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Research Article

Sustainability of Fish Fillet Processing Industries in Batang District

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Abstract

The existence of fish fillet processing industries in Batang are able to have a positive impact on the surrounding community because it can create employment opportunities and increase community income. Therefore, it is necessary to know the importance of the sustainability of fish fillet processing industries to see the prospect of fishery business after a feasibility study. The aims of this study were to analyze the sustainability index value, determine the sensitive attributes of each dimension, and provide alternative management strategies of fish fillet processing industries in Batang. The method of analysis used was Rapfish method which is based on the technique of ordination by putting something measured using MDS on the program of Rapfish G77 Alscal program (VBA and Excel). Status management of fish fillet processing industries sustainability in Batang, which are multidimensionally sustainable, are 50.39. Whereas in other dimensions such as resources 58.20 (quite sustainable), economic 55.33 (fairly continuous), social 48.60 (less sustainable), legal and institutional 40.27 (less sustainable) and technological 48.90 (less sustainable). Based on this results, several management strategies should be prepared including increasing the capacity of government institutions, enhancing the role of fish fillet processing industry on society, increasing the application of technology and infrastructure, increasing the revenue of the entrepreneurs of fish fillet processing industry, preventing decline of quality and quantity of fish resources.

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1. Introduction

The increase in economic value of a nation can be indicated by the availability and consumption of various food by the people. Fish fillet is one of the raw materials and processed products that is well developed in Indonesia nowadays, including Batang District. Fish fillet is a semi-finished from fish meat which will later be processed into another form from food, such as meat floss, meatballs, sausages, and it also can be used to diversify various processed products (Yuwono *et al.*, 2012).

Fish fillet processing industries in Batang District are located in the area of Coastal Fishery Port (TPI) of Klidang Lor, because most of the fish fillet raw material is obtained at the Fish Auction of this port, although some of the fillet businessmen also get the raw material from other Fish Auctions or other areas, such as Tegal, Pati, Rembang, and Brondong. It happens if the catch of fishermen auctioned by TPI Klidang Lor is insufficient to meet fish fillet production. The existence of fish fillet processing industries in Batang is able to give positive impact on the surrounding community since it can open up employment opportunities and increase their income. The average income of a fish fillet processing owner in Batang can reach ± Rp 641 million per month with an average employee salary of Rp 300.000,- – Rp 450.000,- per week according to their speed and their expertise in filing fish (productivity) (PPP Klidang Lor, 2011).

Fish fillet is categorized based on the material; they are fish fillet from high economic value fish and from low economic value fish. High economic value fish used for fish fillet are salmon, red snapper and grouper. While fish fillet from low economic value fish are threadfin beam, purple-spotted big eye fish, Sulphur goatfish, banana fish, pony fish, and grunTERS (Heruwati, 2002). These low economic type of fish are used to optimize the use of the fishermen's catches through value-added product development. The fish used for fish fillet basic material in Batang District are Sulphur goatfish, purple-spotted big eye fish, threadfin beam, and cotton fish. The volume of raw fish material production used in 2012 was 3,826,695 kg with fish fillet production of 8,908,000 kg (PPP Klidang Lor, 2011).

Based on the description above, it can be seen that the fish fillet processing industries in Batang has an estimate to be developed optimally, therefore it requires research that leads to sustainability and managing them by using several dimensions including the dimensions of resources/raw materials, economic, social, law and institutions and technology/infrastructure. The fish fillet processing industries have the potential to encourage

and enhance economic development in Batang District. In addition, increasing them can provide guarantees for the price of fish and their markets, so they can obtain income from fisheries. Sustainability is basic for marine and fisheries development which is expected to improve the condition of resources, the processing industries and the community.

Previous studies on the fish processing industries and specific processed fish products have not yet examined holistically from various dimensions, most of which are limited to business feasibility in one dimension, namely economics, such as Priyantini *et al.* (2014) about the feasibility study of tilapia filet agro-industry in Mesuji, Ambarini (2016) on the protection and development of micro fisheries, Talib (2018) about opportunities and challenges of the fisheries processing industry in supporting the realization of national fish barns in North Maluku, Istiqomah *et al.* (2019) concerning the analysis of the potential for multi-business sustainability in the fisheries sub-sector in Sidoarjo Regency District. Therefore, it is important to assess the sustainability of fishing industries holistically, especially for the fish fillet processing industries by looking at the prospect of a fishery business after a feasibility study, which means if a business is economically feasible, it is not certain that the feasibility can guarantee the sustainability of a fishery business from the perspective of other dimensions since business feasibility studies use controlled variables. The analysis of business sustainability is better because the variables are measured thoroughly both controlled and uncontrolled from many dimensions (resources/ raw material, economic, social, legal and institutional, also technology/infrastructure) such that it is able to guarantee in a fisheries business.

This research aims to analyze the sustainability index value of the fish fillet processing industries in Batang for every dimension, determine sensitive attributes of each dimension, and provide alternative management recommendation on fish fillet processing industries in Batang District.

2. Materials and Methods

2.1 Research Location

The research on fish fillet processing industries took place in North Karangasem, Batang District, Batang Regency, Central Java located at coordinates 6°53'23.1''S and 109°44'18.096''E. The basis is selecting this research location is that the location is a center for fish fillet industries in Batang and its conditions are able to present the business conditions of fish fillets in Batang.

2.2 Data Collection

Collected data in this research included primary and secondary data. Primary data was collected through field observation on several fish fillet processing industries in Batang. Information gathering from the interviewees was carried out by structured and in-depth interviews using questionnaires and semi-participatory direct observations in the research site to explore much information as possible. Data included attribute values on resources/material, economic, social, legal and institutional, also technology/infrastructure dimension of fish fillet industries. The questionnaire was used to determine the attribute value on each dimension to obtain sustainability status.

Secondary data for sustainability analysis, indicator identification and management recommendation were obtained from several units of fish fillet industries and material supplier, Provincial and District Marine and Fishery Services, Central Bureau of Statistics (BPS) of Batang District, Klidang Lor Fishing Port, fishery research institutions, universities, and related institutions including governmental and non-governmental institutions, and scientific publication (books, journals, dissertations, research reports, proceedings) and others.

2.3 Sampling Techniques

Sampling technique used was purposive random sampling (Walpole, 1995), which was non-random sampling and full of consideration. Sampling was done based on the consideration that the respondents must comply with two criteria, (1) had a reputation, position and credibility as an expert in their field; (2) had enough experience and were willing to be interviewed. Sampling determining technique was done by dividing the zones according to the population, namely Zone 1: production zone (catching), Zone 2: intermediary zone (institutions), and Zone 3: industrial zone (factories/UPI). Samples in zone 1 were 100 respondents from fishermen with seine nets as the catching equipment. Samples in Zone 2 were 3 respondents from each governmental and non-governmental institution. Samples in Zone 3 were from fish fillet processing units which were divided into two scales; medium scale industries and large scale industries. There were eight units of medium scale industries and seven units of large scale industries. 100 respondents were taken from each industry. The number of samples for respondents was calculated with the following formula (Umar, 2002)

Where:

n = the number of samples taken

N = the number of population zone unit

d^2 = the maximum error that can be received $(0.1)^2$

z^2 = Normal variable $(1.96)^2$

P = percent variance (0.05)

2.4 Data Analysis

Analysis method used in this case study research was descriptive analysis, referred to as Rapfish method (*Rapid Appraisal for Fisheries*). According to Nazir (2011), a case study or a case research aimed to provide a detailed description about the background, the distinctive character, or individual status which would later be made into a general thing. Descriptive method aimed to provide a systematic, factual, and accurate description about the facts, characters of the studied phenomena.

Rapfish method was developed by University of British Columbia Canada in 2000, which was an analysis to evaluate the sustainability of fisheries in a multidisciplinary manner. Rapfish was use based on the ordination technique that was placing something on a measured order of an attribute by using Multi-Dimensional Scaling (MDS) (Alder et al., 2000). MDS method in this research used Rapfish Program G77 Alscal (VBA and Excel) (Kavanaghand Pitcher, 2004).

Stages in sustainability analysis of fish fillet processing industries in Batang were identification and attribute determination; attribute scoring made for each sustainability dimension; Multi-Dimensional Scaling (MDS) analysis using Excel to determine ordination; and stress value through ALSCAL Algorithm as the test of the accuracy and validity of the data; rotating to determine the position of the dimensions on “bad” or “good” ordination in the range of 0-100; index arrangement and the sustainability status of fish fillet processing industries with status category (Table 1); sensitivity analysis (Leverage Analysis) and Monte Carlo analysis to calculate the uncertainty dimensions (Alder et al., 2000).

Table 1. Results on management categories for sustainability status based on the Index value of Rapfish analysis

Index	Categories
≤ 24.9	Very poor
25 – 49.9	Poor
50 – 74.9	Fair
> 75	Good

Based on Marzuki (2012).

