Techno-Economic Analysis of The Ciplukan (*Physalis Angulata* Linn) Functional Drink Industry

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Abstract. The functional beverage has high prospects because it has the function to increase endurance and immunity. The ciplukan plant (*Physalis angulata* Linn) is a type of local wisdom typical of Indonesia and is easy to be cultivated. Ciplukan has the potential as a blood sugar-lowering for people with Type II DM (Diabetes Mellitus) sufferers because it has a high content of antioxidants and flavonoids. The ciplukan plant is also a typical Indonesian plant that has not been used optimally. Through the process of it into a functional drink, it will have added value and can increase people's income. Thereby supporting sustainable development in agriculture (SDGs). This study aims to analyze the technical-economic feasibility aspects of the ciplukan beverage industry and the selection of industrial locations. Descriptive methods were used to create an overview of situations and events. Location selection decisions using the BAYES method. The investment feasibility criteria used were Net Present Value (NPV), Internal Rate Return (IRR), Net Benefit and Cost Ratio (Net B/C), and Pay Back Period (PBP). The results show that the NPV value with an interest rate of 18% was Rp. 947,215,168, IRR of 22.19 % was greater than the prevailing interest rate of 18 %, and Net B/C was 1.36 greater than one. The PBP obtained was 3.94 years. Break Event Point (BEP) product sales can reach 12,853 bottles per year. The selected location was West Bandung Regency with the highest total decision value of 4.15. Based on the financial analysis and economic feasibility, it can be concluded ciplukan functional beverage industry has prospects and is feasible to run.
Keywords: Ciplukan, Financial Feasibility, Functional Drink, Technical-Economic, Sustainable Development.

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1 Introduction

In this era of industrial development and ever-evolving human needs, sustainable development is becoming an increasingly important concept. Sustainable development involves the integration of economic growth, environmental protection, and social welfare. In this context, the ciplukan functional drink industry (Physalis angulata Linn) has significant potential to support sustainable development in the economic field.

The functional beverage industry has high prospects because it has a function to increase endurance and immunity. Functional drinks have become a popular choice for consumers who are increasingly aware of the importance of a healthy lifestyle and a better quality of life. Functional drinks offer additional health and wellness benefits, through their unique nutritional content and natural ingredients. One of the interesting potential raw materials in the functional drink industry is ciplukan (Physalis angulata Linn.)

The ciplukan plant is a type of local wisdom typical of Indonesia and is easy to cultivate due to the availability of raw materials. Ciplukan is a plant that thrives in various regions, especially in the tropics and subtropics. Ciplukan fruit has a rich nutritional content, including vitamin C, vitamin A, fiber, and antioxidants. [1] Showed that almost all parts of the ciplukan plant have an antioxidant effect which is measurable from the IC50 value of 141.07; 133.76; 96.97; 129;25 and 134.53 µg/mL for extracts from the stem bark, rind, leaf, unripe fruit, and ripe fruit sections. The total content of flavonoids in each of these sections was 9.04; 10.7; 33.33; 22.41 and 11.91 mgQE/g where this value is positively correlated with its antioxidant strength. The higher the total phenolic content, the higher the antioxidant activity as seen from the smaller the IC50 value.

[2] Flavonoid compounds are antioxidant compounds that overcome or inhibit free radicals to prevent damage to body cells and the emergence of degenerative diseases such as diabetes. [1] Stated that Ciplukan (Physalis angulata Linn) has the potential as a blood sugar-lowering functional drink for Type II DM [15] sufferers because it contains high levels of antioxidants and flavonoids. In addition, ciplukan also has beneficial pharmacological properties, such as anti-inflammatory, anticancer, and antimicrobial properties. [3] Ciplukan activity as an antioxidant, anti-arthritis, anti-inflammatory, and immunomodulator. [4] [5] The ethanolic crude extract of the fruit of physalis has a role in the immune system (immunomodulation), anti-inflammatory effect, and antioxidant activity. In this context, the ciplukan functional beverage industry's development can significantly contribute to sustainable development.

