Analysis of Choice Shrimp Technology based on Business Process, Productivity, Financial and Risk

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Abstract. The application of new technology in shrimp ponds, autofeeder, has many advantages, but carries a greater risk compared to conventional shrimp ponds, therefore a more structured analysis is needed to decide the best shrimp pond technology. The comparison is seen from business processes, productivity, financial and risk. The results of business process efficiency level with conventional worth 67.19% while for the autofeeder level worth 88.71%. The productivity results show FCR 1.34 (conventional) and 1.34 (autofeeder); SR 79% (conventional) and 90% (autofeeder); and productivity of 13 tons / ha (conventional) and 25 tons / ha (autofeeder). The financial shows an NPV of Rp 1,515,178.503 (conventional) and Rp 7,721,596,229 (autofeeder); IRR 38.24% (conventional) and 51.23% (autofeeder); payback period 2.68 years (conventional) and 2.17 years (autofeeder); BCR 1,696 (conventional) and 2,065 (autofeeder). Furthermore, for the calculation of risk consisting of production risk and revenue risk with a total risk of 6% for conventional and 31% for autofeeder. In the results of technology selection with an assessment of the 15 criteria above, the results obtained 4 criteria are better for conventional technology and 11 criteria are better for autofeeder technology. So between the two technologies, the selected shrimp pond system is the Autofeeder technology.

Keywords: technology selection, shrimp farms.

1. Introduction

In line with the shrimp production trend that continued to rise for 5 years from 2009 to 2015, the volume of shrimp exports over the past five years also showed a positive trend despite a decline in 2015. The increase in shrimp production volume is in line with the increase in export volumes (directorate general of aquaculture, 2017). The potential for the development of the Indonesian shrimp industry in shrimp ponds with untapped potential of ponds is 830,900 ha and 70% of conventional shrimp ponds in Indonesia are individual MSME companies [1].

The problem in conventional shrimp culture systems is that mortality increases with decreasing water quality during the maintenance period. The source of the decline in water quality is an increase in metabolic products resulting from the decomposition of feed residues and shrimp feces that are not controlled by water quality management measures. The increase in metabolic products occurs due to inaccurate feeding with an indication of the value of the ratio of feed conversion (feed conversion ratio, FCR) and the ratio of the addition of biomass to the addition of feed is irrelevant resulting in low productivity.

Autofeeder is a structured feeding technology using time performance indicator technology that provides feed automatically using the time program that has been inputted. The emergence of this new
technology in shrimp ponds has a positive impact on shrimp farmers because it gives the impact of shrimp growth so quickly and effective and efficient feeding. But the use of autofeeder adds new problems such as the emergence of new diseases. This outbreak is called Hepatopancreatic Necrosis Syndrome (AHPNS), or better known as Early Mortality Syndrome (EMS). All shrimp affected by this disease will experience death in a short time.

2. Methods

2.1 Technology Management
Technology management is a study or discussion that links the disciplines of engineering/engineering, science, and management in placing planning, development, and implementation of the ability to form and complete operational and strategic objectives of the company. Technology management and several fields within it are very relevant and needed to assist in government decision making, industry leaders and business management studies, including: technology strategy, technology capability development, innovation management, forecasting technology, management technology, manufacturing strategies, business competition, barriers to adopting technology, manufacturing technology and e-business flexibility.

2.2 Business Process
A business process can be explained simply as a flow of activities. A business process is a collection of structured tasks or activities that can produce certain services or products for one or many consumers. Business process modeling is very important in the life of the Business Process Reengineering (BPR) cycle.

2.3 Productivity
Productivity is a measure that states how well resources are managed and utilized to achieve optimal results. Productivity can be used as a measure of the success of an industry in producing goods or services, the higher the ratio, means the higher the product produced. The results obtained by farmers at harvest are called production, and the costs incurred are called production costs. Good farming business is productive or efficient farming. Productive farming means farming that has high productivity. This understanding of productivity is a combination of the conception of business efficiency (physical) and land capacity.

- Productivity
  \[
  \frac{\text{Total Harvest (tons)}}{\text{Land Area (ha)}}
  \]

- FCR
  \[
  \frac{\text{Total Feeds}}{\text{Total Harvest}}
  \]

- SR
  \[
  \frac{\text{Size} \times \text{Total Harvest}}{\text{Total Seeds}} \times 100\%
  \]

2.4 Financial
The financial aspects of project preparation and analysis explain the financial effects of a proposed project on the parties involved in it. The main purpose of financial analysis is to determine projections about the budget that will be used efficiently by estimating revenue and expenditure during project implementation and in the years to come each year.