Management recommendation formulation was carried out by sorting priority of dimensions and priority attributes in each dimension that needed to be fixed. To find out which priority that needed to be fixed, the dimension priority determination was done by sorting sustainability index value of each dimension. Dimensions with low index value were considered as the ones

that required management and improvement. Attributes of five dimensions were resources, economic, social, legal and institutions, and technology dimension were then be arranged based on the priority order using Root Mean Square (RMS) indicator value

3. Results and Discussion

3.1 Validity and MDS Accuracy

Validity test using Monte Carlo analysis and MDS analysis at the 95% confidence level showed that the index value of sustainability status of fish fillet processing industry in Batang District, which was the average difference between the two analyses, was too small (<1). This means that the model of MDS analysis was sufficient to estimate the index value of sustainability status of fish fillet processing industry in Batang District. According to [Nurmalina \(2008\)](#) that small difference in a value of the sustainability index between the results of analysis of two methods indicates that errors in making scores of each attribute are relatively small, the variety of scoring due to differences in opinion is relatively small, the process of analysis carried out repeatedly tends to be stable, and data entry errors and lost data can be avoided. This difference shows that the system studied has a high level of trust. The difference in value can be seen in [Table 2](#).

Based on the results of MDS analysis conducted on the fish fillet processing industries in Batang, the coefficient of determination (R^2) ranged from 0.94 to 0.95 and stress value was only between 0.13 to 0.14. This shows that the attributes studied are quite accurate and can be justified. That is no need to add more attributes, because this is approaching the real situation. Based on [Kavangh \(2011\)](#) that if the determination coefficient was higher than 80% or close to 100%, it means that the estimation model of sustainability was good and was sufficient to be used. The stress value was lower than 0.25 or 25%, Therefore, the MDS analysis model has a high accuracy (goodness of fit) to assess the sustainability index. A detailed description is shown in [Table 3](#).

3.2 Resource Dimension

Rapfish analysis conducted on 9 (nine) attributes of resources in fish fillet processing industries in Batang are obtained an index of sustainability level of 58.20, as seen on [Figure 1](#), where the value of 51.00-75.00 mean that it was quite sustainable. This sustainability index value showed that the material resources ware enough to support the sustainability of fish fillet processing industries in Batang District. However, according to the index value, if the resources were not well managed, it would affect the sustainability of other dimensions such that the status of fish fillet processing industries in

Table 2. The Difference in Sustainability Index Value of Fish Fillet Processing Industries Between Rapfish Analysis and Monte Carlo Analysis

Dimension	MDS Analysis	Monte Carlo Analysis	Difference (MDS – MC)
Resources	58.2	58.2	0
Economic	55.33	55.32	0.01
Social	48.6	48.6	0
Legal and Institutions	40.27	40.27	0
Technology	48.9	48.9	0.101

Table 3. Stress Value and Determination Coefficient of Rapfish Analysis of Fish Fillet Processing Industries in Batang District

Dimension	Sustainability Index Value	Stress	R^2	Iteration
Resources	58.2	0.14	0.94	2
Economic	55.33	0.14	0.94	2
Social	48.6	0.13	0.95	2
Legal and Institutions	40.27	0.14	0.95	2
Technology	48.9	0.14	0.95	2

