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Implementation of End-to-End Circular Economy in Dairy Farming: A Case Study of KOP SAE Pujon, Indonesia

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ABSTRACT: This study was conducted at KOP SAE, Pujon District, Malang Regency, East Java Province, with the aim of identifying the application of the 5R principles (Reduce, Reuse, Recycle, Refurbish, and Renew) in the circular economy across three main sectors: the upstream sector (dairy cattle farming), the processing sector (dairy processing industry), and the downstream sector (cafe units and souvenir shops). Additionally, this study aims to explore the economic potential generated from the implementation of these principles. The respondents in this study consisted of three key informants selected purposively, namely (1) the Head of the Dairy Cattle Development and Resource Unit, (2) the Head of the Cattle Maintenance Unit, and (3) the Head of the Cafe and Souvenir Shop Unit. Data collection was conducted over a one-month period, from May 21 to June 21, 2024, using three main methods: questionnaire distribution, in-depth interviews, and documentation. The data obtained were analyzed based on the 5R principles of the circular economy to measure the level of sustainability in each sector. The research results indicate that the three sectors observed have made significant efforts to apply the 5R principles, but their benefits for the environment, society, and economy have not been fully realized. In the upstream sector (dairy cattle farming), the application of the 5R principles averaged over 51%. In the milk processing sector, the application was higher, averaging above 76%. Meanwhile, in the downstream sector (cafés and souvenir shops), the implementation rate of the 5R principles averaged over 50%. From an economic perspective, the implementation of the circular economy has produced tangible impacts. The utilization of biogas from livestock waste can generate approximately 120 3-kg LPG cylinders every year, which, when converted economically, is equivalent to IDR 2,400,000. The R/C ratio from biogas utilization reaches 1.11, indicating that this venture is profitable and economically viable. Pasteurized milk processing generates an added value of IDR 9,750/liter of raw material, with an added value ratio of 49.3%. Meanwhile, yogurt processing provides a higher added value of IDR 17,160/liter and generates a company profit of 59.27%. The profit margin from the sale of dairy products by KOP SAE reaches 20%, indicating that the company's profitability is in a healthy category.

KEYWORDS: Circular Economy, Dairy Cows, Livestock Farming, KOP SAE

INTRODUCTION

East Java Province, with a total of 282,364 cows (55.7%), is the center of cow milk production in Indonesia (BPS, 2024). Malang Regency is the region with the second largest dairy cow population in East Java, with 90,237 cows. Of these, 20,574 belong to the Sinau Andhandani Economic Cooperative (KOP SAE) in Pujon. KOP SAE Pujon is a pioneer dairy cooperative in Indonesia, established in 1962 and has been partnering with PT Nestle since 1975. KOP SAE operates its own dairy farm with a herd of 200 cows (upstream), has milk processing facilities (processing), and operates a café and souvenir shop (downstream). Currently, livestock waste products—including liquid, solid, and gas waste—cannot be fully processed. This is evident in the biogas system at KOP SAE's dairy farm, which cannot fully process waste due to capacity limitations. KOP SAE's dairy farm produces approximately 4,000–5,000 kg of manure daily.

Livestock products themselves contribute to greenhouse gas emissions more than most other food sectors. These emissions are caused by various factors, including feed production, enteric fermentation, animal manure, and land use change (FAO, 2017). Beef cattle (45%) and dairy cattle (26%) are the largest contributors to greenhouse gas emissions (Grossi et al., 2019). However, despite their potential to damage ecosystems with harmful effects, animal manure can be considered a valuable resource if utilized within a circular economy framework. The circular economy is a sustainable development strategy that minimizes waste, maintains long-term value, uses resources efficiently, protects the environment, and provides socioeconomic benefits (Xijie et al., 2023). By 2030, the circular economy in Indonesia is predicted to be economically, environmentally, and socially beneficial (Bappenas, 2021).

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The implementation of the circular economy concept at KOP SAE is crucial. Given that the circular economy can be applied at all levels, from the micro level (businesses and customers), meso level (eco-industrial zones), to the macro level (cities, provinces, and countries) (Latif et al., 2023). The circular economy has been implemented in various countries and has proven to have a significant impact on sustainable development (Kounani et al., 2024; Sadeghpour and Afshar, 2024; Knable et al., 2022; Castro et al., 2022). The circular economy is projected to reach maturity by 2036 and decline by 2056, presenting significant opportunities for the development of this sector (Hollas et al., 2022).

