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Research Article

Best Alternatives Determination and Financial Feasibility Analysis of the Cleaner Production Application at *Amplang* Crackers Industry

Penentuan Alternatif Terbaik dan Analisis Kelayakan Finansial Penerapan Produksi Bersih Industri Kerupuk Amplang

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Abstract

Small-medium enterprises "Bintang Kertasada" is the mackerel fish crackers industry in Sumenep which generate solid and liquid waste, negatively affecting the environment. Therefore, a strategy in reducing the volume of waste produced and its impacts is the implementation of cleaner production, and further determined through this present study. A method of AHP (Analytical Hierarchy Process), followed by feasibility study through BEP (Break Event Point), PP (Payback Periode), B/C Ratio (Benefit-Cost Ratio), NPV (Net Present Value), and IRR (Internal Rate of Return) analysis were performed. This study demonstrated that the best alternative was processing fish skin into crackers that was attributed by the AHP score of 0.565. Furthermore, the financial feasibility analysis indicated that the production of fish scale crackers was feasible, indicated by the BEP of IDR 4,412 with 27,617 units produced, PP of 11 months, B/C ratio of 1.2, NPV of IDR 23,176,128, -, and IRR of 27.12%. Overall, the processing solid waste of fish skin into crackers was the best alternative with the most financial feasibility.

Abstrak

UD. Bintang Kertasada-Sumenep merupakan salah satu industri pengolahan kerupuk amplang yang menghasilkan limbah padat dan cair. Selama ini, limbah yang dihasilkan sudah ditangani secara optimal namun tidak pada limbah padat kulit ikan. Produksi Bersih merupakan salah satu strategi yang digunakan untuk mengurangi pencemaran lingkungan dengan mengurangi jumlah sumber daya dan limbah hasil samping produksi. Tujuan dari penelitian ini adalah mengetahui alternatif terbaik penerapan produksi bersih di UD. Bintang Kertasada-Sumenep dan mengetahui kelayakan finansial dari alternatif terbaik tersebut. Alternatif penerapan produksi bersih yang digunakan adalah kerupuk kulit ikan, keripik kulit ikan crispy, kulit ikan goreng berbalut telur asin, minyak kult ikan, gelatin dan lem kulit ikan. Penentuan alternatif terbaik dilakukan dengan metode AHP (Analytical Hierarchy Process). Parameter kelayakan finansial menggunakan perhitungan BEP (Break Event Point), PP (Payback Periode), B/C Ratio (Benefit Cost Ratio), NPV (Net Present Value), dan IRR (Internal Rate of Return). Hasil Penelitian menunjukkan bahwa alternatif terbaik yakni mengolah limbah padat kulit ikan menjadi kerupuk dengan nilai bobot sebesar 0,565. Analisis Kelayakan finansial menunjukkan bahwa produksi kerupuk kulit ikan layak untuk dilakukan dengan perolehan BEP harga sebesar Rp. 4.412, BEP produksi sebanyak 27.617 kemasan, PP selama 11 bulan, B/C Ratio 1,2, NPV sebesar Rp 23.176.128, dan IRR sebesar 27,12%.

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1. Introduction

Amplang cracker is one of the popular foods made from mackerel fish. According to data from the Department of Industry and Trade of Sumenep Regency in 2017, the number of small and medium enterprises producing chips and crackers in 2017 was 113 industries. It implies that Sumenep Regency has the potential of producing waste which potentially generates negative social and environmental impacts due to the results of cracker production. According to data from the Department of Industry and Trade of Sumenep Regency (2017), six *amplang* cracker industries could be found in Kertasada Village.

Waste has the potential to add economic value. One of the attempts to add economic value to the industry is to implement cleaner production. Cleaner production is a preventive and integrated environmental treatment strategy that is applied continuously in the production process and product life cycle to reduce risks to humans and the environment (UNEP, 2003). The cleaner production strategy is proven effective and economical for the waste prevention and management for small-scale industries in developing countries (Hilson, 2000). Besides, it is beneficial in improving the environmental performance of industrial processes through the efficient utilization of raw materials, water and energy-related to pollution and waste reduction (Rao, 2004). Furthermore, Indrasti and Fauzi (2009) stated that the selection of the cleaner production implementation could be classified into five parts, namely good housekeeping, material inputs changes, technological changes, product changes, and on-site reuse. The cleaner production implementation depends on the situation and condition of each industry.

Small-medium enterprise Bintang is one of the *amplang* cracker industries producing solid wastes in the form of mackerel fish skin, entrails, bones, heads, and eggshells, all of which could still be utilized. The utilization of solid waste from the *amplang* cracker production process is highly profitable. Besides being capable of increasing economic value, the utilization of solid waste from the *amplang* industry is predicted to reduce the environmental pollution impact. Some alternatives to reduce solid waste include processing waste into other products or reducing the number of pollution sources. The most possible alternative is to process the solid waste of the *amplang* cracker industry into valuable products. Hence, the best alternative among to process the waste should be investigated and applied at small-medium enterprise Bintang

This research is significantly essential to be taken into account to assist small-medium enterprise Bintang to be more environment-friendly by reducing solid waste and processing it into another valuable product. Therefore, other *amplang* cracker industries which produce similar waste is expected to be more environment-friendly by practicing this research method. The cleaner production implementation is expected to encourage sustainable development through process optimization, cost-saving, higher business return, and higher compliance level toward the environmental regulations (Rahim and Raman, 2015).

