



## Design of integrated plastic waste management business model based on digital circular economy in Cilegon city

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### ABSTRACT

*Indonesia is the number two producer of plastic waste. According to Cilegon Mayor Regulation Number 30 of 2019, Article 5 of the Regional Regulation, Cilegon City has a target of reducing waste by 30% and handling waste by 70% of the generation of household waste and waste similar to household waste. One solution is to implement the concept of a circular economy, which is consistent with the five-year master plan data from 2020 to 2024. This research aims to find solutions to problems associated with plastic waste, which is difficult to decompose. An expert opinion, a financial feasibility test using the benefit-cost ratio (BCR) to new revenue streams, and determining the relationship between the circular economy and sustainable development goals were all part of the circular business model canvas (CBMC) used Sustainable Development Goals (SDGs). This research is based on qualitative methods, and quantitative methods are used to test the financial viability of the new revenue stream. Based on the data processing results, it is necessary to redesign using a circular business model canvas, seek product diversification from processing plastic waste, and calculate the feasibility test of the paving block business as a new revenue stream. The current business model canvas was designed as a result of this research. This research is expected to assist IPST Asari and the Bank Sandi Team in maximizing the potential for processing plastic waste in Cilegon City.*



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## INTRODUCTION

According to Jambeck et al. (2015), Indonesia is country number two among the 20 biggest countries with the problem of managing plastic waste. A study of 192 coastal countries in 2010 reported that Indonesia was the second-largest producer of plastic waste in the ocean in the world. Meanwhile, other countries with the same coastal population, India, are in 12th place (Jambeck et al. 2015). Indonesia produces 67.2 million tons of waste per year, and about 11% of this waste is plastic waste. Currently, in Indonesia, it is estimated that 85,000 tons of waste are generated, with an estimated increase of 150,000 tons per day in 2025. This amount is dominated by household waste, ranging from 60 percent to 75 percent (Sanusi and Sutriyanto 2021). The waste problem is a common problem for both the government and society. Therefore, waste management must involve all stakeholders to be effective and efficient. Effective and efficient waste management can reduce waste significantly. One method used in waste management involving the community is building a waste bank (Budihardjo et al. 2022).

In Indonesia, a waste bank, or Bank Sampah, is a waste management concept that handles recyclable waste and allows people to earn money in savings by storing their recycled waste in the waste bank (Khair et al. 2019). The waste bank was established because the public was concerned for the environment, which is getting more and more waste, so further action is needed, which is expected to help the government manage the waste pile and improve the community's economy (Nabillah et al. 2019). The benefit of a waste bank helps in community-based waste management to create a clean and healthy environment.

The current direction of development in Indonesia refers to the Sustainable Development Goals (SDGs) as stated in the Presidential Regulation of the Republic of Indonesia No. 59 of 2017 concerning the implementation of the achievement of Sustainable development goals (SDGs) is the development that maintains the improvement of the economic welfare of the community on an ongoing basis. This development maintains the sustainability of community social life. This development maintains environmental quality and development that ensure justice and the implementation of governance that can maintain an improved quality

of life from one generation to the next (Bappenas, 2021).

Handling waste through waste banks is in line with the target of Sustainable development goals (SDGs) in goal 11.6, namely by 2030, reducing the adverse per capita urban environmental impacts, including paying special attention to air quality and municipal handling of waste. The goal is clarified in indicator 11.6.1. (a) Percentage of municipal solid waste handled. Goal 12.5 states that by 2030 every country will substantially reduce waste generation through prevention, reduction, recycling, and reuse of waste. The circular economy refers to an economic paradigm in which consumed commodities can be reprocessed (reduce, reuse, recycle, replace, and repair (Purwant 2021).

According to Winans et al. (2017), the circular economy became popular around the 1990s to answer economic development challenges and reduce excessive use of natural resources. The main point of a circular economy is to take advantage of manufactured goods and balance economic growth with environmental and natural resource development. According to Kircherr et al. (2017), in their research, a circular economy is an economic system with the end of the product life cycle with the main concept of reducing, reusing, and improving materials in the production/distribution and consumption processes. The activity can conduct at the micro-level (business, consumer), the Meso-level (eco-industrial area), or the macro-level (city, region, country) to develop a sustainable economy by promoting environmental quality, economic prosperity, and social justice.

Waste management problems also occur in Cilegon City. Based on an interview with the Head of TPSA Bagendung from the Environmental Service of Cilegon City, obtained information that from 2018 to 2020, Cilegon City produced 17,069 m<sup>3</sup>/month of household waste and similar household waste, or equivalent to 6,028 tons/month. The amount of waste shows the high amount of waste generated by the people of Cilegon city. The Cilegon City Government has issued Mayor Regulation number 30 of 2019 regarding Cilegon City policies and strategies in managing household waste and household-like waste. Article 5 of the regulation states that the City of Cilegon targets reducing waste by 30% and handling waste by 70% of the generation rate of household waste and household-like waste

(Peraturan Wali Kota Cilegon, 2019). This target follows the target of achieving Sustainable development goals (SDGs) by the central government. The existence of this Cilegon Mayor Regulation is expected to overcome the complexity of the waste problem that occurs in Cilegon City. The Cilegon City Environment Agency is also trying to implement these policies, such as providing vehicles, TPS, TPA, and cleaning staff to deal with the increasing waste generation. Waste management is also scrutinized at the sub-district and sub-district levels regarding more disciplined waste disposal times. However, this effort is not considered sufficient considering that many areas in Kendari City have not received regular services, including the level of public awareness regarding waste management. Based on the problems that have been mentioned, this research will develop a business model for waste management in Cilegon City using the circular business model canvas (CBMC) method. In addition, a feasibility test of the proposal will also be carried out based on the results of the circular business model canvas using the benefit-cost ratio (BCR) method.