2.5 Risk of Shrimp Culture
Production Risk Analysis that occurs can be caused due to pests and diseases both sudden and widespread. So that it can result in a decrease in the yield of up to 65% and can even lead to crop failure. Details of production risk analysis in shrimp farming can be seen in Table 6 below.
### Table 1. Risk of Shrimp Culture

| No. | Period             | Production (Kg/Ha) |
|-----|--------------------|-------------------|
| 1   | cultivation cycle 1| 158.88            |
| 2   | cultivation cycle 2| 155.81            |
| 3   | cultivation cycle 3| 147.72            |
|     | a. Average         | 154.14            |
|     | b. Variance        | 33.26             |
|     | c. Standard Deviation (V) | 5.77       |
|     | d. Coefficient Variance (CV) | 0.04      |

Source: Achmad Rizal et al. (2018)

#### 2.6 Shrimp Culture System

Shrimp farming in ponds is the business of raising or enlarging shrimp from seed size (fry) to a size that is fit for consumption. Naturally, shrimp seeds enter the pond along with the tide that irrigates the pond. Shrimp production obtained is uncertain because it only depends on the amount and small amount of shrimp seeds that occur naturally in the sea around the pond. Shrimp seeds can be chosen which is quickly grown and the species is much-loved. (economically important). Life pass (SR), feed conversion ratio and production per hectare. Quality data taken include temperature, dissolved oxygen, pH, salinity and ammonia. Farm fertility can be improved by greater fertilization and water management so that the carrying capacity to maintain shrimp is better. Pest control is more intensified. The construction of ponds, embankment construction and irrigation canals are improved so that the quality of the tabak water can be better controlled and suitable for the life of the shrimp to be maintained. Shrimp cultivation systems in developing ponds are now known to have three levels according to the technology application category, namely the level of simple cultivation (traditional, extensive), middle cultivation level (semi-intensive), and advanced cultivation level (intensive) [7]

#### 2.7 Conceptual Model

Depicting a diagram of a set of relationships (Figure 1) between certain factors that are believed to have an impact on or lead to a target condition. In this research process aims to choose the optimal technology alternative using the zero one method. This research can provide a good impact on pond farmers who have not yet decided to use autofeeder technology or conventional systems. The concept of the process is then processed into a research method and data collection needed to describe the problem discussed.

In this study conducted in the village of Brondong, Lamongan, East Java, with the research period 18 February 2019 to 10 June 2019. With direct data retrieval with historical data owned by the farmers for conventional shrimp pond observation objects and autofeeders, where the shrimp pond system with Conventional technology is studied in 2 ponds each with an area of 4,600m2. As for the autofeeder pond system that was studied as many as 5 ponds and 1 treatment pond each with an area of 2500 m2.

### 3. Result and Discussion

#### 3.1 Business Process

The business process aspect is used to choose alternative considerations between conventional shrimp ponds and autofeeder shrimp ponds. business process data processing is done by taking the time data used in one cultivation cycle. In terms of deciding this consideration will be based on the results of changes in efficiency through the Business Process whether the results show a better chance or not between the two.
In the results of the business process calculations, it is given that the total business process time on conventional shrimp ponds is 859.3 hours higher than the autoteeder pond business process with a total time of 813.1 hours. The efficiency level in conventional ponds is 67.19% while in autoteeder ponds it gets an efficiency level of 88.71%. This shows that a good autoteeder farm is better than the business process aspect.

3.2 Productivity

In the aspect of productivity, it is used to choose an alternative consideration between conventional shrimp ponds and Autoteeder shrimp ponds. In terms of deciding this consideration will be based on the results of the FCR (feed conversion ratio), SR (survival rate) and productivity per hectare through productivity calculation methods in the shrimp culture world. Whether the results show a better chance or not between the two. Therefore. The following is the average productivity of the last 5 cycles in each pond.