Circular economy activities focus on the 5Rs, namely Reduce, Reuse, Recycle, Refurbish, and Renew. This study describes the application of the 5R circular economy in the upstream, processing, and downstream sectors (End-to-End model) at KOP SAE. The integration of upstream, processing, and downstream sectors (End-to-End model) at KOP SAE covers the entire process from start to finish. The End-to-End model can serve as a traceability system to monitor and manage the transition from a linear to a circular supply chain. Changes at the consumer level (downstream) drive changes in the supply chain (upstream-processing) up to the corporate level as policy makers (Anastasiadis et al., 2022). A good traceability system can prevent food safety crises that could endanger public health, resulting in economic losses for stakeholders, damage to business reputation, and ultimately loss of consumer trust (Zhang et al., 2016). Through an end-to-end model, KOP SAE can improve business efficiency, reduce operational costs, ensure product quality, enhance customer satisfaction, boost productivity, and increase visibility (Tanjung, 2023).

This research is important because the implementation of the circular economy in Pujon District is still not optimal, especially in the livestock sector. Many farmers face difficulties in managing livestock waste, which causes most of the waste to be disposed of directly into rivers (Fadil et al., 2020; Utomo et al., 2019). In addition, research on the circular economy in Pujon District is still limited. Similarly, studies on the circular economy are still dominated by waste management strategies (Nazhifah and Rimantho, 2024). Therefore, considering the urgency and gaps identified, this study is expected to make a significant contribution to accelerating the implementation of the circular economy in the dairy farming sector.

METHOD

This study was conducted at KOP SAE Pujon, Pujon District, Malang Regency, East Java, from May 21 to June 21, 2024. This study used a survey method with a qualitative approach. Data were collected using questionnaires, structured interviews, observations, and documentation studies. The sample was determined using purposive sampling. There were three respondents, namely (1) the Head of the Dairy Cattle Development and Member Resources Unit, (2) the Head of the Cattle Maintenance Unit, and (3) the Head of the Personnel Unit. Primary data in this study consisted of questionnaire results, observations, documentation, and interview transcripts with relevant parties. Secondary data was obtained through literature review from various KOP SAE reports, books, articles, and journals related to this study.

Data Analysis

Costs and Revenue

Production costs are expenses incurred to obtain the factors of production and raw materials needed to produce goods. In general, costs are the value spent by producers to fulfill all factors of production in order to achieve maximum results. There are two types of costs: variable costs and fixed costs. Variable costs are costs whose amounts can fluctuate in response to changes in production volume, while fixed costs are costs that remain unchanged regardless of changes in production volume, and fixed costs can be used in more than one production process (Habib and Risnawati, 2017).

According to Tommy (2017), the revenue of a business is the product of the volume of production and the selling price of the products produced. The selling price is the transaction price between the buyer and the producer for each commodity. The units used are those commonly used between sellers and buyers, such as kilograms (kg), tons, quintals (kw), bundles, and others. Revenue is formulated as follows:

$$R = Py \times Y$$

Explanation:
R = Revenue
Py = Production Price (IDR)/kg
Y = Total Production

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Meanwhile, according to Sukirno (in Ngatini, 2017), income is the result in the form of money or other material assets derived from the use of wealth or free human services. Income can also be defined as the total revenue minus the total overall costs during the production process. Income is formulated as follows:

$$I = R - TC$$

Explanation:
I = Income
R = Renevue
TC = Total Cost

R/C Ratio Analysis

The R/C value is a measure that shows the ratio between business revenue (R) and total costs (C). Based on the R/C value, it can be determined whether a business is profitable or unprofitable (Nugroho and Mas'ud, 2021).

R/C = Total Revenue/Total Cost

Explanation:
R = Revenue
C = Cost

There are three criteria in the calculation, namely:
a. If R/C > 1, it means that it is profitable.
b. If R/C = 1, it means that it is break-even.
c. If R/C < 1, it means that it is a loss.

Value Added

Value added is an increase in the value of a commodity as a result of further processing, transportation, or storage during the production process. According to Hayami et al. in Zaini, et al. (2019), in the processing stage, value added can be defined as the difference between the value of the product and the cost of raw materials and other inputs (excluding labor).

The method used in the value added analysis refers to Zaini et al. (2019) using the Hayami method. The Hayami method was chosen not only to determine the value added of a product but also to determine the conversion factor of a business, the labor coefficient in a business, the value added every unit of product, the contribution of other inputs, labor income, and the profit of a business. The components of the Hayami method calculation are presented in Table 1.

