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MULTI-DIMENSIONAL SUSTAINABILITY ASSESSMENT IN MICRO-BUSINESS OF SIAMESE FIGHTING FISH CULTIVATION DURING THE COVID-19 PANDEMIC

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ABSTRACT

The economic value of Siamese Fighting fish and betta fish (*Betta splendens*) cultivation at the micro-business level has good potential to be developed during the COVID-19 pandemic. Considering the potential of the betta ornamental fish business, not a few parties use this as an alternative solution to the community's income crisis. During the COVID-19 pandemic, many parties engaged as ornamental fish cultivators to become a commodity of economic value, which in the past was usually only fish for complaints and not specifically cultivated to become aesthetic fish. The research objective focuses on assessing multi-dimensional sustainability in micro-business *Betta splendens* aquaculture during the pandemic. The data collected in this study include primary data and secondary data. Primary data was collected based on a questionnaire through interviews with micro-business actors of betta fish spread across six villages community associations, while secondary data was collected based on reports, journals, and the results of relevant studies. Data analysis used multi-dimensional scaling (MDS), leverage test, and Monte Carlo test. The analysis results show that two dimensions are categorized as less sustainable, namely business feasibility and business strategy, and three other dimensions, namely market networks, infrastructure, and maintenance and handling categorized as moderately sustainable. Ten sensitive attributes are considered unstable. The conclusion of the five dimensions assessed shows a less sustainable category. Leveraging factors in each dimension can be a key to developing a sustainable strategy for micro-business siamese fighting fish farming in the future.

KEYWORDS: Multi-dimensional scalling; Betta fish; Sustainability; Micro-business

INTRODUCTION

The COVID-19 pandemic has changed all community activities. The Covid-19 pandemic has forced people to be more creative to survive, one of which is by cultivating ornamental fish. The community adapts by opening a home-scale business. Ornamental fish is one of the fishery commodities that has become a potential trade commodity domestically and abroada and also as a source of income (Kartamihardja *et al*., 2017; Khoironi & Saskara, 2017; Ng, 2016). Ornamental fish has the charm to attract ornamental fish lovers (hobbies). Maintenance and care for siamese fighting fish or betta fish (*Betta splendens*) are relatively easy. There are 73 types of betta in the world, of which 52 are spread in public waters in Indonesia. One of the Betta types of ornamental fish that is commonly known in the community is *Betta splendens* (Panijpan *et al*., 2020). The production of ornamental fish during the COVID-19 pandemic experienced positive developments. This is indicated by an increase in the number of production and the number of ornamental fish cultivators. Betta fish micro-business actors generally work at home. The average capacity of the number of adult fish cultivated on a micro-business scale is 50-150 individuals. The average turnover is 3 million a month with a selling price per head in a price range of IDR5 thousand to IDR30 thousand per head (assuming 1 USD = 14,000 IDR).

During the COVID-19 pandemic conditions, the selling price of betta ornamental fish is booming. However, the sustainability of the micro-business prospects for ornamental fish farming have not been predicted with certainty by micro-business actors. The problems of ornamental fish micro-business actors often appear on the surface, such as business feasibility, competitors, market networks, infrastructure and maintenance facilities, and many more. Based on the description above, the purpose

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of this study is to examine the business sustainability of micro-business of betta fish in a multi-dimensional manner.

MATERIALS AND METHODS

Data collection

The data collected include primary and secondary data. Primary data was collected from interviews with micro-scale ornamental fish business actors, and key informants who became betta fish breeders for commercialization. Meanwhile, secondary data is collected based on reports, journals, and the results of studies from various related agencies. The method of determining respondents is purposive sampling. The number of betta fish breeders is as many as 36 people, but truly consistent breeders are fewer, around a dozen. In addition, the consideration of easy access and the limitations of researchers became the basis for selection (convenience sampling). As an illustration of the condition, traditional betta fish breeders in the city of Bogor, West Java province, generally operate at home. The location is spread out in a narrow alley. So the researchers took a sampling that is easy to access and affordable with a small vehicle. In this study, the selection of micro-business was carried out using a simple random sampling system and 12 betta fish micro-business were selected from six villages (VL) or sub-rural (rukun kampung). Data were collected from interviews using a semi-structured questionnaire designed to measure the attributes of each indicator on an ordinal scale from 0 to 10 (Coll *et al.*, 2013).

