



vol. 17 / 2023



The 7th International Conference on Science Technology

organized by
Faculty of Social Science and
Law Universitas Negeri Manado and
Consortium of International Conference
on Science and Technology

The Innovation Breakthrough in Digital and Disruptive Era

Environmental Performance Analysis Of CV Barokah Tofu Waste Factory Using Green Productivity

Rachmad Hidayat¹, Nuriyanti Arifiyah^{2*}, and Rayhan Ahsanul Hidayat³

¹University Of Trunojoyo Madura

²University Of KH. Bahaudin Mudhary Madura

³University Of Brawijaya

Abstract. Tofu is a food product that is a necessity for daily consumption by the community. The basic ingredient in making tofu is soybeans which have high nutritional value and can be a healthy protein alternative for the community. Tofu is made from coagulated soybean seed sediment, so that the processing produces water which becomes waste in the tofu-making industry. In increasing production it is necessary to have attention to environmental performance. The aspect of environmental performance is in the form of liquid waste resulting from a large number of tofu production processes. The purpose of this study is to analyze the liquid waste from tofu production using the Green Productivity (GP) method to provide suggestions for improvements in increasing company productivity. Based on the results of the study, the company has an initial environmental performance index (EPI) of -376.305. The initial Green Productivity Index (GPI) at CV Barokah has a value of 0.003 and GPI Liquid Waste of 0.75. There are two alternative solutions, namely the utilization of liquid waste to become Nata de soya and liquid organic fertilizer. The alternative chosen is the utilization of liquid waste as organic fertilizer with a profit of Rp. 126,447,163 with the final productivity value also increasing to 703.10%.

Keywords: Productivity, Environmental Performance, Green Productivity

1 Introduction

Soybean is a food ingredient that can be processed into several types of processed food products, one of which is processed products from soybeans in the form of tofu. Tofu is a source of protein that is widely consumed by Asian people, because apart from having a high protein content, tofu also has an economical price[1].

For the people of Indonesia, the name tofu is familiar, because tofu is included in the staple food as a substitute for fish. Tofu originally came from China, but almost every day Indonesian people consume tofu for their daily needs[2].

The tofu processing system is still identical to using traditional technology. The tofu production process starts from selecting soybeans, weighing soybeans, soaking, washing, grinding, extracting, filtering, cooking, coagulating, separating whey, wrapping, pressing, cooking, and packaging[3]. In its production, tofu processing produces a lot of waste which can be in the form of gas, liquid and solid waste. The waste produced can pollute the surrounding environment[4]. The development of the industry has fluctuated from year to year. The greater the number of Indonesian people's consumption will have an impact

on national *tofu production. If the production rate increases, the productivity of the tofu industry will also increase.

CV Barokah is the first tofu factory in Batuan Village, Sumenep Regency. This factory has been established since 2015 which is managed by Mr. Yasid and is named CV Barokah Tahu Batuan. The amount of tofu production has decreased and every month the production figures are not fixed. The production capability carried out by CV Barokah is 5,200 kg in one month. While every day has a production capacity of 200 kg. When tofu production has decreased, the amount of waste produced has also decreased. But the threat of wasted waste still exists. Solid waste generated from the tofu production process every day under normal conditions reaches 106 kg. If production conditions decrease in 2011, about 85 kg of waste will be produced every day.

* Corresponding author: nuriyanti@unibamadura.ac.id

Table 1. Data on total production and solid waste of CV Barokah Tahu Batuan Bulai March-June 2023

No	Bulan	Produktivitas
1	Maret	203%
2	April	193%
3	Mei	197%
4	Juni	182%
Rata-rata		193,75%

Observations made at the tofu factory at CV Barokah found two problems, namely productivity and environmental performance. Productivity problems are related to the amount of tofu production which has decreased. While the environmental performance problems that occur are due to the processing of waste generated from the tofu production process that is not carried out optimally. Solid waste and liquid waste produced by tofu factories can cause bad smells if not managed properly. The amount of liquid waste produced is quite large because the tofu processing requires a lot of water. Waste that is allowed to flow without prior processing will cause environmental pollution around the tofu factory. This research is based on the problem of liquid waste. Liquid waste that is managed properly is believed to be able to provide good benefits for the factory, one of which is to increase revenue for the company.

