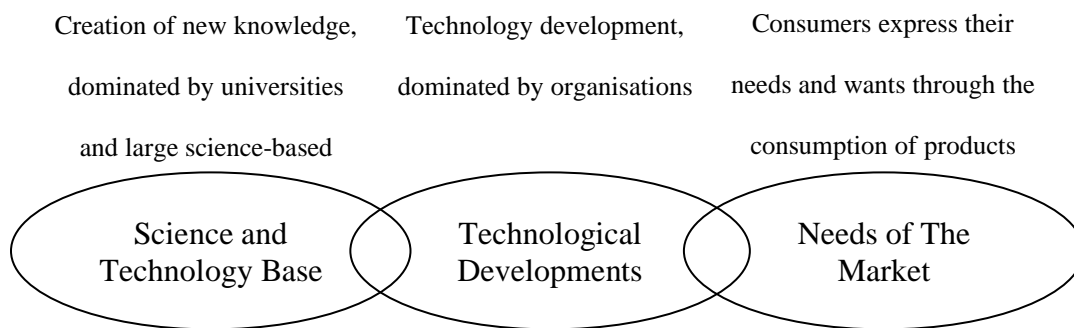


Figure 1
Innovation Concept Framework (Trott, P. 2017)

Shellfish Waste

The literature on shell waste discusses a lot about sustainable use in various sectors, especially in environmental management and resource recovery. The content of Shellfish/clam shells is calcium carbonate (Qiang, Wang., et, al, 2022; Poliana, Bellei, et.al, 2023), which can be reduced into various products.

RESEARCH METHOD

This research was conducted in Gisik Cemandi, Sedati, Sidoarjo, East Java. Collecting data, like observation and interviews, was held around on February – August 2024. It uses qualitative methods by conducting observations and interviews with informants with Snowball Sampling. Meanwhile, along with the research process, the number of informants is increasing where the number of informants was initially small and then enlarged (Sugiyono, 2015). The results of observations and interviews are supported by literature studies. A literature study is a tool used to collect data or sources related to the topic raised in a study. Informants who have been interviewed include the Head of Gisik Cemandi Village (*Lurah*), Fishermen, Shell Collectors, Shell Peelers, Agricultural Lecturers, Chemical Engineering Lecturers, and NGO (Non-Government Organization) Management. Some statements from informants provide basic data in determining what derivative products are supported by literature studies.

The following is the research **process to find the mapping of waste potential:**

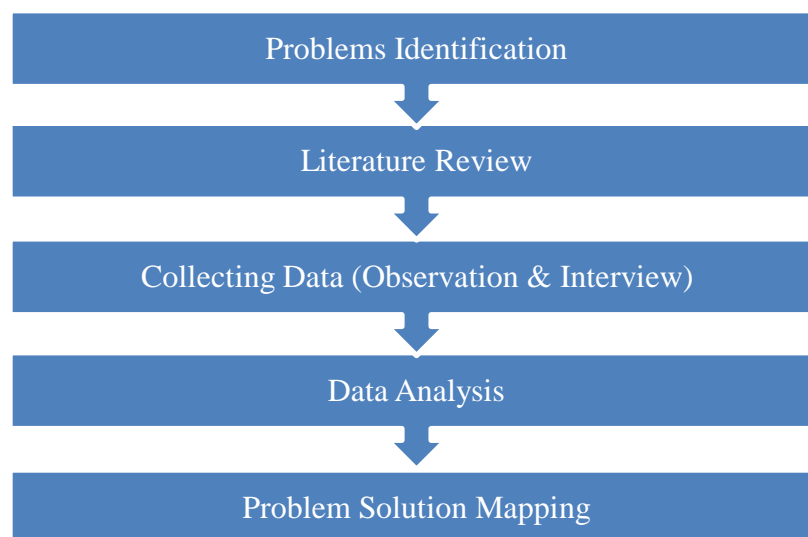


Figure 2
Research Process

RESULTS AND DISCUSSION

Results

Gisik Cemandi Village is one of the villages in the coastal area of Sidoarjo, currently led by *Lurah* as the village head. According to *Lurah*, there is quite a lot of potential in the village that can be developed, such as river tours, several tombs that are visited by pilgrims on certain days, seafood, and locations that can be used as cafes with views of airplane runways.