The business model canvas is a common language for describing, visualizing, assessing, and changing a company's business model. A company's business model can be described, analyzed, and designed using the business model canvas. According to Osterwalder & Pigneur, the business model canvas consists of nine elements, namely value propositions, customer segments, customer relationships, channels, key resources, key activities, key partnerships, cost structure, and revenue streams (Purwanto and Hakim 2020). Customer segments are groups of people or organizations that the company wants to reach and serve. Osterwalder and Pigneur (2019) stated that the value propositions block describes the combination of products and services that create value for specific customer segments. Channels are the link between the company and the customer, the customer touchpoint that plays a very important role in every event the customer experiences. Customer relationship is the type of relationship that the company wants to build with customer segments. It can be personal or public. The revenue stream describes the company's cash from each production activity. Key resources describe the most important assets required for a business model to function, enabling a company to create and offer value propositions, reach markets,

maintain customer relationships and generate revenue. Key activities describe the most important things a company must do for its business model to operate successfully. Key partnerships describe the network and partners that make a business model work because partnerships are the foundation of various business models to optimize, reduce risk, or acquire resources. The cost structure describes all the costs incurred to operate the business model (Laurentia 2020).

Linder and Rashid (2015) define the circular business model canvas (CBMC) as a business model in which the conceptual logic of value is based on the utilization of the economic value stored in the product after it is used in production (Linder and Williander 2017). CBMC has eleven components, and nine components are the same as BMC. Two additional components are the take-back system and the adoption factor. The take-back system in this circular economy assumes that the product, its components or materials, can be transported (in the case of biological nutrition), reused, reproduced, or recycled (in the case of technical nutrition), which requires collection first from consumers and reverse logistics (reverse logistics). The adoption factor is a transition to a circular business model that must support various organizational capabilities and external factors. Internal and external factors that influence the adaptation of business models to the circular economy principles. Internal factors concern the organization's ability to switch to a circular economy business model. Such capabilities require intangible resources, such as team motivation and organizational culture, knowledge, and transition procedures.

The dominant costs of technology are some of the fixed costs and variable costs needed to build the system. The value is the benefits obtained by the community from the existence of the campus, which the existence can see in current and future businesses (Susanto et al. 2017).

Several studies related to this research include: Susanto et al. (2017) researched the development of a plastic waste recycling business model using the canvas business model at CV Majestic Buana Group. Aula et al. (2018) researched the design of a circular economy-based business model using CBMC. Salsabila et al. (2019) researched designing a waste bank business model in the city of Bandung using a canvas business model. Purwanti (2020)

conducted research using the circular economy concept and implemented it at the waste bank Tanjung, in Pekalongan Regency, Central Java Province. Putra et al. (2020) studied waste selection technology based on business processes, productivity, and benefit-cost ratio. This research aims to assess the existing circular economy-based business model in Cilegon City, develop a digital circular economy-based business model redesign in Cilegon City using a circular business model canvas, and test the feasibility of a new revenue stream CBMC using a circular economy model. Through the Integrated Waste Management Industry - Overcome Waste, Manage Independently (IPST), Chandra Asri with the community in Cilegon. The benefit-cost ratio method and the potential of products that can be developed at IPST (Industri Pengelolaan Sampah Terpadu) Cilegon City in a digital circular economy-based plastic waste business in Cilegon City.

## METHODOLOGY

This research was conducted using the BMC method, redesigning the CBMC method, and calculating business feasibility using BCR. Business model proposals will be created using the BMC process, which was based on interviews and brainstorming with good experts from the company. Interviews were conducted to determine the nine elements in the business model canvas for handling plastic waste. The results obtained from this interview are used to make the existing business model canvas. After getting the existing business model canvas, then brainstorming with experts from academics and professionals was carried out to design a CBMC.

The CBMC method determines the circular economy from existing business models. In making CBMC, an analysis of the revenue stream will be carried out using the benefit-cost ratio (BCR) method. The data needed in making CBMC is direct observation in the IPST Asari environment and data collection on the number of MSMEs, collectors, fishers, and waste banks in 43 urban villages in Cilegon City. The results obtained from the two methods are the proposed best business model for handling plastic waste based on a digital circular economy in Cilegon City.

The data collection method used in this study is primary data obtained through direct

observation by documenting activities in the environment to get an overview of the business model created. Secondary data is obtained through various sources that are considered relevant to the research. These sources can be the results of literature studies, namely journals and theses relevant to the research topic. This study's data analysis focused on the circular economy of waste management and the SDGs. This research focuses on handling plastic waste that previously had no selling value to become more valuable and have an exchange value. In this research, a circular economy-based business model will be designed for handling plastic waste in Cilegon City using the circular business model canvas (CBMC). In addition, this study will calculate a financial feasibility analysis using the benefit-cost ratio (BCR) method.