Table 3. The results of conventional pond productivity calculations

| No | Pond | Pond Area (m²) | ∑ Seed (ekor) | Density (Seed/m²) | DOC (Hr) | Harvest (Kg) | Size (ekor/kg) | ∑ Feed (kg) | FCR | SR (%) | Productivity (ton/ha) |
|----|------|----------------|---------------|------------------|----------|--------------|---------------|-------------|-----|--------|----------------------|
| 1  | West | 4.600          | 329.600       | 72               | 115      | 5.874,70     | 44,4          | 11100,1     | 1.89| 79     | 12,8                 |
| 2  | East | 4.600          | 329.600       | 72               | 115      | 5.838,90     | 44,8          | 10886,2     | 1.86| 79     | 12,7                 |
| TOTAL | 9.200 | 659.200       | 11.714        | 115               | 5.857     | 45           | 10.993  | 21986.3     | 25  |        |                      |
| AVERAGE | 4.600 | 329.600       | 72            | 115               | 5.857     | 45           | 10.993  | 21986.3     | 25  |        | 13                   |
In the results of calculations in Table 3, conventional technology productivity which shows the ratio of total feed to shrimp yield (FCR) is an average of 1.88 while the SR which shows the level of shrimp life during cultivation shows an average SR yield of 79% and aquaculture productivity amounting to 13 tons per hectare.

| No | Pool | Area (m²) | ∑ Seed (seed/m²) | Density (seed/m²) | DOC (Hr) | harvest (Kg) | Size Shrimp (kg) | Feed (kg) | FCR | SR (%) | Productivity (ton/ha) |
|----|------|-----------|-----------------|------------------|-----------|-------------|-----------------|-----------|-----|--------|---------------------|
| 1  | A    | 2.500     | 356.400         | 143              | 87        | 6.014,68    | 51.9            | 8240,6    | 1.37| 88     | 24,1                |
| 2  | B    | 2.500     | 356.400         | 143              | 90        | 6.460,78    | 49.9            | 8083,2    | 1.25| 90     | 25,8                |
| 3  | C    | 2.500     | 356.400         | 143              | 90        | 6.509,33    | 50.1            | 8209,2    | 1.26| 91     | 26,0                |
| 4  | D    | 2.500     | 355.000         | 142              | 87        | 5.870,32    | 55.5            | 8222,6    | 1.40| 92     | 23,5                |
| 5  | E    | 2.500     | 355.000         | 142              | 86        | 5.771,90    | 54.3            | 8220,9    | 1.42| 88     | 23,1                |
| TOTAL |   | 12.500   | 1.779.200       |                  |           | 30.627      | 40976,5        |           |     |        | 123                 |
| AVERAGE | | 2.500    | 355.840         | 142              | 88        | 6.125       | 52              | 8.195     | 1.34| 90     | 25                 |

Whereas in the calculation of Table 4 which shows the productivity of the pond system autofeeder technology shows an average FCR of 1.34 while the SR is 90%, the cultivation productivity is 25 tons/ha. For this productivity assessment, the smallest FCR is the best, the highest SR is the best and the highest productivity is the best.

Based on the comparison of FCR, SR and Productivity tons/ha between conventional technology and autofeeder technology, the following results are obtained:

1. Conventional pond FCR criteria produce FCR 1.88 while autofeeder technology produces FCR 1.34, so the best FCR uses Autofeeder technology because it produces a smaller FCR.
2. SR criteria show that conventional pond SR is 79% while Autofeeder technology is 90%, so SR is best to use Autofeeder technology because it produces higher SR.
3. Productivity criteria indicate that conventional farms produce 13 tons/ha while Autofeeder technology is 25 tons/ha, so the best productivity is to use Autofeeder technology because it produces higher productivity.

Then the assessment of the 3 productivity criteria is the best shrimp farming method is Autofeeder technology.

### 3.3 Financial

In the financial calculation of the two alternative shrimp farming systems between conventional technology and autofeeder technology, the results are shown in Table 5. The assessment is based on 9 criteria, namely investment, income, operational costs, COGS (Cost of Production) / Kg, profit and loss, NPV (Net Present Value), IRR (Internal Rate of Return), payback period and BCR (Benefit Cost Ratio):

| Calculation | Conventional | Autofeeder | Analysis |
|-------------|--------------|------------|----------|
| 1. Investment/Ha | Rp 2,008,271,546 | Rp 3,521,385,600 | In the calculation of conventional technology investment is better with a smaller investment of Rp 2,008,271,546 |
| 2. Revenue/Ha (*) | Rp 3,419,141,854 | Rp 4,741,266,282 | In the calculation of Autofeeder technology revenue is better with greater income, amounting to Rp 4,741,266,282 |
Table 5. Financial calculations of conventional technology vs. auto feeder technology

