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Turning Waste into Food Ingredients: A Case Study of the Application of Innovation and Technology in Utilizing Umami Sources from Swimming Crab By-Product

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Abstract: This research is an important stage to provide an overview of the business in the utilization of crab waste. Marine and fisheries industries generally produce solid waste, such as carapace, bones, skin, gills and fish heads and other wastes. These wastes with technology and innovation can be transformed into output beneficial for the economic development of society. A creativity and innovation are needed in solving problems and opening up new opportunities, by transforming previously useless material into a very valuable product. The idea of turning waste into something more valuable is needed in solving the waste problem. The case studies analyzed involved innovation and technology in utilizing crab shell waste in Central Java. This study presents an empirical perspective covering (1) the business potential of crab shell waste; (2) the use of crab shell waste as a source of umami food through the role of innovation technology; (3) business analysis and commercialization. Finally, a presentation related to new business concepts to get environmental balance, namely connecting innovation theory with technology transfer.

Keywords: innovation; technology; swimming crab shell waste; food ingredients; umami.

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INTRODUCTION

Competition in the international fisheries market will be aligned with innovation in variety of new products. However, environmental sustainability requirements are getting stricter and will become important attention. Sustainability and development of the Indonesian Crab Industry depends on sustainable natural resources (Yusuf & Trondsen, 2014; Yusuf *et al.*, 2018). Increasing fishery production followed by the development of the fishery processing industry. Based on MMAF (2021) there are still between 25 - 30% of the catch of sea fish which ultimately must be leftover fish or waste fish due to various reasons, including limited knowledge and facilities of fishermen in how to process fish. Fishery waste that does not have market value, consequently this waste must be disposed of again and becomes a new problem and give negative impacts on the environment. This study aims to explore more deeply the potential for industrial waste crab to become a useful product.

Umami is one of the five basic tastes. Although the concept of umami taste is relatively new compared to sweet, salty, sour and bitter tastes, umami has actually been consumed for centuries in food products such as broths and sauces. The existence of the overall umami taste will create a softer taste in the mouth with a savory sensation, thereby increasing the sensory characteristics of the food as a whole (Wang *et al.*, 2020; Zhao *et al.*, 2019). Dr. Ikeda was the inventor of the first umami in 1908, which isolated glutamate in a Japanese broth made from seaweed konbu. One year later, monosodium glutamate (MSG) as a source of umami was produced commercially, and used as a spice as well as salt and sugar (Ninomiya, 2002).

In the early 1970s, the Chinese Restaurant Syndrome (CRS) phenomenon occurred in the United States, namely symptoms of headaches, shortness of breath, nausea, and heart palpitations after consuming foods containing MSG. Although experts from the United States food and drug regulatory agency and the WHO advisory commission for food additives have stated that MSG is safe for consumption, controversies related to MSG are still of special concern to the world community including in Indonesia (Karjadidjaja, 2009; Saraswati & Hardinsyah, 2012). In the last decade, researchers in the food sector have explored source compounds for umami from a variety of animal and vegetable food stuffs (Istiqamah *et al.*, 2019; Manninen *et al.*, 2018; Mouritsen *et al.*, 2019; Song *et al.*, 2016; Wang *et al.*, 2016).

Fishery waste is believed to contain high umami components, this refers to several studies that have been previously reported (Guo *et al*., 2014). One of the abundant fishery wastes in Indonesia is the swimming crab shell. All wastes generally contain very valuable components. Swimming crab shell waste contains glutamic acid of 1150 mg/100 g (Yonata *et al*., 2021), which has the potential to be developed into a source of umami food. Processing of swimming crab by-products into umami source food is a new innovation in processing waste into value-added products. New product development requires an appropriate innovation management, thus giving birth to creative ideas that can affect capabilities towards commercialization (Foss *et al*., 2011; Okpara, 2007). Innovation itself is an instrument used by entrepreneurs to take advantage of change as an opportunity (Drucker, 1985). The components of useful substances that are available in waste are important aspects that must be considered, this is a determining factor for the success of the product in penetrating the market.