The researches on the potential of cleaner production implementation in the food industry have been conducted, such as the cleaner production in fish clouding by Thrane *et al.* (2009), the cleaner production in the fishery product processing industry by Ibrahim (2004), the cleaner production in the cracker industry by Khuriyati *et al.* (2015), the cleaner production in the Kimchi (salt-pickled or fermented food) industry by Yi *et al.* (2001), and the cleaner production in the tofu industry by Djayanti (2015). All of these researches assessed that the cleaner production approach taken was capable of improving environmental performance with each alternative carried out. Likewise, Aryanti (2014) agreed that cleaner production could successfully reduce 6.95% of non-product output. Whereas, Cong and Hien (2016) reported that the rice processing plants in Vietnam saved energy by 5% of the total power consumption by applying the cleaner production. Therefore, cleaner production is crucial to be studied and applied in industries to improve their environmental performance.

Moreover, research on the cleaner production implementation in the *amplang* cracker industry has been carried out by Wardiyatun and Purwanto (2017) with a case study in a small industry in West Kalimantan. It determined that the best alternative is to sell used cooking oil to collectors and to save water up to 28,800 L per year. This study employed the 1E4R concept approach in analyzing the potential of cleaner production implementation by considering economic benefits, technical implementation eases, and environmental effects. Nevertheless, this study only considers those three criteria regardless of the sub-criteria and some experts in decision-making. Therefore, the study analyzed the cleaner production implementation in the *amplang* cracker industry in Sumenep Regency. The study aims to identify criteria and sub-criteria in determining cleaner production alternatives and establish the best alternative for cleaner production potential in the *amplang* cracker industry. Moreover, this research was conducted by a multi-criteria decision-making method, namely the Analytical Hierarchy Process (AHP). The results could be recommended for small-medium enterprise Bintang to increase production efficiency, reduce pollution level, and increase economic value.

2. Materials and Methods

The study employed a qualitative approach to case study techniques. Also, this research was integrated with the cleaner production audit method. This research was carried out in the *amplang* cracker industry, namely small-medium enterprise Bintang, Kalianget Sub-district, Sumenep District, Madura. Several parties involved were the researchers, owners of small-medium enterprise Bintang, and two owners of similar industries. Moreover, this study activity was divided into several stages, referring to the cleaner production audit method by UNEP (2003). Figure 1 illustrates the research stage, as follows.