The benefit-cost ratio compares the net benefits of the relevant year, which has been assessed. This criterion is distinguished between years with positive net benefits and years when net benefits are negative (Putra, 2020). The following is the formula for BCR (Phelia and Sinia, 2021) :

$$BCR = \frac{\sum_{t=0}^T \frac{Bt}{(1+r)^t}}{\sum_{t=0}^T \frac{Ct}{(1+r)^t}} \quad (1)$$

The benefit-cost ratio (BCR) or cost-benefit ratio can be calculated by the present value (PV) of the benefits divided by the present value (PV) of the costs. If  $BCR > 1$ , the project or investment may be a good candidate for acceptance (Aula et al., 2019). BCR is closely related to three things; namely, the benefits of the business domain are in the form of reducing costs and or increasing performance or revenue.

## RESULTS AND DISCUSSION

### Business Model Canvas (BMC)

The business model canvas (BMC) is needed because, in this business model, the relationship between elements in IPST Asari is known as a representation of the integrated waste processing industry in Cilegon City. The elements are customer segment, value proposition, channels, customer relationship, revenue stream, key resource, key activity, key partnership, and cost structure. The following Figure 1. is the existing BMC from IPST Asari, namely:

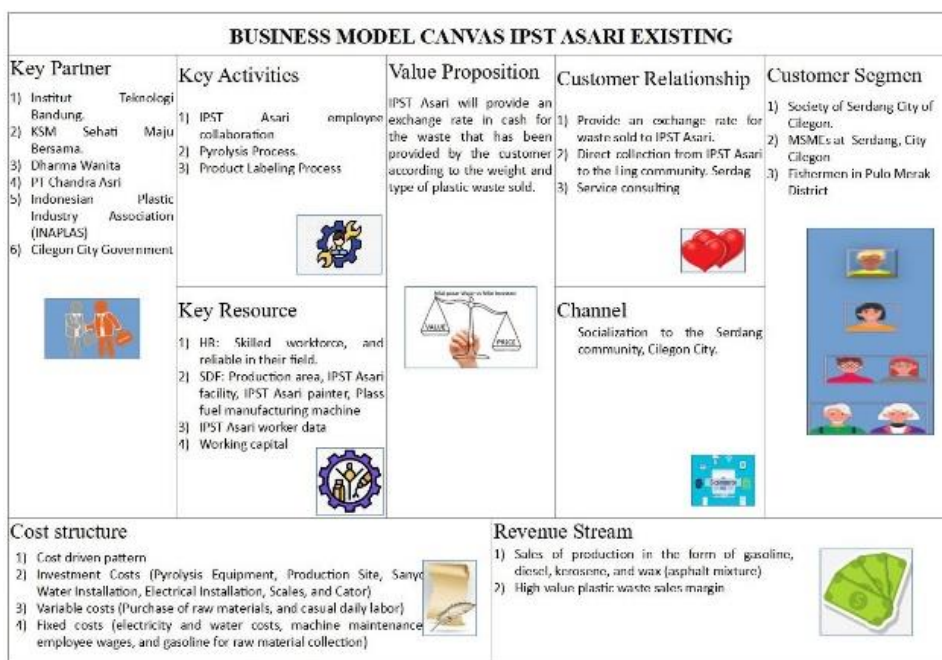


Figure 1 Existing Business Model Canvas of IPST Asari

Value propositions that customers will accept are the exchange rate of plastic waste for money. The award will be determined after the customer confirms the provision of plastic waste to the service center. So, from waste that has no selling value, it will have a selling value by selling it to IPST Asari.

Customer segments from IPST Asari are determined by location, internet users, and producers of plastic waste per day. This grouping is divided into communities within the Serdang environment, MSMEs in the Serdang environment, and anglers in the Serdang environment. IPST Asari currently has a small land area capacity, and IPST Asari also has a partnership with PT Chandra Asri for plastic waste raw materials.

Channels are a way of delivering from the company to the customer segment on the value proposition given. IPST Asari is currently socializing with the Serdang Environment community, Banten, Cilegon City. The socialization is often done according to the general chairman of IPST Asari. So, the steps taken on the channel's element are socialization to the Serdang Environment community, Cilegon City, Banten.

The relationship between the company and its customers is expected to reach the customer segments that have been created. So, this customer relationship can be grouped into a personal

approach to the community, MSMEs, and anglers in the Cilegon City Serdang environment, talking directly to the Cilegon City Serdang environment community, and giving criticism and suggestions to the company (service consultation).

IPST Asari's income is from selling high-value waste that can resell resold directly. The low-value income is in the form of diesel, gasoline, kerosene, and residue in the form of candles. The company's revenue is generated from the sale of kerosene, diesel fuel, gasoline, and wax sale.

A key partnership is a form of cooperation between two or more parties to agree on activities or resources. The key partnership carried out by IPST Asari itself involves six stakeholders, namely Inaplas, PT Chandra Asri, ITB (Bandung Institute of Technology), DWP (Dharma Wanita Persatuan), Cilegon City, KSM Sehati Maju Bersama (Non-Governmental Organization), and the Cilegon City Government. Apart from the six stakeholders, there are customers from the sandy bank in this key partnership: the community, students, and parents in Cilegon City.