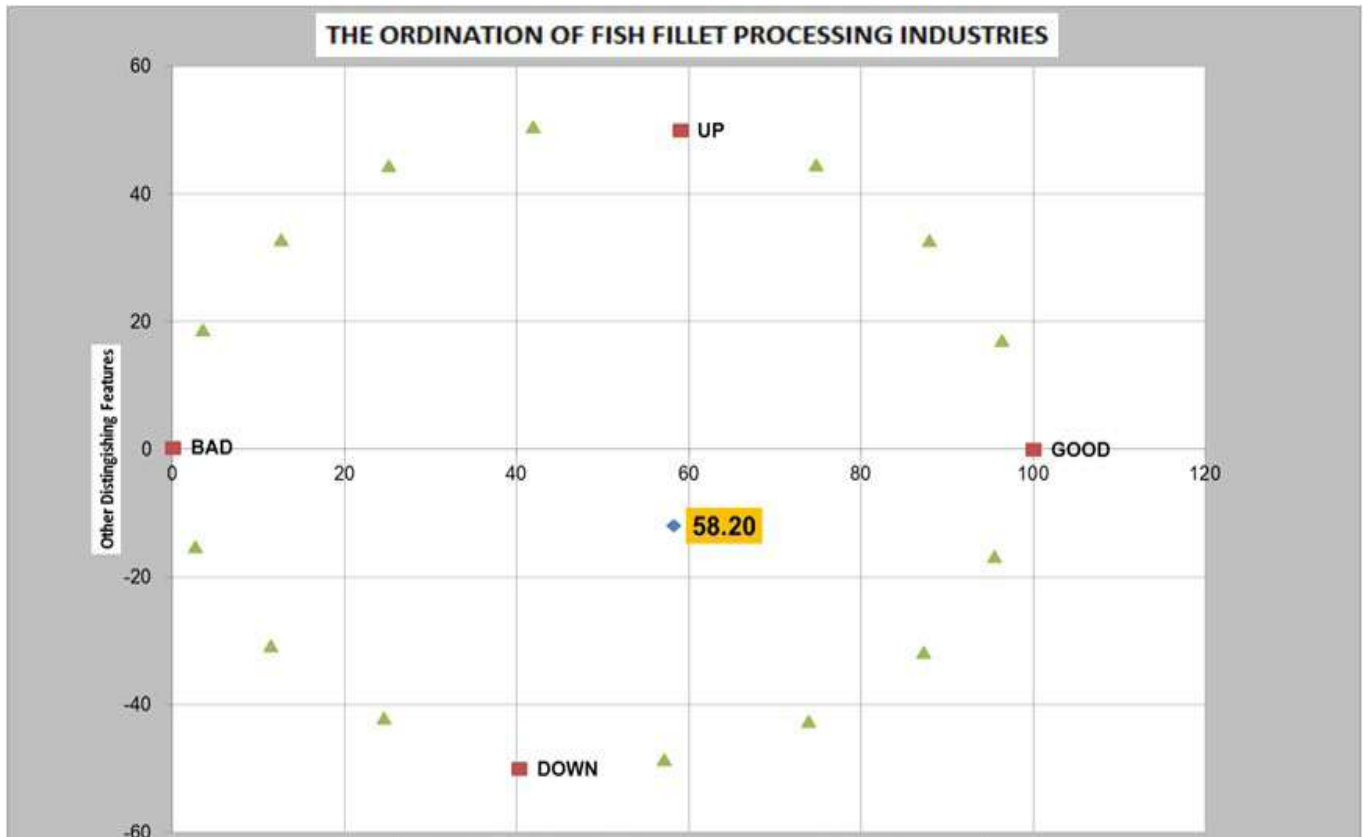


Figure 1. Index Value and Sustainability Status in Resource Dimension

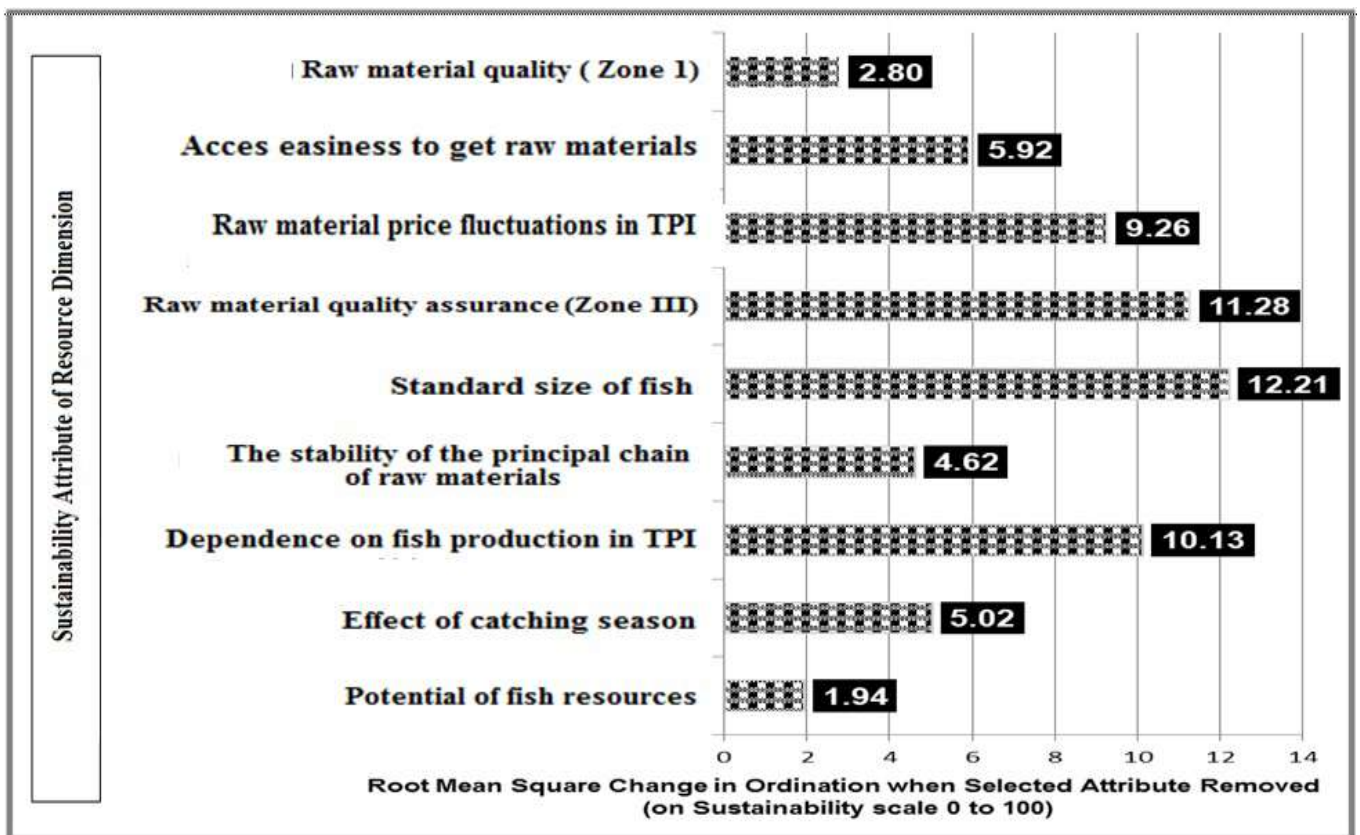


Figure 2. Attribute Sensitivity Value of Resource Dimension Expressed in the Change of Root Mean Square (RMS) on Sustainability Scale of 0-100

Batang District would decrease into less sustainable or even unsustainable. In 2002-2010, TPI PPP Klidang Lor could fulfil the material to produce fish fillet. However, from 2011 to 2012, the fish production volume in TPI was unable to comply with the material needs in Batang, so the fish fillet company owners brought the material from other regions, like Rembang and Tegal. The data of fish production volume as the material for fish fillet in 2010 was 23.70 tons; in 2011 was 20.46 tons; and in 2012 was 18.06 tons (PPP Klidang Lor, 2012). Even though the original resource condition had decreased in production or in the catch, the fish fillet processing industries were still trying to get the material from other regions so that the industries could continue their business. This made the sustainability status of fish fillet processing industries from resource dimension quite sustainable. Sustainability status in resource dimension could be improved from the present condition through policy intervention on dimensions and sensitive attributes (leverage attribute). The sensitive attributes of resource dimension are presented in Figure 2.

According to the above attributes, the three most sensitive attributes in resource dimension were taken through the highest value of RMS, they were standard size of fish (RMS=12.21), quality assurance of raw material (RMS=11.28), and dependence in the fish production in TPI (RMS=10.13).

Standard size of fish was the first sensitive attribute to the sustainability of fish fillet processing industries on the resource dimension which showed that the standard size of fish has declined sharply. According to the interview result, standard fish size in 2004, a basket of fish weighed ± 25 kg could load 20-25 fish, but from 2009 until 2012, the basket could load more fish, about 50-60 fish. It indicated that the fish size used as the fish fillet raw material was smaller. The standard size of fish used as the fish fillet would affect the amount of fish yield produced. The smaller size of the fish, the less fish yield obtained (Radityo et al., 2014)

Raw material quality assurance attribute was the second sensitive attribute on management sustainability of fish fillet processing industries at the resource dimension which showed that there was no guarantee of the quality of the raw material from the fish caught by the fishermen and was supplied to the fish fillet processing industries was in the fresh condition. Fish fillet processing industries in Batang got the material directly from the fishermen through the auction process in TPI Klidang Lor, in which most of the native fishermen in Batang in Klidang Lor Port used seine net ship with the size of <10 GT such that fish handling on board was very limited. Means of transportation used were pedi-

cabs, motor cycles with a basket without insulation and raw material hygiene maintenance, only an open basket with crushed ice cube, hence bacterial contamination could happen which reduced the quality of the raw material. Fish is well-known as a highly nutritious commodity but it was easy to rot since it contained high protein with free amino acids, therefore a good fish handling technique was needed to assure the fish quality (Delgaard et al., 2006).

Dependence on fish production in TPI was the third sensitive attribute on the management sustainability of fish fillet production industries at the resource dimension which showed that fish fillet processing industries were still depended on the fishermen's catch in TPI. Fish production in TPI Klidang Lor in 2010-2011 decreased by 15.81%, as was directly proportional to the fish production in Batang by 10.76%. Dependence on fish production in TPI would take effect on the raw material continuity, it can interfered the fish fillet production since the availability of the main material was very dependent on the season. When the fish season was scarce, the fish fillet processors would find it difficult to fulfil the material

3.3 Economic Dimension

From Rappfish analysis results on ten attributes affected the economic dimension, the sustainability index value obtained was 55.33, as shown in Figure 3, the values were in the range of 51.00-75.00, which means they were quite sustainable. The values showed that the economic condition was quite supportive for fish fillet processing in Batang District. But if it is not well-managed, then it would affect the sustainability of other dimensions. According to the result, the management sustainability status of fish fillet processing industry in Batang District would decline.

Sustainability status could be improved from the present condition through policy intervention on dimensions and sensitive attributes (leverage attribute). Improvement on the indicators with high sensitive value would take positive effect on the improvement of sustainability index (Marzuki, 2013). The sensitive attributes of economic dimension are presented in Figure 4.

According to the above attributes, the three most sensitive attributes on the economic dimension were taken based on the highest RMS value. They were fillet product diversification (RMS=11.41), market uptake (RMS=10.11), and the price of fillet products (RMS=9.90).

Fillet product diversification was the first sensitive attribute on the management sustainability of fish fillet processing industries in Batang. According to the