Table 1. Hayami Model Value Added

No	Variable	Value	Pasteurized Milk (Liter)	Yoghurt (Liter)
Output, Input, and Price				
1	Output (liters/production)	(1)		
2	Raw materials/input (liters/production)	(2)		
3	Labor (HOK)	(3)		
4	Conversion factor	(4) = (1)/(2)		
5	Labor coefficient (HOK/liter)	(5) = (3)/(2)		
6	Output price (IDR/liter)	(6)		
7	Wage rate (IDR/HOK)	(7)		
Revenue and profit				
8	Raw material price (IDR/liter)	(8)		
9	Other input contributions (IDR/liter)	(9)		
10	Output value (IDR/liter)	(10) = (4)x(6)		

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No	Variable	Value	Pasteurized Milk (Liter)	Yoghurt (Liter)
11	a. a. Added value (IDR/liter)	(11a) = (10)-(9)-(8)		
	b. b. Added value ratio (%)	(11b) = [(11a)/(10)]x 100		
12	a. a. Labor compensation (IDR/liter)	(12a) = (5)x(7)		
	b. b. Labor share (%)	(12b) = [(12a)/(11a)]x 100		
13	a. a. Profit (IDR/liter)	(13a) = (11a)-(12a)		
	b. b. Profit rate (%)	(13b) = [(13a)/(10)]x 100		
Compensation for Owners of Production Factors				
14	Margin (IDR/liter)	(14) = (10)-(8)		
	a. a. Labor income (%)	(14a) = [(12a)/(14)]x 100		
	b. b. Other input contributions (%)	(14b) = [(9)/(14)]x 100		
	c. c. Company profits (%)	(14c) = [(13a)/(14)]x 100		

The criteria for assessing added value according to Mumpungningsi (in Rahmi, 2019) are as follows:
1. If the added value is >0, then the industry is said to provide positive added value.
2. If the added value is <0, then the industry is said to provide negative added value.

The added value ratio is the basis of productivity. The ratio can be used to measure progress achieved in productivity. According to Kipdiyah (in Arianti, 2019), the categories of value added are as follows:
1. Value added can be said to be low if the value added ratio is <15%.
2. Value added can be said to be moderate if the value added ratio is 15-40%.
3. Value added can be said to be high if the value added ratio is >40%.

Profit Margin Analysis

Daeli, et al. (2022) state that profit margin is the profit from sales after calculating all costs and taxes on income. This margin describes and shows the comparison between net profit after tax and sales.

Profit Margin Formula = (Net Profit After Tax) / (Total Sales) x 10

RESULT AND DISCUSSION

Application of the 5R Principles of the End-to-End Circular Economy Model at KOP SAE

The implementation of the 5R principles of circular economy at KOP SAE has not been maximized, so its benefits for the environment, society, and economy have not been fully realized. The implementation of the 5R principles in livestock farming (upstream) averages above 51%, the implementation of the 5R principles in dairy product processing averages over 76%, and the implementation of the 5R principles at the KOP SAE café (downstream) averages above 50%. Although the implementation of the 5R principles in the upstream sector averages 51%, circularization of waste only occurs in the upstream sector. This circularization is able to save on the purchase of LPG gas by up to IDR2,400,000 every year. Meanwhile, the use of high-quality equipment in the processing and downstream sectors is able to minimize cost reductions from the purchase of new equipment.

The integration of production processes through to distribution in dairy farming is a systematic approach to managing the entire supply chain, from cow maintenance to the delivery of dairy products to the end consumer. The goal of this integration is to improve efficiency, quality, and profitability by ensuring that all aspects of the production process through to distribution are managed harmoniously. Upstream integration involves dairy cow maintenance and management of all aspects related to health and milk productivity. This includes cattle selection, feed management, animal health, barn maintenance, reproduction management, and milk collection. Processing integration involves processing milk into ready-to-consume products. This includes milk processing,

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quality control, and packaging. Downstream integration involves the distribution of final products from milk processing to KOP SAE cafes. This includes marketing strategies, inventory management, and customer service.