Key activities are the most important things a company must do so that its business processes can run successfully. So, in key activities at this time, there is a cooperation between IPST Asari employees, the pyrolysis process, and the labeling process for IPST Asari products

Key resources are important assets that determine success in running the company's business. Key resources include physical resources (buildings, vehicles, equipment), human resources, and intellectual assets (brands, copyrights, patents, customer database). The key resources owned by IPST Asari are production sites, one cator (cart motorcycle) pyrolysis equipment, condensation equipment, chopper equipment, which currently has ten employees, and knowledge of pyrolysis. So, IPST Asari's key resources are human resources, physical resources, and production tools.

The cost structure is all costs arising from operating the business model. So, the costs incurred by IPST Asari are fixed costs consisting of electricity and water costs, machine maintenance costs, employee wages, and gasoline costs for taking raw materials. Variable costs consist of purchasing raw materials and wages for casual daily workers. The investment costs consist of pyrolysis equipment, production site, water installation of Sanyo, electrical installation, and cator.

**Value Proposition Canvas (VPC)**

The value proposition canvas based on Figure 2. is a method introduced by Osterwalder et al. to better map the business from the customer side (Osterwalder, 2014). The data obtained for

compiling the VPC is data taken through direct interviews with the manager of IPST Asari as a special place for processing plastic waste in Cilegon City at this time. Customers in this study are customers in the Cilegon City Serdang Environment, and only agencies that have collaborated with IPST Asari will be discussed. VPC is divided into two sides: the customer and the company. The following is a VPC created using field studies and the results of interviews conducted at IPST Asari.

Customer Jobs describe customers' functional, social and emotional tasks, the problems customers are trying to solve, and the needs they want to fulfill (Osterwalder 2014). IPST Asari's current customer jobs are first sorting plastic waste from other household waste. Customers do not need to separate plastic waste based on the standards made by IPST Asari, namely low-value plastic waste, high-value plastic waste, and residue.

Second, depositing plastic waste to IPST Asari. Customers only need time to wait for plastic waste to be collected from their respective residences, and plastic waste is taken by IPST Asari employees using a cator. Third, bringing a trash passbook, but this job is optional because IPST Asari also has its record book for purchasing plastic waste from residents.

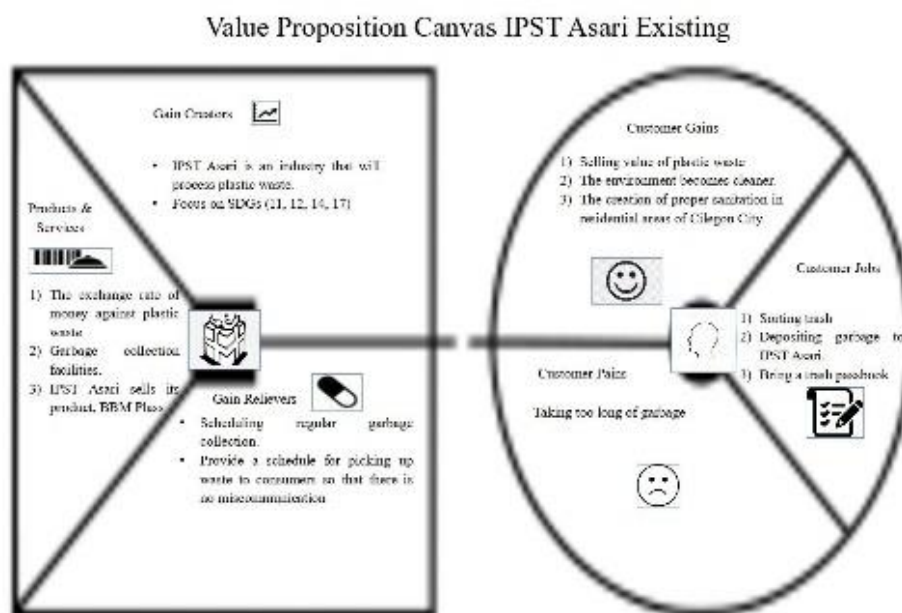


Figure 2 Existing Value proposition Canvas of IPST Asari

Customer pains are negative experiences or risks that customers have experienced in completing a matter in their work (Osterwalder, 2014). Currently, at IPST Asari, customers are only disappointed about the irregular garbage collection based on interviews that have been conducted. In addition, customers often wait for employees from IPST Asari to pick up their trash. As a result, many customers immediately dispose of their waste at a temporary waste disposal site, not at IPST Asari.

Customer gains explain the benefits expected by consumers (Osterwalder 2014). The sale of plastic waste can benefit customers, namely, the exchange value of selling plastic waste. The second is the preservation of the environment from plastic waste. Public trust for processing plastic waste to IPST Asari will lead to a cleaner environment.

Products and services explain the products and goods that can help customers complete functional, social, and emotional tasks (customer jobs) (Osterwalder, 2014). The following are things that IPST Asari will do to solve and help the wishes of its customers, namely, first, the purchase of plastic waste. Waste that has no selling value will have a selling value if the customer sells it to IPST Asari. Second, waste collection facilities. IPST Asari will collect plastic waste that has been collected by customers using a cator. So that customers only need time to wait for the cator to come to the customer's house. Third, sales of pyrolysis products. IPST Asari is currently producing low-value plastic waste with the results obtained is Plass fuel, but SNI has not standardized diesel and gasoline products. However, kerosene and wax have been traded because they have been standardized.

Pain relievers explain how we solve the negative problems experienced by customers (Osterwalder 2014). So it is hoped that pain relievers' can reduce customer pain caused by bad

experiences from customers. In this case, IPST Asari will reduce customer disappointment in two steps: first, schedule regular garbage collection. Second, provide the schedule that has been made to residents so that there is no miscommunication between customers and IPST Asari parties.

