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Implementation Of Green Productivity Through Wood Waste Processing To Optimize Productivity And Environmental Performance At PT. Sinar Indah Furniture

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ABSTRACT

This research aims to implement the concept of Green Productivity through wood waste processing to optimize productivity and environmental performance at PT Sinar Indah Furniture. In the furniture industry, wood waste is one of the major issues affecting environmental sustainability and production efficiency. The research method used in this study is descriptive analysis with a quantitative approach to evaluate the company's productivity before and after the implementation of wood waste processing. The results of the study show that the company's productivity experienced fluctuations during the observation period, but by processing wood waste into economically valuable products, such as particle boards, the company was able to reduce the generated waste and improve productivity. Additionally, the implementation of green productivity has the potential to enhance environmental performance by reducing the negative impact caused by wood waste. This study concludes that the implementation of green productivity not only brings environmental benefits but also increases the company's economic value. Based on the results, it is recommended to continue the broader implementation of these practices to support the sustainability of the furniture industry in Indonesia

Keywords: Green Productivity; Environmental Performance Index; Environmental Performance; Productivity.

INTRODUCTION

Productivity is a very important aspect for a company as one of the ways to monitor its production performance (Sofyan, 2023). It is crucial for companies to pay attention to environmental aspects in their production operations to create harmony with the surrounding environment. The appropriate approach to help companies improve productivity and environmental performance is by implementing the green productivity method. The application of Green Productivity can enhance customer service and response rates, reduce environmental impact by minimizing waste, and increase social responsibility for industries across all sectors.

Industry is one of the sources of prosperity for the nation. There are various types of industries operating in different fields, one of which is the Furniture Industry. The furniture industry is one of the important industrial sectors in Indonesia. Although the furniture industry makes a significant contribution, it also generates a considerable amount of waste, especially wood waste. This wood waste can pollute the environment if not managed properly.

Waste is essentially the residue or byproduct of human activities. Waste can originate from household (domestic) activities or industrial activities. In other words, waste is material that has no economic value and is discarded because it is no longer needed. In 2023, wood waste in East Java province amounted to 9.13% (Kementrian Kehutanan dan Lingkungan Hidup, 2023). Although this figure is relatively small, it still has a significant impact on the environment, one of which is waste burning. Waste burning is one of the contributors to poor air quality pollution. Exposure to pollutants from wood burning can cause various health problems, such as asthma, bronchitis, heart disease, and chronic obstructive pulmonary disease (PPOK) (Ruben

Ferdian, 2024). Burning wood releases carbon dioxide, which will affect greenhouse gases as a major player in climate change. In addition to particles and greenhouse gases, burning wood that contains chemicals such as paint, glue, or coatings can release harmful substances into the air, such as dioxins and furans, which are toxic and can cause serious health problems. Indonesia is among the countries with poor air quality. Recorded in the 2023 data, the average Air Quality Index in Indonesia is at a value of 105, falling into the category of Unhealthy for Sensitive Groups (IQAir, 2023)

To prevent this, a strategy is needed that not only reduces air pollution but also increases business productivity and environmental performance. The strategy can be implemented through a method called Green Productivity. Green Productivity is an approach to simultaneously improve productivity and environmental performance. In other words, Green Productivity aims to produce more output using fewer resources and generating less waste and emissions.

One of the furniture industries that uses wood as its main material is PT Sinar Indah Furniture. PT Sinar Indah Furniture is one of the many furniture industries in East Java. The products they sell are diverse and custom-designed, such as dressing tables, dining tables, bed frames, kitchen shelves, and more. In a year, the production demand is also at a high level.

However, behind the high production numbers, this company also generates a significant amount of waste. The company produces solid waste in the form of wood dust and small wood scraps. Additionally, the company also generates liquid waste in the form of a mixture of leftover paint from spray machines, resin, and thinner.

Research on green productivity by Elvis et al. (2021) in their work titled "Environmental Impact Assessment of the Tofu Industry Using Life Cycle Assessment (Case Study: Sari Murni Tofu Factory, Kampung Krajan, Surakarta)" explains that environmental impact assessment using the Life Cycle Assessment method depends on assumptions that are not always accurate. Furthermore, LCA tends to focus on environmental aspects without comprehensively considering social and economic impacts.

METHOD

The quantitative descriptive method plays a crucial role in research by providing a detailed examination of phenomena and research outcomes using numerical data. This method allows researchers to systematically quantify and describe the characteristics of the subjects under study. By relying on statistical measurements and numerical representations, it enables the extraction of objective insights that form the basis for a deeper understanding of the phenomena being analyzed (Creswell, 2014).

In this study, the quantitative descriptive method is employed to explore various aspects related to PT Sinar Indah Furniture, a company engaged in furniture manufacturing. The data utilized in this method is categorized into two types: primary data and secondary data. These data types serve complementary functions, enabling a comprehensive investigation of the research subject. Primary data is essential as it provides first-hand information gathered directly from the sources. In this case, primary data is collected through interviews, questionnaires, and observations. These methods allow researchers to capture real-time, context-specific insights that reflect the immediate circumstances and behaviors of individuals and processes within PT Sinar Indah Furniture.