The development of the ciplukan functional beverage industry not only provides potential economic benefits but also creates positive social impacts. This industry can create new jobs, both in the agricultural sector (such as planting and caring for ciplukan) as well as in the production and distribution of functional drinks. In addition, the development of this industry can also strengthen cooperation with local farmers, increase their income, and reduce dependence on single food crops.

However, to achieve sustainable development in the ciplukan functional beverage industry, a comprehensive techno-economic analysis is necessary. This includes technological aspects like product innovation, quality monitoring, and research and development to boost production efficiency. [6] The establishment of a mini-factory to produce cookies from Adlay flour supplemented with moringa leaf powder is techno-economically feasible. [7] Techno-economic analysis to build a mini factory to produce synbiotic fermented drinks from mung beans (Vigna radiata L) and analyzes site selection, using an analytical hierarchy process (AHP). [8] Techno-economic analysis of small and medium-sized cocoa businesses in the Luwu Regency of South Sulawesi to

determine the ratio of NPV to BC to determine business viability. In addition, economic aspects must also be considered, such as market potential, agricultural diversification, and export potential. In this context, techno-economic analysis of the ciplukan functional beverage industry is important to understand the potential and challenges involved in the development of this industry. [9] Provides a flexible tool for decision-makers to evaluate investment projects to meet the need for flexibility and simplicity in assessing and measuring sustainability.

With a deep understanding of technological and economic aspects, appropriate steps can be taken to ensure that the ciplukan functional beverage industry can make a significant contribution to supporting sustainable development in the economic field. This research is limited to the technological aspects and financial feasibility aspects. The technological aspects that will be discussed are the process of making ciplukan functional drink and the selection of industrial locations, while the financial feasibility aspects include calculating the financial feasibility of establishing an industry, namely Net Present Value (NPV), Internal Rate Return (IRR), Net Benefit and Cost Ratio (Net B/C), and Pay Back Period (PBP). So the purpose of this study was to analyze the feasibility of the technical-economic aspects of the ciplukan beverage industry (Physalis angulata Linn) and the selection of industrial locations.

2 Materials and methods

2.1 Materials

The fixings utilized ciplukan natural products, ciplukan buds, low-calorie sugar, CMC, and water. Creation gear machines used scales and other supporting equipment. These materials and equipment are expected for the creation cycle primers to procure data and assumptions to be used in working out financial feasibility. This exploration utilized the expressive investigation technique. The illustrative procedure was a strategy for taking a gander at the circumstance with a gathering, protests, a bunch of conditions, an arrangement of thought, or a class of events in the present [10]. The phases of exploration were completing the issue plan, writing a study, information assortment, and examination of results, and ideas.

2.2 Technical feasibility analysis

2.2.1 Production process

The information acquired from the specialized perspectives was the definition and item process stream charts, the number and particulars of machines, the quantity of hardware and work, item details, working time, and creation limit.

2.2.2 *Plant location selection*

Two factors need to be considered in determining a strategic project location, namely primary and secondary factors. The primary factors that technically have to be considered are the availability of main raw materials and supporting materials, the availability of direct labor, the availability of transportation facilities, the availability of telecommunications, water, and electricity facilities, and proximity to the location of the intended market. While secondary factors include the climate and soil conditions, the possibility of development in

the future, and government policy strategies [11]. The approach taken in determining alternative locations is to choose locations based on the general availability of raw materials. Ciplukan, which is the raw material for the fruit juice industry, even though it grows in all regions in West Java, there are still not many cultivation centers. Thus, the determination of alternative locations was chosen by several areas in West Java Province, which were close to the location of raw materials, so 3 alternative locations were taken, namely Subang Regency, West Bandung Regency, and Sumedang Regency. The decision to choose the location of the three alternatives will be taken based on a decision-making system using the "BAYES method" [16], namely by weighing the primary factors and secondary factors. The location with the highest final weight was chosen as the location for the establishment of the ciplukan fruit juice industry.

