International Journal of Research and Review
Vol. 10; Issue: 12; December 2023
Website: www.ijrrjournal.com
Research Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Factors Affecting the Sustainability of Vannamei Shrimp (*Litopenaeus vannamei*) Farming in IBL Prigi Using Process Hierarchy Analysis (AHP)

Fetriyani[1], Nimmi Zulbainarni[2], Harianto[3]

[1,2,3]Business School – IPB University, JL Pajajaran Bogor, Indonesia.

Corresponding Author: Fetriyani

DOI: https://doi.org/10.52403/ijrr.20231277

ABSTRACT

The purpose of this study is to determine the factors and variables affecting the sustainability of vannamei shrimp (L. vannamei) farming at the Prigi Marine Aquaculture Installation (IBL) which will later become a priority of attention by IBL Prigi itself. The respondents of this study consisted of 7 people who were directly related to the cultivation process at IBL Prigi, namely the Head of Installation, Aquaculture Technician and Fish Farming Supervision Manager. The importance of each factor and variable is determined using the Analytic Hierarchy Process (AHP). The results of this study found that the most influential factor was the ecological factor with a priority weight of 0.35 or 35%, while the variables that had the most dominant influence were shrimp protection, market availability, water quality management, suitability of cultivation sites, feed management and quality of worker resources.

Keywords: *AHP, Sustainability, Vannamei Shrimp, IBL Prigi*

INTRODUCTION

Vannamei shrimp farming is one of the aquacultures that has high economic value (Akmal *et al*. 2021) which since 2018 began to be developed at the Prigi Marine Aquaculture Installation (IBL). IBL Prigi itself is a technical implementation unit for marine aquaculture development located in Watulimo, Trenggalek. IBL Prigi is under the auspices of the Fisheries and Marine Service of East Java Province, precisely at the Technical Implementation Unit (UPT) of Brackish Water and Bangil Sea Aquaculture, Pasuruan. The decline in shrimp farming production occurred in 2022 where IBL Prigi in that year was only able to produce 19.63 tons. Even though in 2021 IBL Prigi was able to produce 20.1 tons of vannamei shrimp (*L. vannamei*) (Figure 1). This problem makes one of the factors that affect the sustainability of vannamei shrimp farming itself. The aquaculture industry itself in general experiences many obstacles in addition to handling diseases, the obstacles it faces are a decrease in water quality, environmental pollution, the occurrence of conflicts both internal and external, the absence of protection for workers, until the technology used is not appropriate to produce low productivity (Cahyaningrum, 2017)

Aquaculture is one of the fisheries sub-sectors that is being promoted by the government in recent years. After tiger shrimp farmers have experienced many problems, now the government is looking for new breakthroughs to solve these problems. One of the efforts is to maintain a new species, namely vannamei shrimp. The presence of vannamei shrimp in the midst of problems in tiger shrimp rearing against disease is a commodity that is welcomed by shrimp farmers (Purwono *et al* 2012).

Vannamei shrimp has the right advantages for shrimp farming activities in ponds. These advantages such as responsiveness to feed or have a high appetite, this type of shrimp also has a strong body resistance to disease attacks and poor environmental quality, has a fast growth cycle, the survival rate in this type of shrimp is high, at a fairly high stocking and relatively short maintenance time of approximately 90-100 days per cycle (Purnamasari *et al.* 2017).

The decline in production at IBL Prigi is a problem for the sustainability of vannamei shrimp farming at the location. Therefore, researchers feel the need to conduct a sustainability analysis of factors and variables related to the sustainability of vannamei shrimp farming in IBL Prigi. This analysis aims to determine which variables should be a priority for attention by IBL Prigi in the sustainability of vannamei shrimp farming.

MATERIALS & METHODS

This research was carried out from June to October 2023 at the Prigi Marine Aquaculture Installation (IBL), Tasikmadu Village, Watulimo District, Trenggalek Regency. The data collected consists of 2 (two) data, namely primary data and secondary data. Primary data were collected by means of questionnaire dissemination. Filling out the questionnaire was carried out on 7 (seven) respondents. Respondents were selected by purposive sampling based on involvement and expertise in vannamei shrimp farming. Respondents involved in vannamei shrimp farming activities at IBL Prigi include the Head of Installation, Aquaculture Technician and Fish Farming Supervision Manager. Filling out the questionnaire aims to determine vannamei shrimp farming activities at IBL Prigi from various factors of sustainability of vannamei shrimp farming business, both from ecological, economic, social and technological factors. Filling out the questionnaire aims to determine vannamei shrimp farming activities at IBL Prigi from various factors of sustainability of vannamei shrimp farming business, both from ecological, economic, social and technological factors. Secondary data are obtained from literature, journals and previous research results.