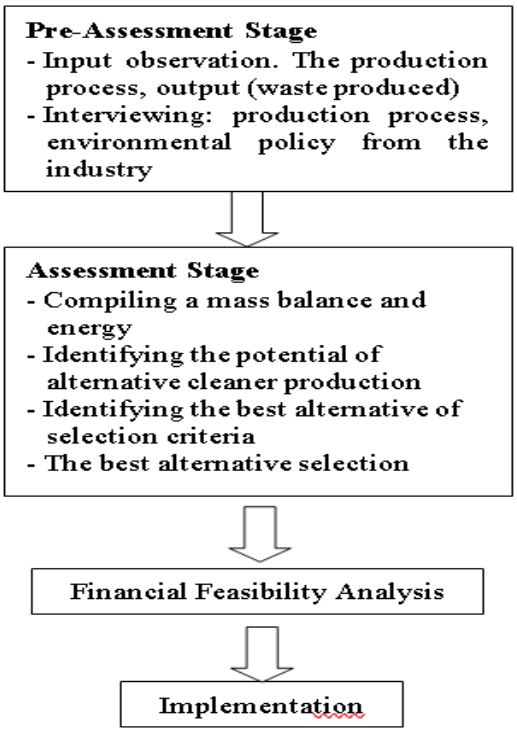

Figure 1. Research Stages

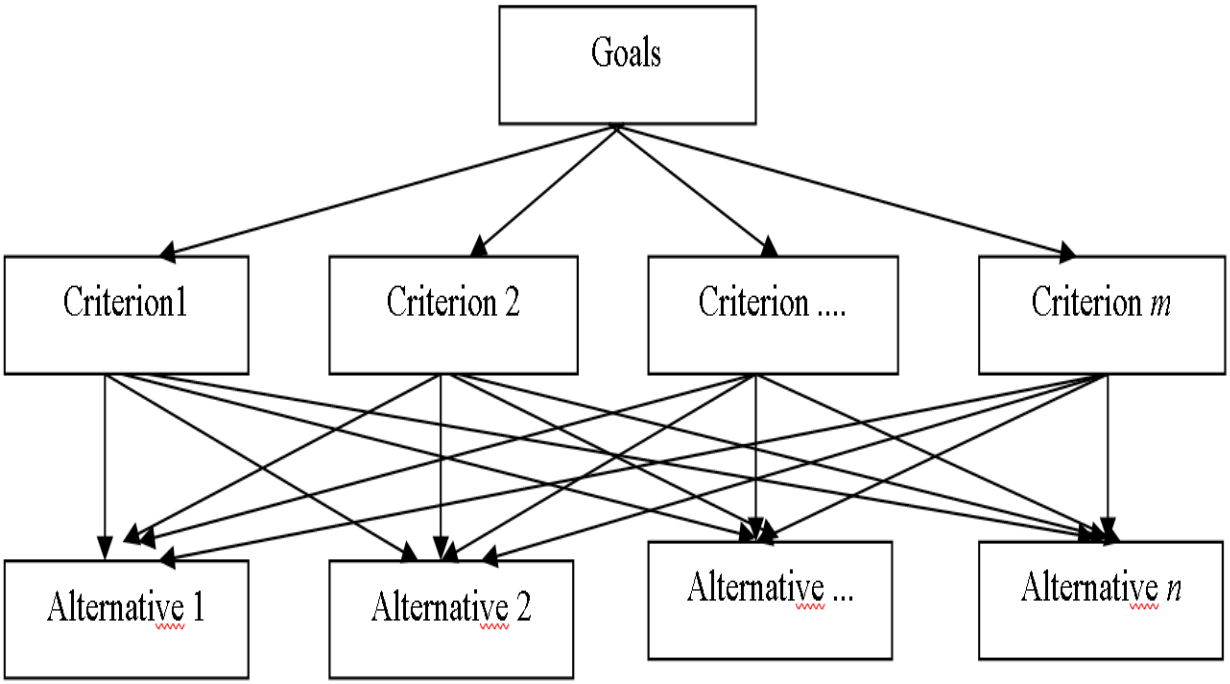

Figure 2. AHPHierarchy Structure. AHP hierarchy structure to obtain the best alternative with criterion m and alternative n

2.1 Pre-Assessment Phase

This stage was a pre-assessment stage by interviewing owners and production staff about the production process, inputs, waste produced, and environmental policies from the industry.

2.2 Assessment Phase

At this stage, a mass balance was compiled from the production process of *amplang* crackers based on data obtained in the previous stage. Afterward, the researchers analyzed waste which had not been utilized. Furthermore, the researchers sought an alternative cleaner production to minimize waste. The alternative determination was carried out using literature from previous studies, which was confirmed through a questionnaire by six owners of the *amplang* cracker industry. Besides, the criteria were identified using a survey method from the six owners of the *amplang* cracker industry. The best alternative was determined using the Analytical Hierarchy Process (AHP) method (Figure 2). Analytical Hierarchy Process (AHP) is a process of identifying, understanding, and estimating the overall system interaction (Saaty, 1994). It reasonably combined personal consideration and judgment. Besides, this process was influenced by imagination, knowledge, intuition, and experience to provide consideration.
Decision-making using the AHP method was conducted using *Software Expert Choice 11*. The AHP method was a functional hierarchy with human perception as the primary input. In this phase, questionnaires were distributed to experts, namely the owners of *amplang* cracker industry in Kertasada Sub-district, Sumenep Regency. The industry owners were considered highly knowledgeable about the cracker production process, the potential of fish skin waste process, and a good understanding of alternatives applied in the industry. The assessment data from experts would then be processed using *Software Expert Choice 11*.

2.3 Financial Feasibility Analysis

Financial aspects are related to information acquisition on capital or costs of investment, production, fixed, and variable, and other data related to the business establishment. According to Kusuma and Maysti (2014), the purpose of the financial feasibility analysis is to determine whether the business is feasible or not. Before implementation, a financial feasibility analysis must be carried out first with the best alternative chosen. Some financial eligibility criteria used are Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit-Cost Ratio (Net B/C) and Pay Back Period as follows:

Analysis of Net Present Value (NPV)

$$NPV = \frac{Net\ Cash1}{(1+r)} + \frac{Net\ Cash\ 1}{(1+r)} + \cdots + \frac{Net\ Cash\ 1}{(1+r)} - Investment \quad \text{.....(1)}$$

Note :
r: discount rate
1, 2, n: t period

In the Net Present Value (NPV) analysis, the assessment criteria are as follows:
If NPV>0, the business or project proposal is accepted
If NPV<0, the business or project proposal is rejected
If NPV=0, the project returns the investment spent

Analysis of Internal Rate of Return (IRR)

$$IRR = i_1 + \frac{NPV}{NPV_1 - NPV_2}\ x\ (i_2 - i_1) \quad \text{.....(2)}$$

Note :
i_1: discount rate resulting NPV_1
i_2: discount rate resulting NPV_2
NPV_1: positive NPV
NPV_2: negative NPV

In the analysis of the Internal Rate of Return (IRR), the assessment criteria are as follows:
If IRR> social discount rate, the business proposal is eligible to conduct
If IRR< social discount rate, the business proposal is not eligible to conduct

Analysis of Net Benefit-Cost Ratio (Net B/C)

$$Net\frac{B}{C} = \frac{\sum PV\ net\ cash}{\sum PV\ investment} \quad \text{.....(3)}$$

In the analysis of Net Benefit-Cost Ratio (Net B/C), the assessment criteria are as follows:
If Net B/C Ratio>1, the business proposal is eligible to conduct
If Net B/C Ratio<1, the business proposal is not eligible to conduct
If Net B/C Ratio=1, cash inflows is equal to cash outflows

Analysis of Pay Back Period

$$Payback\ Period = \frac{Investment}{Net\ cash\ per\ year}\ x\ 12\ years$$

.....(4)

2.4 Implementation

In this stage, the best alternative to net production was carried out in small-medium enterprise Bintang.