Data analysis

Data processing was conducted using the software tool Rapfish (Rapid Appraisal for Fisheries) version 2.0 based on Microsoft Excel. Data analysis was carried out qualitatively and quantitatively. The qualitative analysis is the descriptive analysis of sustainability, while the quantitative analysis is the Rap-Betta analysis (a modification of Rapfish), leverage test, and Monte Carlo (MC) test. These two analyzes are presented simultaneously and are interrelated in the discussion. The Detection of the level of sustainability used in Multi-dimensional Scaling (MDS). MDS is a multivariate statistical analysis method that determines the position of geometric based on the Euclidean distance between concepts based on questionnaire responses (Borg & Groenen, 2013; Sukwika *et al.*, 2016). This analysis is carried out through three stages, namely (Pitcher *et al.*, 2013): (1) Determination of the dimensions of sustainability for the sustainability of the micro-business of betta ornamental fish cultivation during the pandemic; (2) The assessment of each attribute on an ordinal scale is based on the sustainability criteria of each dimension; (3) Calculates and analyzes the sustainability index status.

In the MDS method, score for each dimension is stated from the lowest score (unsustainable) 0% to the best (sustainable) 100% (see Figure 1), and is grouped into four categories namely; 0-25.00% (poor or unsustainable), 25.01-50.00% (less sustainable), 50.01-75.00% (moderately sustainable), and 75.01-100.00% (very sustainable). Table 1 describes the index and ranking.

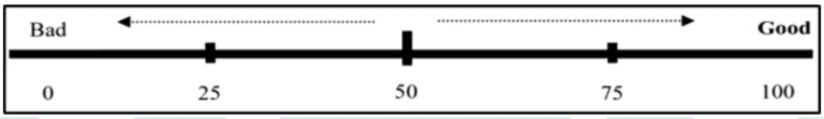

Figure 1. The value of the sustainability index score is 0% (bad) - 100% (good).
Source: Sukwika *et al.* (2016)

Table 1. Sustainability status value categories

Index	Category
00.00 – 25.00	Poor Sustainable
25.01 – 50.00	Less Sustainable
50.01 – 75.00	Moderately Sustainable
75.01 – 100.00	Very Sustainable

Source: Sukwika *et al.* (2016)

Sustainability index values in each dimension can be visualized simultaneously using a kite diagram. The sensitivity analysis shows which leveraged attributes contribute to the sustainability value of the resource. The effect of each attribute is observed on changes in the root mean square (RMS), especially on the x-axis for the sustainability scale with extreme values or at least RMS worth 2.00 (Sukwika *et al.*, 2016).

The RMS formula is as follows (Borg & Groenen, 2013; Ding, 2018):

$$RMS = \sqrt{\left[\frac{\sum_{i=1}^{n}\{Vf(i,1)-Vf(,1)\}^2}{n}\right]} \quad \text{..................(1)}$$

Where: Vf (i,1) = MDS output value (after rotation and flipping) Vf (,1) = MDS output median in column-1.

Sukwika *et al.* (2016) state that the results of MDS and MC are said to be accurate if the difference between the two is not more than 2%. Sukwika *et al.* (2016) recommends that the difference between MDS and MC results be even lower, which is no more than 1% because the smaller the error, the closer to validity dan accuracy. Pitcher *et al.* (2013) provide a perspective that if the results of the Monte Carlo simulation do not change significantly or have a small difference in the ordinance value, it can be concluded that the ordinance results have been able to overcome random errors. The Goodness of fit on the MDS is indicated by the magnitude of the S-Stress value, which is calculated based on the values of S and R^2. A lower stress value indicates a good fit, while a higher S value indicates the opposite. In the Rap-Betta approach, the good model contains a stress value of less than 0.25 or $S<0.25$ (Borg & Groenen, 2013; Ding, 2018), and the relatively better model has an R^2 close to 1.0.