Productivity is the ratio between the total value obtained (output) and the total input value (input) used to carry out the production process. Productivity is used to analyze and review the occurrence of efficiency in the production process and find out how optimal the company's use of resources is in producing the targeted output[5]. The increase experienced by a company in each period shows the condition of the company is in a good position. This shows that it is important to take measurements so that companies know that productivity has increased or decreased[6]. In increasing its productivity, companies often experience problems, namely the inappropriate use of resources in carrying out the production process[5].

The level of productivity can be collaborated with the company's environmental performance by using the Green productivity (GP) approach which is a strategy to increase company productivity and environmental performance simultaneously in overall socio-economic development. The application of the Green productivity (GP) concept is expected to be able to provide significant improvements to company productivity and environmental performance[7]. GP implements productivity using tools, techniques, and environmental management technologies to reduce the environmental impact of organizational activities[8].

2 Research Method

This research was conducted using a quantitative descriptive approach which was carried out by looking directly at the detailed description of the phenomenon and the final results of the research. This approach

describes the phenomenon by using numbers that describe the characteristics of the subject under study. The stages of the research method are as follows:

1. Material Balance, to identify the amount of input and output resulting from the production process.
2. Productivity Calculation, to determine the level of productivity achieved by the company. Productivity formula:

$$\text{Productivity} = \frac{\text{output}}{\text{input}} \times 100\%$$

3. Calculation of the Environment Performance Index (EPI), to determine the environmental performance of the CV Barokah Batuan tofu factory. EPI index formula:

$$\text{Index EPI} = \sum_{i=1}^k W_i \cdot P_i$$

Information:

k : the number of criteria for a proposed waste

W_i : the weight of each criterion

P_i : percentage of deviation

$$P_i = \frac{\text{Standar-Analisa}}{\text{Standar}} \times 100\%$$

4. Identify the Causes of Problems, to identify the causes of the problems that occur. Namely the amount of waste generated from the tofu production process. Identification of problems is done by using a fishbond diagram to show what are the causative factors of the problems that occur.
5. Calculation of the initial GPI to determine the comparison between productivity levels and environmental performance. GPI formula:

$$GPI = \frac{\text{productivity level}}{\text{Environmental impact}} \times 100\%$$

Next, calculate the ratio between liquid waste and production inputs

$$GP \text{ liquid waste} = \frac{\text{waste}}{\text{Input material}}$$

6. Calculation and Selection of Alternative Solutions to provide solutions to problems that occur in the company. Next is the calculation of alternative solutions based on economic value.

3 Result And Discussion

3.1 Material Balance

Table 2. Material Balance for June

Number	Stages	Input		Output	
		Material	Amount (kg)	Material	Amount (kg)
1	Washing	Soya bean	1.350	Wastewater	8.932,95
		Water	9.000	Soybean Excrement	4,05
2	Immersion	Water	2.700	Wastewater	2.412
3	Milling	Water	1.800	Soybean Retail	36
4	Boiling	Water	4.500	Water vapor	188,37
5	Filtering	Water	2.700	Dregs of Tofu	1.890
6	Clumping	Vinegar	3.158,01	Liquid waste	6.682,14
7	Printing	-	-	Liquid waste	1.012,5
		-	-	Tofu	4.050
Total			25.208,01		25.208,01

Based on table 2 it is known that the raw material used in the production process is 1,350 kg/month. The resulting product output is 4,050 kg so that the material balance that occurs is 25,208.01 kg every month.

3.2 Productivity

Table 3. Productivity

Number	Month	Produktivitiy
1	March	203%
2	April	193%
3	May	197%
4	June	182%
Average		193,75%

The productivity value from March to June each month has an unstable value and has decreased. Even so, productivity every month is still above 100%, which means that productivity at CV Barokah is still quite good with an average productivity of 193.75%.