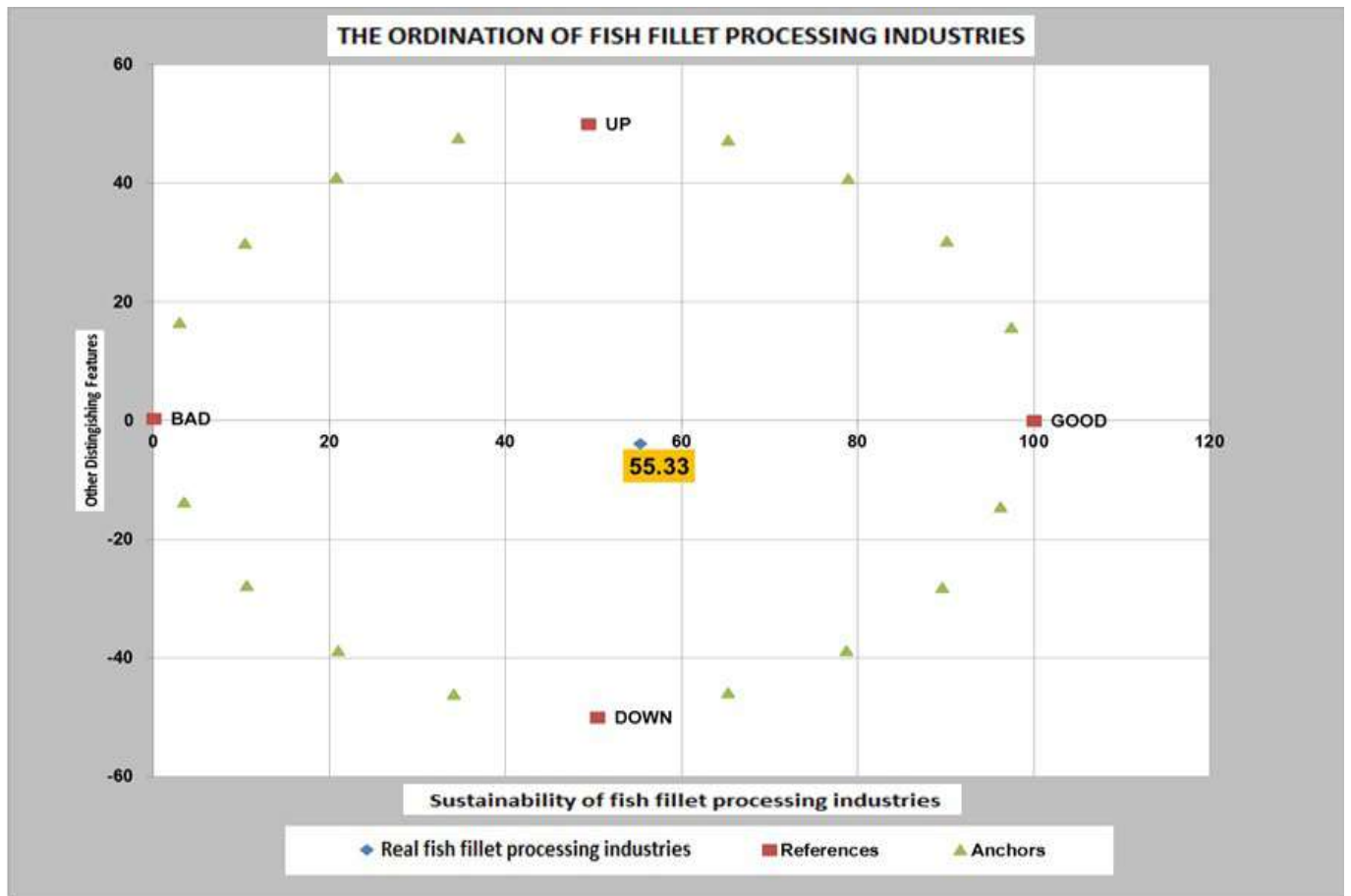


Figure 3. Index Value and Sustainability Status on Economic Dimension

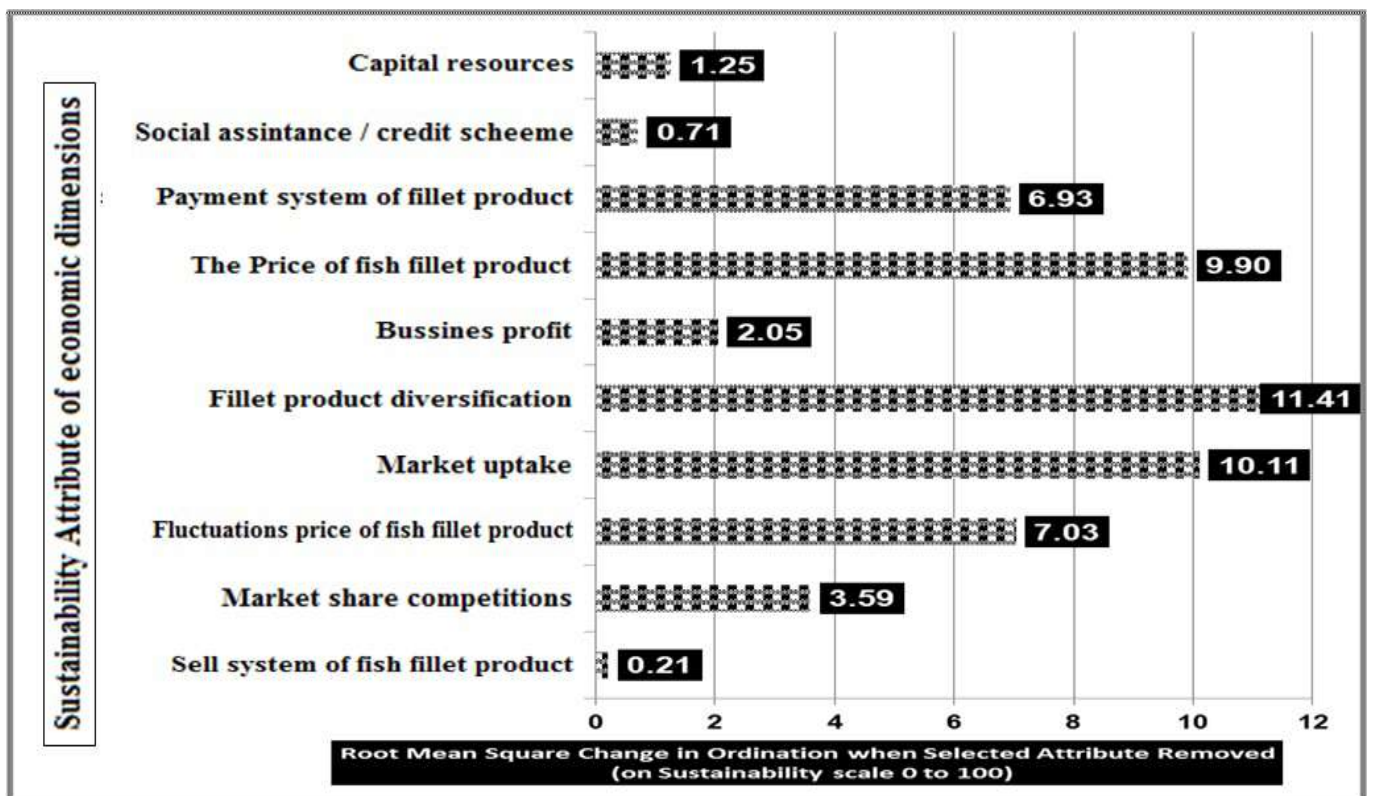


Figure 4. Attribute Sensitivity Value of Economic Dimension Expressed in the Change of Root Mean Square (RMS) on Sustainability Scale of 1-100.

result of the interviews with the respondents, product diversification of processed fish in Batang was less diverse and less innovative. The existing processed fish product in Batang District was dragon foot, with 15-20% of fish fillet requirement from the total fish fillet production a day. This caused fish fillet processing industries in Batang not to be economically developed because the consumers less creative, who used the fillet product, were less competitive and less creative in creating innovative products of processed fish. According to Hanafiah *et al.* (2010) that the development of new processed food ingredients from fishery products will open up opportunities to be marketed in other regions more broadly and increase consumer spending on fishery products, it can give impact on increasing consumption of fishery products and a final result can give an additional income for fishermen or raw material providers. In line with Nurhayati (2004) the value added product would give additional value on the raw material by delivering it at least to the next production steps.

Market uptake attribute was the second sensitive attribute on management sustainability of fish fillet processing industries in Batang. Fish fillet product in Batang could only fulfil local, regional, and national market demand. It has not been able to go through international market. This was still constrained by the inadequate raw material, labour and technology. Therefore the fish fillet industries in Batang were not able to fulfil the international market demand quota. According to the research, fish fillet business owners of both medium and large scale were still depended on the local, regional, national market, where the average consumer income in these markets is relatively low. Revenue is a determining factor for the demand for fish fillet products. If consumers income is low then demand, it would be low as well as the market absorption capacity from fish fillet products. This is accordance with Hanafiah *et al.* (2010) that the level of income is a resource or a ability to give (purchasing power) from consumers, this can be the most important determination of demand, because the difference of income can indicate quantity and quality of the products consumers will buy. The increase of consumer income will affect the increase of a number and quality of products to be bought.

The Price of fish fillet product was the third attribute of the management sustainability of fish fillet processing industries on the economic dimension, which means that the price of fillet product was affordable for the consumers. However, for the fish fillet industries, giving the consumers affordable prices did not always get a fixed profit because fish fillet production was

still depended on the fish raw material caught from the wild by the fishermen. The price of fish raw material was highly fluctuated, especially in the famine season. The price of fish fillet raw material in the famine season raised up to 10-30%. This was not comparable with the price of fish fillet products. If the price of product was raised, the number of local, regional and international consumers would decrease. As a result, fish fillet industries would lose. According to Hanafiah *et al.* (2010) that for products whose harvest or harvest season is short or products whose marketing is seasonal, the price change will be greater.. Comparison of prices between the raw material and the final product is presented on Table 4.

Table 4. Comparison of Prices Between The Fish Raw Material and The Fillet Product in Batang District.

Type of Fish	The price of raw material in the fish season for 25 kg per basket (Rp)	The Price of Fish Fillet Product per kilogram (Rp)
Purple Spotted Big Eye Fish	180,000	30,000
Cotton Fish	200,000	20,000
Sulphur Goatfish	150,000	18,000
Threadfin Beam	150,000	18,000

3.4. Social Dimension

According to Rapfish analysis results on nine attributes which affected the social dimension, the sustainability index value obtained was 48.60, as it is shown in Figure 5. Those values ranged between 26.00 -50.00; which means that they were less sustainable. This index value showed that the condition of fish fillet processing industries in Batang District was socially less supportive to be sustainable. Fish fillet business owners were still reluctant to work together in groups through the formation of joint business groups, therefore communication between processing industries did not go well. If this condition is not treated immediately, then it would affect the sustainability of other dimensions, and as result, sustainability status of fish fillet processing industries in Batang district would decline.

Sustainability status could be improved from the present condition through policy intervention on dimensions and sensitive attributes (leverage attribute). The sensitive attributes of social dimension are presented in Figure 6.