This paper critically examines the potential of swimming crab waste which can be optimized to become a natural source of umami food. Primarily, the focus is on identifying opportunities and implementing innovations in waste utilization; identifying solids for business conduct; and identifying challenges, benefits and implications from a global perspective. This study is an important basis for entrepreneurs and governments to increase their attention to environmental issues and the social and economic benefits associated with waste management.

METHODOLOGY

This study is designed to form a business framework used in identifying entrepreneurial opportunities through innovation, with the aim of analyzing the potential for new entrepreneurship by creating an innovation and being able to adapt to the business environment. Primary data were collected through a field survey in the swimming crab industry in Central Java, which was followed by laboratory-scale experiments. Secondary data is needed to support the depth of material related to potential marketing imagery. In general, the method used follows the following steps:

1. Observation stage, this process involves employees and managers of swimming crab factories in Central Java who are interviewed directly to explore information regarding the potential of raw materials, the flow of the production process and industrial R&D activities;
2. The experimental stage, in this process a laboratory test is carried out to see the structure of the swimming crab shell powder which is then processed into umami spices, then analyzed;
3. Step description, which is an overview of the supporting factors including business planning, team building and commercialization strategy. The results obtained provide a factual description of the benefits of the swimming crab by-product and are further explained in the business concept.

STUDY INNOVATION IN SWIMMING CRAB WASTE MANAGEMENT FOR BUSINESS

The swimming crab industry in Central Java

The swimming crab or internationally known as the *Portunus pelagicus* is a fishery product that is mostly found in the waters off the Indo-Pacific, and is the main export commodity for fishery products in Central Java. Based on the latest data, during January 2021 the value of the swimming crab commodity in Central Java reaches Rp. 119.6 billion, is in the first rank of 42 types of commodities exported. Overall, the export figure for swimming crab exports in Central Java averages 3,635 tons in a year, with the main export destination countries, namely the United States, China, Japan, Thailand, Vietnam and Singapore, both canned, frozen and fresh swimming crabs (Agustina *et al*., 2014; BKIPM, 2018, 2021).

The export of swimming crabs was first carried out in the mid-1990s, when the situation of foreign market demand for swimming crabs increased significantly, especially importers from the United States. Initially, the swimming crab products were only consumed by people on the coast, who caught small crabs using gill nets and small traps. As the export value of small crab exports has increased, thousands of workers have been absorbed to maintain the rhythm of production so that global market demands can be fulfilled (Khasanah *et al*., 2019; Riniwati *et al*., 2017). Until now, various industrialization strategies have been implemented ranging from the aspects of fishing, production and resource data collection, handling of results to marketing of swimming small crabs, which have been designed to maintain the sustainability of small crab fishing with the preservation of resources and quality of swimming crabs so as to provide added value and income (Zarochman & Prabawa, 2013).

Supply chains in the swimming crab industry

The export volume of Indonesian swimming crab to various destination countries is very fluctuating every year, the global market structure which is oligopolistic is led by moderate forces (Riniwati *et al*., 2017). If you look at market conditions, the global demand for swimming crab has increased every year, so that the supply chain of swimming crab from fishermen to consumers is a fundamental thing because it affects the low or high price of crab crabs (Ilmi & Riniwati, 2018). Observations made in the field show that there are various types of crab supply chain patterns, this is due to differences in rules and systems between the parties involved. This difference in pattern allows companies, both exporters and importers, to play with prices so as to produce bigger margins. Additional information, at the fishermen level also has different fishing patterns,

some use fishing gear for folding traps, mini trawl (jarring arad) and gillnet, the result is that fishing gear using folding traps produces swimming crab quality according to the demand of exporters (Agustina *et al*., 2014). However, the pattern at the fishermen level does not have a significant effect because prices are controlled at the company level.