Interviews offer a platform for in-depth discussions with key personnel in the organization, such as managers, production supervisors, and workers. Through this process, researchers can acquire detailed information about the production processes, challenges, and strategies employed in the company. Questionnaire filling, on the other hand, allows for the collection of standardized responses from a broader audience. This method is especially useful for identifying patterns, trends, and perceptions among stakeholders. Observations complement these methods by providing a non-intrusive way to study activities,

behaviors, and processes in their natural environment.

Secondary data is equally significant in supporting the analysis by providing a historical and contextual foundation for the research. This data is derived from existing records and documents within PT Sinar Indah Furniture. Examples of secondary data include company reports on the production process, records of the quantity of goods produced, details on the input and output in manufacturing processes, and information on waste generation. These data points not only provide a factual basis for analysis but also allow researchers to identify patterns and trends over time. For instance, understanding the volume of waste generated can offer insights into production efficiency and sustainability practices within the company (Miles et al., 2014).

The combination of primary and secondary data enhances the robustness of the quantitative descriptive method. By integrating real-time observations and historical records, researchers can cross-validate findings and ensure a comprehensive understanding of the subject matter. This dual approach is particularly beneficial in industrial contexts, such as that of PT Sinar Indah Furniture, where dynamic production processes interact with established organizational practices.

Through the quantitative descriptive method, researchers can analyze and interpret the numerical data to draw meaningful conclusions about the company's operations. This method not only provides clarity on the current state of production, input-output relationships, and waste management but also lays the groundwork for potential improvements. By relying on numerical evidence, the study ensures objectivity and reliability, making the findings valuable for decision-making and strategic planning.

RESULT and DICUSSION

1. Material Balance

Material balance is used to monitor the flow of production and raw materials involved in the furniture manufacturing process. Material balance is obtained through observation of the production process, which includes input and output analysis (Ghiffari, 2022). From this input and output analysis, the material balance in the production process can be determined. Here is the material balance from October to December.

Table 1 Company's Material Balance on October

October (2023)				
Process	Input		Output	
	Material	Subtotal	Material	Subtotal
Cutting Material	Wood	660	Wood Pieces	30
			Wood Dust	15
Frame Construction	Nail	4,4	Nail	0,3
Install Profi	Wood	15	Wood Pieces	0,25
	Nail Gun	2,2	Nail	0,15
	White Glue	0,5	White Glue Splatter	0,2
Pendempulan	Sanpolac	1,8	Sanpolac Splatter	0,2
	Lem Putih	1,7	White Glue Splatter	0,13
Scrubbing	Sandpaper size 120	0,55	Sandpaper dust	0,54
	Sandpaper size 180	0,4	Sandpaper dust	0,39
Basic Coating	Thinner	4,4	Thinner Splatter	0,2
	Sanpolac	2,75	Sanpolac Splatter	0,2
	Sanding Brown	2,97	Sanding Brown Splatter	0,19
Sanding	Amplas uk 180	0,15	Amplas halus	0,14
Wood Stain Coating	Sanding Brown	2,97	Sanding Brown Splatter	0,2
Clear Doff Coating	Clear Doff	3,96	Clear Doff Splatter	0,3

	Thinner	1	Thinner Splatter	0,1
TOTAL		**704,75**		**48,49**

Table 2 Company's Material Balance on November

November (2023)				
Process	Input		Output	
	Material	Subtotal	Material	Subtotal
Cutting Material	Wood	523	Wood Pieces	27
			Wood Dust	13
Frame Construction	Nail	4	Nail	0,2
Install Profi	Wood	13	Wood Pieces	0,2
	Nail Gun	1,8	Nail	0,13
	White Glue	0,4	White Glue Splatter	0,1
Pendempulan	Sanpolac	1,5	Sanpolac Splatter	0,2
	Lem Putih	1,5	White Glue Splatter	0,13
Scrubbing	Sandpaper size 120	0,4	Sandpaper dust	0,3
	Sandpaper size 180	0,3	Sandpaper dust	0,1
Basic Coating	Thinner	4	Thinner Splatter	0,2
	Sanpolac	2,3	Sanpolac Splatter	0,2
	Sanding Brown	2,2	Sanding Brown Splatter	0,19
Sanding	Amplas uk 180	0,12	Amplas halus	0,1
Wood Stain Coating	Sanding Brown	2,4	Sanding Brown Splatter	0,2
Clear Doff Coating	Clear Doff	3,2	Clear Doff Splatter	0,3
	Thinner	0,8	Thinner Splatter	0,1
TOTAL		**562,92**		**42,65**

Table 3 Company's Material Balance on Desember

December (2023)				
Process	Input		Output	
	Material	Subtotal	Material	Subtotal
Cutting Material	Wood	493	Wood Pieces	19
			Wood Dust	10
Frame Construction	Nail	2,3	Nail	0,1
Install Profi	Wood	9	Wood Pieces	0,18
	Nail Gun	1,5	Nail	0,8
	White Glue	0,3	White Glue Splatter	0,1
Pendempulan	Sanpolac	1,4	Sanpolac Splatter	0,2
	Lem Putih	1,4	White Glue Splatter	0,13
Scrubbing	Sandpaper size 120	0,4	Sandpaper dust	0,3
	Sandpaper size 180	0,3	Sandpaper dust	0,1
Basic Coating	Thinner	4	Thinner Splatter	0,2
	Sanpolac	2,1	Sanpolac Splatter	0,2
	Sanding Brown	2	Sanding Brown Splatter	0,19
Sanding	Amplas uk 180	0,12	Amplas halus	0,1
Wood Stain Coating	Sanding Brown	2,4	Sanding Brown Splatter	0,2
Clear Doff Coating	Clear Doff	3,2	Clear Doff Splatter	0,3
	Thinner	0,8	Thinner Splatter	0,1
TOTAL		**524.22**		**32.3**

Looking at the three tables above, it indicates that the waste residues are at a quite high level, leading to the accumulation of waste residues, which is quite dangerous considering the chemicals used.