RESULTS AND DISCUSSION

Dimension-1: Business Feasibility

The analysis of Rap-Betta shows that the sustainability index for the feasibility dimension is 41.75 (Figure 2a). The main factors contributing to the "less sustainable"dimension are attributes with the largest RMS values or are considered sensitive attributes in the business feasibility dimension (Figure 2b). Namely, KUR (people's business credit) COVID-19 Aid (RMS = 2.73) and the production capacity of betta fish (RMS = 3.29). For control, it must be handled or intervened with a plan or policy. Lam dan Pitcher (2012) stated that the government needs to respect the local business culture; provide social subsidies to support local micro-business; financial assistance strengthens micro-business actors. Another form of encouragement is increasing the management capacity of fish farmers to increase the income (Ng, 2016). Furthermore, the obstacle for ornamental fish micro-business actors is related to the production capacity of ornamental fish breeds. Sometimes, it is not following the prevailing ornamental fish market demand (Anwar, 2019).

Dimension-2: Business Actor Strategy

The strategic dimension of business actors has an average value of 40.48 or is categorized as "less sustainable" (Figure 3a). The two attributes that are sensitive are the price discounts for betta fish (RMS = 3.82) and the diversity of betta fish species owned by sellers (RMS = 4.00). Betta fish are very susceptible to bacteria. The emergence of bacteria can be due to food factors, contracting from other fish infected with bacteria, aquarium water conditions, and a humid and stuffy environment. Khoironi dan Saskara (2017) ound information that a factor in the largest operational expenditure cost is electricity. The ornamental fish price is determined by production costs and fluctuating selling prices . The attractiveness of betta fish consumers is largely determined by the collection of the diversity of betta fish species. Therefore, a business strategy is needed, starting from the selection of brooders, the spawning process, the maintenance of eggs, and fry (Florindo *et al.*, 2017; Ng, 2016; Srikrishnan *et al.*, 2017).

Dimension-3: Market Network

The average of sustainability index on the market network dimension is 50.87 (Figure 4a), so it is considered "moderately sustainable". There are two most sensitive attributes, namely access to market information (RMS=3.24), exhibitions or bazaars (RMS=2.84) (Figure 4b). Social media associations can increase knowledge and access of ornamental fish micro-business actors to market information relate to the development market and the consumers of ornamental fish (Hendrizal *et al.*, 2021).

Dimension-4: Infrastructure

The infrastructure dimension has a value of 50.94, indicating a "moderately sustainable" (Figure 5a). The most sensitive attributes are water circulation facilities (RMS=2.19), the availability of vertical shelves (RMS=2.16) (Figure 5b). So that, betta micro-business actors need to increase the number of vertical shelves so that the arrangement of betta fish jars is more space efficient and space effective. The results of research by (Yulianto *et al.*, 2014) stated that water circulation facilities affect the water quality for betta fish, so it is useful for increasing the production value. Betta fish have an aggressive and aloof character, especially male betta fish, which have a more beautiful body shape and color pattern and have economic value (Awaludin *et al.*, 2020; Florindo *et al.*, 2017; Panijpan *et al.*, 2020). The obstacle faced by micro-business actors for betta fish is the need for vertical shelves to place jars of betta fish. The unavailability of vertical racks causes the betta fish to be put together in one reservoir. As a result, male betta fish to compete with each other so that some die or are physically disabled.

Dimension-5: Maintenance and Handling

The sustainability index value of the maintenance and handling dimension was 56.12, indicating a "moderately sustainable" (Figure. 6a). Two attributes that are the most sensitive, namely solid and liquid waste

(RMS = 2.05), health and stamina in betta fish (RMS = 2.12) (Figure 6b). The ability of micro-business actors to maintain health and stamina is very limited. All of thatis dependent on their experience and knowledge (Florindo *et al*., 2017; Ng, 2016; Srikrishnan *et al*., 2017). Cleaning the aquarium, and feeding it regularly, does not guarantee fish avoid disease. According to Khoironi dan Saskara (2017), if find ornamental fish are infected with the disease, instead disposed of them immediately rather than spreading the disease to other fish. Furthermore, solid waste that sinks into the pond can interfere with the betta fish hatchery and rearing process and ultimately interfere with the betta fish production process (Amparyup *et al*., 2020; Florindo *et al*., 2017; Ng, 2016; Srikrishnan *et al*., 2017; Yulianto *et al*., 2014). The overall results of the leverage analysis on five dimensions yield 10 attributes (see Table 2). These leveraging factors are important for developing a model for the sustainability of a prospective betta ornamental fish farming micro-business during a COVID-19 pandemic. This leveraged analysis approach is considered a practical decision support tool to identify scenarios for managing ornamental fish farming micro-business (Rossetto *et al*., 2015).