2.3 *Financial feasibility analysis*

2.3.1 *Break Event Point (BEP)*

Break Event Point (BEP) is the point where the total cost of production equals revenue [7]. BEP shows the level of production that has generated income that has been equal to the total production issued. Break-even analysis can be done using the following formula:

$$BEP = \frac{Total\ \cos t(IDR)}{Selling\ price(IDR)} \tag{1}$$

2.3.2 *Net Present Value (NPV)*

Net Present Value (NPV) in a venture is the distinction between the current value of income and the current value of expenses The calculation formula is as follows [7].

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+i)t} \tag{2}$$

where Bt: the benefits received every year, Ct: costs incurred every year, n: the number of years, i: the interest rate (discount). The criteria for business feasibility using the NPV value are (a) If the NPV > 0, the investment is considered profitable and feasible to implement, (b) If the NPV = 0, the investment is not profitable but also not detrimental, (c) If the NPV < 0, the investment is considered unprofitable and not feasible to implement.

2.3.3 *Internal Rate of Return (IRR) [12].*

IRR technique will find the loan fee when the NPV rises to nothing. The computation strategy for getting the NPV is equivalent to zero utilizing introduction estimations. The data got is as the capacity of incomes to return the speculation which is portrayed in the % period. Speculation is supposed to be plausible assuming that the IRR esteem ≥ MARR. MARR (Least Appealing Pace of Return) is the worth of the commitment that should be met.

$$IRR = i_1 + \frac{NPV_1}{NPV_1 - NPV_2} \times (i_1 - i_2) \tag{3}$$

where i_1: The interest rate that produces a positive NPV, i_2: The interest rate that produces a negative NPV, NPV_1: a positive NPV, NPV_2: negative NPV.

2.3.4 Payback period

The period expected to cover speculation costs utilizing income is known as the recompense period. The equation for computing the compensation time (*Payback Period*):

$$Payback\ period = \left(\frac{1}{Ab} \times 1 year \right) \tag{4}$$

where I: investment value, Ab: net cash which has been discounted.

2.3.5 *Benefit Cost Ratio (BCR)*

According to [13], this proportion is gotten by separating the current value of the progression of advantages (PV) by the current value of the progression of expenses, which means deciding the proportion between the total costs caused in a business and the benefits that will be acquired.

3 Results and discussion

3.1 Technical feasibility analysis

3.1.1 Production process

The production process for ciplukan juice refers to [14] where the initial stage is the selection of quality raw materials. With the use of quality raw materials, it is hoped that the fruit juice produced will also be good. To determine the quality of raw materials, namely by sorting the ciplukan fruit. The selected ciplukan fruit is a fruit that is ripe, healthy (not diseased), and not rotten.

The initial process of making ciplukan juice is the process of making ciplukan fruit extracts and buds. The ciplukan fruit is peeled and washed to remove latex and dirt. Furthermore, the ciplukan fruit and ciplukan buds were separately extracted using an extractor with the addition of water to obtain fruit extract and ciplukan bud extract. At this extraction stage, screening is also carried out at the same time so that a by-product in the form of dregs will be produced. The resulting fruit extract and bud extract are then used as raw materials for making fruit juice. The mixture of fruit extracts and ciplukan buds then flows into the mixing tank to be mixed with auxiliary ingredients, namely stevia, honey, benzoate, CMC, and citric acid. The addition of these ingredients aims to improve the quality of fruit juice products, provide flavor and aroma, improve taste, and extend shelf life. The next step is the pasteurization of ciplukan juice using a plate heat exchanger. Pasteurization is carried out at a temperature of about 80 - 90^{o} C. The purpose of pasteurization is to kill some of the microbes in pineapple juice, especially pathogenic microbes. After the pasteurization process, the fruit juice must be immediately put into the packaging using an automatic packaging machine. The type of packaging used is plastic bottles. After finishing packing, then put it into cartons. The stages of production of ciplukan juice can be seen in Fig. 1.