The variables in the study, using sustainability factors and variables in vannamei shrimp farming as in the (Table 1)

Table 1. Factors and variables of cultivation sustainability

No	Factor	Variable
1	Ecology	Suitability of cultivation sites
		Environmental protection
		Protection against shrimp
2	Economy	Internal characteristics of the business
		Market availability
3	Social	Worker protection
		Potential conflict
		Quality of worker resources
4	Technology	Water quality management
		Feed management
		Disease management
		Early conditioning and harvesting

Source: Nurdiansyah et al (2020)

The results of this study will later be analyzed using the Analytical Hierarchy Process (AHP). AHP in this paper is used to determine the weight of each criterion so that the priority weight of sustainability of vannamei shrimp farming is obtained using Microsoft Excel 2013. The analysis procedure using the AHP method is as follows:

1. The created hierarchy consists of the overall objectives at the top of the hierarchy, criteria, sub-criteria, and alternatives at the next level.
2. Data collected from experts or decision makers who conform to the hierarchical structure in comparison of paired alternatives on a qualitative scale as described on the Saaty scale. The (Saaty, 1987) scale is in Table 1.

Table 2 Fundamental scale of absolute values for AHP assessment

Intensity of Importance	Definition
1	Both elements are equally important and have an equally great influence
3	One element is slightly more important than the other
5	One element is more important than the other
7	One element is clearly more important than the other
9	One element is absolutely more important than the other
2,4,6,8	The average value between two adjacent considerations. This value is given when it is felt that there is a compromise between the two adjacent considerations
Prinsip resiprokal	If the intensity of importance of element A is equal to x of element B, then the importance of element B must be 1/x of element A

3. Make a pairwise comparison of the various criteria generated in the previous Step arranged in a square matrix.

Table 3. Pairwise Comparison Matrix

C	A_1	A_2	.....	A_n
A_1	A_{11}	A_{12}	.....	A_{1n}
A_2	A_{21}	A_{22}	.....	A_{2n}
.....	.....	.....	.....	.....
A_m	A_{m1}	A_{m2}	.....	A_{mn}

4. Calculate the results of pairwise comparisons with geometric averages, this is done because the assessment involves many people. The value must be multiplied to determine the geometric mean, which is then determined by taking the square root of the number of respondents like the following equation:

$$G = \sqrt[n]{x_1.x_2.x_3 \ldots x_n}$$

Information:

G : Geometric mean

x1. x2. x3... xn: Data to 1,2, 3, n

n : Amount of data

5. Simplify and then count the sum in each column with formulas as follows:

$$jtk = \sum_{i=1}^{3} a[i,k], dengan\ k = 1,2,3$$

Information:

jtk : Total Number of Columns

6. Divide the values of each member of the matrix in pairs by the number of values in each column to get the normalization with the following formula:

$$K_{[i,k]} = \frac{a[i,k]}{jtk}$$

Information:

$K_{[i,k]}$: normalized weight

$a_{[i,k]}$: member values on the matrix

7. Until reaching the goal will be calculated eigenvector from the pairwise comparison matrix. The calculation is carried out as follows:

$$Eigen\ vektor = \frac{\sum_{i,k=1}^{n} a[i,k]}{n}$$

Information:

$a_{[i,k]}$: member values on the matrix

N : the number of criteria

8. Calculate the eigenvalue by summing the multiplication result of jtk with the eigenvector.

9. Calculate the consistency index (CI) to describe the consistency of decision makers during the evaluation process. CI can be calculated using the following equation:

$$CI = \frac{\lambda maks - N}{N - 1}$$

Where λmax is the maximum eigenvalue and N is the number of items compared. The consistency ratio (CR) is calculated using the following equation:

$$CR = \frac{CR}{RI}$$

Where RI is obtained from the random consistency index table as below for the number of experts.

Table 4. Random consistency index table

N	1	2	3	4	5	6	7	8	9
RCI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Source: Saaty (1987)

A paired comparison matrix is considered consistent if the CR is <0.1. If the CR is >0.1, the decision maker must repeat the pairwise comparison due to inconsistencies.