2. Productivity Calculation

Productivity is calculated through the observation of input and output in the production process (Ghifarri, 2023). Input data includes variables such as raw materials, energy, and labor. Meanwhile, output data is obtained from the sales of the produced products. Here are the details of input and output prices for the October-December period

Table 4 Input & Output Price Values for October

Variable	Material	Pieces	Unit	Price	Total
	MDF 9mm	33	lembar	Rp113,000	Rp3,729,000
	Sandpaper 120	33	lembar	Rp5,000	Rp165,000
	Sandpaper 180	22	meter	Rp17,000	Rp374,000
	Thinner Dasar	121	liter	Rp15,000	Rp1,815,000
	Sanpolac	22	kg	Rp11,500	Rp253,000
	Sanding Brown	55	liter	Rp55,000	Rp3,025,000
Material	Clear Doff	55	liter	Rp55,000	Rp3,025,000
	Thinner Special	77	liter	Rp21,000	Rp1,617,000
	White Glue	11	bungkus	Rp17,500	Rp192,500
	Nail Gun F30	1	dus	Rp38,000	Rp38,000
	Nail Gun F25	1	dus	Rp32,500	Rp32,500
	Nail Gun F20	1	dus	Rp26,000	Rp26,000
	Glass uk 65x135	11	lembar	Rp190,000	Rp2,090,000
Energy	Electricity			Rp4,200,000	Rp4,200,000
Manpower	Salary			Rp1,510,000	Rp1,510,000
	Total Input				**Rp22,092,000**
	Total Output				**Rp28,400,000**
	Keuntungan				**Rp6,308,000**

Table 4 shows the price of each material used in the production process of the Coffee Table in October. In the table, the total input cost is Rp 22,092,000 and the total output cost is Rp 28,400,000, resulting in a profit of Rp 6,308,000 for the month of October.

Table 5 Input & Output Price Values for November

Variable	Material	Pieces	Unit	Price	Total
	MDF 9mm	27	lembar	Rp113,000	Rp3,051,000
	Sandpaper 120	27	lembar	Rp5,000	Rp135,000
	Sandpaper 180	18	meter	Rp17,000	Rp306,000
	Thinner Dasar	99	liter	Rp15,000	Rp1,485,000
	Sanpolac	18	kg	Rp11,500	Rp207,000
	Sanding Brown	45	liter	Rp55,000	Rp2,475,000
Material	Clear Doff	45	liter	Rp55,000	Rp2,475,000
	Thinner Special	63	liter	Rp21,000	Rp1,323,000
	White Glue	9	bungkus	Rp17,500	Rp157,500
	Nail Gun F30	1	dus	Rp38,000	Rp38,000
	Nail Gun F25	1	dus	Rp32,500	Rp32,500
	Nail Gun F20	1	dus	Rp26,000	Rp26,000
	Glass uk 65x135	9	lembar	Rp190,000	Rp1,710,000
Energy	Electricity			Rp4,200,000	Rp4,200,000
Manpower	Salary			Rp1,095,000	Rp1,095,000

Total Input	**Rp18,716,000**
Total Output	**Rp14,450,000**
Keuntungan	**-Rp4,266,000**

Table 5 shows the price of each material used in the production process of the Coffee Table in November. In the table, it is noted that the total input cost is Rp 18,716,000 and the total output cost is Rp 14,450,000, resulting in a loss of Rp 4,266,000 in November.

Table 6 Input & Output Price Values for December

Pengeluaran dana Desember					
Variable	Material	Pieces	Unit	Price	Total
Material	MDF 9mm	18	lembar	Rp113,000	Rp2,034,000
	Sandpaper 120	18	lembar	Rp5,000	Rp90,000
	Sandpaper 180	12	meter	Rp17,000	Rp204,000
	Thinner Dasar	66	liter	Rp15,000	Rp990,000
	Sanpolac	12	kg	Rp11,500	Rp138,000
	Sanding Brown	30	liter	Rp55,000	Rp1,650,000
	Clear Doff	30	liter	Rp55,000	Rp1,650,000
	Thinner Special	42	liter	Rp21,000	Rp882,000
	White Glue	6	bungkus	Rp17,500	Rp105,000
	Nail Gun F30	1	dus	Rp38,000	Rp38,000
	Nail Gun F25	1	dus	Rp32,500	Rp32,500
	Nail Gun F20	1	dus	Rp26,000	Rp26,000
	Glass uk 65x135	6	lembar	Rp190,000	Rp1,140,000
Energy	Electricity			Rp4,200,000	Rp4,200,000
Manpower	Salary			Rp830,000	Rp830,000
Total Input					**Rp14,009,500**
Total Output					**Rp12,300,000**
Keuntungan					**-Rp1,709,500**

Table 6 shows the price of each material used in the production process of the Coffee Table in December. In the table, it is known that the total input price is Rp 14,009,500 and the total output price is Rp 12,300,000, resulting in a loss of Rp 1,709,500 in December.