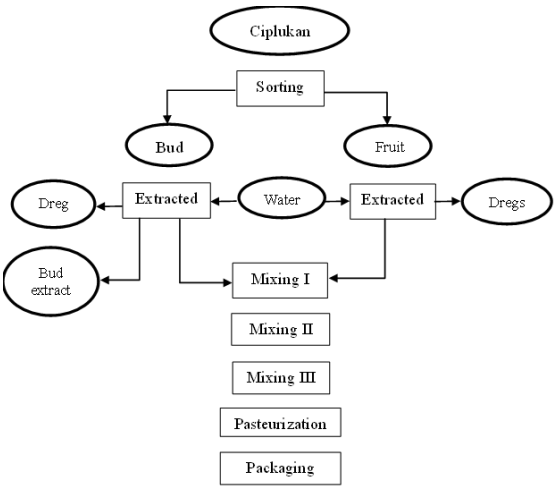

Fig. 1. Flow chart of the process of making ciplukan functional drink

Machines and equipment used for the process of making ciplukan juice are needed to support the production process. It is important to study energy needs to predict energy use, both electrical energy and gas energy used for production needs. This is related to the costs that must be incurred to pay for the energy used. The list of equipment and energy consumption required can be seen in Table 1.

Table 1. Details of machines need for production equipment

No.	Process	Machine details	Number of units	Capacity (kg/hour)	Power (Watt)	Time (Hour)	Energy Needs (KwH)
1	Washing	Washer	1	200	900	3	2.7
2	Crushing	Crusher	2	50	900	1	0.9
3	Pulping	Pulper	1	100	900	1	0.9
4	Mixing	Mixing Tank	1	200	2000	2	4
5	Homogenization	Homogenizer	2	200	900	5	4.5
6	Pasteurization	Pasteurizer	1	1000	3000	0.5	1.5
7	Cooking	Boiler	1	600	2000	2.5	5
8	Packaging	Filling Machine	1	300	2000	1	2

3.1.2 Plant location selection [11]

To determine a strategic project location, many factors are considered, both primary and secondary. The primary factors that technology must be considered include the following: Availability of main raw materials and auxiliary materials, Availability of direct labor, Availability of transportation facilities, Availability of telecommunications, water, and electricity facilities, and Proximity to the location of the intended market. While secondary factors include: climate and soil conditions, possible future development, and government policy strategy.

In determining alternative locations, the approach taken is to choose a location based on the general availability of raw materials. Ciplukan, which is the raw material for the fruit juice industry, even though it grows in all regions in West Java, there are still not many cultivation centers. Thus the determination of alternative locations selected several areas in West Java Province which are close to the location of raw materials.

Based on the explanation above which shows the availability of raw materials in the West Java area, 3 alternative locations were taken, namely Subang Regency, West Bandung Regency, and Sumedang Regency. The decision to choose the location of the three alternatives will be taken based on a decision-making system using the "BAYES method". Based on the calculation, the assessment looks like Table 2.

Table 2. Location assessment decision matrix according to the BAYES technique

No	Criteria	Alternative Location			Weight
		Bandung Barat	Subang	Sumedang	
1.	Raw materials and auxiliary	4	3	5	0.25
2.	Labor	3	4	3	0.15
3.	Transportation	5	4	4	0.15
4.	Telecommunication	4	4	4	0.05
5.	Water and electricity	4	4	4	0.15
6.	Target market location	5	5	4	0.20
7.	Government policy strategy	3	3	3	0.05
	Decision Value	4.15	3.9	4.05	1
	Ranking	1	3	2	

The determination of the weight in the BAYES method above emphasizes the need for raw and auxiliary materials as a critical point because, for the food industry, the need for raw materials is needed in large enough quantities so that the raw material factor is given the greatest weight.

In analyzing the availability of this raw material, the focus is on the proximity of the location to the main raw material, namely ciplukan. Sumedang Regency is the area with the largest production compared to other regions so in its assessment Sumedang Regency is given a higher value. For labor criteria, relatively cheap labor costs are a factor to consider in choosing the location of an industry. The following is UMK data for 2018.