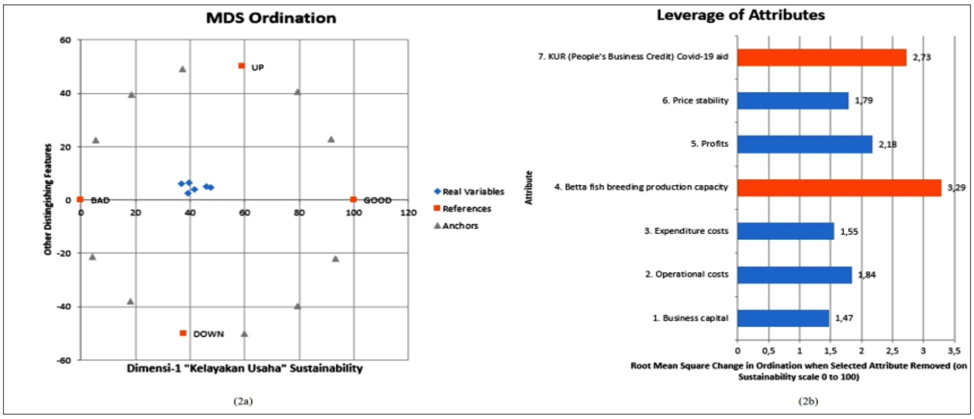

Figure 2. (a) sensitive attributes (b) business feasibility dimensions.

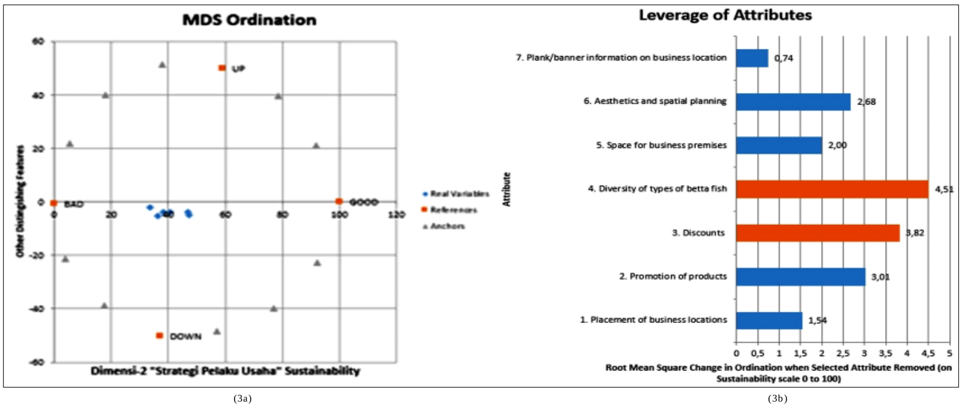

Figure 3. (a) sensitive attributes (b) the strategy of business actors dimensions.

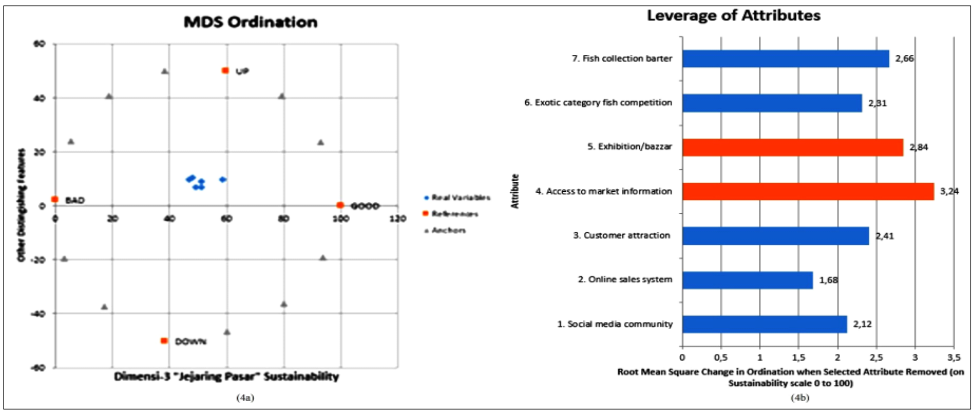

Figure 4. (a) sensitive attributes (b) market network dimensions.