3. Results and Discussion

3.1 Pre-Assessment Stage

In the pre-assessment stage, the researchers conducted an interview with the owners of the *amplang* cracker industries in Kertasada-Sumenep. There were six *amplang* cracker industries, namely small-medium enterprise Bintang, small-medium enterprise Matahari, small-medium enterprise Pestiyajaya, Mrs. Nuwami's *amplang* crackers, Mrs. Satiya's *amplang* crackers, and Mrs. Nurjannah's *amplang* crackers. The interview results from the six *amplang* cracker industries demonstrated that the most productive *amplang* cracker industry was small-medium enterprise Bintang. The wastes produced were solid and liquid. The solid wastes were mackerel skin, entrails, bones, heads, and eggshells; meanwhile, the liquid wastes include dirty water and used cooking oil.

3.2 Assessment Stage

Small-medium enterprise Bintang is one of the industries engaged in the processing of *amplang* crackers. According to Mahmud (2008), *amplang* is generally made from fish which has high protein content, therefore produces a savory and delicious *amplang*. Mackerel fish has a protein content of 21.5%, and it is capable of yielding a savory taste to the *amplang* produced. The mass balance of *amplang* cracker production is illustrated in Figure 3.

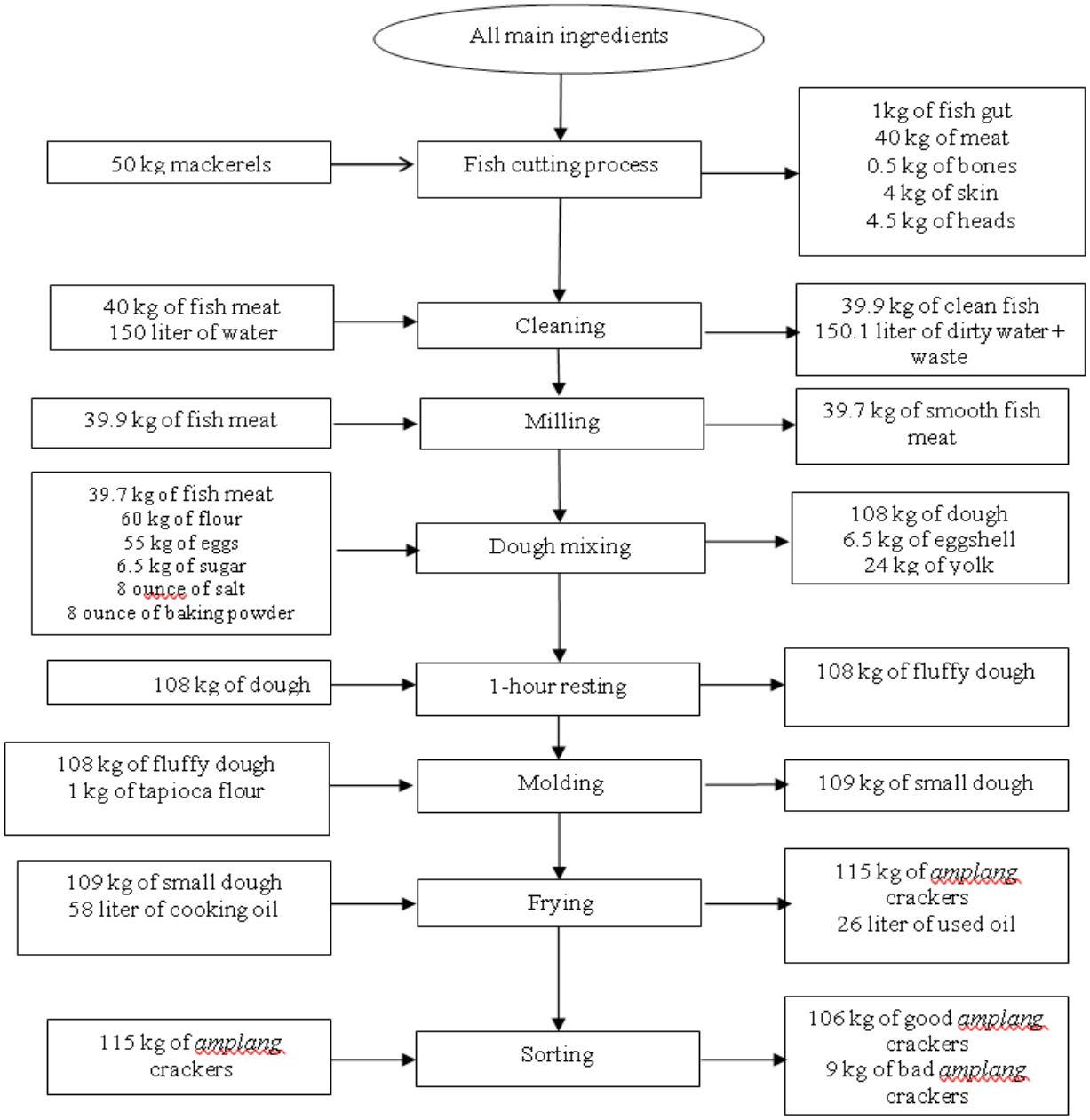

Figure 3. The mass balance of *amplang* cracker production. The mass balance per 1 batch production @ 50 kg mackerels and 115 kg *amplang* crackers in Small-Medium Enterprise Bintang.