The benefits of upstream-downstream integration at KOP SAE include improved efficiency, quality control, cost reduction, market responsiveness, and increased profitability. Through integration, KOP SAE can improve coordination between various stages of the process, from farming to the sale of dairy products to consumers. KOP SAE can ensure consistent product quality through control at every stage and reduce costs through process optimization, especially since the distance between the farm, processing facility, and café is very close. With this integration, KOP SAE can also respond more quickly to market demand and adjust accordingly.

5R Principle of Circular Economy Upstream Sector

The reduce aspect in the upstream sector, namely the KOP SAE Pujon dairy farm, is reflected in efforts to improve efficiency in the use of resources, including feed, water, electricity, and gas. Feed efficiency is achieved by providing feed according to the animals' needs. Dairy cows are fed twice a day with a composition of 8–12 kg of concentrate with a crude protein (CP) content of 18%, and 35–40 kg of corn silage. Water efficiency is achieved through the installation of water taps as the primary distribution source. The use of taps allows for water savings as they can be turned off when not in use. The water supply system for cows uses the ad libitum method, which involves providing water continuously in drinking troughs to ensure availability and prevent dehydration. Additionally, water is used for sanitation purposes, such as cleaning the barn, washing equipment, and bathing the cattle, as shown in Figure 1. Wastewater from these activities is partially utilized as a mixture in the biogas production process, while the remainder is discharged into the Konto River with appropriate control measures. Electricity use at the KOP SAE Pujon farm is limited to essential needs, namely lighting and operating the manure separator. Energy savings are achieved by turning off switches or electronic devices when not in use. For thermal energy needs, the farm uses LPG gas as fuel for cattle dehorning. However, as part of energy conservation and sustainable energy transition efforts, KOP SAE Pujon also produces and utilizes biogas independently. This biogas is used as an alternative fuel for cooking, heating water, and milk, replacing most of the energy requirements.

Figure 1. Cleaning the pens and bathing the animals.
Source: Personal documentation.

The reuse aspect in the upstream sector of KOP SAE Pujon's livestock farming is realized through the reuse of waste that is still usable, particularly feed and water waste. One of the main practices is the collection of discarded forage, as shown in Figure 2. Leftover forage that is not consumed by livestock is collected using a special internally made tool. Forage that is large enough and still usable is sorted and returned to the livestock. This practice has proven effective in reducing the volume of discarded feed waste, although approximately 1–2% of the forage cannot be reused due to its small size and contamination with soil or manure, making it unfit for livestock consumption.

In addition to feed, reuse is also applied to wastewater management. Water from cleaning the pens is utilized as a mixture in the biogas fermentation process alongside cattle manure. This practice not only reduces liquid waste discharged into the environment

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but also supports efficiency in the production of alternative energy from organic waste. However, this implementation still faces capacity constraints, as the size of the available biogas digesters is insufficient to accommodate the entire volume of used water from cleaning the pens. Therefore, optimizing the capacity of the digesters is one aspect that needs further development to maximize the application of the reuse principle in this livestock sector.

Figure 2. Collecting animal feed.
Source: Personal documentation.

The recycling aspect in the livestock sector of KOP SAE Pujon is reflected in the efforts to process livestock waste into compost fertilizer. Solid waste in the form of cow manure is recycled through a fermentation process using a digester, resulting in environmentally friendly organic fertilizer. The compost fertilizer produced is then stored in a special facility called a compost house and distributed to cooperative members for use in agricultural activities, particularly as additional nutrients for plants. This recycling practice not only contributes to reducing solid waste but also supports sustainable agricultural cycles through the reuse of local resources. However, the effectiveness of waste recycling still faces limitations, particularly regarding the digester's capacity, which cannot accommodate the entire volume of manure produced daily. This results in some waste not being processed optimally. Therefore, there is a need to develop larger waste processing capacities to ensure that the principle of recycling can be applied more comprehensively and sustainably in this livestock sector.

Figure 3. Compost house and sludge drying equipment.
Source: Personal documentation.

The refurbishment aspect in the KOP SAE Pujon livestock sector is realized through maintenance, repair, and renewal efforts for equipment and waste that still have potential for use. All livestock equipment is maintained regularly to minimize damage and

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extend its service life. One of the key pieces of equipment focused on in maintenance is the manure separator, a device that separates and dries solid livestock waste. Maintenance of this equipment involves routine cleaning, checking mechanical functions, and replacing damaged components. However, the manure separator is no longer actively operated due to technological limitations and efficiency issues. As an alternative, the slurry byproduct from the biogas production process is directly utilized by cooperative members as organic fertilizer for crops, even without prior drying.