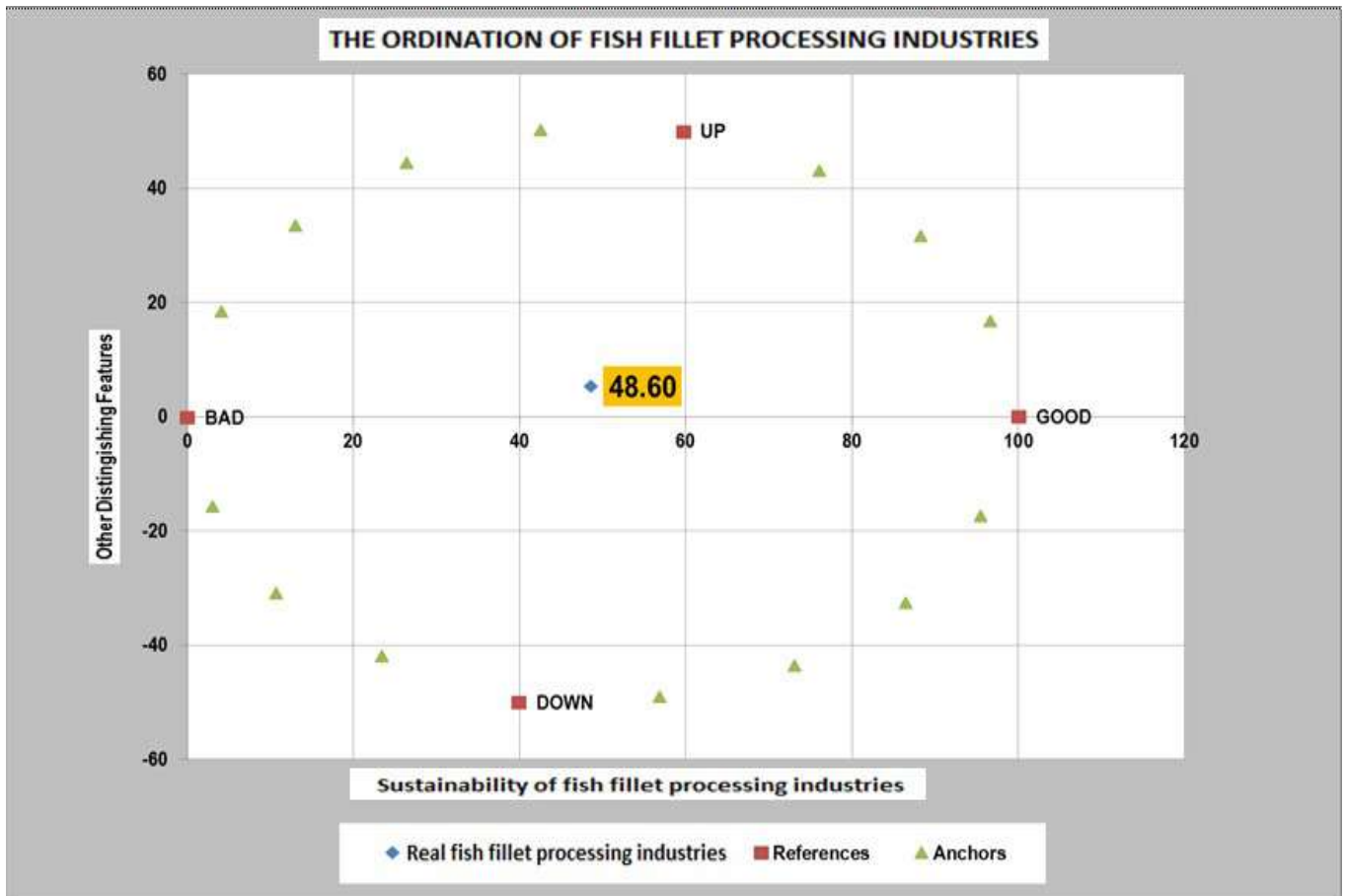


Figure 5. Index Value and Sustainability status on Social Dimension

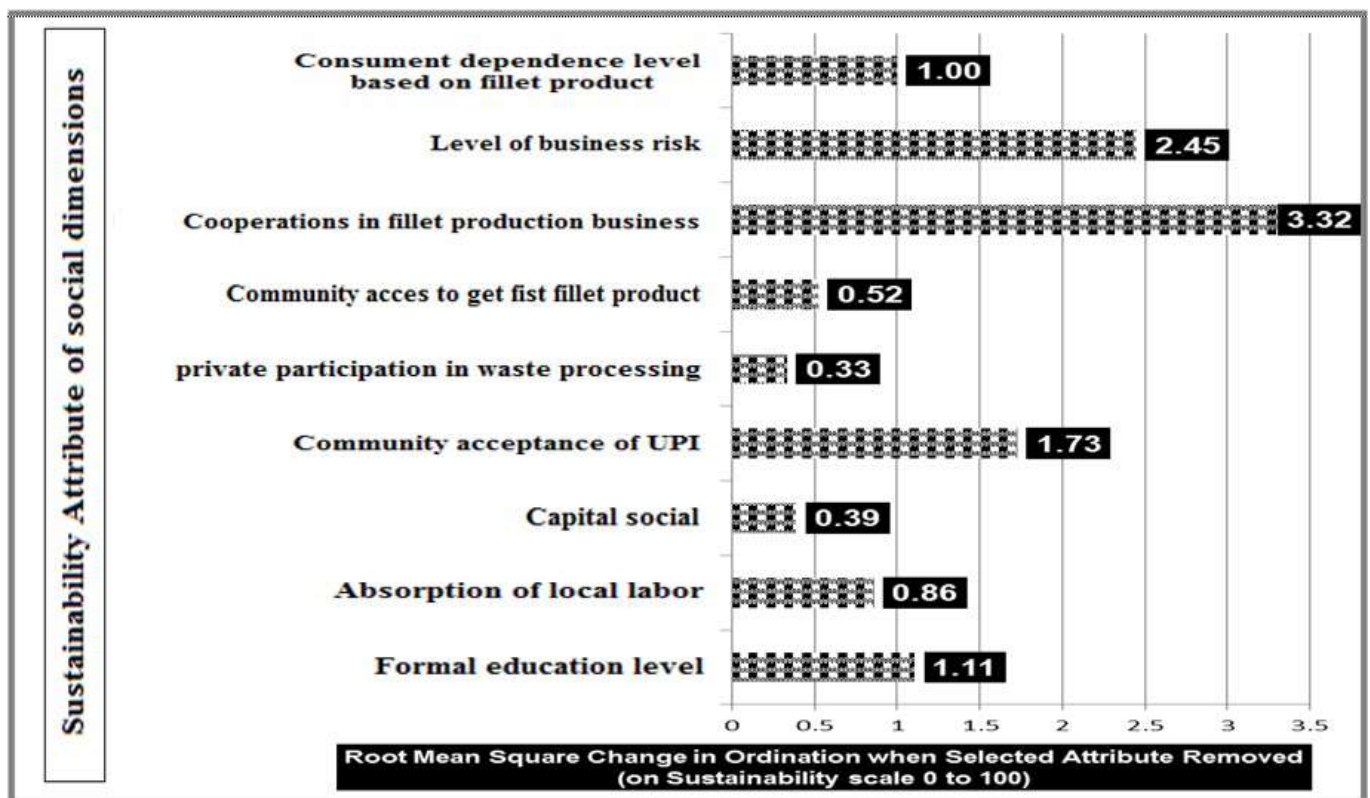


Figure 6. Attribute Sensitivity Value on Social Dimension Expressed in the Change of Root Mean Square (RMS) on Sustainability Scale of 0-100.

According to the above attributes, the three most sensitive attributes in social dimension were taken through the highest value of RMS, they were fish fillet processing business collaboration (RMS=3.23), level of business risk (RMS=2.45), and community acceptance of UPI (RMS=1.73).

Fish fillet processing business was the most sensitive attribute on the management sustainability of fish fillet processing industries on social dimension which showed that the business of fish fillet processing in Batang as a whole is still individual. It had an influence in the sustainability of fish fillet business in Batang. Observation results showed that the social relationship between fish fillet business owners were still low. It was shown that fish fillet business owners were reluctant to collaborate in groups through joint business groups. The reluctance of entrepreneurs to cooperate may also be due to the low ability to participate, which is a social characteristic of coastal communities. According to [Hendratmoko et al. \(2014\)](#) the social characteristics of coastal communities are an obstacle to developing their ability to participate in regional development. This situation has a major influence on the slow flow of socio-economic changes that occur in coastal areas.

If the entrepreneurs want to be formed into a joint business group, it will greatly help the development of the fish fillet business, especially those that are still small and medium scale. They can conduct business discussions together, so the fish fillet processing industries in Batang can develop evenly. The establishment of Kelompok Usaha Bersama/KUB is able to increase the development of regional fisheries business, for example as in regions that have implemented *minapolitan* programs such as Boyolali. Joint Business Group (KUB) was one of the means of collaboration for fish processors to learn about processing business management, how to make decisions, being responsible on the decision implementation. Through KUB, fish processors would obtain some sort of coaching in the form of skill and management training to develop productive economic business ([Yuliana, 2007](#))

Level of Business Risk attribute was the second sensitive attribute on the sustainability of fish fillet processing industries in Batang which showed that fish fillet business in Batang had a high level of business risk socially. The high risk that would be faced socially by fish fillet processing industries in Batang was the pollution impact on the surrounded community caused by those industries. The impact was in the form of liquid waste from the fish fillet production. The water from the fish washing flowed directly into the sewers so that it disturbed the surrounded community. The onset of foul

odor was caused by advanced proteins decomposition, which were rich in sulphuric amino acid (cysteines), producing sulphide acid, thiol group, and ammoniac. This is in accordance with [Syahrul et al. \(2016\)](#) which states that industrialization is inseparable from the demands of waste management, because each increase of a volume of waste is a burden for the community and will one day have an impact on the sustainability of the industry.