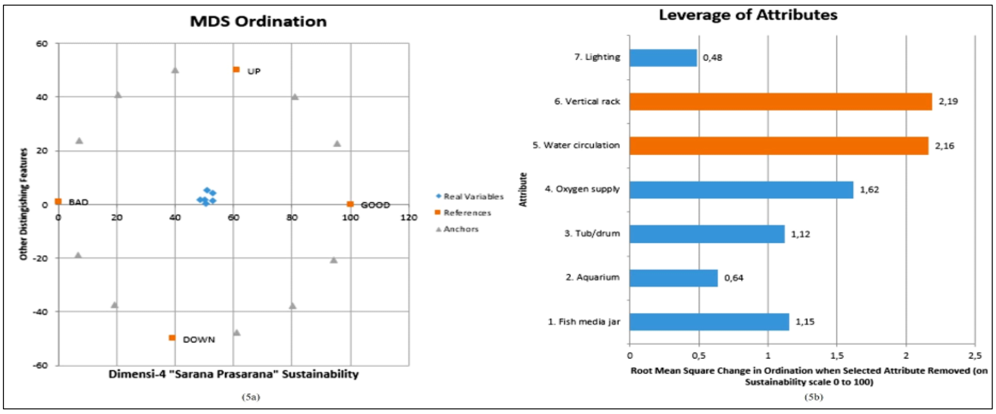

Figure 5. (a) sensitive attributes ad (b) infrastructure dimensions.

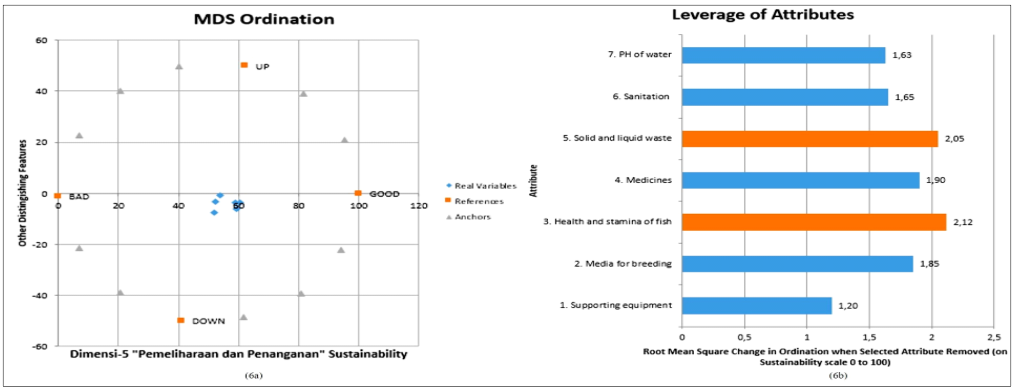

Figure 6. (a) sensitive attributes (b) maintenance and handling dimensions.

Validity and Accuracy Test

Table 2 contains the results of MD and MC. The results of the analysis of the validity of the MC test at the 95% confidence level are generally below 1.00%. That is, the MC value does not much different from the results of the Rap-Betta analysis. So that the model is adequate to estimate the value of the sustainability index of the betta micro-business. A small validity value indicates a minimal error from data acquisition and analysis and does not compromise the results of this study (Sukwika *et al.*, 2016).

The results of the MC simulation can help betta fish micro-business actors determine strategies realistic business-worthiness expectations. Wang *et al.* (2012) and Janssen (2013) believe that MC analysis can analyzing risks and uncertainties, especially those related to financing for the sustainability businesses.

The results of the MDS analysis accuracy test (good and fit) obtained a coefficient of determination (R^2) between 91.66% - 93.73%. The value of R^2 greater than 80% considered good category (Borg & Groenen, 2013; Ding, 2018; Sukwika *et al.*, 2016). The resulting stress value is 0.192 - 0.226 (good and fit), the range of its stress values is still below 0.250. That is, reflect the actual data and are sufficient to assess the sustainability index (Borg & Groenen, 2013; Pitcher *et al.*, 2013; Sukwika *et al.*, 2016). Table 3 contains the stress coefficient of determination from the Rap-Betta analysis.