After the input and output of the company's production are known, the productivity calculation for the months of October to December is then carried out.

Productivity for October

$$Productivity = \frac{Output}{Input}\ x\ 100$$
$$= \frac{28.400.000}{22.092..000}\ x\ 100\%$$
$$= 128\%$$

Productivity is at a very high level of 128%, indicating that the company has successfully reached its maximum operational capacity.

Productivity for November

$$Productivity = \frac{Output}{Input}\ x\ 100$$
$$= \frac{14.450.000}{18.716.000}\ x\ 100\%$$
$$= 77\%$$

Productivity dropped significantly to 77%, indicating a sharp decline in operational performance compared to the previous month.

Productivity for December

$$Productivity = \frac{Output}{Input}\ x\ 100$$
$$= \frac{12.300.000}{14.009.000}\ x\ 100\%$$
$$= 87\%$$

Productivity slightly increased to 87%, but it is still far below the productivity levels of October. This indicates that despite

recovery efforts, productivity remains at a low level.

Table 7 Company's Average Productivity Data from October to December

Period	Productivity
October	128%
November	77%
December	87%
Average	**97,3%**

Based on Table 7, the company experienced significant fluctuations in productivity during the last quarter, with a drastic decline after October. Although there was a slight increase in December, the company still needs to identify the causes of this decline and take steps to restore productivity to optimal levels.

3. Waste Identification

The waste identification process is based on the observation of the material balance that has been conducted. The waste identification analysis aims to determine the types of waste generated and their impact. Here are the details of the waste identification table:

Table 8 Waste Identification

No	Waste Type	Waste Form	Waste Sources	Impact of Waste	Waste Quantity
1	Wood Chips	Solid	Wood Cutting Process	Excessive accumulation of waste in warehouses	563kg
2	Wood Dust	Solid	Wood Sawing Process	Causes health problems such as respiratory disorders	6,24 Kg
3	Glass Fragments	Solid	Glass Cutting	Excessive accumulation of waste in warehouses	170kg
4	Thinner, Resin Mixture	Liquid	Table Lamination Process	Environmental pollution with hazardous chemicals	20,8l

Based on Table 8, there are two categories of waste, namely solid and liquid, which are then divided into four types of waste generated during the table production process. These wastes include wood scraps, wood dust, glass shards, and a mixture of thinner and resin. Among all these wastes, solid waste has the largest quantity, which is 563 kg. The large amount of this waste can affect the quality of water, soil, and air in the surrounding environment.

4. Calculation of the Weight for Each Parameter

The calculation of the Environmental Performance Index is conducted to assess the extent of pollution's impact on the surrounding environment. In the calculation of the Environmental Performance Index, weighting is required, which is obtained through the distribution of questionnaires. The questionnaire was distributed to 10 employees and the owner of PT Sinar Indah Furniture. Here are the results of the questionnaire that have been collected.

Table 9 Questionnaire Score Data

No	Question	Information				
		1 (Not Dangerous at All)	**2 (Not Dangerous)**	**3 (Somewhat Dangerous)**	**4 (Dangerous)**	**5 (Very Dangerous)**
1	Biological Oxygen Demand (BOD) for	5	4			

	human and environmental health					
2	Chemical Oxygen Demand (COD) for human and environmental health	>5	3			
3	Total Suspended Solid (TSS) for human and environmental health	3	5		5	
4	Power of Hydrogen (pH) for human and environmental health	4			5	
5	Mercury (Hg) for human and environmental health	1			5	4
6	Cadmium (Cd) for human and environmental health	5	3			5
7	Lead (Pb) for human and environmental health	3				7

After obtaining the questionnaire scores, the hazard level weighting calculation is performed. Here are the results of the weighting calculation.

BOD

$$Weight\ (Wi) = \frac{\sum_{i=1}^{n} Xi\ .Si}{n} = \frac{(1x0)+(2x0)+(3x0)+(4x6)+(5x4)}{5} = \frac{44}{5} = 8{,}8$$

COD

$$Weight\ (Wi) = \frac{\sum_{i=1}^{n} Xi\ .Si}{n} = \frac{(1x0)+(2x0)+(3x2)+(4x5)+(5x3)}{5} = \frac{41}{5} = 8{,}2$$

TSS

$$Weight\ (Wi) = \frac{\sum_{i=1}^{n} Xi\ .Si}{n} = \frac{(1x0)+(2x0)+(3x0)+(4x6)+(5x4)}{5} = \frac{44}{5} = 8{,}8$$

pH

$$Weight\ (Wi) = \frac{\sum_{i=1}^{n} Xi\ .Si}{n} = \frac{(1x0)+(2x0)+(3x0)+(4x4)+(5x6)}{5} = \frac{46}{5} = 9{,}2$$

Mercury (Hg)

$$Weight\ (Wi) = \frac{\sum_{i=1}^{n} Xi\ .Si}{n} = \frac{(1x0)+(2x0)+(3x1)+(4x5)+(5x4)}{5} = \frac{43}{5} = 8{,}6$$

Cadium (Cd)

$$Weight\ (Wi) = \frac{\sum_{i=1}^{n} Xi\ .Si}{n} = \frac{(1x0)+(2x0)+(3x2)+(4x3)+(5x5)}{5} = \frac{43}{5} = 8{,}6$$