| Calculation                  | Conventional       | Autofeeder         | Analysis                                                                 |
|------------------------------|--------------------|--------------------|--------------------------------------------------------------------------|
| 3. Operational Cost/ Ha (*)  | Rp 2,434,005,206   | Rp 2,446,326,459   | In the calculation of conventional technology operational costs is better with a smaller operational costs of Rp 2,434,005,206 |
| 4. COGS/Kg (*)               | Rp 64,240          | Rp 46,594          | In the calculation of HPP / Kg autofeeder technology is better with a smaller HPP / Kg of Rp. 46,594 |
| 5. Profit & loss/ Ha (*)     | Rp 886,622,983     | Rp 1,869,861,592   | In the calculation of profit and loss technology, Autofeeder is better with a bigger profit of Rp 1,869,861,592 |
| 6. NPV                       | Rp 1,515,178,503   | Rp 7,721,596,229   | In the NPV calculation the Autofeeder technology is better with a greater NPV of 7,721,596,229 |
| 7. IRR                       | 38.24%             | 51.23%             | In the calculation of IRR, Autofeeder technology is better with IRR greater than 51.23 |
| 8. Payback Period            | 2.68               | 2.17               | In the calculation of BCR, Autofeeder technology is better with a smaller PBP of 2.17 |
| 9. BCR                       | 1.696              | 2.065              | In the calculation of BCR, Autofeeder technology is better with a bigger BCR of 2.065 |

Based on a comparison of the 9 financial criteria above, the results show that conventional technology is better on 2 criteria, namely investment and lower operational costs when compared with autofeeder technology. Whereas for the other 7 criteria, Autofeeder technology is better than conventional technology, which is assessed from the criteria of income, COGS / Kg, profit and loss, NPV, IRR, payback period and BCR. So from the results of financial analysis on the shrimp pond system, the best method is to use autofeeder technology.

3.4 Risk
The risk calculation results consist of production risk and income risk between conventional technology shrimp ponds and autofeeder technology shrimp ponds as shown in Table 6.

Table 6. Risks of conventional technology vs. autofeeder technology

| Calculation        | Conventional | Autofeeder | Analysis                               |
|--------------------|--------------|------------|----------------------------------------|
| 1. Production Risk | 3%           | 14%        | Production risk on conventional technology is better with a smaller risk of 3% |
| 2. Revenue Risk    | 3%           | 17%        | The risk of revenue on conventional technology is better with a smaller risk of 3% |

In the calculation of the total risk in conventional technology calculated from the calculation of the coefficient of variation is 6%. Whereas the autofeeder technology has a coefficient of variation or a total risk of 31%. The results of the coefficient of variation become a reference to determine how high the risk of failure in shrimp farming production.

In the delta ratio calculation (risk difference between conventional shrimp ponds and autofeeders) compared (IRR difference between conventional shrimp ponds and autofeeders).
1. The difference in risk between conventional technology and autofeeder technology which has a delta ratio of 25%.
2. The IRR difference between conventional technology and autofeeder is 12.99%.
3. The risk difference is 25%> greater than the IRR difference of 12.99%, so Autofeeder technology has a high risk with a lower IRR / return.

Based on the comparison between the risk difference and the IRR difference, conventional technology is better when compared with the autofeeder technology in terms of the risk of the shrimp pond system.

### 3.5 Analysis of Alternative Choice

This alternative selection analysis uses the zero one method that is for the selected technology (better) is rated 1 while for those who are not selected given a value of 0. The selection is seen from the largest number of scores between the two alternative shrimp pond systems. The assessment is based on the 15 criteria described above as shown in Table 7 from the calculation results for each criterion in the two alternative technologies.