10. The overall score of each alternative is calculated.

RESULT

Research Site Overview

The Prigi Marine Aquaculture Installation (IBL) was originally established under the name Balai Bibit Udang Galah (BBUG) in 1980 which is a technical implementation unit that develops giant shrimp farming products which was inaugurated by Imam Sardjono. However, at present IBL Prigi is one of the aquaculture installations under the technical implementation unit or UPT Aquaculture Oayau dan Laut (BAPL) Bangil, Pasuruan and operates under the Fisheries and Marine Service of Java Timur Province.

Based on the decree of the Governor of East Java Number 131 of 2008 on August 26, 2008, the Prigi Galah Shrimp Seed Center (BBUG) changed to the Prigi Aquaculture Management Unit (UPPB). However, on June 30, 2014 based on East Java Governor Regulation Number 31 of 2014 UPPB Prigi changed its name to the Prigi Brackish Water Aquaculture Installation (IBAP) which later became the Marine Aquaculture Installation (IBL Prigi) on October 1, 2019 until now.

Operational activities carried out to obtain the desired results are supported by existing facilities and infrastructure. The map used for operations is hatchery 1 which is used for hatchery vannamei shrimp (*L. vannamei*) which amounts to 20 round concrete tubs with a volume of 1000 dm3. Hatchery 2 which is used for small-scale intensive vannamei shrimp (*L. vannamei*) system cultivation also amounts to 20 concrete tubs with a square shape, 10 concrete cultivation ponds and 4 HDPE ponds and shrimp sorting places (handling fish).

Technically, the cultivation method carried out at IBL Prigi is an intensive method where IBL Prigi itself spreads seeds as much as 160-190 heads / m2. The number of seeds has been adjusted to the existing land capacity. IBL Prigi has implemented Good Fish Farming Methods (CBIB), one of which is by not using antibiotics when shrimp farming. Pond preparation carried out at IBL Prigi is the same as the preparation of aquaculture ponds in general where there is pond cleaning, pond drying, liming ponds, water filling, aeration, fertilization and seed provision. The feed used is the manufacturer's feed as a whole and uses a waterwheel to increase the supply of dissolved oxygen in the cultivation pond.

Pairwise Comparison of Factors and Variables of Sustainability of vannamei Shrimp (L. vannamei) Farming in IBL Prigi

A pairwise comparison of factors and variables is carried out between each factor and variable using a scale of 1-9. A value of 1 indicates both elements are equally important and a value of 9 indicates one element is absolutely more important compared to the other. The results of a pairwise comparison based on 4 (four) factors in IBL Prigi obtained that the ecological factor was the factor that received the highest priority scale value of 0.35 (Figure 1). From these results, it can be concluded that ecological factors are very influential factors in the sustainability of shrimp cultivation. According to (Akbarurrasyid *et al.* 2020), ecology is the main factor that supports the success of vannamei shrimp (*L. vannamei*) farming business. The low value of sustainability is found in social factors. Social factors have a priority scale value of 0.15. The low priority scale value on social factors is caused by there has never been a conflict between employees and with outside parties. Wigiani *et al*. (2019) stated that the existence of aquaculture is sought not to cause social conflicts. Regional arrangement according to RTRW and / or zoning can minimize the potential for external conflicts.