Community acceptance of Fish Processing Unit (UPI) was the third sensitive attribute on the sustainability of fish fillet processing industries in Batang on the social dimension, which was showed by the community acceptance of the fish fillet processing industries in Batang was quite good. The intended community in this research was the community around the fish fillet industrial area. Generally, fish fillet processing industries were less acceptable by the community around the settlement because most of the people were worried about the future pollution that will be caused by the unmanaged fish fillet waste. However, there were a small number of people who supported the existence of fish fillet processing industries in their region, since these industries gave a big benefit, such as job opportunities for the surrounding community which helped to reduce unemployment rates in that location.

3.5. Legal and Institutions Dimension

According to Rapfish analysis results on ten attributes which affected the legal and institutional dimension, the sustainability index value obtained was 40.27, as it is shown in [Figure 7](#). Those values were ranged between 26.00 -50.00, which means that they were less sustainable. Those values showed that the condition of legal and institutional aspects in the research sites were unsupportive of the management of the fish fillet industries. If the legal and institutional condition is not well-managed, it would affect the sustainability of other dimensions, hence the management sustainability status of fish fillet processing industries in Batang District would decline.

Sustainability status of legal and institution could be improved from the present condition through policy intervention on dimensions and sensitive attributes (leverage attribute). The sensitive attributes of legal and institution dimension are presented in [Figure 8](#).

According to the above attributes, the three most sensitive attributes in legal and institution dimension were taken through the highest value of RMS, they were cross-sector collaboration mechanism (RMS=5.54), regional and central government collabo

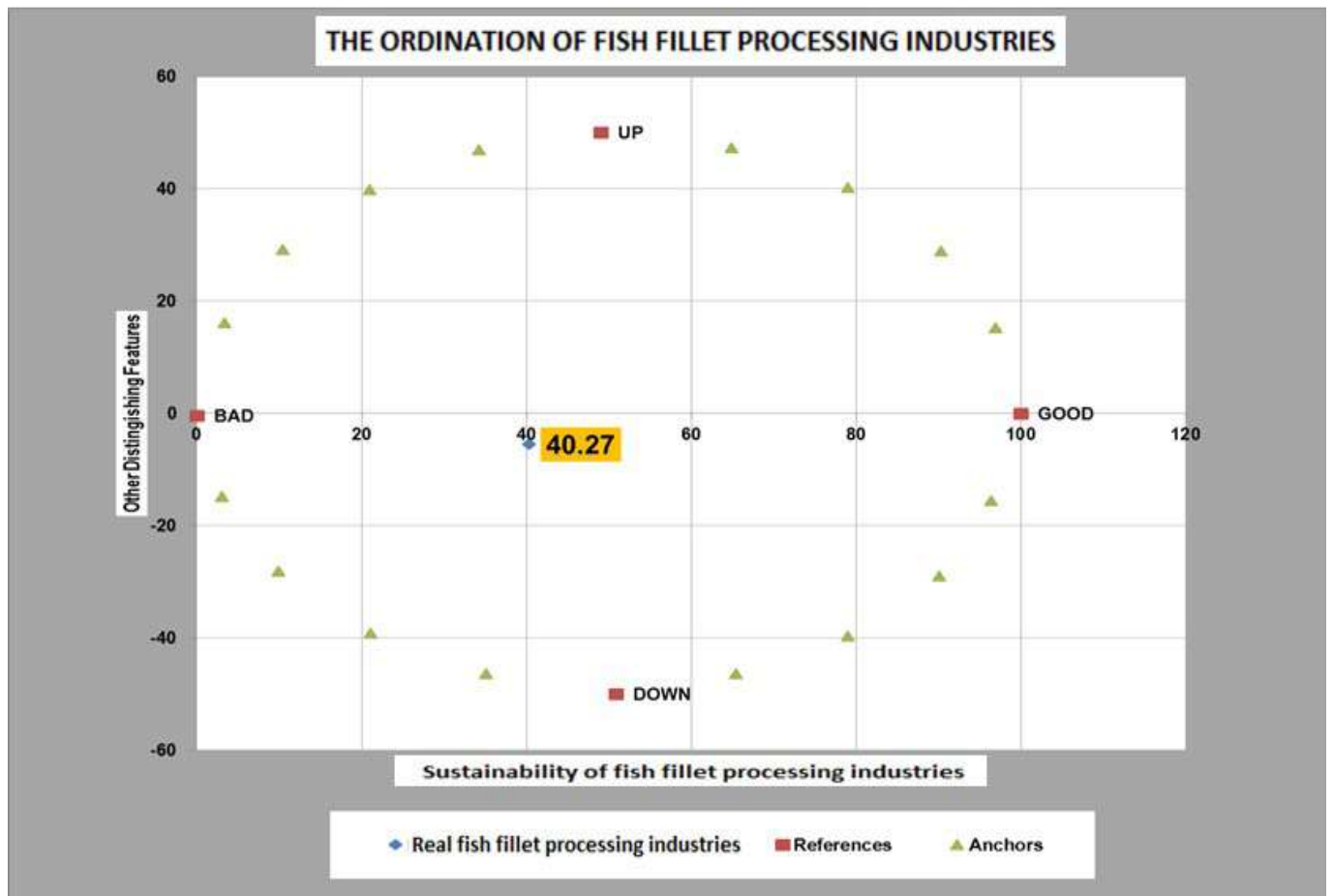


Figure 7. Index Value and Sustainability Status on Legal and Institution Dimension

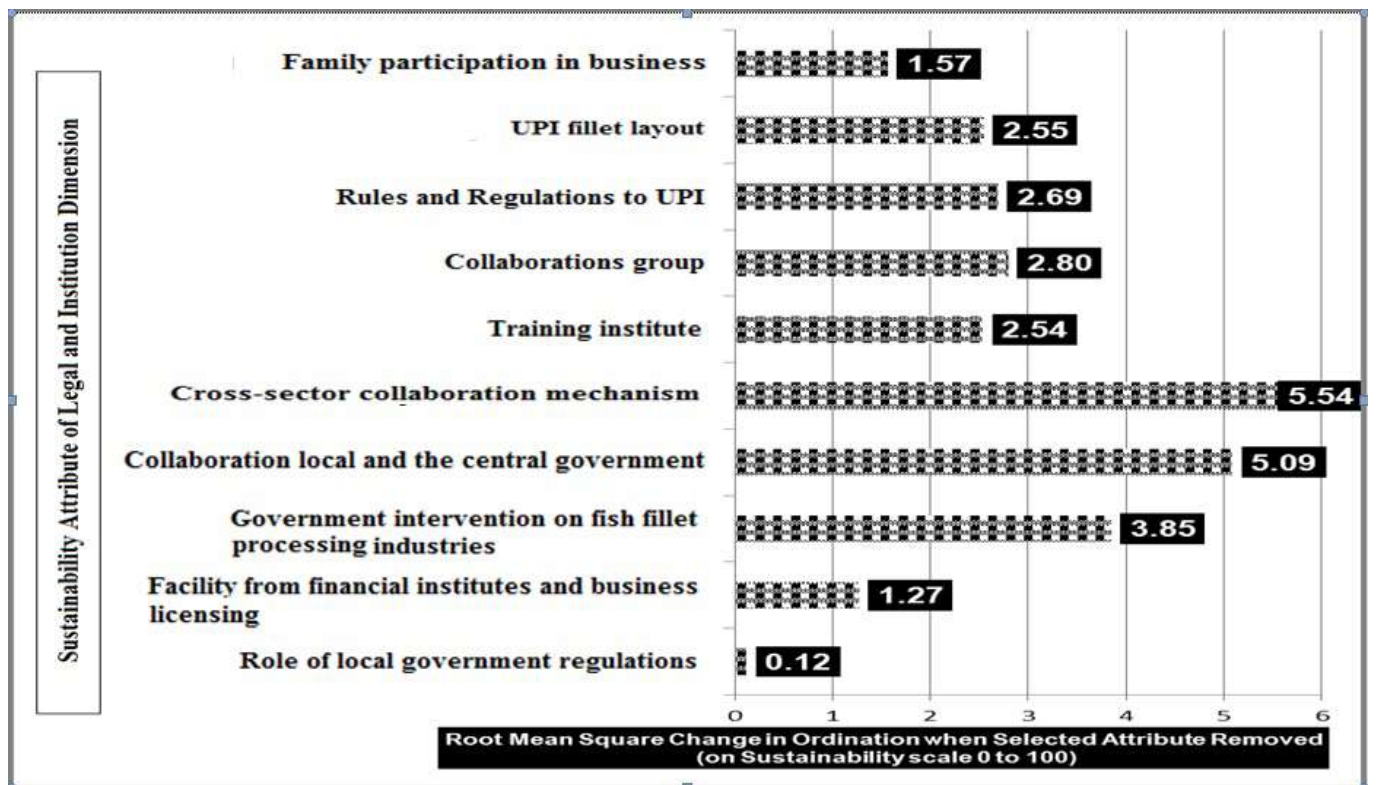


Figure 8. Attribute Sensitivity Value on Legal and Institution Dimension Expressed in the Change of Root Mean Square (RMS) on Sustainability Scale of 0-100.

ration (RMS=5.09), and government intervention on the fish fillet processing industries (RMS=3.85).