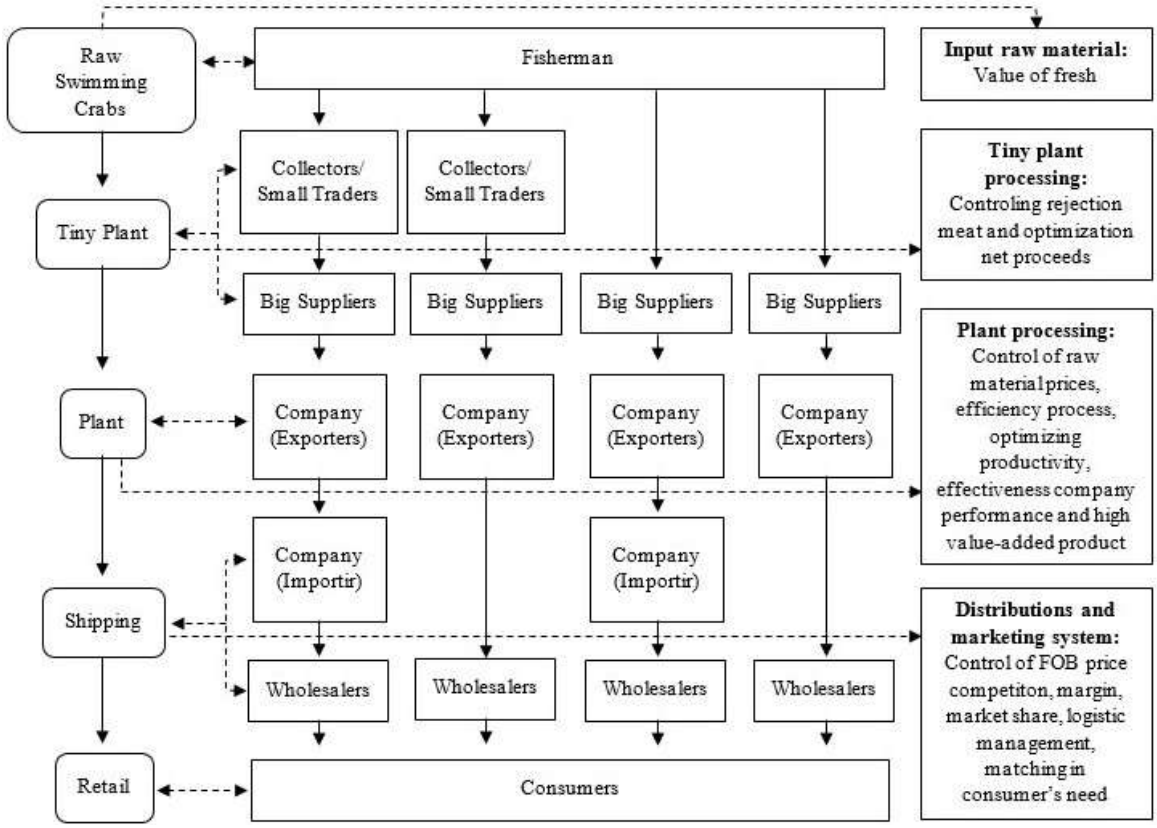

Figure 1. Supply chains of Indonesian swimming crab (adapted from Ilmi & Riniwati, 2018; Yusuf, 2014)

Swimming crab waste management

Swimming crab waste, is it a problem or a potential? In general, waste is defined as a material whose existence cannot be avoided and must be disposed of because it has no value, resulting from domestic activities or industrial operations (Sridhar & Hammed, 2014). The high demand for swimming crab exports, requires the industry to produce products with excellent quality in order to meet market demand standards. In addition, this process will also produce waste in the form of solid, liquid and gas waste. Until now, swimming crab waste management is still a very complex and unsolved problem. Generally, these wastes are simply scattered and piled up, resulting in an unpleasant aroma. Some industry players dispose of swimming crab waste into the sea, rivers and beaches. If left unchecked, this condition will disrupt the sustainable development of the fisheries sector in the future. This is certainly not in accordance with the established concept of environmentally oriented sustainable development.