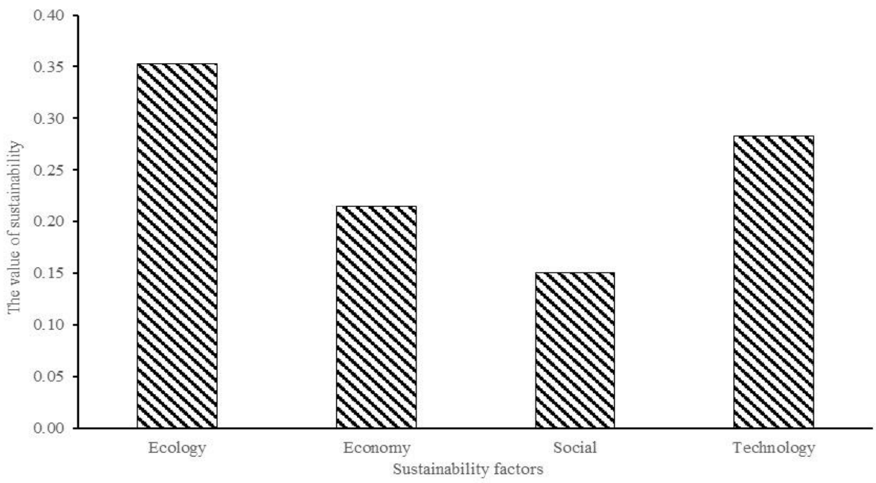

Figure 1. Sustainability of vannamei shrimp farming at IBL Prigi

The results of the comparison of paired variables in ecological factors that obtained the highest priority scale value were protection variables for shrimp with a priority weight value of 0.68 (Figure 2). Protection of shrimp is important to ensure that it starts from ensuring that fry are stocked with fry that do not have disease, ensuring shrimp get the right food intake and shrimp avoid disease. This is also in accordance with the importance of protection against shrimp because one of the factors for the failure of shrimp farming is due to the presence of disease in the shrimp itself. The presence of disease can threaten the sustainability of shrimp farming (Lestantun *et al*. 2020). Meanwhile, the low environmental protection is because IBL Prigi only relies on security and cleaners/pickets to minimize unexpected events, such as cultivation products taken by unknown people or poisoned by unknown people.

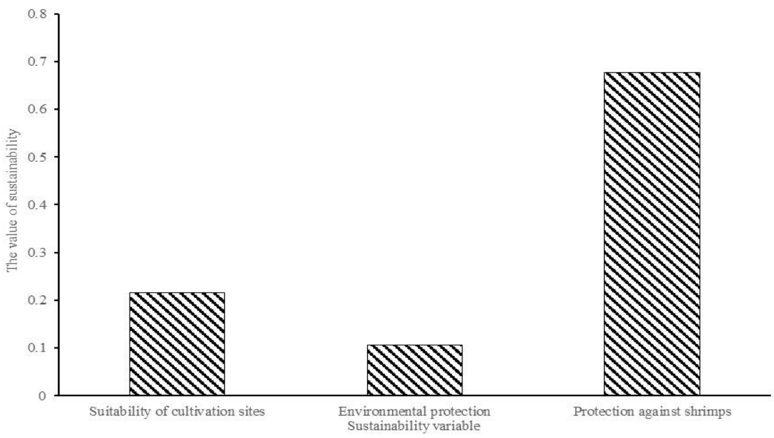

Figure 2. Sustainability of vannamei shrimp farming based on ecological factors

Comparison of paired variables in economic factors is carried out on 2 (two) variables, namely internal business characteristics and market availability. The results of a pairwise comparison of economic factors can be seen in Figure 3. Based on these results, the variable that has the highest priority value is the market availability variable with a priority value of 0.74. The marketing process at IBL Prigi itself through middlemen for sizes that are in accordance with demand, if at the time of sorting there is an inappropriate size then the production will be sold in the local market (around IBL Prigi). This is in accordance with the opinion of Yusuf *et al*. (2023), with market availability, demand is higher and the volume of cultivation can continue to be developed.

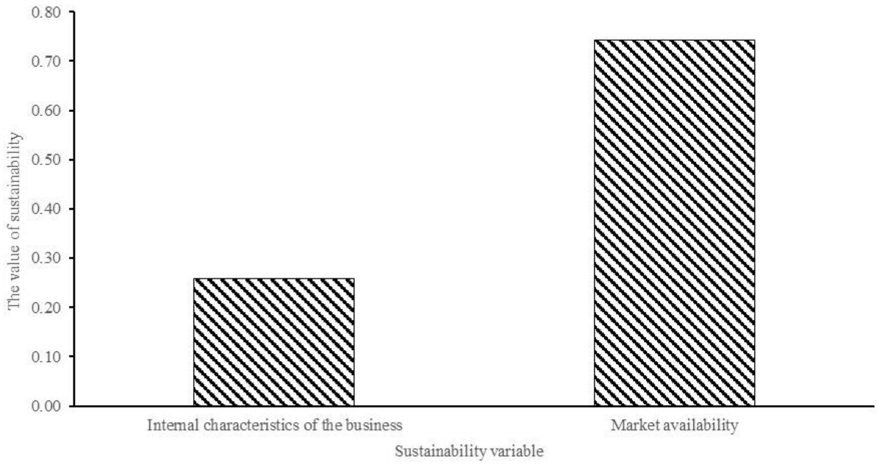

Figure 3. Sustainability of cultivation based on economic factors

Pairwise comparison of variables contained in social factors is carried out on 3 (three) variables, namely worker protection, potential conflict and quality of labor resources. Of the three variables, the highest priority weight value was the quality of workers' resources with a priority value of 0.42 (Figure 4). The quality of worker resources at IBL Prigi is classified as qualified where the level of education of the technicians is Bachelor of Fisheries with a minimum work period of 2 years in the field of aquaculture. This proves that the workers at IBL Prigi have qualified knowledge in their fields. The importance of the quality of worker resources is in accordance with the opinion of Prakoso *et al*. (2016), qualified human resources in the technical field of vannamei shrimp (*L. vannamei*) cultivation are needed because human resources are one of the important factors in the success of vannamei shrimp (*L. vannamei*) farming.