3.3 Alternative identification

Based on the information at the assessment stage, disused solid waste was the mackerel skin. The utilization of fish skin waste was expected to be capable of adding economic value and also capable of reducing the environmental pollution impact due to the absence of such waste processing. Several alternatives of fish skin waste were processed into crackers, crispy fish skin chips, fried fish skins with salted egg, fish skin oil, fish skin glue, and gelatin. From the results of the distribution of the questionnaires distribution to rank the six alternatives available, the researchers obtained three alternatives which would be continued in the next stage, namely fish skin crackers, crispy fish skin chips, and fried fish skins with salted eggs.

3.4 Results Identification Criteria

According to Ulya and Hidayat (2018), the decision to select the best alternative for the cleaner production implementation is carried out using three aspects of the criteria, which are broken down into several sub-criteria. Since the cleaner production is one of the effective strategies in accomplishing sustainability, the aspects that underlie the criteria for decision-making are related to the sustainability concept, namely economic, technical, and environmental aspects. Hence, the criteria determination was carried out using questionnaires distributed to the six owners of the *amplang* cracker industry. The researchers proposed several criteria and based on the research results, six criteria were identified, namely: 1) production cost, 2) market interest, 3) machinery operation and equipment facility, 4) procedure production ease, 5) low environmental pollution, and 6) environmental capacity.

3.5 The Best Alternative Determination

The next stage was to determine the best alternative using the AHP method. The hierarchy in the decision-making process to determine the best alternative from the three available alternatives based on the six pre-determined criteria (Figure 4).

3.6 Analysis of Priority Value Criteria

Priority value analysis was conducted by pair comparisons using the AHP method, which was processed using Software Expert Choice 11. The value for each criterion sequentially. It starts from the low production costs which had the highest value of 0.319, followed by the market interest of 0.222, machinery and equipment operational facility of 0.169, production procedure ease of 0.146, low environmental pollution of 0.093, and environmental capacity of 0.050. The waste produced by the industry could be utilized to reduce the environmental pollution impact. The community could manage the waste produced into products that have an economic value so that it could benefit them (Table 2).

The low production cost reaches the highest value since it is considered the most crucial aspect of experts. According to Mulyadi (1999), the production cost is the expenses incurred to process raw materials into finished products that are ready for sale. Likewise, the depreciation cost of machinery and equipment, the cost of raw materials and supporting materials, and the cost of employee salaries are associated with the production process. The production costs are one of the factors highly considered in business investment (Kasmir and Jakfar, 2003). The cheaper the production costs and the larger the profit opportunity is, the more the industry is interested in developing the business.

The fish skin crackers process was the best alternative reviewed from the six criteria. It is proven that this alternative had the highest weight value among all criteria. Conversely, the lowest alternative on all criteria was fish chips with salted egg (Figure 5).

3.7 The Best Alternative Determination

The alternative value determination of the cleaner production in the *amplang* cracker industry of "Small-medium Enterprise Bintang" was carried out using the AHP method, assisted by Software Expert Choice 11.

The highest priority is processing fish skin into crackers with a weighted value of 0.565. It is followed by the second priority, namely crispy fish skin chips with a weighted value of 0.307. Meanwhile, the third-highest priority is fried fish skins with salted eggs with a weighted value of 0.128. Of the three alternatives, it is discovered that fish skin crackers had the highest priority value. In other words, waste processed into fish skin crackers has the potential for further development. These research results are different from Wardiyatun and Purwanto (2017), who also examined the cleaner production of *amplang* crackers in West Kalimantan. The previous research suggests that selling used cooking oil to the broker is the priority. It is, nevertheless, different from the small-medium enterprise Bintang condition. So far, almost all waste, including waste cooking oil had been sold, except fish skin (Table 2).

Crackers are famous as food that could arouse appetite. Many various crackers types and shapes sold in the market include shrimp, fish, tapioca, *puli*, and cassava crackers (Wahyono and Marzuki, 2005). Fish skin crackers have a delicious taste which was not too different from cow skin crackers. The quality of fish skin crackers is not only affected by the process of fish skin crackers but also influenced by fish processing (Indraswari, 2003).