Table 3. District minimum wage West Java Indonesia 2018

No	Regency	Wages per person (IDR)
1.	West Bandung Regency	3,145,427
2.	Subang Regency	2,965,468
3.	Sumedang Regency	3,139,275

The amount of wages received by each worker in each region in West Java is quite different. Labor wages in Subang Regency are the lowest among other regions, and the highest is in West Bandung Regency. So Subang Regency gets a higher score than other Regencies. Some of the considerations for a location chosen based on the availability of transportation facilities are easy access to the factory and very supportive infrastructure so the most important thing to consider is the condition of the infrastructure in the selected area. Therefore, West Bandung gets a higher score because the infrastructure in West Bandung is relatively better compared to Subang and Sumedang. After all, it is near industrial areas/centers and close to the capital city of West Java. Locations that will be considered are the availability of electricity, and the availability of water that is quite abundant (easy to obtain), for example near a direct spring or river which can reduce costs for water and electricity usage. For the availability of water and electricity, all alternatives

are given the same score because it is considered that all locations have the same equipment and facilities as well as water and electricity infrastructure. Likewise, currently, telecommunications has reached even remote areas. Therefore the availability of telecommunications facilities for each alternative location is given the same score. In the government policy category, all alternative locations are also given the same score because it is considered that government policies regarding production businesses are the same in all regions. Based on the results above (Table 2), the location chosen was West Bandung Regency with the highest total decision value of 4.15.

3.2 Financial feasibility analysis

Making a financial analysis of the establishment of the ciplukan beverage industry is carried out using assumptions that are adjusted to the conditions at the time the feasibility study was carried out. The assumptions used can be seen in Table 4.

Several speculation possibility measures utilized incorporate Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit and Cost Ratio (Net B/C), Pay Back Period (PBP), and Profitability Index (PI). The following is an explanation of the investment criteria mentioned above. The break-even point is the point where the total cost of production equals revenue. BEP shows the level of production that has generated income that has been equal to the total production issued. The project can be said to break even (no loss or profit) if the total sales of its products can reach 12,853 bottles per year.

The NPV with an interest rate of 18% is 947,215,168 IDR. This value indicates the net profit received for the next 10 years if measured by the present value. NPV shows a positive number, so the industry is declared feasible. The internal Rate of Return or project interest rate is the project's ability to generate profits and can be expressed as the loan (bank) interest rate that produces a zero NPV. A venture is viewed as practical on the off chance that the IRR value is greater than the prevailing bank interest rate. The IRR value is 22.19%. This value is higher than the prevailing interest rate of 18 percent, so the project is declared feasible.

Table 4. Financial calculation assumptions

Assumptions set	
Production capacity per day	500 l /day or 2500 bottles @200ml
Raw material prices	20.000 IDR per kg
Project length	10 years
Number of production days	24 days per month
Interest rate	18%
Year of project development	Years 0
Depreciation calculation method	Straight-line method
Residual value for main machinery and equipment and other supporting equipment	5% of the initial value
First-year to fourth-year production	90% of the total planned production which will be realized in the fifth year onwards
Maintenance costs for buildings, machinery, and equipment	0.1% of investment value
Capital in the form of loans (debt)	0
Land value	fixed every year

Net B/C is a comparison between a positive NPV and a negative NPV. If the Net B/C value is > 1, then the NPV is > 0, so the project is said to be feasible. The ciplukan functional drink industry's Net B/C value is 1.36, so the project is declared feasible. Based on the results of the feasibility calculation, the PBP (Pay Back Period) obtained is 3.94 years. This shows that this business is possible to establish because the compensation period is not more than the age of the venture (10 years).