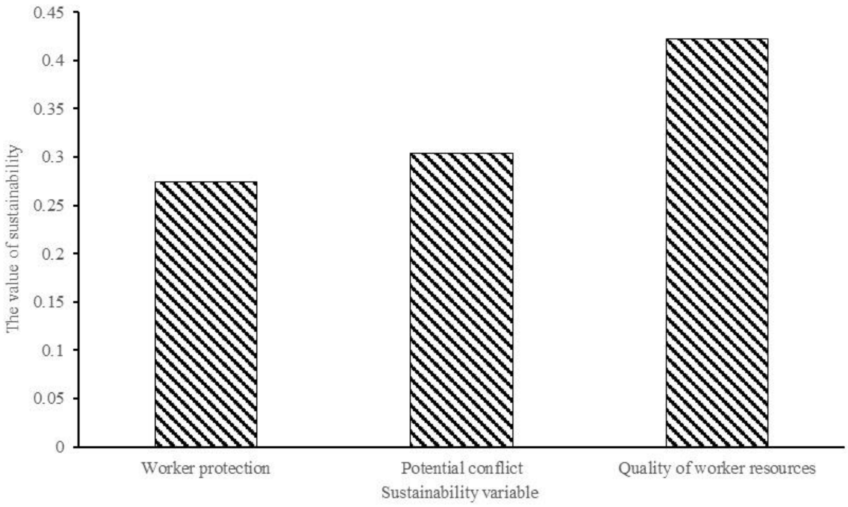

Figure 4. Sustainability of cultivation based on social factors

Pairwise comparisons on variables contained in technological factors are carried out on 4 (four) variables, namely water quality management, feed management, disease management and initial conditioning and harvesting. Of the four variables, the highest priority weight value was water quality management with a priority value of 0.43 (Figure 5). Water quality management at IBL Prigi is carried out by monitoring water quality twice a day to find out whether the water quality is optimal or not. This monitoring is also carried out in order to find out whether the addition of probiotics, waterwheels, and minerals is needed to optimize water quality in aquaculture ponds. This high level of priority is in line with the opinion of (10) Prakoso *et al*. (2016), the condition of stable water quality parameters will greatly affect optimal cultivation conditions, during the shrimp farming period the level of interrelation between the chemical parameters of water physics has a strong relationship with each other.

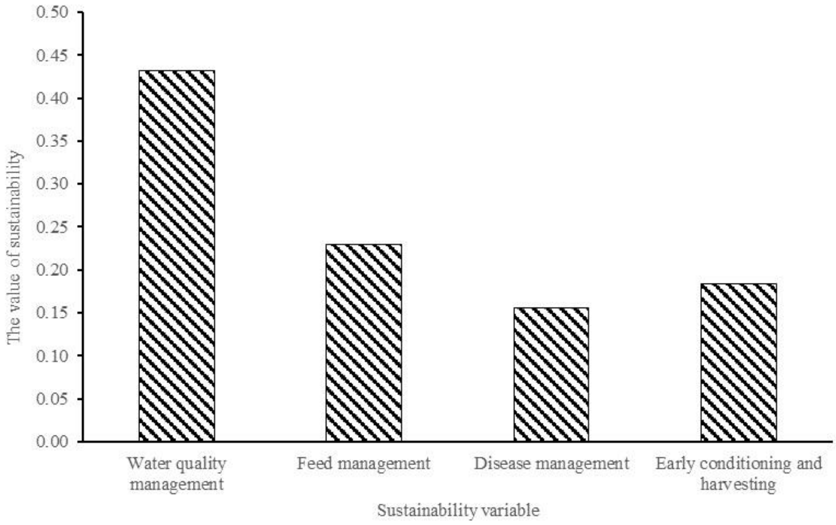

Figure 5. Sustainability of cultivation based on technology factors

From the results of the pairwise comparison of each variable on the existing factors, a global priority value is obtained These results can be seen in Table 5. From the table below, it can be seen that the global priority value shows the relative importance of each variable to the sustainability of vannamei shrimp (*L. vannamei*) farming. As can be seen in Table 5, the variables that obtain the highest priority value are shrimp protection variables, then successively market availability, water quality management, suitability of cultivation sites, feed management, quality of worker resources, internal business characteristics, initial conditioning and harvesting, potential conflict, disease management, worker protection and environmental protection.