Table 2. Differences in the value of the sustainability index and the Monte Carlo result of Rap-Betta

DIMENSIONS	MDS VL1	MC	Differ-ence	MDS VL2	MC	Differ-ence
[1] Business feasibility	36.73	36.92	0.19	47.49	47.12	0.37
[2] Business actors strategy	38.30	37.54	0.76	46.86	47.01	0.15
[3] Market network	51.27	51.18	0.10	58.42	58.49	0.06
[4] Infrastructure	50.10	50.05	0.05	52.80	52.53	0.26
[5] Maintenance and handling	52.05	51.95	0.09	58.87	58.83	0.05
Average	45.69	45.53	0.24	52.89	52.80	0.18
DIMENSIONS	MDS VL3	MC	Differ-ence	MDS VL4	MC	Differ-ence
[1] Business feasibility	41.78	41.92	0.14	39.16	38.93	0.23
[2] Business actors strategy	40.56	41.25	0.70	33.58	34.49	0.91
[3] Market network	51.38	51.50	0.13	46.92	46.97	0.05
[4] Infrastructure	48.40	48.05	0.35	50.67	50.57	0.10
[5] Maintenance and handling	52.33	51.86	0.47	59.15	59.47	0.32
Average	46.89	46.92	0.36	45.90	46.09	0.32
DIMENSIONS	MDS VL5	MC	Differ-ence	MDS VL6	MC	Differ-ence
[1] Business feasibility	45.88	45.89	0.01	39.43	38.83	0.60
[2] Business actors strategy	47.15	47.69	0.54	36.44	35.52	0.91
[3] Market network	49.11	48.86	0.25	48.12	48.32	0.20
[4] Infrastructure	52.69	52.72	0.03	50.99	51.04	0.05
[5] Maintenance and handling	54.02	54.05	0.03	60.31	60.32	0.01
Average	49.77	49.84	0.17	47.06	46.81	0.36

Table 3. Index, stress and determination (R^2) value from Rap-betta

Parameter	Dimensions					
	[1] Business feasibility	[2] Business actors strategy	[3] Market network	[4] Infra-struc-ture	[5] Mainten-ance and handling	Ave-rage
Index *value* *	41.75	40.48	50.87	50.94	56.12	48.03
Stress *value* **	0.209	0.192	0.210	0.226	0.226	0.213
R^2 ***	93.06	93.75	92.72	91.86	91.66	92.61
Iteration	2.00	2.00	2.00	2.00	2.00	2.00

Kite Diagram

Based on the analysis of the value of the sustainability index of five dimensions, in Figure 7 shows the business viability and strategy of business actors are "less sustainable" at 41.75% and 40.48%, respectively. The other three dimensions, namely market networks, infrastructure, and maintenance and handling, are "moderately sustainable" with sustainability indexes of 50.87%, 50.94%, and 56.12%, respectively

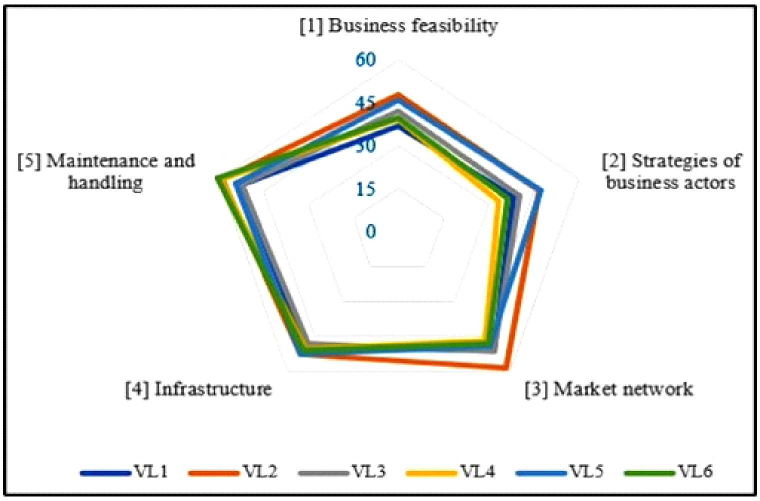

Figure 7. Kite diagram based on Rap-Betta analysis results.

CONCLUSION

Based on the analysis of the value of the sustainability index of five dimensions, known the business viability and strategy of business actors are "less sustainable". At the same time, three dimensions, namely market networks, infrastructure, and maintenance and handling, are "moderately sustainable". There are ten dominant leverage factors considered sensitive that can be a key to formulating a sustainable strategy for micro-business betta fish cultivation in the future.

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