Table 5. Financial Criteria of feasibility analysis for the ciplukan functional drink industry

Feasibility Criteria	Values	Feasible or not feasible
Break-even point (BEP)	12.853 bottles	
NPV	947.215.168 IDR	> 0, feasible
IRR	22,19 %	≥ MARR (18%), feasible
Net B/C	1,36	≥ 1, feasible
Payback period	3,94 years	≤ project period (10 years), feasible

4 Conclusion

The results of the investment feasibility criteria used are NPV, IRR, Net B/C, and PBP. The results show that the NPV value with an interest rate of 18% is 947,215,168 IDR, IRR of 22.19% is greater than the prevailing interest rate of 18 %, and Net B/C is 1.36 greater than one. The PBP obtained was 3.94 years. BEP product sales can reach 12,853 bottles per year. Based on the financial analysis and economic feasibility, it can be concluded ciplukan functional beverage industry has prospects and is feasible to run. The selected location was West Bandung Regency with the highest total decision value of 4.15.

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References

[1] A. C. Iwansyah, W. P. Julianti, and R. Luthfiyanti, "Characterization of nutrition, antioxidant properties, and toxicity of physalis angulata L plant extract," Asian J. Pharm Clin Res., vol. 12, no. 11, pp. 95-99, 2019.

[2] A. Agil, D. Ademulani, A. K. Putri, B. Wulandari, and R. Dewi, "Efektivitas guci (yogurt ciplukan) sebagai sumber minuman kaya antioksidan alami," J. Ilmu dan Teknologi Peternakan Indonesia, vol. 5, no. 1, pp. 27-34, 2019.

[3] Nurul L, Ariefah H A, Rossano Y S and Endang S, "Ciplukan (Physalis angulata L.)," [Online]. Available: https://ccrc.farmasi.ugm.ac.id/?page_id=193, 2008.

[4] I. K. Adnyana, E. Yulinah, N. Maeistuti, and F. Setiawan, "Evaluation of ethanolic extracts of mullaca (Physalis angulata L.) herbs for the treatment of lupus disease in mice induced pristane," Procedia Chem., vol. 13, pp. 86-93, 2014.

[5] R. W. Kusumaningtyas, N. Laily, and P. Limandha, "Potential of ciplukan (Physalis angulata L.) as a source of the functional ingredient," Procedia Chem., vol. 14, pp. 67-72, 2015.

[6] Y. Andriana et al., "Techno-economic analysis of mung bean-based (Vigna radiata L.) synbiotic beverage production," IOP Conf. Series: Earth and Environmental Science, vol. 733, p. 012137, 2021.
[7] A. Indriati et al., "Techno-economic analysis on cookies production made from Adlay (Coix lacrymal-jobi) flour that supplemented with moringa (Moringa oleífera) leaves powder," IOP Conference Series: Earth and Environmental Science, vol. 672, no. 1, 2021.
[8] Astuti et al., "The optimization of cocoa processing in small and medium enterprises in South Sulawesi," AIP Conference Series, 2023.
[9] I. Baffo et al., "A decision support system for measuring and evaluating solutions for sustainable development," Sustainable Futures, vol. 5, p. 100109, 2023.
[10] M. Nazir, "Metode penelitian," Ghalia, Indonesia, 2014.
[11] Suratman, "Studi kelayakan proyek," Gramedia, Jakarta, 2002.
[12] M. Giatman, "Ekonomi teknik," PT Rajagrafindo Persada, Jakarta, 2011.
[13] H. Khotimah and Sutiono, "Analisis kelayakan finansial usaha budidaya bambu," J. Ilmu Kehutanan, vol. 8, no. 1, pp. 14-24, 2014.
[14] R. Luthfiyanti et al., "Study of antioxidant activities acceptability and shelf life prediction of ciplukan (Physalis angulata L.) juice drinks," IOP Conf. Series: Materials Science and Engineering, vol. 1011, pp. 1-11, 2021.
[15] A. C. Iwansyah et al., "Antidiabetic activity of physalis angulata L fruit juice on steptozotocin induced diabetic rats," South African J. of Botany, vol. 141, pp. 1-7, 2022.
[16] A. H. Rangkuti, "Teknik pengambilan keputusan multi kriteria menggunakan metode Bayes, MPE, CPI dan AHP," ComTech, vol. 2, pp. 229-238, 2011.