Table 5. Priority of Comparison of Factors and Variables of Sustainability of Vannamei Shrimp (*L. vannamei*) Farming

Faktor	Priority Value	Variabel	Local Priority Value	Global Priority Value	Ranking
Ecology	0,353	Suitability of cultivation sites	0,217	0,076	4
		Environmental protection	0,106	0,037	12
		Protection against shrimp	0,678	0,239	1
Economy	0,215	Internal characteristics of the business	0,258	0,055	7
		Market availability	0,742	0,160	2
Social	0,150	Worker protection	0,274	0,041	11
		Potential conflict	0,304	0,046	9
		Quality of worker resources	0,422	0,063	6
Technology	0,282	Water quality management	0,431	0,122	3
		Feed management	0,230	0,065	5
		Disease management	0,156	0,044	10
		Early conditioning and harvesting	0,183	0,052	8

CONCLUSION

From the results of the analysis above, it can be concluded that the factors that must be considered by IBL Prigi in the sustainability of vannamei shrimp (L. vannamei) farming are ecological factors, while successive variables that must be prioritized for the sustainability of cultivation are shrimp protection, market availability, water quality management, suitability of cultivation sites, feed management, quality of worker resources, internal characteristics of the business, initial conditioning and harvesting, potential conflict, disease management, worker protection, environmental protection.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Akmal Y, Rindhira H, Muliari M, Zulfahmi I. Peningkatan Nilai Ekonomi Pada Kelompok Pembudidaya Udang Vannamei (Litopenaeus vannamei) Laut mina Budidaya Kabupaten Bireuen, Aceh. J SOLMA. 2021;10(02):275–86.
2. Cahyaningrum DC. Strategi Pengelolaan Tambak Udang Secara Berkelanjutan (Kasus Di Wilayah Pesisir Kabupaten Bantul Daerah Istimewa Yogyakarta) [Internet]. Institut Teknologi Bandung; 2018. Available from: https://digilib.itb.ac.id/index.php/gdl/view/26518
3. Purwono J, Sugyaningsih S, Yuliati E. Strategi Pengembangan Usaha Pembenihan Udang Vannamei (Studi Kasus Pada Pt Suri Tani Pemuka – Serang Banten). NeO-Bis. 2012;6(1).
4. Purnamasari I, Purnama D, Utami MAF. Pertumbuhan Udang Vannamei (Litopenaeus vannamei) di Tambak Intensif. Biodiversitas. 2017;2(1):58–67.
5. Nurdiansyah MA, Rosmiati M, Suantika G. Analisis Keberlanjutan Dan Strategi Pengelolaan Tambak Udang Putih Sistem Intensif Di Pesisir Selatan Jawa Barat. J Sosioteknologi. 2020;19(3):426–41.
6. Saaty RW. The analytic hierarchy process-what it is and how it is used. Math Model. 1987;9(3–5):161–76.
7. Akbarurrasyid M, Tarigan RR, Pietoyo A. Analisis Keberlanjutan Usaha Budidaya Udang Vannamei (Litopenaeus Vannamei) Di Teluk Cempi, Dompu Nusa Tenggara Barat. Saintek Perikan Indones J Fish Sci Technol. 2020;16(4):250–8.
8. Wigiani DP. Status Keberlanjutan Kawasan Pesisir Berbasis Budidaya Udang Vannamei Di Kecamatan Indramayu. JFMR-Journal Fish Mar Res. 2019;3(2):18–28.
9. Lestantun A, Anggoro S, Yulianto B. The Role of Biosecurity to Control The Diseases of Vannamei Seed in Banten. Pros Semin Nas. 2020;53–8.
10. Prakoso AA, Elfitasari T, Basuki F. Studi analisa usaha dan prospek pengembangan budidaya udang vannamei (litopenaeus vannamei) sistem intensif di Kecamatan Sluke , Kabupaten Rembang," Prosiding Seminar Nasional Tahunan Ke V Hasil Hasil Penelitian Perikanan dan Kelautan. Fakultas Perikanan. Pros Semin Nas. 2016;311–31.

How to cite this article: Fetriyani, Nimmi Zulbainarni, Harianto. Factors affecting the sustainability of Vannamei Shrimp (Litopenaeus vannamei) farming in IBL Prigi using process hierarchy analysis (AHP). *International Journal of Research and Review*. 2023; 10(12): 777-784. DOI: *https://doi.org/10.52403/ijrr.20231277*

******