Gain creators explain how products and services can make customers feel useful and benefit (Osterwalder 2014). Gain creators must be able to realize existing customer gains. IPST Asari has implemented a circular economy system and focuses on the SDGs. So the realization of the customer gain it has, IPST Asari has done several things, namely, providing sales of plastic waste. Second, focus on the SDGs, namely 11, 12, 14, and 17. The SDGs points are sustainable cities and settlements (11), sustainable consumption and production (12), marine ecosystems (14), and partnerships for reaching the goal (17).

**Circular Business Model Canvas (CBMC)**

CBMC was created based on input from experts to develop the existing business model at IPST Asari. The circular business model canvas is required because the relationships between the elements in IPST Asari are described in 11 elements in this business model. The elements are customer segment, value proposition, channels, customer relationship, revenue stream, key resource, key activity, key partnership, cost structure, take back system, and additional factors. The following is an explanation of the 11 elements that will be proposed after data collection through brainstorming with the business development section of the Digital Waste Bank (Bank Sandi) is as follows:

In comparing the existing BMC and the proposed CBMC based on Figure 3, several proposals were obtained to change each element of the existing business model canvas to be redesigned by an expert opinion. The following Table 1. is a proposal given by the Sandi Bank Team for the IPST Asari proposal, namely:

Table 1 Comparison Value proposition between BMC Existing and CBMC Proposal

<i>Value proposition</i>	
<b>Existing BMC</b>	<b>Proposed CBMC</b>
IPST Asari provides an exchange rate in money for the waste that has been given to customers according to the weight and type of plastic waste sold.	After confirming the customer to the service center, the digital waste bank provides an exchange rate between the waste exchanged for either high value or low value for money.

Table 2 Comparison of Customer Segment between BMC Existing and CBMC Proposal

<i>Customer segment</i>	
<b>Existing BMC</b>	<b>Proposed CBMC</b>
<ol style="list-style-type: none"> <li>1. Residents</li> <li>2. MSMEs</li> <li>3. Fishermans</li> </ol>	Residents of Cilegon City who know technology want extra money and sort out plastic waste.

Table 3 Comparison Channel between BMC Existing and CBMC Proposal

<i>Channel</i>	
<b>Existing BMC</b>	<b>Proposed CBMC</b>
Socialization to the community of Serdang Environment, Cilegon City	<ol style="list-style-type: none"> <li>1. Environmental Office of Cilegon City.</li> <li>2. Cilegon City Waste Bank Forum</li> <li>3. Educational institutions in Cilegon City.</li> <li>4. Industry in Cilegon City.</li> <li>5. Socialization to the people of Cilegon City.</li> <li>6. Social media promotion</li> </ol>

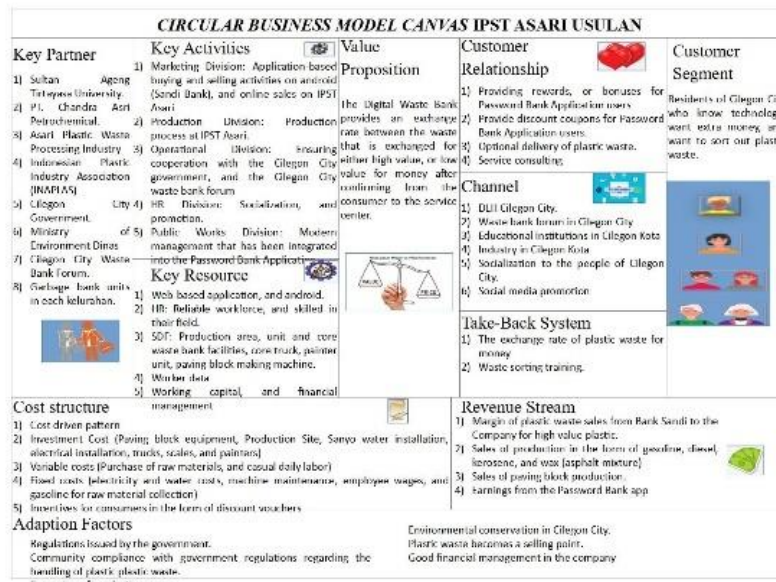


Figure 3 Redesign CBMC Based on Expert Opinion

The value proposition received by customers is an exchange rate for plastic waste in the form of money. The award is determined after the customer confirms the provision of plastic waste to the service center. So, from waste that has no selling value to have a selling value, if people want to sell it to the IPST Asari through Bank Sandi App.

Based on Table 2. the customer segment of the IPST Asari Digital Waste Bank is determined based on its location, internet users, and producers of plastic waste per day. This grouping is divided into residents of Cilegon City because IPST Asari is located in Cilegon City. Students (15-24 years old), because today's young people understand

more about technology, will make it easier for Bank Sandi to reach its target market. Parents (25-50 years old) will produce the most plastic waste every day because parents, especially housewives, will cook for their families. Before cooking, they will buy their necessities first, then use a plastic bag as a wrapper. In addition, the market segment of IPST Asari is MSMEs in Cilegon City, fishers in Cilegon City, companies in Cilegon City, and educational institutions in Cilegon City. So, the customer segment that will be the target market for the IPST Asari Waste Bank is the Cilegon City community, which knows technology, wants extra money, and wants to sort out plastic waste.