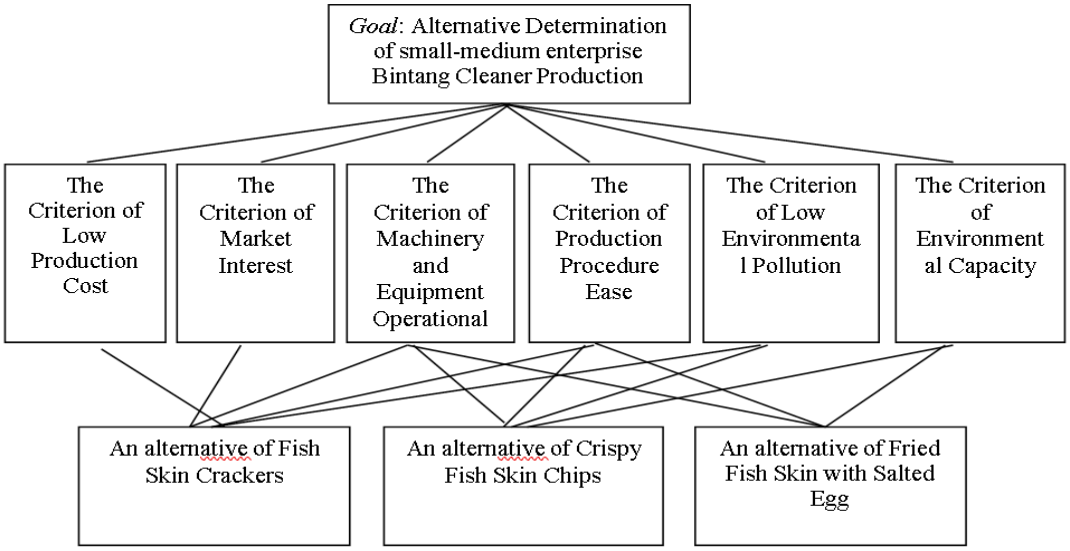

Figure 4. Hierarchy of the Best Alternative Determination. The AHP hierarchy structure to determine the best alternative of cleaner production at small-medium enterprise Bintang, with six criteria and three alternatives

Table 1. Priority Value of Each criterion

Criteria	Value	Priority
The market Interest	0.222	2
The Low Production Cost	0.319	1
Production Procedure Ease	0.146	4
Machinery and Equipment Operational Facility	0.169	3
Low Environmental Pollution	0.093	5
Environmental Capacity	0.050	6

Table 2. Value and Priority of Alternative Cleaner Production at small-medium enterprise Bintang

Alternatives	Value	Priority
Fish skin crackers	0.565	1
Crispy fish skin chips	0.307	2
Fried fish skin with salted egg	0.128	3

Table 3. Funding plans and benefits

Initial Investment Value (fixed capital & working capital)	IDR 136,400,900
Debt to Equity Ratio	60 % : 40%
Interest Rate	13.1%
Debit Capital	IDR 54,560,360
Self Funded	IDR 81,840,540
Net cash (profit) year1	IDR 144,732,710

Tabel 4. The Calculation of *Net Prevent Value* (NPV)

Year	Net Cash	DF 14.96%	PV Net Cash
1	IDR 144,732,710	0.870	IDR 125,898,321
2	IDR 8,513,337	0.757	IDR 6,441,786
3	IDR 10,678,550	0.658	IDR 7,028,652
4	IDR 13,926,370	0.573	IDR 7,973,535
5	IDR 27,938,259	0.498	IDR 13,914,435
Total of PV Net Cash			IDR 161,256,728
Total of PV Investment			IDR 138,080,600
NPV			IDR 23,176,128