"...In our village, there are several potential villages that can be developed such as river tours, rice field cafes, religious tourism and seafood..." - Village Head of Gisik Cemandi

However, of the many offers of cooperation with universities, not many discuss waste and its treatment. Moreover, based on observations of the area, there are a lot of shells scattered around, which has an impact on environmental cleanliness. The shells from which the meat is taken have their own market where the shellers get a peeling service fee.

"...Some people take the shell meat, shelling services are priced at IDR 10,000 per kilo and the shells are removed..." - Shell Peeler

With the results of the shells scattered around, there is one resident who has the initiative to collect shells in the Gisik Cemandi village area. The results of the shell collection will be stacked in a special area which will later be purchased by other buyers from outside the city.

"...There are several types of shells here, feather shells are easily crushed compared to virgin shells. I collect some shells there and some have been sacked to be ready for collection..."

- Shell Collector

The flow of clam shells into waste is from the separation of clam meat from their shell. Harvested shells by fishermen are channeled to the fish auction site (TPI) to be sold to traders or some directly through fishermen. However, with the demand from the specialty market for clam meat, some residents work as shellers. These shells are the origin of waste, some of which are collected for sale.

"...mussels are usually sold at fish shelters, there are usually collectors but there are also many people from outside who buy directly from fishermen..." - Fisherman

From this phenomenon, one of the NGOs (Non-Government Organization) located in Surabaya, which focuses on environmental issues, highlighted the shell waste in coastal areas. The problem of shell waste needs to be addressed, not only because of its negative impact on the environment but also public health. Based on observations, some residents in

coastal areas have taken the initiative to sell their shells to other parties, but that is not enough. According to them, these shells should be turned into other products that can provide added value and welfare to coastal communities.

“...the problem of shell waste needs to be addressed so that it can provide added value to the community...” - NGO Management

So based on the search results of interviews and observations, the flow of clam shells is as follows:

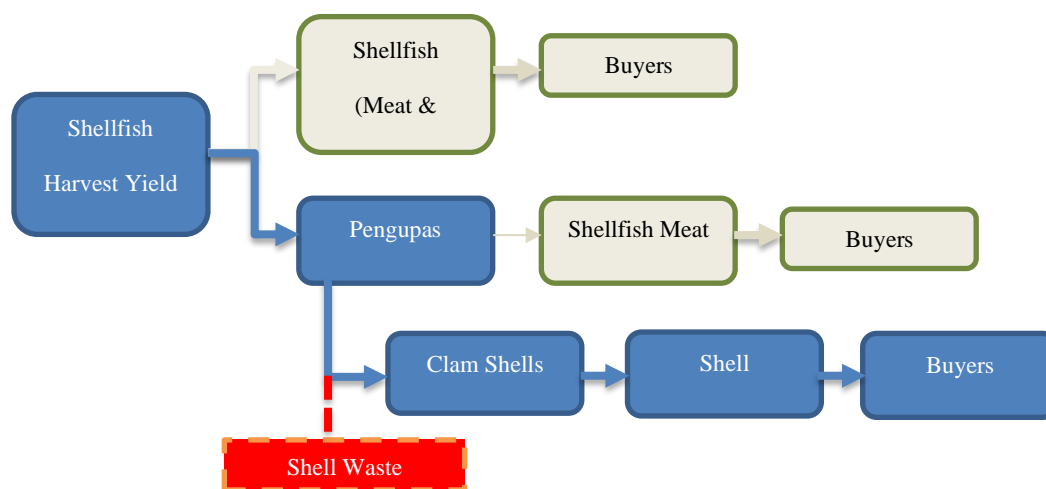


Figure 3
Shellfish/ Clam shell waste flow

Based on several statements by informants, researchers are looking for literature studies that support this data to serve as a mapping of innovative solutions. Some of the innovation mappings below are not only based on statements from informants, but also researchers added from several other references:

Table 1
Product Mapping Study Literature

No.	Result	Authors	Year	Research Title
1	Fertilizer Materials	Daud, Z., Detho, A., Rosli, M. A., Abubakar, M. H., Samo, K. A., Rais, N. F. M., & Tajarudin, H. A.	2020	Ammoniacal Nitrogen And COD Removal From Stabilized Landfill Leachate Using Granular Activated Carbon And Green Mussel (Perna Viridis) Shell Powder As A Composite Adsorbent.
2	Chitin - Chitosan	Firdaus, F. E., Purnamasari, I., & Gunatama, P.	2018	Chitin And Chitosan From Green Shell (Perna Viridis): Utilization Fisheries Wastes From Traditional Market In Jakarta.

3	Building Material Mixture	Rahman, N. A. A., Said, M. I. M., & Azman, S.	2017	Carbonized Green Mussel Shell As Heavy Metal Removal
		Julia Widia Nika Anisah Sittati Musalamah	2019	Pemanfaatan Limbah Cangkang Kerang Hijau Dengan Variasi Suhu Pembakaran Sebagai Bahan Pengganti Sebagian Semen Pada Pembuatan Beton
4	Animal Feed Mixture	Qurrota A'yuni; Atik Widiyanti; Ika Fitri Ulfindrayani; Yanuar Risah Prayogi; Sonhaji Ari;F Anggun Fitria; Laila Ningsih	2019	Pemanfaatan Limbah Cangkang Kerang Sebagai Pakan Ternak Berkualitas Di Desa Tambak Cemandi Sidoarjo
5	Raw Material and Chemical Mixture	Prihanto, A., Muryanto, S., Ismail, R., Jamari, J., & Bayuseno, A. P.	2022	Practical Insights Into The Recycling Of Green Mussel Shells (Perna Viridis) For The Production Of Precipitated Calcium Carbonate.
		Ismail, R., Fitriyana, D. F., Santosa, Y. I., Nugroho, S., Hakim, A. J., Al Mulqi, M. S., & Bayuseno, A. P.	2021	The Potential Use Of Green Mussel (Perna Viridis) Shells For Synthetic Calcium Carbonate Polymorphs In Biomaterials
		Ismail R, Cionita T, Shing WL, Fitriyana DF, Siregar JP, Bayuseno AP, Nugraha FW, Muhamadin RC, Junid R, Endot NA	2022	Synthesis And Characterization Of Calcium Carbonate Obtained From Green Mussel And Crab Shells As A Biomaterials Candidate.
6	Handicrafts	Isti Yani; Desi Erawati	2021	Pemanfaatan Limbah Kerang; Solusi Alternatif Income Rumah Tangga (Analisis Fenomenologi Husserl)

From the reference table above, the results of shellfish waste can be mapped as follows:

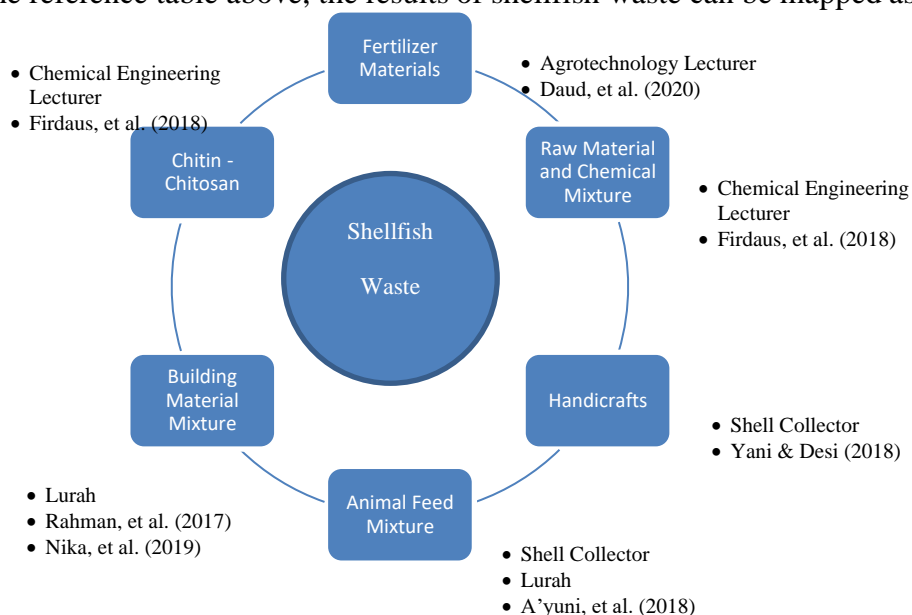


Figure 4
Shell Waste Product Mapping

Discussion

Based on the mapping of the table above, it can be explained that shells have several products that can be developed, among others:

1. Building Material Mixture (Construction)

“..There is a collector of shellfish here, namely Mr. xxx..usually taken for the purposes of animal feed mixture. In an earlier time, it was also from ITS to be made into a mixture of building materials such as paving” - Lurah Gisik Cemandi

Several studies have raised the potential of clam shells as an effective substitute in concrete and asphalt mixtures as a form of environmentally friendly practice in the construction industry. Shells can replace cement in concrete mixes, improve mechanical properties and reduce carbon emissions during production, biofiller in asphalt, and innovative building materials such as paving (Sofia, et.al, 2024; L, Caroscio, et.al, 2024; Wen-Cheng, Sao, et.al 2024; Fatma, Zohra, Melais, et.al; 2023).

The benefits of this product not only reduce waste as a form of overcoming environmental problems (Rosanna, Leone, et.al, 2023) but also the content can increase water absorption (Maryam Mohammad, et.al; 2022), contribute to the strength of concrete mixtures

(Syafiadi, Rizki, Abdillah, et.al; 2023), and reduce material costs (Rosanna, Leone, et.al, 2023).

Based on the results of other studies, the use of plastic bottle waste and green clamshell waste as a substitute for sand and cement in the paving block mixture gives good results, this can be shown by increasing the compressive strength value of normal paving blocks so that it can be used as an alternative environmentally friendly construction material (Gita, 2019; Setyoningrum, A, et.al, 2024).

2. Handicrafts

“...some of the dara shells are rather expensive. They have a strong texture and are often used for handicrafts...” - Shell Collector

Shell waste has great potential and opportunities for improving the community's economy. A wide range of products can be made from shells, including souvenirs, home decorations, photo figurines, lamps, and in the form of accessories such as necklaces, brooches, bracelets, rings and so on (Abubakar, S., et.al, 2021; Musapana, S, et.al, 2020). The number of products that can be made from shells shows that shells have the potential to be developed by the community.

3. Fertilizer Materials

“Some research on clam shell flour can be used for fertilizer but before it enters the market it needs to be tested further” - Agrotechnology Lecturer

The use of clam shells as fertilizer is gaining attention due to its environmental benefits and effectiveness in promoting plant growth. Research shows that clam shells can be converted into organic fertilizer. Blood clam shells can be processed into organic fertilizer, utilizing waste materials that are otherwise difficult to decompose. This method not only supports plant growth but also presents a sustainable business opportunity (Tan et al., 2023). Clam shell organic fertilizer, which includes a variety of organic components, improves nutrient availability and plant growth, overcoming previous mineral solubility limitations (Liming, 2018).

4. Animal Feed Mixture

“...Based on some research results, most of the shells contain calcium...”
- Chemical Engineering Lecturer

“...Every week to two weeks there are people from Pasuruan and Banyuwangi who take clam shells. The same people who take the shells are said to be used for a mixture of animal feed ingredients...” - Shell Collector

Clam shell waste can be utilized as a quality animal feed because, based on laboratory tests, clam shell flour contains high calcium (Ca), which is 40-48%, and the rest is complementary minerals. As a source of calcium and minerals, shell flour is very good to be given as a mixture of animal feed in farm animals such as laying hens, broilers, laying ducks, broiler ducks, and poultry pets such as free-range chickens, pelung chickens, bekisar chickens, ornamental chickens, fighting chickens, and grain-eating birds (Kurniasih, D, et.al, 2018). The benefits of clamshell flour include strengthening bones and eggshells, improving hatchability and egg quality, helping the digestive process, increasing stamina and endurance, preventing nail and beak defects, and many other benefits (A'yuni, et al., 2019).