Plumbun (Pb)

$$Weight\ (Wi) = \frac{\sum_{i=1}^{n} Xi\ .Si}{n} = \frac{(1x0)+(2x0)+(3x0)+(4x3)+(5x7)}{5} = \frac{47}{5} = 9{,}4$$

Table 10 Questionnaire Score Data and Parameters Weight

No	Question	1 (Not Dangerous at All)	2 (Not Dangerous)	3 (Somewhat Dangerous)	4 (Dangerous)	5 (Very Dangerous)	Weight
1	Biological Oxygen Demand (BOD) for human and environmental health		4		5		
2	Chemical Oxygen Demand			5	3	2	

	(COD) for human and environmental health						
3	Total Suspended Solid (TSS) for human and environmental health		3		4		
4	Power of Hydrogen (pH) for human and environmental health		4				
5	Mercury (Hg) for human and environmental health	1		3		4	86
6	Cadmium (Cd) for human and environmental health			3			
7	Lead (Pb) for human and environmental health		3				

Calculation of EPI (Environmental Performance Index) and Deviations

After the weights for each parameter are determined, the next step is to calculate the environmental performance or Environmental Performance Index (EPI) by considering the level of hazard. These are the EPI calculation results that provide an overview of the level of hazard to the environment.

Table 11 Data for standard quality calculations

Indicator	Weight (Wi)	Unit	Test Result	Quality Standards	Explanation
Biological Oxygen Demand (BOD)	88	mg/L	70	50	Does Not Meet Quality Standards
Chemical Oxygen Demand (COD)	88	mg/L	180	100	Does Not Meet Quality Standards
Total Suspended Solid (TSS)	88	mg/L	120	100	Does Not Meet Quality Standards
Power of Hydrogen (pH)	34	-	6.0-9.0	-	Does Not Meet Quality Standards
Mercury (Hg)	86	µg/L	0.3	-	Does Not Meet Quality Standards
Cadmium (Cd)	86	mg/L	0.6	0.1	Does Not Meet Quality Standards
Plumbum (Pb)	9.4	mg/L	0.25	0.03	Does Not Meet Quality Standards

Based on table 11, it is evident that all parameters do not meet the established quality standards. Quality standards serve as a benchmark to ensure that waste is safe for the environment. If a company disposes of waste that meets the quality standards, then the waste is considered safe and does not have a significant impact on the environment. After the analysis of waste content is conducted, the next step is to calculate the deviation from the established quality standards. The calculation of deviations is carried out as follows.

a. Deviation Calculation (Pi)

BOD

$$Pi = \frac{Standart-Analysis}{Standart}\ x\ 100\% = \frac{50-70}{50} x\ 100\% = -0{,}4\%$$

COD

$$Pi = \frac{Standart-Analysis}{Standart}\ x\ 100\% = \frac{100-180}{100} x\ 100\% = -0{,}8\%$$

TSS

$$Pi = \frac{Standart-Analysis}{Standart} x\ 100\% = \frac{100-120}{100} x\ 100\% = -0{,}2\%$$

pH

$$Pi = \frac{Standart-Analysis}{Standart}\ x\ 100\% = \frac{6-5.4}{6} x\ 100\% = 0{,}006\%$$

Hg

$$Pi = \frac{Standart-Analysis}{Standart}\ x\ 100\% = \frac{0{,}2-0{,}3}{0{,}2} x\ 100\% = -0{,}5\%$$

Cd

$$Pi = \frac{Standart-Analysis}{Standart}\ x\ 100\% = \frac{0{,}1-0{,}6}{0{,}1} x\ 100\% = -0{,}5\%$$

Pb

$$Pi = \frac{Standart-Analysis}{Standart}\ x\ 100\% = \frac{0{,}3-0{,}25}{0{,}3}\ x\ 100\% = -0{,}17\%$$

From the calculations above, it can be seen that several indicators have negative values from the generated waste. If the deviation result is negative, it means that the waste deviates from the established quality standards. Although the pH indicator is positive, the number is very small because it is far from the 50% mark. After the deviation is calculated, a table is created as follows.

Table 12 Deviation Data for Each Indicator

No	Indicator	Weight (Wi)	Unit	Test Result	Standards	Explanation	Deviation
1	Biological Oxygen Demand (BOD)	88	mg/L	50	40	Does Not Meet Quality Standards	0.04
2	Chemical Oxygen Demand (COD)	82	mg/L	180	100	Does Not Meet Quality Standards	0.08
3	Total Suspended Solid (TSS)	88	mg/L	120	100	Does Not Meet Quality Standards	0.02
4	Power of Hydrogen (pH)	54	-	9.2	6.0-9.0	Does Not Meet Quality Standards	0.006
5	Mercury (Hg)	86	µg/L	0.3	0.2	Does Not Meet Quality Standards	0.50%
6	Cadmium (Cd)	86	mg/kg	0.6	0.1	Does Not Meet Quality Standards	0.50%
7	Plumbum (Pb)	94	mg/kg	0.25	0.03	Does Not Meet Quality Standards	-0.17%

b. EPI Index

The Environmental Performance Index (EPI) is calculated by multiplying the weight value and the deviation value. If either of these values is unknown, the EPI calculation cannot be performed. Therefore, it is important to ensure that every element of the calculation is carefully considered. Here are the calculations

for the Environmental Performance Index for each parameter.