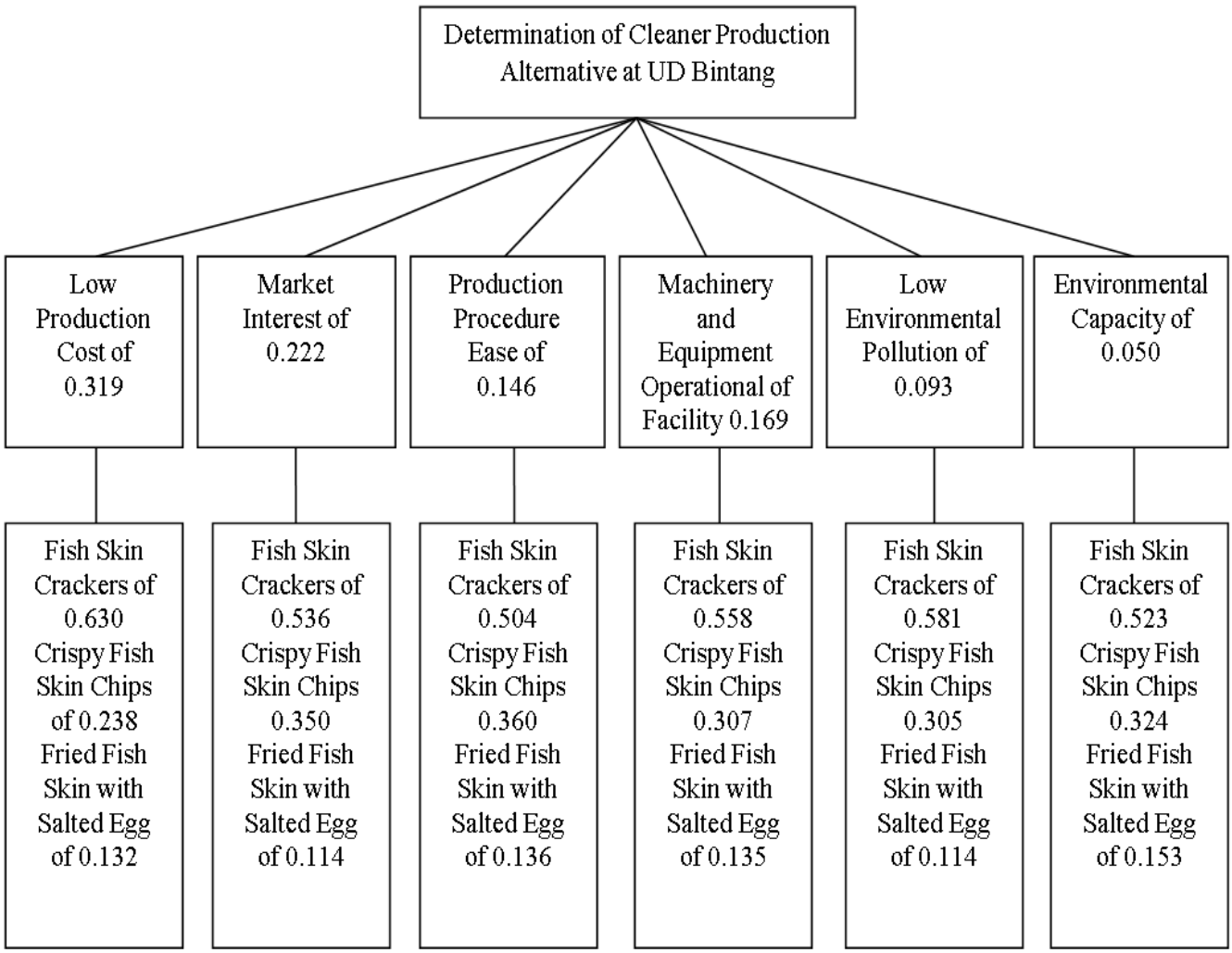

Figure 5. The alternative priority value based on each criterion

3.8 *Financial Feasibility Analysis of Fish Skin Crackers*

The production of fish skin crackers was planned to be applied at small-medium enterprise Bintang; therefore, the financial calculation process was based on data available at small-medium enterprise Bintang. Moreover, fish skin waste produced was 4 kg/day. In a year, from 768 kg of fish skin waste mixed with several other ingredients, namely tapioca flour, and spices, fish skin crackers were produced as much as 3,129.6 kg. Afterward, the fish skin crackers were packaged in 100-gram packages so that the manufactures could obtain 31,296 packs of fish crackers per year. The main production cost for fish skin crackers was IDR 4,412 and the profit was 13.32%. Thus, the selling price of each product was IDR 5,000.

Payback Period (PP)

Payback Period (PP) method is a calculation technique conducted to examine the period of investment of capital return used in a project or business.

$$Payback\ Period = \frac{Investment}{Annual\ net\ cash}\ x\ 12\ months$$

$$= \frac{136,400,900}{144,732,710}\ x\ 12\ months$$

= 11.31 months (11 months and 9 days)

From the above calculation results, it is identified that the payback period for the establishment of fish skin cracker business is 11 months, which means small-medium enterprise Bintang is eligible to run since the feasibility parameter of the payback period is less than five-year-investment period. The value of the Payback Period is faster than the feasibility of a cracker business with a bank loan capital of 30% which produces a payback period of one year nine months four days (Santoso, 2008). This situation occurs since the low price of the raw ingredient for fish skin waste is regarded as worthless. Thus, the feasibility value calculation is better than crackers with non-waste ingredients.

Table 5. Net Present Value with DF 27% and 28%

Year	Net Cash	DF 27%	PV Net Cash	DF 28%	PV Net Cash
1	IDR 144,732,710	0.787	IDR 113,962,763	0.781	IDR 113,072,429
2	IDR 8,513,337	0.620	IDR 5,278,279	0.610	IDR 5,196,128
3	IDR 10,678,550	0.488	IDR 5,213,161	0.477	IDR 5,091,929
4	IDR 13,926,370	0.384	IDR 5,353,318	0.373	IDR 5,187,977
5	IDR 27,938,259	0.303	IDR 8,456,307	0.291	IDR 8,131,104
Total of PV Net Cash			IDR 138,263,828		IDR 136,679,568
NPV Positive Value			IDR 183,228		
NifPV Negative Value					IDR (1,401,033)

Table 6. Calculation of Benefit-Cost and Ratio

PV Net Cash	IDR 161,256,728
PV Investment	IDR 136,400,900
BC Ratio	1.2

Net Prevent Value (NPV)

Net Prevent Value (NPV) is a calculation between the net cash in the future with the investment value during that period. The difference between the value of the two PVs for five years was IDR 23,176,128. The fish skin cracker industry was said to be feasible because NPV is positive (+). According to research by Kasmir and Jakfar (2003), a business is feasible if the NPV value is positive. This finding is in line with research by Wardiyatun and Purwanto (2017), who reported that the business of *amplang* crackers is feasible with a positive NPV value of 619,418.508.

Internal Rate of Return (IRR)

Internal Rate of Return (IRR) is the interest rate that equates the value of future net cash receipts with the investment value.

IRR = ((27 – 183,228)*((28-27) / (-1,401,033–183,228))
IRR = 27.12%

The IRR calculation result of the fish skin cracker industry was 27.12%. IRR value was higher than the loan interest. In other words, the establishment of the fish skin cracker industry was said to be feasible. Notwithstanding, this IRR value is higher than the value of IRR by Santoso (2008) which stated that the cracker IRR industry with a loan capital of 30% is 24.90% and with 100% self-funded capital produces IRR of 25.78%.

Benefit-Cost Ratio (B/C Ratio)

Benefit and Cost Ratio (B/C Ratio) is the activity ratio from the total present value of net income to the present value of investment expenditure over the investment period. The B/C value ratio was 1.2 times. The B/C ratio value was greater than 1, so the fish skin cracker industry was said to be feasible. This finding is congruent with research by Wardiyatun and Purwanto (2017), who analyzed the feasibility of the *amplang* cracker industry and obtained a Net B/C ratio of 1.739.