5. Raw Material and Chemical Mixture

“...shell flour can be derived into various products such as calcium carbonate flour (CaCo₃) and Chitin Citosan which is useful in the pharmaceutical industry..”

- Chemical Engineering Lecturer

“...the substance in the shell can be used as an adsorbent...” - Chemical Engineering Lecturer

“...the substance of CaCo₃ (Calcium Carbonate) can come from limestone or shells, depending on what the product will be used for, consumption or chemical mixture...”

- Chemical Engineering Lecturer

a. Calcium Carbonate (CaCo₃)

Calcium is formed from three elements: calcium, carbon, and oxygen, which can be found in rocks and shells of marine organisms such as snails and clams (Omari, et al, 2016). In application in the industrial world, especially in construction, CaCO₃, calcium carbonate cement was developed to capture and utilize carbon, offering a sustainable alternative for several materials such as cement production (Hargis et al., 2021) including being widely used as an additive in plastics and paints which aims to increase durability and reduce production costs (Fadia, et al., 2021). Meanwhile, in medicine, CaCO₃ is used for its bioactive properties, increasing the rate of bone resorption and functioning as a drug delivery system (Rodríguez-Sánchez et al., 2019) (Jung et al., 2021).

b. Metal Adsorbents

At present, high population density increases the growth of commercial and industrial development in most countries. Increased population growth also increases the rate of urban waste generation (Daud, Z, et al; 2020). The impact of this waste is hazardous materials that can pollute soil and water quality. One of the alternatives that can absorb hazardous content is using mussel shells (Murphy, JN, et al., 2020). Green mussel shells as aqua culture solid waste, successfully used as a low-cost alternative adsorbent to remove harmful heavy metals such as cadmium, chromium, and lead (Rahman, et al., 2017).

6. Chitin - Chitosan

“Clam shell flour can be derived into various products such as calcium carbonate flour (CaCo₃) and chitin chitosan which is useful in the pharmaceutical industry.”

- Chemical Engineering Lecturer

“...in the past, fishermen used to use chitin chitosan to preserve seafood, but it seems to be more expensive...” - Lurah Gisik Cemandi

Chitosan is a white, gray or clear white powder produced from the deacetylation of chitin, the main source of chitin and chitosan is the shell of Crustaceae sp, namely shrimp, lobsters, crabs, shellfish, crabs and other shelled animals, especially those from the sea (Sartika, I. D; 2016). Green mussel and crab shells can be utilized in chitosan, where chitosan can be produced through the process of deacetylation or removal of acetyl groups on chitin, which is a glucosamine long-chain polymer (Aditia, R. P, et al; 2023). Chitin Chitosan can be utilized in several industries, namely medical, agricultural, environmental, to the food industry, including preservation (Oladele, 2023; Desai et al., 2023; Quiroga & Coy-Barrera, 2024; Prihanto et al., 2024).

CONCLUSION

In this innovation mapping research on the utilization of clam shell waste, it was found that clam shells have great potential to be used in various sectors, such as additives in food products to the pharmaceutical industry. In addition, the utilization of shell waste can also contribute to more sustainable waste management and reduce its negative impact on the environment. The content present in the waste has many benefits that can be developed. However, it is important to continue in-depth research to evaluate the economic feasibility,

content, and long-term impact aspects of utilizing clam shells in various industrial applications. The mapping of this product innovation will lead to the next stage of the feasibility analysis process, as well as the design of the business model to be developed.

This research is still mapping the potential that can be developed by taking data from various journals, interviews, and observations. The next research can be more specific in analyzing the market and feasibility of each potential product. This research can be a reference in seeing the potential of clamshell waste to be used as a business, especially to empower local coastal communities.

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