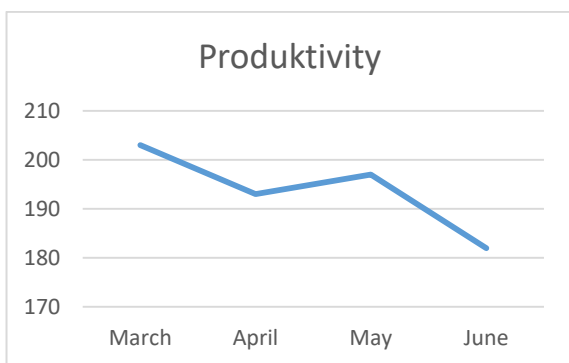


Fig. 1. Productivity graph

3.3 Environment Performance Index (EPI)

Table 4. Test results for the content of tofu waste

Number	Parameter	Quality Standards	Analysis results	Weight (Wi)
1	PH	6-9	5,2	5,5
2	Total Suspended Solids (TSS)	200 Mg/L	985	4,7
3	Chemical Oxygen Demand (COD)	300 Mg/L	12.564	5,1
4	Biochemical Oxygen Deman (BOD)	150 Mg/L	4.862	4,8

Table 4 is the result of testing the content of tofu waste from production. The results of each indicator are compared with the main standards that have been set in accordance with the 2014 Minister of Environment regulations[9]. Based on the observation results, there are 3 indicators that are not in accordance with the main standard and there is only 1 indicator that is in accordance with the main standard, namely the PH indicator. If all the indicators are contained in the waste generated from tofu production, it can be said that the waste is safe and does not have much impact on the environment.

Table 5. Calculation of EPI

Number	Parameter	Quality Standards	Analysis results	Weight (Wi)	Deviation (Pi)	Index EPI (Wi.Pi)
1	PH	6-9	5,2	5,5	26%	1,414
2	Total Suspended Solids (TSS)	200 Mg/L	985	4,7	-393%	-18,448
3	Chemical Oxygen Demand (COD)	300 Mg/L	12.564	5,1	-4088%	-208,488
4	Biochemical Oxygen Deman (BOD)	150 Mg/L	4.862	4,8	-3141%	-150,784
Total Index EPI						-376,305

In table 5 there are 3 parameters with negative values and 1 parameter with positive values. Good environmental performance is having a positive EPI index and getting better if the index touches 100 or more. The table above shows that the total EPI index is -376.305, which means that environmental performance is still relatively low.

3.4 Identify the Cause of the Problem

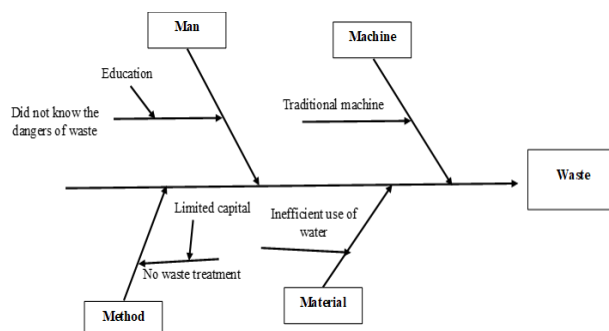


Fig. 2 Fishbone diagram

3.5 Green Productivity Index

The calculation of green productivity is used to find out the balance of economic/productivity performance and environmental performance.

The calculation of the initial GPI is:

$$GPI = \frac{\text{productivity level}}{\text{Environmental impact}} \times 100\%$$

$$= \frac{1,4325}{-376,305} \times 100\%$$

$$= 0,003$$

$$GP_{\text{waste cair}} = \frac{\text{waste}}{\text{input marerial}}$$

$$= \frac{19.039,59}{25.208}$$

$$= 0,75$$

Calculation of GP waste to increase the amount of waste generated by the company. Based on the calculation of the liquid waste GP it is known that the result is equal to 0.75.