Meanwhile, the renew aspect is reflected in the utilization of livestock waste as a renewable energy source through the biogas production process. KOP SAE Farm has implemented a system for processing liquid and solid waste into biogas using a biogas reactor or digester. Cattle waste is directly channeled from the barn into a waste storage tank via a special pipeline installed in the middle of the barn floor. This waste is then processed in the digester to produce methane gas, which is used as an alternative energy source, replacing part of the LPG gas requirement. The implementation of this technology not only helps reduce environmental pollution but also supports the transition toward clean and sustainable energy in the livestock sector.

Circularization in the upstream livestock sector owned by KOP SAE demonstrates an integrated and sustainable resource management mechanism. Cows produce milk as the primary product, along with solid and liquid waste as byproducts. The milk produced is then distributed to various parties, including PT Nestle, Frisian Flag, and the KOP SAE café. Solid and liquid waste is partially processed into biogas and compost fertilizer, while the remainder is still directly disposed of into rivers and soil. The direct use of biogas by the KOP SAE farm has successfully reduced the need to purchase LPG gas by 10 cylinders every month, equivalent to cost savings of approximately IDR 200,000/month or IDR 2,400,000/year. This practice is a concrete example of the application of circular economy principles that support resource efficiency and waste reduction. This circularization also marks KOP SAE's commitment to sustainable economic development in line with the Sustainable Development Goals (SDGs). KOP SAE has implemented water conservation and wastewater reuse (SDG 6), optimized feed waste utilization, and processed manure and water into biogas and organic fertilizer. These steps also contribute to the creation of safe and comfortable urban and residential environments (SDG 11) and support efforts to mitigate climate change (SDG 13) through the reduction of greenhouse gas emissions generated from livestock waste.

5R Principle of Circular Economy in the Processing Sector

In the milk processing sector at KOP SAE Pujon, the *reduce* principle is applied through efficient raw material management and in accordance with actual needs based on internal Standard Operating Procedures (SOPs). Each stage of production, from the receipt of raw materials from the farm to the final processing, follows strict protocols to ensure efficiency and quality. Raw materials are weighed and counted accurately to avoid waste and minimize the risk of material damage.

Most of the fresh milk produced by KOP SAE is distributed to large companies such as PT Nestle and Frisian Flag. Meanwhile, the rest is utilized to be processed into various dairy products in KOP SAE's production unit. This processing is carried out in accordance with demand and capacity, starting from the milk heating stage, fermentation, to the packaging process, while maintaining product quality and hygiene.

The principle of *reuse* is also optimally implemented. The remaining fresh milk raw materials that are still viable and of good quality are reprocessed into value-added products such as yogurt, kefir and cheese. In addition, milk that has gone through the pasteurization process and milk cream are used as the main ingredients for making ice cream and other processed products. With this strategy, KOP SAE manages to minimize waste and optimize the utilization of all raw materials, so that no part is wasted.

The flagship product of KOP SAE is pasteurized milk with various flavors. This product is then developed into various other forms of dairy according to market trends and consumer needs. In supporting the sustainability of the production process, KOP SAE uses hygienic and durable equipment, such as heating pans, ladles, and milk filters made entirely of *stainless steel* and *food grade* plastic as shown in Figure 4. The use of such equipment not only supports food safety, but also ensures long-term durability and efficiency, and reduces the need for periodic equipment replacement.

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Figure 4. SAE KOP equipment is reusable
Source: Personal documentation

The *refurbish* aspect in the dairy processing sector is not found, due to the lack of milk processing waste that is wasted and the perishable nature of milk so that milk processing waste is difficult to recycle or refurbish. In contrast, the *recycle* aspect in this sector is realized through the repair and maintenance of equipment that has been damaged so that it can be reused. KOP SAE Pujon routinely repairs production equipment to reduce operational costs and maintain a smooth production process. Some equipment that is often repaired when damaged includes milk cup press machines and freezers. By making these repairs, KOP SAE Pujon is able to minimize operational downtime thus ensuring production continuity is optimally maintained.

Figure 5: Caramel candy sample
Source: Personal Documentation

The *renewal* aspect of this sector is demonstrated by KOP SAE prioritizing the use of environmentally friendly equipment in its production process. Some of these include the use of wooden spoons for stirring milk and making caramel candies, as well as the use of stainless steel pots for boiling milk. KOP SAE Pujon always goes through a strict *quality control* process to ensure product quality before marketing. The *quality control* process is carried out by trying samples of finished products before they are finally packaged and marketed.