There are several aspects that cause large problems in waste management in the fisheries and aquaculture industries, namely volume of waste, pollutant load, disposal rate to the assimilation capacity of the receiving media. Particularly for the type of solid waste, swimming crabs produce waste in the form of shells with the largest volume, around 40-60% (Yonata *et al*., 2021). If the existence of waste is properly managed, it will produce value added products. The process of minimizing and reproducing waste materials is required. The fishery industry can be integrated with the utilization of waste in its activities. Efforts that can be made are that the industry collaborates with partners who are able to analyze the swimming crab waste, it is necessary to provide incentives so that the program runs well, the concept of mutual benefit must be prioritized.

A business potential by utilization of swimming crab waste

The swimming crab waste product, if left unchecked, can have a negative impact considering that the waste is easily damaged and decomposes, so it needs to be handled first. The application of innovative aspects in swimming crab waste management aims to introduce ideas that can increase the value of the product, improve environmental health, and open up new business opportunities. With the business of using swimming crab waste, at least this activity is able to provide several benefits such as: (1) getting the opportunity to explore the valuable components

contained in the shell; (2) utilizing technology to make product innovations; (3) generate economic value from waste; and (4) opening new business and marketing networks

Development of by-product from swimming crab waste

Being one of the main export commodities of Indonesian fishery products, has an impact on the high production of swimming crabs in the country. Most of the export swimming crabs are in the form of processed products, either in airtight packaging or in cans. About 40-60% of swimming crabs are waste in the form of shells which are rich in glutamic acid and disodium 5'ribonucleotides which are classified as source compounds of umami (Tu *et al*., 2020; Yonata *et al*., 2021). These compounds are the great potential contained in the swimming crab shell waste. Not just a material for making feed, swimming crab shells can be managed and produced into various kinds of food products. Several high value products such as: (1) seasoning powder; (2) umami flavor enhancer powder; up to (3) seafood flavor flour, can be produced from the swimming crab by-product. Thus, there is a huge potential in swimming crab shell waste, this innovation needs development and collaboration with the food industry, especially the seasoning additives industry.