BOD

$$Index\ EPI = \sum_{i=1}^{K} Wi.Pi = 8{,}8\ x - 0{,}4 = -3.52$$

COD

$$Index\ EPI = \sum_{i=1}^{K} Wi.Pi = 8{,}2\ x - 0{,}8 = -6.56$$

TSS

$$Index\ EPI = \sum_{i=1}^{K} Wi.Pi = 8{,}8\ x - 0{,}2 = -1.76$$

pH

$$Index\ EPI = \sum_{i=1}^{K} Wi.Pi = 9{,}2\ x\ 0.006 = 0.0552$$

Hg

$$Index\ EPI = \sum_{i=1}^{K} Wi.Pi = 8{,}6\ x - 0{,}5 = -4{,}3$$

Cd

$$Index\ EPI = \sum_{i=1}^{K} Wi.Pi = 8{,}6\ x - 0{,}5 = -4{,}3\ 22$$

Pb

$$Index\ EPI = \sum_{i=1}^{K} Wi.Pi = 9{,}4\ x - 0{,}17 = -1.598$$

After calculating the EPI index for each parameter, the next step is to create a total EPI index table by summing all the EPI index values.

Table 13 EPI Index Each Indicator

No	Indicator	Weight (Wi)	Unit	Test Result	Standards	Explanation	Deviation	EPU Index
1	Biological Oxygen Demand (BOD)	88	mg/L	70	50	Out of Standards	-0.4	-3.52
2	Chemical Oxygen Demand (COD)	82	mg/L	180	100	Out of Standards	0.8	6.56
3	Total Suspended Solid (TSS)	88	mg/L	120	100	Out of Standards	0.02	0.165
4	Power of Hydrogen (pH)	92	-	9.2	6.0-9.0	Out of Standards	0.006	0.0552
5	Mercury (Hg)	86	mg/kg	0.3	0.2	Out of Standards	-0.50%	-4.3
6	Cadmium (Cd)	86	mg/kg	0.6	0.4	Out of Standards	-0.50%	-4.3
7	Plumbum (Pb)	94	mg/kg	0.25	0.03	Out of Standards	0.17%	-1.598
	Total EPU Index							21.9828

The table above shows that out of 7 indicators, only one has a positive value. Environmental performance is considered good if the Environmental Performance Index (EPI) value is positive, and it will be even better if the index reaches or exceeds 100. Therefore, environmental performance is still classified as very low because the total EPI value is -21.9828.

5. Identification of Problem Causes and Goal Setting

The table above shows that out of 7 indicators, only one has a positive value. Environmental performance is considered good if the Environmental Performance Index (EPI) value is positive, and it will be even better if the index.

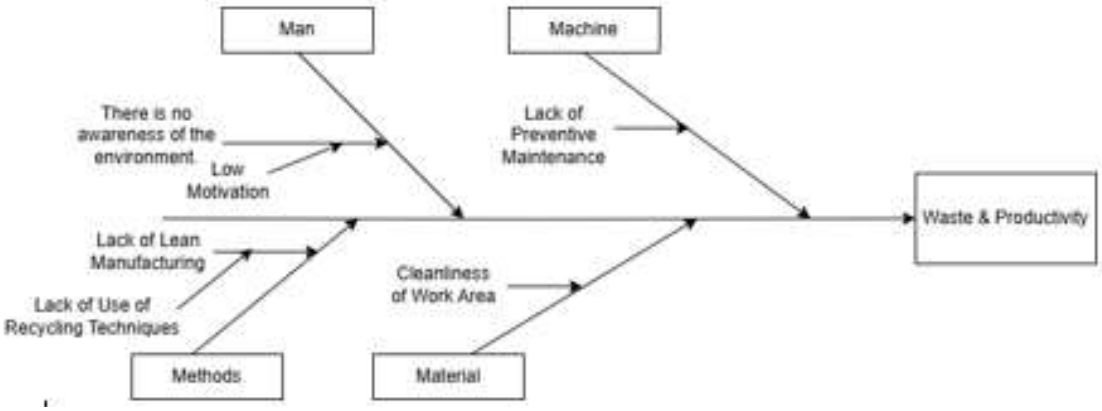

Figure 1 Waste and Productivity Fishbone Diagram

Based on the observations that have been made, four categories of causes have been identified, namely Man, Machines, Methods, and Materials. In the Man category, there are two causes: lack of environmental awareness and low work motivation. In the Machines category, there is one cause: lack of preventive maintenance. In the Methods category, there are two causes: lack of lean manufacturing and lack of use of recycling techniques. In the Materials category, there is one cause: cleanliness of the work area.

6. Determination of goals and targets

Based on the results of the identification, the next step is to set the goals and targets to be achieved in addressing the identified issues. These goals and targets can be seen in the table below.