3.6 Calculation and Selection of Alternative Solutions

Table 6. Summary of profits for the month of June

Raw material	Amount (Month)	Units	Unit price (Rp)	Total value (Rp)
Soya bean	1.350	Kilograms/month	Rp 6.550	Rp 8.842.500
Water	20.700	Liters/month	-	-
Vinegar acid	3.158,01	Liters/month	-	-
Tools and Energy				
Solar	250	Liters/month	Rp 6.900	Rp 1.725.000
Firewood	1,5	Trucks/month	Rp 1.000.000	Rp 1.500.000
Electricity (Water pump and lights)	1	Rupiahs/month	Rp 500.000	Rp 500.000
Employee salary	5	People/month	Rp 1.500.000	Rp 7.500.000
Total Input				Rp 20.067.500
Tofu	4.050 kg (36.450 pieces)	Pieces/month	Rp 1.000	Rp 36.450.000
Total Output				Rp 36.450.000
Monthly Profits				Rp 16.382.500

Table 6 is a summary of the income and expenses of CV barokah before utilizing waste from tofu production. The profit earned is Rp. 16,382,500.

Alternative 1

Tofu liquid waste can be used for simple things, namely for the manufacture of fertilizer from liquid waste resulting from the tofu production process. Utilization of tofu waste into organic fertilizer can make the company zero waste on liquid waste.

Table 7. Profits after utilization as organic fertilizer

Raw material	Amount (Month)	Units	Unit price (Rp)	Total value (Rp)
Soya bean	1.350	Kilograms/month	Rp 6.550	Rp 8.842.500
Water	20.700	Liters/month	-	-
Vinegar acid	3.158,01	Liters/month	-	-
Tools and Energy				
Solar	250	Liters/month	Rp 6.900	Rp 1.725.000
Firewood	1,5	Trucks/month	Rp 1.000.000	Rp 1.500.000
Electricity (Water pump and lights)	1	Rupiahs/month	Rp 500.000	Rp 500.000
Employee salary	5	People/month	Rp 1.500.000	Rp 7.500.000
Total Input				Rp 20.067.500
Tofu	4.050 kg (36.450 pieces)	Pieces/month	Rp 1.000	Rp 36.450.000
Utilization of waste as organic fertilizer	19.309,59	Liters/month	Rp 5.700	Rp 110.064.663
Total Output				Rp 146.514.663
Monthly Profits				Rp 126.447.163

Table 7 is the result of calculating the profits obtained by CV Barokah by using the utilization of liquid waste to become organic fertilizer. The profit earned is Rp. 126,447,163.

Alternative 2

Tofu liquid waste produced by CV Barokah in large quantities can be utilized to become a new innovative product that has economic value. One of these innovative products is Nata de soya, with this utilization plan it can increase company productivity.

Table 8. Benefits after utilization as Nata de soya

Raw material	Amount (Month)	Units	Unit price (Rp)	Total value (Rp)
Soya bean	1.350	Kilograms/month	Rp 6.550	Rp 8.842.500
Water	20.700	Liters/month	-	-
Vinegar acid	3.158,01	Liters/month	-	-
Tools and Energy				
Solar	250	Liters/month	Rp 6.900	Rp 1.725.000
Firewood	1,5	Trucks/month	Rp 1.000.000	Rp 1.500.000
Electricity (Water pump and lights)	1	Rupiahs/month	Rp 500.000	Rp 500.000
Employee salary	5	People/month	Rp 1.500.000	Rp 7.500.000
Total Input				Rp 20.067.500
Tofu	4.050 kg (36.450 pieces)	Pieces/month	Rp 1.000	Rp 36.450.000
Utilization of waste as organic fertilizer	19.309,59	Liters/month	Rp 792	Rp 15.293.195
Total Output				Rp 51.743.195
Monthly Profits				Rp 31.675.695

Table 8 is the result of calculating the profits obtained by CV Barokah by using the utilization of liquid waste to become Nata de soya. The profit earned is Rp. 31,675,695.