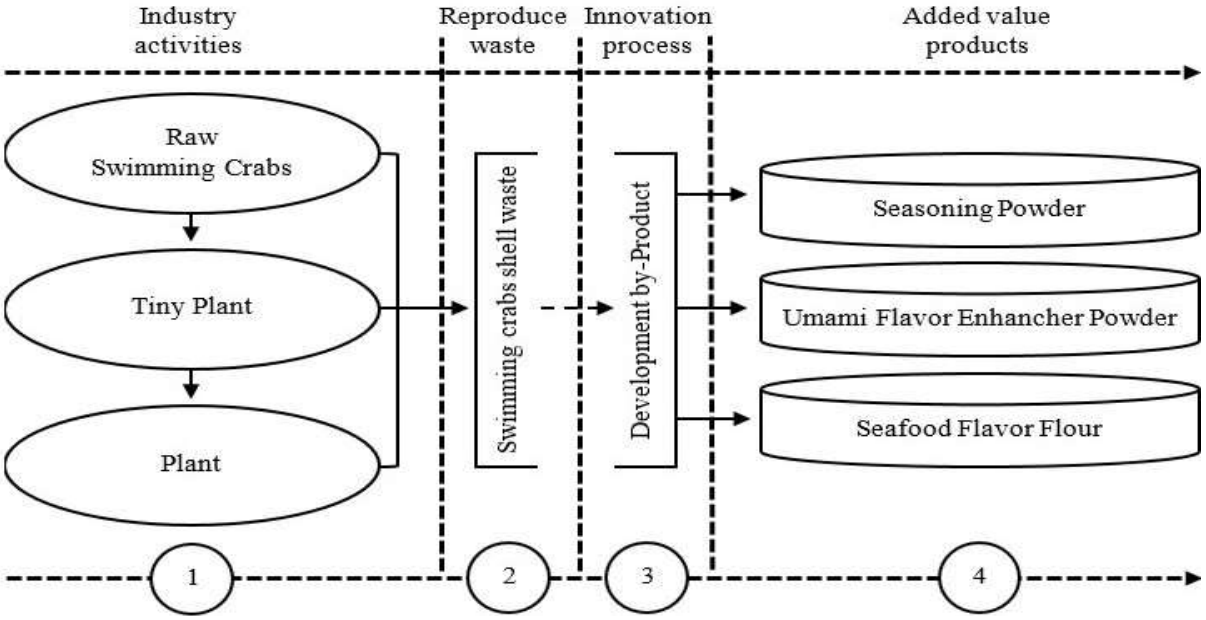

Figure 2. Product development of swimming crab shell waste (adapted from Yonata *et al*., 2021; Yusuf, 2014)

From swimming crab shell waste to food ingredients – infrastructure technology

Several literatures have reported the method of making swimming crab shell flour. The results of recent research, Yonata *et al*., (2021) have described the procedure for making swimming crab flour in a comprehensive manner. There are several steps that must be done, from cleaning, drying, grinding to sifting. The shell of the swimming crab is first cleaned under running water, then boiled in boiling water for up to 5 minutes, then drained. The clean swimming crab shells are then dried at 50 °C for 4 hours, then the shell size is reduced using a disk mill to form a powder. The final stage is sieving with a 100 mesh sieve in order to obtain flour with an even size distribution. Swimming crab shell flour is ready to be developed into various kinds of food additives, especially food spices for umami sources.

Flour products certainly have limited use, the role of innovation combined with technology is needed to produce new products with more added value. Technology transfer and innovation will transform products that initially have low economic value into commercial products needed by consumers. Some of the products that can be produced from swimming crab shell flour are seasoning powder, umami flavor enhancer powder, and seafood flavor flour. The need for technology is not only for producing new innovative products, but also for testing nutritional content, packaging processes for final products, and controlling daily production.