Table 14 Company Target and Goals

Goals	Target
a. Increasing Productivity b. Reducing waste c. Improving environmental performance	a. Increasing the company's revenue b. Utilization of waste that is not properly processed

7. Initial GPI Calculation

Green Productivity Index Green Productivity Index emerged as a strategy to identify and address the issues that arise. The calculation of Green Productivity is used to understand the balance between economic performance or productivity and environmental performance. The calculation of the company's Green Productivity is as follows.

$$GPI = \frac{Productivity\ Level}{Environmental\ Impact}$$
$$= \frac{97{,}333}{-21{,}9828}$$
$$= -4{,}428$$

The calculations above indicate that the company's green productivity is currently in a negative condition. This means that the environmental performance is worse than its economic performance, or in other words, the environmental impact caused is greater than the economic benefits obtained. This shows that the company needs to take immediate action to improve its environmental performance and reduce the negative impact on the environment in order to achieve a better balance between economic productivity and environmental responsibility

Table 15 GPI Waste

Period	Solid Waste (Kg)	Liquid Waste (L)
October	311.74	8.8
November	255.06	7.2
December	172.44	4.8
Sub Total	739.24	20.8
Grand Total	760.04	

$$GPwaste\ solid = \frac{Waste}{Input\ Material}$$
$$= \frac{739{,}24}{1.733{,}82}$$
$$= 0{,}4263$$
$$GPwaste\ liquid = \frac{Waste}{Input\ Material}$$
$$= \frac{20{,}8}{57{,}95}$$
$$= 0{,}3588$$

The input material was obtained from the summation of waste type inputs. From the calculations above, the result for solid waste (GP) is 0.4263, and for liquid waste, the result is 0.3588

8. Development of Alternative Solutions

The development of alternative solutions is based on the problems faced and the conditions at PT Sinar Indah Furniture. The utilization of wood waste has become an important part of waste management. PT Sinar Indah Furniture has not yet addressed the waste generated in its operations. This research attempts to provide an alternative solution that balances environmental improvement and the company's productivity.

By utilizing the waste generated by the company and developing it into new sellable products, the company can increase productivity by reducing the amount of waste left after the production of goods. The new product is particle board. (Particle Board). Input, Output, and Profit calculations can be seen in the table below

Table 16 Economic Value of Particle Board Variable

Variable	Information	Unit	Material Total	Price	Total
Material	Wood Powder	kg	6,24	-	-
	White Glue 1L	liter	3	Rp50,000	Rp150,000
	Alcohol 96% 500ml	ml	1	Rp13,900	Rp13,900
	Resin 1 liter	pcs	1	Rp135,000	Rp135,000
Tools	Hydraulic Press Machine	pcs	1	-	-
	Sieve	pcs	1	-	-
Total Input					**Rp298,900**
Production Output	Product Results	pcs	5	Rp155,000	Rp775,000
Total Output					**Rp775,000**

Profit	**Rp476,100**

After the profits were known, productivity was increased following the utilization of solid waste.

Table 17. Increase In Output After Utilizing Waste

Variable	Information	Indicator	Unit	Price	Total
Material	MDF 9mm	18	sheet	Rp113,000	Rp2,034,000
	Amplas 120	18	sheet	Rp5,000	Rp90,000
	Amplas 180	12	meter	Rp17,000	Rp204,000
	Thinner	66	liter	Rp15,000	Rp990,000
	Sanpolac	12	kg	Rp11,500	Rp138,000
	Sanding Brown	30	liter	Rp55,000	Rp1,650,000
	Clear Doff	30	liter	Rp55,000	Rp1,650,000
	Thinner Special	42	liter	Rp21,000	Rp882,000
	White Glue	6	pcs	Rp17,500	Rp105,000
	Paku Tembak F30	1	box	Rp38,000	Rp38,000
	Paku Tembak F25	1	box	Rp32,500	Rp32,500
	Paku Tembak F20	1	box	Rp26,000	Rp26,000
	Glass size 65x135	6	sheet	Rp190,000	Rp1,140,000
Energy	Electricity			Rp4,200,000	Rp4,200,000
Labor	Salary			Rp830,000	Rp830,000
Total Input					**Rp14,009,500**
Output	**Table selling**	**6**	**pcs**	**Rp12,300,000**	**Rp12,300,000**
	Particle Board Selling	**15**	**pcs**	**Rp2,325,000**	**Rp2,325,000**
Total Output					**Rp14,625,000**
Profit					**Rp615,500**

9. New Productivity Calculation

$$Productivity = \frac{Output}{Input}\ x\ 100$$

$$= \frac{14.625.000}{14.009.500}\ x\ 100\%$$

$$= 104\%$$

After the implementation of the engineering plan for using waste as liquid organic fertilizer, an increase in productivity was observed. Initially, productivity was recorded at 89% in December, and increased to 104% the following month, assuming the production volume remained the same as in December. It can be concluded that the production of particle board will increase productivity and reduce the amount of production waste.

CONCLUSION

Based on the analysis, PT Sinar Indah Furniture experiences fluctuations in productivity, reflecting the challenges in achieving performance stability under the current operational conditions. The company's environmental performance, measured through the Environmental Performance Index (EPI) and the Green Productivity Index (GPI), initially showed low values. This indicates that the conventional approach to waste management still needs to be improved to achieve more sustainable performance. As a solution, this research proposes the utilization of solid waste as a raw material for the production of particle board, which can not only increase the economic value of the company but also reduce the volume of waste. With this method, the company is expected to improve productivity while also supporting sustainability efforts.

Overall, this research shows that the implementation of green productivity practices can help PT Sinar Indah Furniture achieve a better balance between productivity and environmental responsibility. The implementation of these sustainable solutions

not only has a positive impact on operations but also supports the achievement of long-term environmentally friendly performance targets.

The author suggests that the company increase employee awareness about the importance of waste management through regular training. This training aims to help employees understand their role in maintaining environmental cleanliness and complying with applicable regulations. Additionally, the company can implement the 3R concept (Reduce, Reuse, Recycle) to reduce waste by minimizing the use of hazardous materials, reusing still usable materials, and recycling waste that can be processed again, thereby increasing efficiency and reducing waste.