Based on the calculations of each alternative, alternative 1 was chosen, namely the utilization of liquid waste into organic fertilizer because based on the profit that is obtained each month, it is greater, namely Rp. 126,447,163 compared to the utilization of waste as Nata de soya which only benefits Rp. 31,675,695.

Calculation of Final Productivity

$$\text{Produktivitiy} = \frac{\text{output}}{\text{input}} \times 100\%$$

$$= \frac{146.514.663}{20.067.500} \times 100\%$$

$$= 730,10\%$$

4. Conclusions

1. The initial productivity of CV Barokah in March was 203%, in April it was 193%, in May it was 197%, and in June it was 182%.

- The average productivity is 193.75% with an environmental performance at the initial EPI index of -375.305. From March to June the productivity rate decreased by 21%.
2. CV Barokah has an initial GPI value of 0.003 and a liquid waste GP of 0.75.
 3. Of the two planned alternatives, by utilizing waste as organic fertilizer, a profit of Rp. 126,447,163 and utilization of waste as Nata de soya which only benefits Rp. 31,675,695. So that the chosen solution is alternative 1, namely utilization as organic fertilizer because it has a greater advantage. The final productivity value in June increased from 182% to 730.10%.

- [9] R. Miller, "Review Essay: The Third Way," *Polit. Sci.*, vol. 52, no. 2, pp. 174–180, 2000, doi: 10.1177/003231870005200207.

References

- [1] N. Aryanti, D. Kurniawati, A. Maharani, and D. H. Wardhani, "Karakteristik Dan Analisis Sensorik Produk Tahu dengan Koagulan Alami," *J. Ilm. Teknosains*, vol. 2, no. 2/Nov, 2016, doi: 10.26877/jitek.v2i2/nov.1206.
- [2] D. Herdhiansyah, P. Studi Teknologi Pangan, F. Pertanian Universitas Halu Oleo Kendari JalanHEA Mokodompit Kampus Baru Tridharma, and S. Tenggara, "Kajian Proses Pengolahan Tahu: Studi Kasus Industri Tahu Di Kecamatan Kabangka Kabupaten Muna," *Agritech*, vol. XXIV, no. 2, pp. 1411–1063, 2022.
- [3] S. Djayanti, "Kajian Penerapan Produksi Bersih Di Industri Tahu Di Desa Jemberan, S Study of the Application of Cleaner Production in the Tofu Industry," pp. 75–80, 2015.
- [4] A. Hasibuan, "STUDI SANITASI INDUSTRI RUMAH TANGGA DALAM PENGELOLAAN TAHU DI DESA GLUGUR," vol. 6, no. 2, pp. 9–25, 2023.
- [5] Suseno and M. F. Sitorus, "Analisis Produktivitas Pada Bagian Produksi Menggunakan Metode Objective Matrix Dan Root Cause Analysis (Studi Kasus UMKM Barokah Jaya Bakery)," *J. TRINISTIK*, vol. 1, no. 2, pp. 21–28, 2022.
- [6] E. Z. Afianti, I. K. Satriawan, and I. W. G. Sedana Yoga, "Analisis Produktivitas Produksi PT. Bapak Bakery Badung Bali," *J. Rekayasa Dan Manaj. Agroindustri*, vol. 8, no. 1, p. 127, 2020, doi: 10.24843/jrma.2020.v08.i01.p13.
- [7] I. G. V. Hutagalung, "Perbaikan Produktivitas melalui Green Productivity," *J. Ind. View*, vol. 2, no. 1, pp. 27–32, 2020, doi: 10.26905/jiv.v2i1.4210.
- [8] J. L. Fitri, N. W. Setyanto, and L. Riawati, "Peningkatan Produktivitas dan Kinerja Lingkungan Menggunakan Pendekatan Green Productivity Pada Proses Produksi Pupuk Organik (Studi Kasus di PT. Tiara Kurnia, Malang)," *J. Rekayasa dan Manaj. Sist. Ind.*, vol. 3, no. 2, pp. 363–374, 2015.