The milk processing process at KOP SAE Pujon has generally followed the standard production stages, starting from milk heating, mixing ingredients, cooling, to packaging, storage, and distribution to outlets such as Cafe KOP SAE. However, the application of the circular economy concept in this process has not been fully implemented, especially in the aspect of waste management. One of the main obstacles in realizing the circularization system is the absence of an integrated waste management system. Waste generated during the production process, especially wastewater from equipment washing, is still discharged directly into the sewer without going through a treatment process first. This practice not only hinders the implementation of circular economy principles, but also has the potential to cause negative impacts on the environment.

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Thus, although the production process has been designed to be efficient in terms of raw material usage, the overall sustainability of the process is not optimal due to the lack of waste management. To improve sustainability and resource efficiency, it is imperative to implement better waste management systems. These strategies may include separation of organic and inorganic waste, recycling of washing wastewater, or utilization of organic waste as compost feedstock or energy. The implementation of a proper waste treatment system will not only support the principle of circular economy, but also

5R Principles of Downstream Circular Economy

The *reduce* aspect in the downstream sector of KOP SAE Pujon dairy product sales is reflected in active efforts to minimize waste generation, especially single-use plastic waste. This downstream sector is divided into two main units, namely Cafe KOP SAE and souvenir shops. Both units not only function as product distribution points, but also become an important part in implementing sustainability principles. At Cafe KOP SAE, various fresh milk-based processed products are served to customers with an environmentally friendly approach. For *dine-in* consumption, the cafe uses reusable utensils such as glass cups and stainless steel spoons, instead of disposable plastic cups. In addition, food is served using glass plates and recycled paper boxes as a more sustainable alternative to plastic packaging.

Cafe KOP SAE prepares dairy products after there is a request from consumers according to the available menu. This step is taken to ensure that every dairy product served is always fresh and to minimize waste and product damage. By processing production based on demand, the cafe can control the amount of raw materials used, thereby reducing the risk of overproduction that could lead to waste.

Through the implementation of the *reduce* strategy in the downstream sector, KOP SAE Pujon demonstrates its commitment in supporting sustainable production and consumption practices. This effort is part of the adaptation to the principles of circular economy and responsible resource management amidst the increasing awareness of the importance of environmental conservation.

Figure 6. KOP SAE dairy product packaging.
Source: Personal Documentation

The reuse aspect is realized through the use of reusable equipment, especially in product serving activities at Cafe KOP SAE. One form of reuse is the reduction in the use of disposable cutlery, such as plastic spoons, which are replaced with metal (stainless steel) spoons. The use of metal spoons directly supports the reduction of plastic waste, while improving hygiene standards and quality of service to customers. In addition, the use of glass cups and plates for on-site consumption is also part of the reuse strategy that supports the principle of sustainable consumption.

However, the implementation of the recycle aspect has not been significant. This is due to several factors, including the lack of equipment that is damaged and unfit for use, as well as limitations in recycling equipment materials which are generally made of metal or food grade plastics that are not easily reprocessed. In addition, organic waste from the downstream sector, such as leftover milk-based beverage ingredients, is perishable and has not been optimally managed for recycling or reuse as other materials.

Meanwhile, the refurbish aspect is shown through efforts to maintain and repair equipment that has minor damage. Cafe KOP SAE, which serves customers through a dine-in and take-away system, uses various equipment such as refrigerators for raw material storage, stoves for heating, and blenders for the process of mixing and refining beverage ingredients. These equipment have a risk of damage due to intensive use. Therefore, the management conducts periodic repairs to equipment that has experienced a decline in function, in an effort to extend the service life and delay the purchase of new units. This practice not only saves operational costs, but also reduces e-waste that can pollute the environment if not managed properly.