For future research, it is recommended to develop methods for utilizing other types of waste, such as liquid waste, to enhance productivity and environmental performance. Comparative studies on the application of green productivity in various manufacturing industries can also provide more comprehensive data regarding the effectiveness of this method. Furthermore, the long-term impact analysis of green productivity implementation on environmental sustainability and company profitability needs to be further explored, with long-term measurements to evaluate the success of the implementation in depth.

REFERENCES

Ahmad Sofyan. (2023). PEMANFAATAN LIMBAH KAYU DENGAN MENGGUNAKAN METODE GREEN PRODUCTIVITY PADA UD. DONGAN SAHUTA MEDAN.
https://repositori.uma.ac.id/handle/123456789/19717

Citraresmi, A. D. (2023). Implementation of green productivity as an effort to increase productivity and environmental performance of milk agroindustry. AIP Publishig. https://doi.org/10.1063/5.0119228

Elvis Umbu Lolo, R. I. (2021). Penilaian Dampak Lingkungan Industri Tahu Menggunakan Life Cycle Assessment Assessment (Studi Kasus: Pabrik Tahu Sari Murni Kampung Krajan, Surakarta). Jurnal Serambi Engineering, Vol 6, No 4. https://doi.org/10.32672/jse.v6i4.3480

Farhan, F. (2023). Pengukuran Produktivitas menggunakan Metode Green Produktiviti untuk Meningkatkan Produktivitas dalam Penanganan Limbah Cair di PT Gensap Makmur Sejahtera. Jurnal BSI IMTECHNO, Vol. 4 No. 2.

Ghiffari Zaka Wali, W. H. (2022). Analisis Kinerja Lingkungan dengan Metode Green Productivity pada Limbah Cair Pabrik Tahu FN Gresik. Al-Kharaj: Jurnal Ekonomi, Keuangan & Bisnis Syariah, Volume 4 No 4, 1227-1239.

Handayani, M. S. (2023). Environmental Performance Analysis Using the Green Productivity Method on Convection Waste Baper Shop Surabaya. International Journal of Business and Applied Economics (IJBAE), Vol. 2, No. 5, 2023: 803-818.

Herdian Dwimas, e. a. (2023). PENINGKATAN PRODUKTIVITAS DAN KINERJA LINGKUNGAN PADA INDUSTRI KAYU MENGGUNAKAN METODE GREEN PRODUCTIVITY. Wicida Sebatik, Vol. 27 No. 1 .

Hidayat, R. (2019). Waste Management and Green Productivity in Increased Productivity and Environmental Performance. International Journal of GEOMATE , 16(55).

Hidup, K. K. (2023). Sistem Informasi Pengelolaan Sampah Nasional. Retrieved from https://sipsn.menlhk.go.id/sipsn/public/data/komposisi#parallax

Indriyani, R. (2021). PENGARUH KINERJA LINGKUNGAN TERHADAP KINERJA KEUANGAN DENGAN CORPORATE SOCIAL RESPONSIBILITY SEBAGAI VARIABEL INTERVENING (Studi pada Perusahaan Manufaktur yang terdaftar di BEI periode 2017-2019). REPOSITORY STIE JAKARTA.

Kodrat, K. F. (2023). Peningkatan Produktivitas Dan Kinerja Lingkungan Dengan Pendekatan Green Productivity Pada Industri Tahu Di Kecamatan Mabar Medan. Jurnal UISU.

Mu'alim, R. H. (2019). WASTE MANAGEMENT ANDGREEN PRODUCTIVITYIN INCREASED PRODUCTIVITY AND ENVIRONMENTALPERFORMANCE. International Journal of GEOMATE, 145-152.

(2024, March 05). Retrieved from CNBC: https://www.cnbcindonesia.com/news/20240305185933-8-519917/video-prospek-industri-furniture-untuk-perekonomian-indonesia

Mukti, L. (2023). PENINGKATAN PRODUKTIVITAS DAN KINERJA LINGKUNGAN PADA INDUSTRI KAYU MENGGUNAKAN

METODE GREEN PRODUCTIVITY. Sebatik, Vol. 27 No. 1.

Muslimah, E. (2020). Waste Reduction in Green Productivity in Small and Medium-Sized Enterprises of Kampoeng Batik Laweyan. International Journal of Emerging Trends in Engineering Research, 8(6):2360-2364.

Prasetyo, G. (2020). Inovasi Pengolahan Limbah Industri Mebel Guna Menambah Pendapatan Perusahaan (Studi Kasus UD. Berkah Mebel). Repository Universitas Kadiri.

Ruben Ferdian, N. E. (2024). HUBUNGAN PAPARAN DEBU KAYU DENGAN PERMASALAHAN SISTEM RESPIRASI PADA PEKERJA INDUSTRI MEBEL: SEBUAH TINJAUAN. Media Ilmiah Kesehatan Indonesia, Vol. 2 No. 3 .

Septifani, R. (2020). Green productivity analysis of tempeh chips production. IOP Conference Series: Earth and Environmental Science.

Wulandari, P. D. (2021). ANALISIS PRODUKTIVITAS DAN KINERJA LINGKUNGAN RUMAH POTONG AYAM DENGAN PENDEKATAN GREEN PRODUCTIVITY (Studi kasus RPA Madani). Repository Unhas.