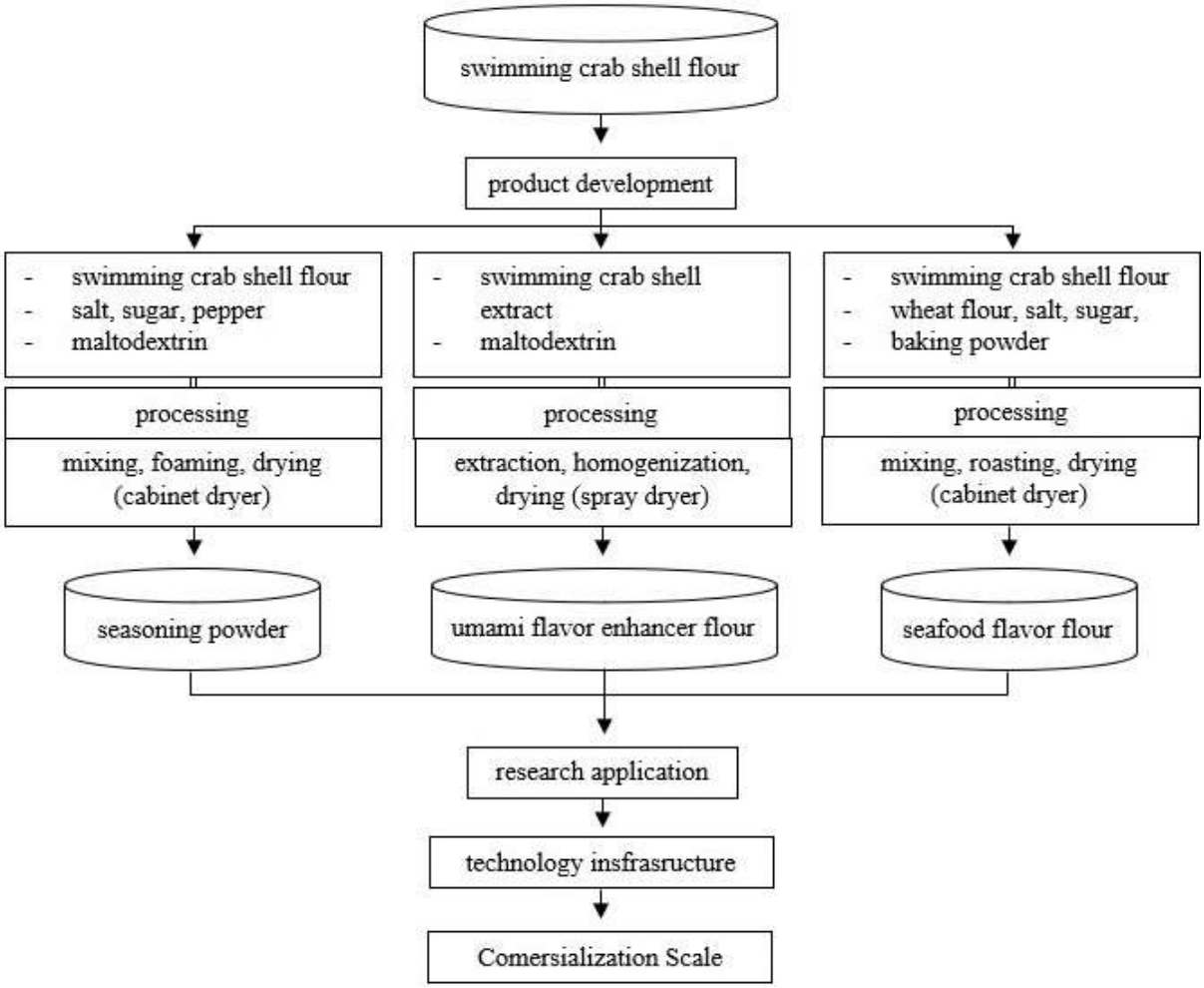

Figure 3. From laboratory-research to commercialization of swimming crab shell waste

From Swimming Crab Shell Waste to Umami Product

The development of swimming crab waste into umami products is very potential. The distinctive aroma of marine products combined with salt, sugar, pepper, and local spices produces various kinds of spices with a very strong local flavor and is favored by the community, especially in the Semarang area This product is believed to be able to compete with products already on the market. However, it takes the development of unique packaging to steal the attention of consumers. In addition, the right packaging will certainly have an impact on product quality, durable products certainly have their own advantages, they can be marketed to various countries.

Framework – planning and model of business

A good business plan and strategy is necessary to achieve the success of the planned business. To achieve this, the establishment of a swimming crab shell processing plant in Central Java is a very appropriate business strategy. Considering that Central Java is a center for swimming small crab export, the raw material for swimming crab shells is abundantly available. The project of processing swimming crab waste into food additives in the form of spices is a very brilliant idea. This project needs cooperation with importers who need food spices, especially Middle East Asian countries which in fact are countries with a very high level of seasoning consumption, then the United States and Southeast Asia countries including Indonesia it self.

Companies that produce snacks certainly need additional seasoning ingredients to enhance their taste generated, this is an opportunity to increase the marketing of various kinds of spices that have been processed from crab waste. The marketing strategy needs to highlight the advantages of the seasoning products produced, such as the label "NON MSG" considering that the health problems associated with producing MSG are still quite high. In addition, seasoning products must obtain a HALAL certificate from MUI Indonesia in order to use the label "HALAL" which is currently a plus point in marketing products, especially to Muslim-majority countries. The target markets include (1) the seasoning industry; (2) snack food industry; (3) noodle industry; (4) sauce industry; and (5) soy sauce industry. In achieving this market target, product advantages must be promoted and presented. In addition, the framework of actors, barriers, challenges and facilitators needs to be studied.