Channel is a way of delivering from the company to the customer segment on the value proposition given. The channel for IPST Asari is proposed. First, the company can easily promote it through social media to cover the student/college customer segment because they spend more time on social media at that age. In addition, the marketing of IPST Asari is helped by the Bank Sandi Application because the application provides all information on how to sell plastic waste, which will be flexible for IPST Asari customers. Second, the company will carry out promotions through socialization, and it will reach the customer segment of the Cilegon city community.

Based on Table 3., in one village socialization is carried out once per three months to remind people about protecting the environment and provide information on exchange rates (money, incentives, and merchandise) given after transactions. Third, the company cooperates with the government, the environmental service, and urban villages in Cilegon City. It will make it easier for the company to pick up waste in its customer segment, namely the people of Cilegon City. Therefore, the company's channel will carry out outreach to the community, and collaboration with the Cilegon City government, especially the Environmental Service, Cilegon City waste bank forums, schools, and educational institutions in Cilegon City. In addition, socialization was also carried out for industries located in Cilegon City, both the manufacturing industry and the service industry, and promotion through social media.

A customer relationship based on Table 4. is a relationship that exists between a company and a customer who is expected to be a part of the newly

created customer segment. The Bank Sandi App of IPST Asari performs three services in this block. First, personal assistance where this interaction will be carried out interpersonally, represented by the head of the social section in each village, scavengers, waste banks, MSMEs, fishers, and companies all located in Cilegon City.

The second is automated services. Automated service is carried out by users of the IPST Asari Digital Waste Bank Application. The preferred target market is students in Cilegon City, parents in Cilegon City, and people in Cilegon City. The third is co-creation. Co-creation at the IPST Asari Sandi Bank is that customers can easily provide criticism and suggestions about the Sandi Bank application and the waste collection services provided by IPST Asari. Giving criticism and suggestions is needed by the company to develop its business in a better direction. So, the customer relationship that IPST Asari will carry out, this proposal provides rewards, bonuses/incentives, and ease in consulting with Bank Sandi services.

The revenue stream is the company's income from the sale based on Table 5. IPST Asari earns money by selling high-value waste that can be resold directly. For low-value plastic, paving blocks are carried out, producing paving blocks.

In addition to revenue from production, income is also obtained from advertising and visits to applications. The revenue generated from IPST Asari is the sales margin of plastic waste from the Digital Waste Bank to direct companies for high-value plastic. In addition, sales from paving blocks, BBM Plass, revenue from advertisements, and visits will be installed in Banking Application Passwords.

Table 4 Comparison Customer relationship between BMC Existing and CBMC Proposal

<i>Customer relationship</i>	
<b>Existing BMC</b>	<b>Proposed CBMC</b>
1. Provide an exchange rate for waste sold to IPST Asari.	1. Provide rewards or bonuses for Password Bank Application users.
2. Direct collection from IPST Asari to the Serdang community of Cilegon City.	2. Provide discounts for users of the Bank Sandi Application with outlets or merchants who have collaborated with the Bank Sandi Application.
3. Consulting services.	3. Provide options for Bank Sandi Application users to send waste to IPST Asari or pick it up from IPST Asari to the homes of Bank Sandi customers.
	4. Consulting services.

Table 5 Comparison Revenue stream between BMC Existing and CBMC Proposal

<i>Revenue stream</i>	
<b>Existing BMC</b>	<b>Proposed CBMC</b>
1. Sales of products in diesel, kerosene, gasoline, and wax.	1. The margin of plastic waste sales from Bank Sandi to companies for high-value plastic.
2. The margin of plastic waste sales from Bank Sandi to companies for high-value plastic	2. Sales of products in diesel, kerosene, gasoline, and wax.
	3. Sales of the production of paving blocks.
	4. Benefits of the Password Bank Application

Table 6 Comparison Key partnership between BMC Existing and CBMC Proposal

<i>Key partnership</i>	
<b>Existing BMC</b>	<b>Proposed CBMC</b>
1. Bandung Institute of Technology	1. Sultan Ageng Tirtayasa University
2. KSM Hati Maju Bersama	2. PT Chandra Asri Petrochemical.
3. DWP Serdang Environment Cilegon City	3. Asari Integrated Waste Processing Industry.
4. PT Chandra Asri	4. Indonesian Plastic Industry Association (INAPLAS)
5. Indonesian Plastic Industry Association	5. Cilegon City Government
6. Cilegon City Government.	6. Department of the Environment Ministry of Cilegon City.
	7. Cilegon City Waste Bank Forum.
	8. Unit waste bank in every district.

Table 7 Comparison Key Activity between BMC Existing and CBMC Proposal

<i>Key activity</i>	
<b>Existing BMC</b>	<b>Proposed CBMC</b>
1. Cooperation with IPST Asari employees	1. Marketing department: ensure android-based buying and selling activities through Bank Sandi and online sales at IPST Asari.
2. Pyrolysis process	2. Production Department: ensure the production process at IPST Asari from the start of plastic waste to IPST Asari until the output comes out.
3. Product labeling process	3. Operational Section: Cooperation with the Cilegon City government and the waste bank forum in Cilegon City and ensuring that the partner has joined the Bank Sandi application.
	4. HR Department: Socialization and promotion to the entire community of Cilegon City.
	5. Public Works Section: Modern management that has been integrated into the Password Bank Application.