4. Conclusion

Based on the results, the researchers concluded that the best alternative of a cleaner production of small-medium enterprise Bintang is processing fish skin into crackers. It is financially feasible considering from several aspects, such as the NPV value amounted to IDR 23,176,128, Payback Period value for 11 months, B/C ratio value of 1.2, and IRR value reached to 27.12%. These research results could be explicitly applied to small-medium enterprise Bintang and other similar industries with several variable adjustments used in financial calculations. The Sumenep Regency may initiate the cleaner production implementation at the *amplang* cracker industrial centers, to be an example for other industrial centers.

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Authors' Contributions

KP collected the data, drafted the manuscript and designed the figures. MU and UP devised the main conceptual ideas and critical revision of the article. All authors 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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This research was supporting independently by the researchers.

References

Aryanti, M. (2014). Analisis Penerapan Produksi Bersih menuju Industri Nata De Coco Ramah Lingkungan. *Jurnal Riset Teknologi Pencegahan Pencemaran Industri,* 5(2): 45-50

Cong, T.Q., & Hien, D. N. (2016). Feasibility of cleaner production for Vietnam rice processing industry. *Science Direct: Procedia CIRP,* 40: 285–288.

Dinas Perindustrian dan Perdagangan Kabupaten Sumenep. (2016). Direktori Industri Kecil Menengah Tahun 2017. Sumenep.

Djayanti, S. (2015). Kajian Penerapan Produksi Bersih di Industri Tahu di Desa Jimbaran, Bandungan, Jawa Tengah. *Jurnal Riset Teknologi Pencegahan Pencemaran Industri (JRTPPI)*, 6 (2): 75-80.

Hilson, G. (2000). Pollution prevention and cleaner production in the mining industry: an analysis of current issues. *Journal of Cleaner Production*, 8(2): 119-126.

Ibrahim, B. (2004). Pendekatan Penerapan Produksi Bersih pada Industri Pengolahan Hasil Perikanan. *Buletin Teknologi Hasil Perikanan,* 7(1).

Indrasti, N. S & Fauzi, A. M. (2009). Produksi Bersih. Bogor : IPB Press.

Indraswari, H. (2003). Rambak Kulit Ikan. Yogyakarta: Kanisius.

Kasmir, & Jakfar. (2003). Studi Kelayakan Bisnis. Jakarta: Kencoulda Prenada Media Group.

Kusuma, P. T. W. W., & Mayasti, N. K. I. (2014). Analisa Kelayakan Finansial Pengembangan Usaha Produksi Komoditas Lokal: Mie Berbasis Jagung. *Jurnal AGRITECH*, 34(2): 194-202.

Mahmsmall-medium enterprise. (2008). Tabel Komposisi Pangan Indonesia. Jakarta: PT. Alex Media Komputindo.

Marimin, & Maghfiroh. (2010). Aplikasi Teknik Pengambilan Keputusan dalam Manajemen Rantai Pasok. Bogor: IPB Press.

Mulyadi. (1999). Akuntansi Biaya. Edisi ke-5. Yogyakarta: Aditya Media.

Rahim, R., & Raman, A. A. A. (2015). Cleaner production implementation in a fruit juice production plant. *Journal of Cleaner Production,* 101: 215–221.

Rao, P. (2004). Greening production: a South-East Asian experience. *International Journal of Operations and Production*. *Management*, 24 (3): 289-320.

Saaty, T. (1994). Fundamental of Decision Making and Priority Theory With The Analytical Hierarchy Process. University Of Pittsburgh: RWS Publication.

Santoso, T. S. (2008). Analisis Finansial Usaha Kerupuk (Studi Kasus: Kerupuk Suka Asih (SKS) di Pondok Labu, Jakarta Selatan). Jakarta: Prodi Sosial ekonomi Pertanian UIN Syarif Hidayatullah.

Thrane, M., Nielsen, E. H., & Christensen, P. (2009). Cleaner Production in Danish Fish Processing Experiences, status, possible Future Strategies. *Journal of Cleaner Production,* 17 (3): 380-390.

Ulya, M., & Hidayat, K. (2018). Pemilihan Alternatif Terbaik *Cleaner Production* Pada Industri Keripik Singkong Dalam Mendukung *Sustainable Manufacturing*. *Jurnal Ilmiah Rekayasa*, 11(02): 110-117.

UNEP. (2003). Cleaner Production Assessment in Industries. *From* http://www.uneptie.ora/pc/cp/understanding_cp/cp industries.html.

Wahyono, & Marzuki. (2005). Pembuatan Aneka Kerupuk. Jakarta: Penebar Swadaya.

Wardiyatun, S. dan Purwanto.(2017). Penerapan Produksi Bersih pada Industri Kecil Kerupuk Amplang Mega Bersaudara di Kecamatan Benun Kayong, Kabupaten Ketapang Provisinsi Kalimantan Barat. Tesis. Semarang: Universitas Diponegoro.

Yi, H., Kim, J., Hyung, H., Lee, S., Lee, C. H. (2001). Cleaner Production Option in a Food (Kimchi) Industry. *Journal of Cleaner Production,* 9(1): 35-41.