Cross-sector collaboration mechanism attribute in the fishery program was the most sensitive attribute where there has been no cross-sector collaboration activities undertaken by the government for the advancement of fish fillet processing industries in Batang. According to the result of interview with the Fisheries Office of Batang District about the cause of the lack of cross-sector collaboration, it was the difficulty of the related institutions to sit together and to coordinate the fishery programs related to the Office or other Ministries, whereas if the fishery business in Batang could be well-managed from upstream to downstream through a strong cross-sector collaboration between the governments, it would raise the regional income so that people would become prosperous. The existence of an appropriate mechanism of cooperation and coordination will create a conducive business climate for the industry, so competitiveness will increase. This is consistent with the results of [Riana et al. \(2014\)](#) that the source of the lack of market competitiveness by medium-scale industries is the result of a non-conducive business environment caused by poor cooperation between sectors. This allows the emergence of illegal levies in each sector that will undermine the margins of the industry.

Regional and Central Government was the second sensitive attribute of the fish fillet processing industries in Batang where the coordination and collaboration between the central and regional government was out of sync and overlapping especially on the policy. Based on the research, the policy overlap between the central and the regional government was caused by management of fisheries development especially in fish fillet industry which was still in the form of top-down direction with the policy implementation that tend to enforce, so it was possible to cause a conflict that caused a policy ineffectiveness and inefficiency to the management of fish fillet industries in Batang. The linear collaboration between regional and central government can develop fish fillet processing industries in Batang economically both locally and regional.

Government intervention on fish fillet processing industries was the third sensitive attribute for the sustainability of fish fillet industries in Batang where there was a government intervention both central and regional government on the industries, but it was not effective. Based on the research

Batang Local Government did not pay attention on the fish fillet processing industries, therefore the industries were slowly developed without any support

from the government. This was clearly seen from the lack of socialization and routine training related to the effective business and technology development of fish fillet processing industries. Even joint collaboration group (KUB) between fish processors in the research site which usually formed and directly supervised by the government was lacking. With the existence of KUB, it is expected that the fish processors, especially the fish fillet processors, could develop well. According to [Riyanto et al. \(2018\)](#) the government has a high influence but has a low interest, these stakeholders have a role in the fisheries processing industry in accordance with the main tasks of their respective functions, but have relatively low responsibilities or have an indirect relationship, so it is easy to be able to improve significant.

3.6 Sustainability Index on Technology Dimension

According to Rapfish analysis results on ten attributes which affected the technology dimension, the sustainability index value obtained was 48.90, as shown in [Figure 9](#). Those values were ranged between 26.00 -50.00, which means that they were less sustainable. Those values showed that the present condition of fish fillet processing industries at the present time in Batang was technologically less supportive to sustainability.

Sustainability status of technology dimension could be improved from the present condition through policy intervention on dimensions and sensitive attributes (leverage attribute). The sensitive attributes of legal and institution dimension are presented in [Figure 10](#).

According to the above attributes, the three most sensitive attributes in technology dimension were taken through the highest value of RMS, they were facility and infrastructure support from the government (RMS=7.36), access road from the fish auction place (TPI) to the Fish Processing Unit (UPI) (RMS=7.31), and Fish Processing Unit (UPI) location (RMS=5.88).

Facility and infrastructure support from the government was the most sensitive attribute for the sustainability of fish fillet processing industries in Batang without any real support for facility and infrastructure needed for fish fillet processing industries in Batang, both information technology facility and physical facility and infrastructure. The condition of the facilities and infrastructure of fish fillet processing industries were still very simple and under the hygiene standard. [Moenir \(1992\)](#) stated that facilities are all kinds of equipment, work equipment and facilities that function as main tools or assistants in the implementation of work and also in the context of interests related to work organizations.