A key partnership based on Table 6. is a form of cooperation between two or more parties to agree on activities or resources. The main partnership is expected by Bank Sandi and IPST Asari so that the company can be competitive. The University of Sultan Ageng Tirtayasa supports this advantage as the pioneer of the Sandi Bank Application, PT Chandra Asri Petrochemical as the main supplier, and the expected Waste Bank

Forum. Become a supplier for IPST Asari, and waste bank units in each village, either made by the village or those made by IPST Asari, who will act as suppliers of IPST Asari

Key activities based on Table 7 are the most important things a company must do so that its business processes can run successfully. This proposed key activity will make paving blocks and activities in company management from suppliers

to customers based on technology digitization using the Bank Sandi Application. IPST Asari proposed important things done at IPST As the main waste bank, and the Sandi Bank team was divided into five divisions. The marketing department ensures android-based buying and selling activities through Bank Sandi and online sales at IPST Asari. The Production Department is responsible for ensuring the production process at IPST Asari from the start of plastic waste to IPST Asari until the output comes out. The Operations Section is responsible for ensuring cooperation with the Cilegon City government and the waste bank forum in Cilegon City and ensuring that these partners have joined the Bank Sandi application. The HR department is responsible for conducting socialization and promotion to the entire community of Cilegon City. Socialization activities are carried out once in three months. The Public Works Department is responsible for

modern management, which has been integrated into the Bank Code Application. The Public Works Division develops product innovations from IPST Asari. It is responsible for managing the financial management of IPST Asari by implementing a cost structure with a cost-driven pattern in the proposed Asari IPST.

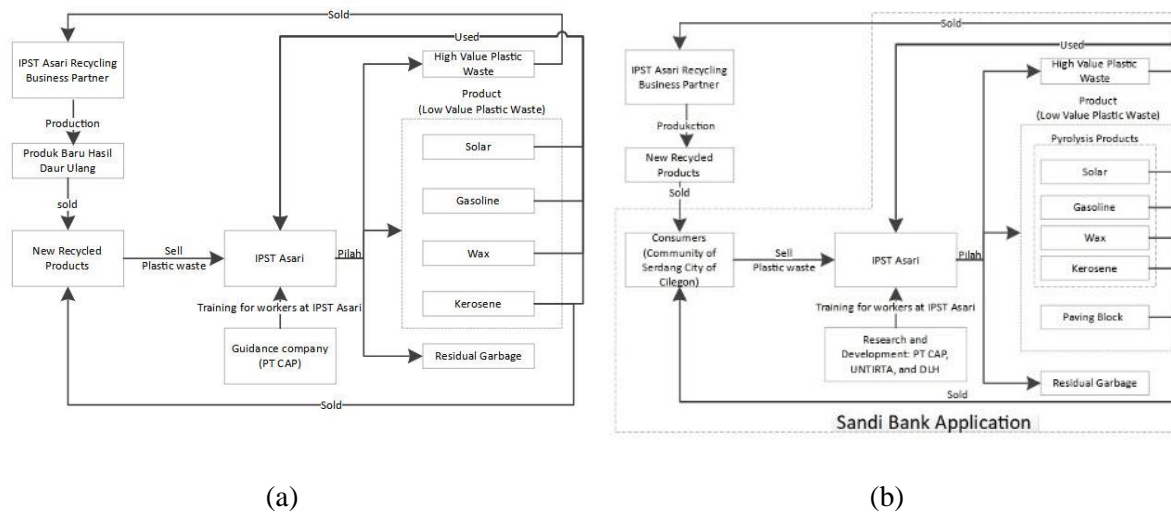
Key resources based on Table 8. are important assets that determine success in running the company's business. Key resources for the proposed IPST Asari are divided into the android-based Sandi bank application and the Sandi bank website. Human resources consist of a reliable workforce in the required field. Physical resources (SDF) such as buildings, vehicles, and equipment. Employee data, both the main waste bank and the unit waste bank. The last is working capital and financial management that has been integrated through the Bank Sandi Application.

Table 8 Comparison Key resources between BMC Existing and CBMC Proposal

<i>Key resource</i>	
<b>Exiting BMC</b>	<b>Proposed CBMC</b>
1. Human Resources: Skilled and reliable workforce in the required field.	1. Web-based application, and android.
2. Physical resources: Production land, IPST Asari facilities, painters at IPST Asari, Plass BBM making machines.	2. Human Resources: Skilled and reliable workforce in the required field.
3. Data for Asari IPST workers.	3. Physical resources: Production land, facility for unit waste bank and main waste bank, main waste bank truck, cator for the unit waste bank, paving block making machine.
4. Working capital	4. Data on employees of the main waste bank and unit waste bank.
	5. Working capital and financial management.

Table 9 Comparison of *Cost structure* between BMC Existing and CBMC Proposal

<i>Cost Structure</i>	
<b>Exiting BMC</b>	<b>Proposed CBMC</b>
1. Cost driven pattern	1. Cost driven pattern
2. Investment Costs (pyrolysis equipment, production site, water installations, electrical installations, scales, and painters)	2. Investment costs (paving block equipment, production sites, water installations, electrical installations, trucks, scales, and painters)
3. Variable cost (purchase of raw materials and casual daily workers)	3. Variable costs (purchase of raw materials and casual daily workers)
4. Fixed costs (electricity and water costs, machine maintenance, employee wages, and gasoline for raw material collection)	4. Fixed costs (electricity and water costs, machine maintenance, employee wages, and gasoline for raw material collection)
	5. Incentives for consumers by providing shopping discounts at merchants/outlets that have collaborated with IPST Asari.