| Criteria | Conventional Result | Autofeeder Result | Better or Beneficial |
|----------|---------------------|-------------------|----------------------|
| Business Process | | | |
| 1. Efficiency | 67.19% | 88.71% | 0 | 1 |
| Productivity | | | |
| 2. FCR | 1.88 | 1.34 | 0 | 1 |
| 3. Survival Rate | 79% | 90% | 0 | 1 |
| 4. Ton/Ha | 13 Ton/Ha | 25 Ton/Ha | 0 | 1 |
| Feasibility Financial | | | |
| 5. Invemnt/Ha | Rp 2,008,271,546 | Rp 3,521,385,600 | 1 | 0 |
| 6. Revenue/Ha (*) | Rp 3,419,141,854 | Rp 4,741,266,282 | 0 | 1 |
| 7. Cost of production/Ha (*) | Rp 2,434,005,206 | Rp 2,446,326,459 | 1 | |
| 8. COGS/Kg (*) | Rp 64,240 | Rp 46,594 | 0 | 1 |
| 9. Profit&loss/Ha (*) | Rp 886,622,983 | Rp 1,869,861,592 | 0 | 1 |
| 10. NPV | Rp 1,515,178,503 | Rp 7,721,596,229 | 0 | 1 |
| 11. IRR | 38.24% | 51.23% | 0 | 1 |
| 12. Payback Period | 2.68 | 2.17 | 0 | 1 |
| 13. BCR | 1.696 | 2.065 | 0 | 1 |
| Risk | | | |
| 14. Production Risk | 3% | 14% | 1 | 0 |
| 15. Revenue Risk | 3% | 17% | 1 | 0 |
| Total Value | | | 4 | 11 |

Description (*): Average for the next 5 years

Based on the analysis of alternative selection in table 6 between conventional technology and autofeeder technology, it was found that conventional technology got a value of 4, while autofeeder technology got a value of 11.

### 4. Conclusion

Calculation of business processes obtained results in the efficiency of conventional ponds worth 67.19% while the autofeeder ponds get an efficiency level of 88.71%. The business process criteria show that the technology of autofeeder ponds is more efficient than conventional ponds.
Calculation of productivity criteria seen from FCR, SR, and ton/ha productivity shows the results for conventional ponds obtained FCR results of 1.88; SR 79%; productivity of 13 tons/ha. While the autofeeder pond technology obtained FCR results 1.34; SR 90%; productivity of 25 tons/ha. The productivity criteria show that the autofeeder pond technology is higher in productivity compared to conventional ponds.

The calculation of financial criteria calculated from the NPV, IRR, payback period and BCR shows that the autofeeder pond technology is higher than the financial ratio when compared to conventional pond systems. The calculation results for the conventional pond system are NPV Rp 1,515,178.503; IRR 38.24%; payback period 2.68 years; and BCR 1.696. As for the autofeeder pond technology, the results are Rp. 7,721,596,229; IRR 51.23%; payback period 2.17 years; and BCR 2.065.

The results of the calculation of risk criteria consisting of production risk and income risk obtained results of 6% for conventional ponds and 31% for autofeeder ponds. From these risk criteria, it is known that the risk of conventional ponds is smaller than that of an autofeeder pond, so the conventional pond system is better when compared to the autofeeder pond technology.

Based on the overall results of the assessment on the alternative selection between conventional shrimp ponds and autofeeder shrimp ponds it is known that conventional farms get a value of 4, while autofeeder ponds get a value of 11. Based on these assessments, the best alternative of the two shrimp farming systems is the shrimp pond technology autofeeder system.

5. References
[1] Chumaidiyah, Endang 2018 Strategy for Capability Development of Knitting Small Medium Enterprises Using SWOT Analysis. Proceedings of the International Conference on Industrial Engineering and Operations Management Bandung, Indonesia, March 6-8, 2018.
[2] Samson, D 2002 Technology Management Text and International Cases. (New York: Mc Graw Hill)
[3] Yun Chank, Byeung 2011 Business Process Management of Telecommunication Companies: Fulfillment and Operations Support and Readiness Cases, International Journal of Future Generation Communication and Networking, 4(3), pp. 73-74.
[4] Coelli, TJ., DSP Rao, and G.E. Battese 1998 Efficiency and Productivity Analysis. (London: Kluwer Academic Publisher)
[5] Rahardja, A Z, Endang Chumaidiyah and W Tripiawan 2018 Feasibility Analysis on the Development of Steel Sheet Zinc Plated and Galvalum Production Factory PT. S Steel. IOP Conference Series: Materials Science and Engineering 528(1), 2019-01-01.
[6] Rizal, Achmad 2018 Analisis Resiko Produksi Dan Pendapatan Budidaya Tambak Udang Rakyat Di Kelurahan Labuhan Deli, Kecamatan Medan Marelan, Kota Medan. Jurnal Perikanan, 8(1), 65-70
[7] Rangka, Nur Ansari 2008 Potensi dan Kendala Pengembangan Budidaya Udang Vanamei, Badan Riset dan sumber Daya Manusia Kelautan dan Perikanan, 3(1).