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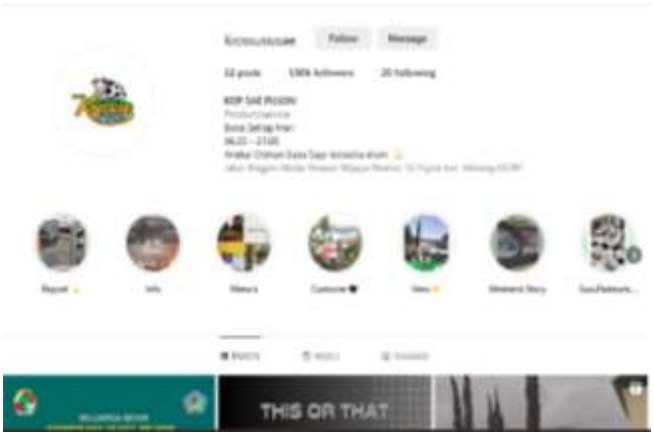

Figure 7. KOP SAE Instagram account
Source: Personal Documentation

The renew aspect is shown with digital marketing as a new marketing strategy. KOP SAE Pujon utilizes Instagram features such as Instagram Stories, IGTV, and Live to provide additional content such as product usage tutorials, behind-the-scenes of the production process, and Q&A sessions with followers. The benefits of social media use by consumers include branding and marketing, business transparency, product pricing, and serving as a communication channel with various stakeholders. This includes involvement in product selection, knowledge sharing, and opinion formation (Morris and James, 2017). More people get information through social media, one of which is Instagram. Instagram posts have been shown to have a positive impact on consumer opinion (Locke, et al., 2023).

Economic Value at KOP SAE

Upstream Sector R/C Analysis

Biogas revenues belonging to the KOP SAE farm with a digester diameter of 12m3 are IDR 200,000/month or IDR 2,400,000/year. Biogas expenditure every year is IDR 2,144,600 and the R/C value is 1.11. Based on these data, it can be concluded that biogas processing with a digester diameter of 12m3 at the KOP SAE dairy farm is profitable but has not overcome the waste as a whole.

Value Added Dairy Processing

The calculation of added value is done by analyzing the frequency of making milk and yoghurt and the price of the main raw materials and other input materials can be seen in Table 2.

Table 2. The results of the calculation of added value

Description	Pasteurized Milk/Liter	Yoghurt/Liter
Value Added (IDR/Liter)	IDR 9.750	IDR 17.160
Profit (IDR/Liter)	IDR 9.188	IDR 14.914
Company Profit (%)	66,82%	59,27%

Based on Table 2 and analysis using the Hayami method, the value added for pasteurized milk processing is IDR 9,750 /liter of raw material, with a value-added ratio of 49.3%. Meanwhile, the added value of the yoghurt processing is IDR 17,160 and gives the company a profit of 59.27%.

Profit Margin

Profit Margin on KOP SAE milk sales with sales costs every year of IDR 2,166,691,438 and profit every year of IDR 436,558,086 so that the profit margin value is 20%. Based on table 3, the company's profit margin shows a healthy profit margin as according to Handayani and Winarningsih (2020), a good profit margin is a profit margin that is above 15%.

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Table 3. Profit Margin Calculation

Description	Value
Sales Result/Year	IDR 2.166.691.438
Net Profit/Year	IDR 436.558.086
Profit Margin	20%

CONCLUSION

Based on the results of the study, it was concluded (1) The sustainability of the upstream sector occurs in increasing the number of members, livestock population, and the amount of milk produced and biogas processing. The upstream sector is the main foundation of KOP SAE to achieve optimal and sustainable productivity. The sustainability of *the processing* sector occurs in the diversification of dairy products according to consumer tastes and the use of quality tools. The *processing* sector maintains and even adds value to various dairy products to meet consumer needs. The sustainability of the downstream sector occurs in sales where it is no longer done from stall to stall, but has partnered with PT Nestle and PT Frisian Flag. KOP SAE has even opened a KOP SAE cafe and souvenir shop to sell various dairy products. The downstream sector supports the success and sustainability of dairy farming in a more competitive market. (2) The application of the 5R principles of circular economy in KOP SAE has not been maximized so that its benefits for the environment, social and economy have not been fully felt. The application of the 5Rs on farms (upstream) averages above 51%, the application of the 5R principles in dairy processing (*processing*) averages more than 76% and the application of the 5R principles in the KOP SAE cafe (downstream) averages above 50%. Although the application of 5R in the upstream sector averages 51%. (3) Economic revenue from biogas processing at KOP SAE farms every year is 120 3 kg LPG cylinders or IDR 2,400,000 with an R/C value of 1.11. The added value for pasteurized milk processing is IDR 9,750/liter of raw material, with an added value ratio of 49.3%. The added value of the yoghurt processing process amounted to IDR 17,160 and gave the company a profit of 59.27%. KOP SAE's profit margin on milk sales is 20% and is a healthy profit margin for the company.

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