Business analysis and commercialization strategy

Business is carried out in an integrated, the process starts from determining the location of the establishment of a swimming crab shell processing industry factory. Several things that were taken into consideration were the ease of obtaining raw materials, supporting resources, and residential areas. The establishment of factory consists of two types, namely a special factory for processing waste shells into flour and a factory for processing flour into seasoning consisting of three divisions (seasoning powder, umami flavor enhancer powder, and seafood flavor flour) and are integrated with each other. Furthermore, namely collaborating with domestic and foreign industries as an integrated business. Several aspects that must be considered include (1) main activities such as operations, logistics and sales; and (2) supporting activities such as procurement, technology development, human resource management and business facilities. Finally, the component of routine monthly costs (costs for procurement of raw materials, supporting materials, packaging, processing operations, labor, transportation and marketing). All components must gain a competitive advantage and be coordinated effectively for efficiency to be achieved.

Business description

Swimming crab shell waste has very good potential, this potential can be seen from the very high needs related to seasonings. Processing of swimming crab shell waste into flour which is then continued with seasoning products is expected to dominate the market share, especially the seasoning food additive industry. Open collaborative activities, publications related to product excellence, and intensive publicity campaigns will open up a wider market. This business was chosen because the existence of small crab shells in Indonesia was not taken into account, it only became waste that was not utilized. When the shell is processed into flour, it will become a food ingredient which is very widely used. Further processing into seasoning products (seasoning powder, umami flavor enhancer powder, and seafood flavor flour) will increase the selling value of the product. This activity also contributes to the preservation of the fishery environment.

Market analysis

The need for umami sources is very high, considering that this compound will produce a tasty dish and can increase consumer preferences. The existence of a source of umami in food has become mandatory for consumers. As reported by Radam et al. (2010), that the demand and consumption of "Non MSG" products in Malaysia is very high and will continue to increase, the current trend also causes food producers in Malaysia to require umami source products that do not contain MSG. This condition is further strengthened by consumers in the United States who generally have a negative attitude towards MSG. However, the need for umami sources in this country is very high, so that umami extract from natural sources is the right choice to replace MSG (Wang & Adhikari, 2018). Globally, the need for umami compounds is very high, this is certainly a huge opportunity for swimming crab shell seasoning products.

Competition and barriers

Competition and barriers cannot be separated in the business world. Therefore, a product concept that is revolutionary and adaptive to change is needed. To produce new products that are competitive and be able to win the market requires innovation, fresh, unique ideas. Seasoning powder, umami flavor enhancer powder, and seafood flavor flour from swimming crab shell waste is the answer. Besides being more economical, this business is also promising. On the marketing side, the business of adding food additives to seasonings or sources of umami has a high level of competition, but the chances of winning the market are very high. Until now, competitors came from producers of umami spices from mushrooms, shrimp, and seaweed produced from countries such as Korea, China, Thailand and India, while the spice industry from swimming crab shells was not yet available. From a regulatory perspective, it is strongly suspected that this barrier is not that significant considering that both the main and supporting materials use safe materials.

Business strategy

Indonesia as a maritime country has enormous fisheries resources. Indonesian fishery products have strong competitiveness in the global market. However, Indonesia is still weak in the aspect of value-added products, very dynamic and competitive market conditions cause competitiveness to decline if this condition is neglected (Yusuf *et al*., 2021). The right strategy will certainly make it easier to attract consumers to buy products and encourage them to open collaborative networks. Managers need to promote their business through a number of marketing methods so that product quality can be known by consumers. The marketing concept with the labels "Non MSG" and "HALAL" is the motor for increasing product marketing numbers. The marketing concept of Tyler, (1996) can be adopted, where the main priority is that waste products that are considered high-value markets should be developed, then waste products with lower value but high volume can be developed afterwards.

CONCLUSION

The development of new organic waste-based products in Indonesia, especially in Central Java, presents a new challenge for business people, waste that initially has no economic value can become a profitable business opportunity. On the one hand, this process has a positive impact on the restoration of the environment, which has been the weakness of the fishing industry. The process of technology transfer and commercialization of scientific research needs to be improved, so that waste can become healthy, safe, and

delicious food product for consumption. This research gave birth to at least two important contributions, namely (1) a theoretical review of creativity and innovation in opening new entrepreneurs, and (2) a business proposal to solve the problem of crab shell waste into a salable source of umami food.

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