Access road from the fish auction place (TPI) to

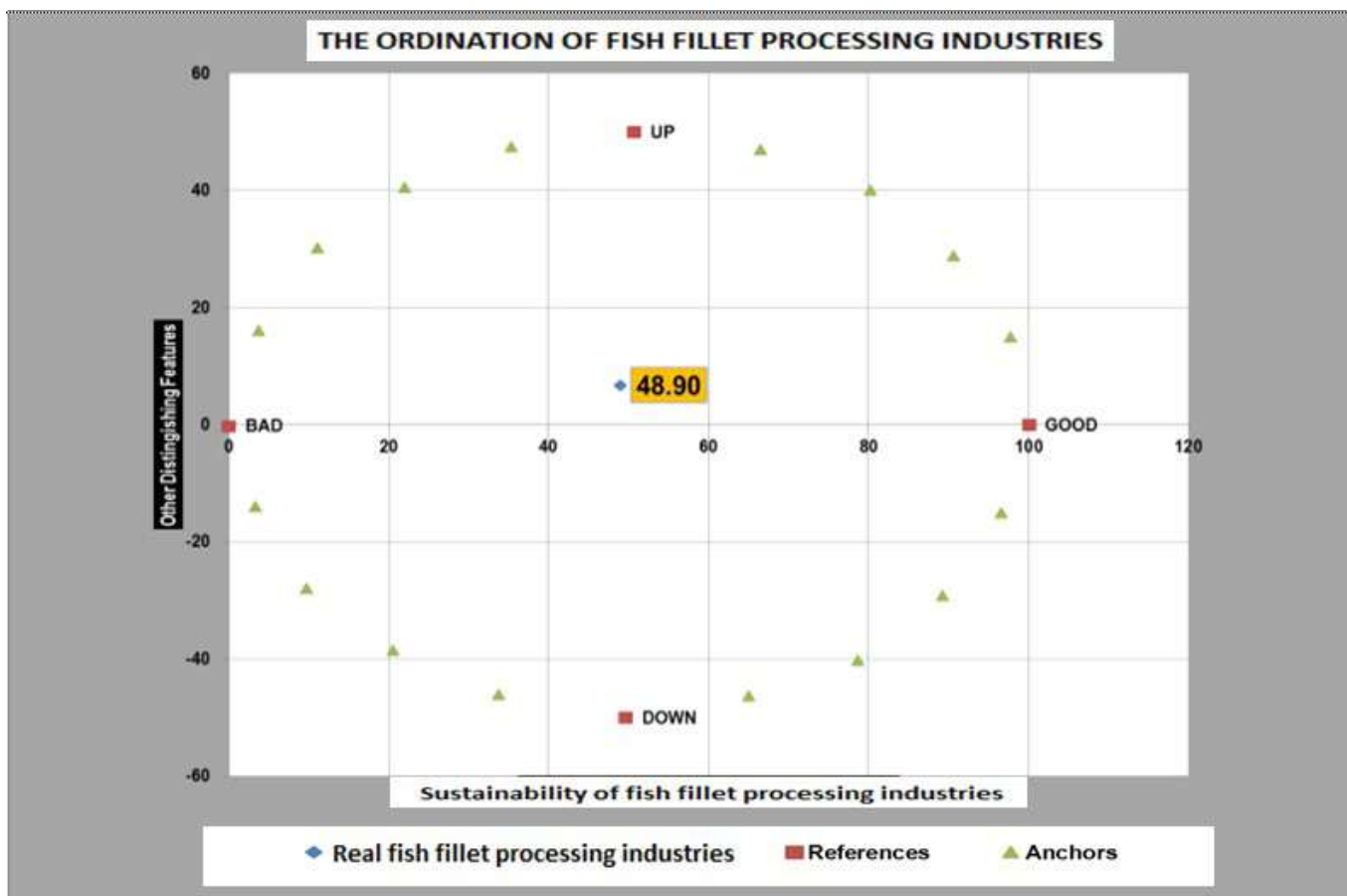


Figure 9. Index Value and Sustainability Status on Technology Dimension

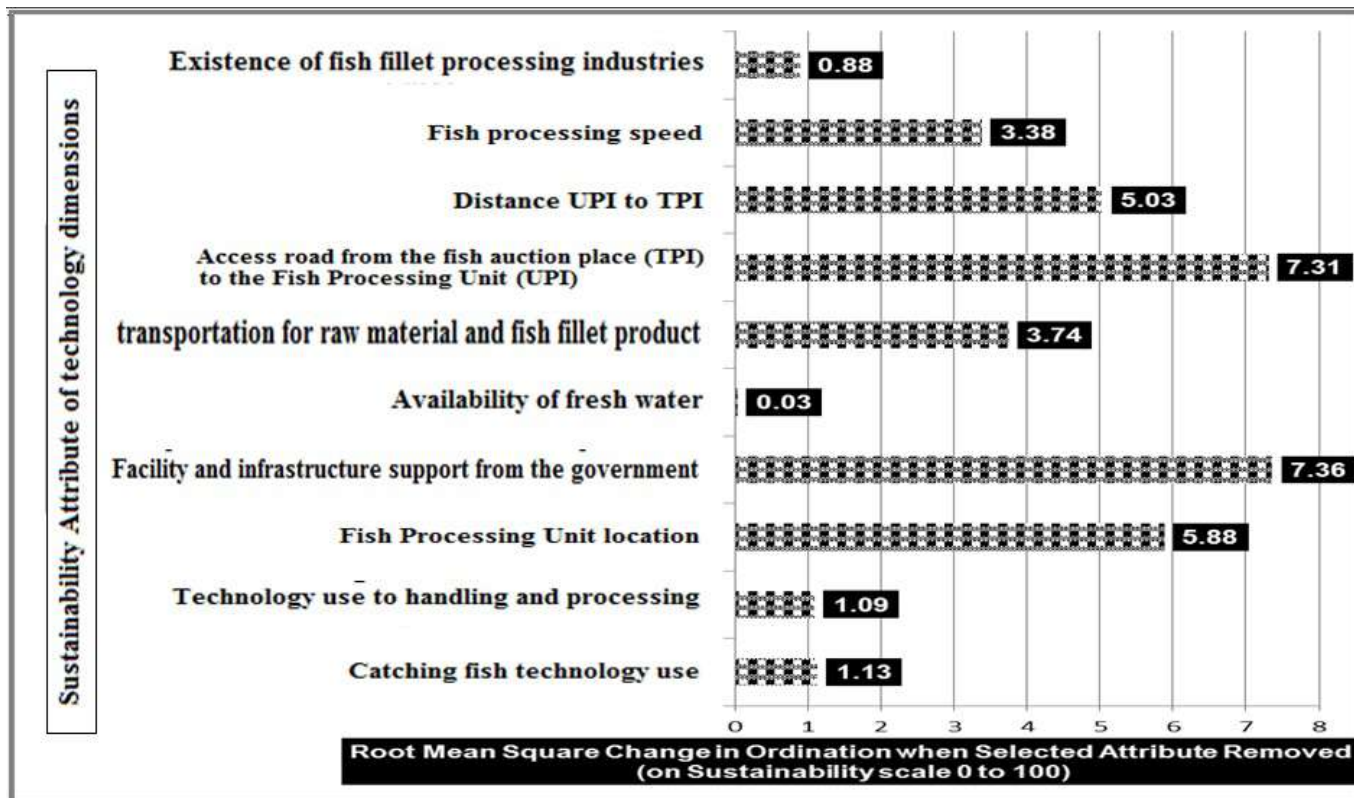


Figure 10. Attribute Sensitivity Value on Technology Dimension Expressed in the Change of Root Mean Square (RMS) on Sustainability Scale of 0-100.

SUSTAINABILITY INDEX OF FISH FILLET PROCESSING INDUSTRIES

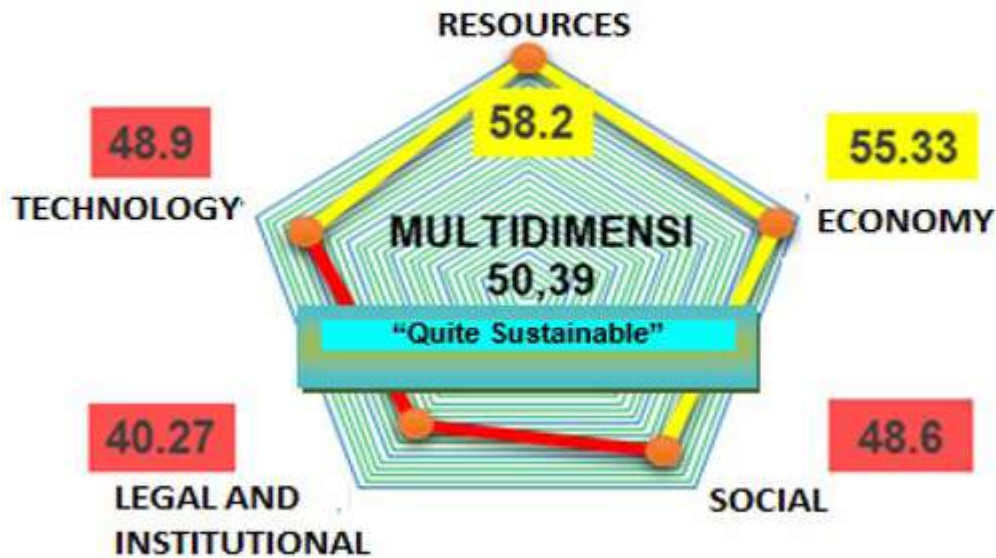


Figure 11. Kite Diagram of Sustainability Status of Fish Fillet Processing Industries in Batang District.

the Fish Processing Unit (UPI) was the second sensitive attribute for the sustainability of fish fillet processing industries in Batang. The condition of road access to transport the material from TPI to the fish fillet processing industries was damaged and potholed due to the frequent exposure to tidal water during high tides which made the fish to drop on the potholed road when transporting from TPI to UPI. If this thing keeps happening, it would directly damage the raw material due to the bacterial contamination after falling during transportation. While it indirectly affected on the fish fillet consumer decrease who bought the fish directly at production place because consumers found it difficult to reach the fish processing unit. Other than that, local and international investors would find it difficult and reluctant to invest their business capital on the fish fillet processing industries in Batang. [Tajerin et al. \(2015\)](#) stated that the main problem of the fishery product processing industry is the lack of infrastructure support such as fishing ports, roads, electricity, and clean water. In addition, the nature and characteristics of perishable fishery products are in dire need of support for logistics network systems and special technologies so that fisheries products can be more durable.

Fish Processing Unit location was the third sensitive attribute for the sustainability of fish fillet processing industries in Batang. The locations of fish fillet processing industries were mostly in the residential area, since it was home industry development. According to the interview result, fish fillet processing industries in Batang were at the residential area because there was no jointly managed processing centre in a form of special area. Therefore, it disrupted the activity of surrounded communities especially the waste from the production process which caused a foul odor, especially in the mid-day during the fillet production. In accordance with [Marwan et al. \(2013\)](#) that moving the location to an appropriate fishery processing unit can provide convenience or increase interaction between regions / service centers. Thus, economic, social and territorial benefits will be gained (opening isolation with other regions), because relations between regions will increasingly encourage population movement. The plan to strengthen accessibility through the placement of one area becomes an opportunity in developing industrialization activities, including the fish processing industry.

3.6 Multidimensional Sustainability Status

The sustainability status of fish fillet production in Batang District was determined by joining the five dimensions through multidimensional sustainability analysis. MDS analysis result for the five sustainability dimensions can be seen in [Figure 11](#).

MDS analysis result showed the value of 50.39%, which means it was quite sustainable. However, the value was at the lower limit, so it needs a proper management to improve the index value. There had to be an effort to improve the attributes with negative impact on the sustainability index and to keep up or even to improve the attributes with positive impact on the sustainability index of fish fillet processing industries. According to [Marzuki \(2012\)](#) the value of sustainability with a range of 50 – 74.9%. They were quite in sustainable status.

3.7 Management Strategy of Sustainable Fish Fillet Processing Industries

Based on the description about sensitive attributes or key factors and the success indicator above, five recommendations and implementation programs of fish fillet processing industries in Batang District are defined. The priority order for management recommendation is formulated based on the order of dimension with the lowest to the highest index value. There are five the priority order and management recommendation for fish fillet processing industries in Batang is as follows: Institutional Capacity of Government Improvement (1), Increasing The Role of Industry towards the Surrounding Community (2), Technology, Facility and Infrastructure Implementation Improvement (3), Increased in Income for Fish Fillet Processors (4), Prevention of the Declining Quality and the Quantity of Fish Resources (5).

4. Conclusion

The sustainability index for fish fillet processing industries in Batang District is included in quite sustainable with the value of 50.39, which is at the lower limit of the quite sustainable range. The dimensions that caused the low sustainability index value are social, legal and institutions, and technology, with values of 48.6; 40.27; 48.9, which means **less sustainable**. Management recommendations that can be done to improve the sustainability value are institutional capacity of government improvement, increasing the role of industry towards the surrounding community; technology, facility and infrastructure implementation improvement; increased income for fish fillet processors; prevention of the declining quantity and quality of fish resources.

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Authors' Contributions

AFD devised the main conceptual ideas and critical revision of the article, collected the data, drafted the manuscript. WFM discussed the results and contributed to the final manuscript.

Conflict of Interest

The authors declare that they have no competing interests

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