(a) (b)  
Figure 4 (a) IPST Asari Eksisting (b) IPST Asari Proposal

The cost structure based on Table 9 is all costs arising from operating the business model. The cost structure consists of two, namely cost-driven and value-driven. Cost-driven is done to minimize costs to make the cost structure lean, while value-driven, cost efficiency is not the main concern. IPST Asari leads to a cost-driven pattern, emphasizing cost minimization/cost efficiency. The costs incurred from the proposed IPST Asari include paving blocks, production sites, water Sanyo installations, electrical installations, trucks for main waste banks, scales, and caters (cart motorcycle), for unit waste banks. Variable costs consist of purchasing raw materials and casual daily workers. Fixed costs consist of electricity and water costs, machine maintenance, employee wages, and gasoline for raw material collection. In addition, there are incentives for consumers by providing shopping discounts at merchants/stores that have collaborated with IPST Asari.

A take-back system is implemented in a circular economy by taking back goods or products that can be reproduced or recycled. The system requires re-cooperation from consumers to collect them (Aula et al. 2019).

Figure 4. (a) shows that IPST Asari is currently buying and selling plastic waste in the Serdang Community of Cilegon City. Plastic waste that has been collected will be sold to IPST Asari with details of the price that has been set in data collection. After that, IPST Asari will sort the waste, where IPST Asari employees have received previous training from PT Chandra Asri Petrochemical. High-value plastic garbage will be

redistributed to recycling companies partnered with IPST Asari. Meanwhile, a pyrolysis process will be carried out for low-value plastic to produce Plasm BBM. Kerosene will be sold to the general public, diesel and gasoline will be used by IPST Asari staff, and PT Chandra Asri will utilize wax as an addition in the production of asphalt.

In Figure 4. (b). it can be seen that there are several differences; namely, the first is the transaction process through digitization through the Bank Password Application. Second, UNTIRTA is trusted by PT Chandra Asri Petrochemical to be a mentor in the existing process at IPST Asari, from application training and training to making new products, namely paving blocks. Third, the Bank Sandi application will sync consumers to the closest route options, namely the unit waste bank or the main waste bank. Fourth, the unit waste bank will sell plastic waste to the main waste bank. The fifth is paving block products purchased online or offline at IPST Asari.

Adoption factors in this circular economy need to be supported by internal and external factors (Aula et al, 2019). The following are the factors that influence IPST Asari and Bank Sandi in conducting their business in the circular economy sector, namely, first, regulations issued by the government regarding the handling of plastic waste, which is more specific for sorting and selling to Waste Banks. Second is the public's compliance with regulations regarding plastic waste recycling that the government has made. The third is an expansion of the production area.

Fourth, environmental conservation in Cilegon City. Fourth, plastic waste has a selling value. Fifth, good financial management in the company.

### **Benefit-Cost Ratio (BCR) Analysis.**

#### ***Breakdown activity of IPST Asari Proposal***

Gjenge makers Ltd inspired the breakdown of the activity for making paving blocks. Gjenge Makers Ltd is a company that works in processing plastic waste in Kenya (Matte, 2021). In addition, the reference to making paving blocks comes from Hatfield (2017), who has made a guidebook for making paving blocks [20]. This reference is useful for finding out whether the revenue stream is feasible or not based on expert opinion. The following is general data obtained from these references, namely, first, the machines used are hydraulic press machines, chopping machines, and extruder machines. The second is the paving block process consists of 7 processes. The processes are sorting plastic based on soft and hard plastic, chopping soft plastic using a chopping machine, mixing plastic (50% soft plastic and 50% sand), and melting a mixture of plastic and sand using an extruder machine. With a melting point of 350°C, pressing the melted material using a hydraulic press, immersing paving blocks in a container by workers, and sanding processes workers. Third, one paving block weighs 2.5 Kg based on the size after the plastic mixture, and the sand is melted.

#### ***Cost of the Unit Waste Bank***

The following is an example of calculating the costs required by the unit waste bank. The

following table has three scenarios, namely the normal scenario, the quiet scenario, and the crowded scenario, as follows:

Table 10. is the processing of cost data issued by the unit waste bank. The total costs in the table are costs incurred in period 0. In the first period, the costs incurred are variable, and fixed costs are only in the calculation. The costs incurred are divided into three scenarios in this study: the quiet scenario, the normal scenario, and the crowded scenario.

#### ***Income obtained by the Main Waste Bank***

The following is an example of calculating the income obtained by the Main Waste Bank/IPST Asari. Table 11 shows the comparison of Asarai's IPST income based on three scenarios, namely the normal scenario, the quiet scenario, and the crowded scenario, as follows:

Table 11. is an example of processing revenue data on a new revenue stream or the Asari Proposed IPST. The income is divided into three sources: resale of high-value plastic waste, sales of paving block production, and revenue from the Bank Sandi application. The income in the normal scenario is Rp. 4,368,283,636.36 in its first month. Meanwhile, in the waste bank, the income unit is obtained from the sale of plastic waste from residents to the Main Waste Bank / IPST Asari only.

Table 10 Cost of Waste Bank Unit Three.

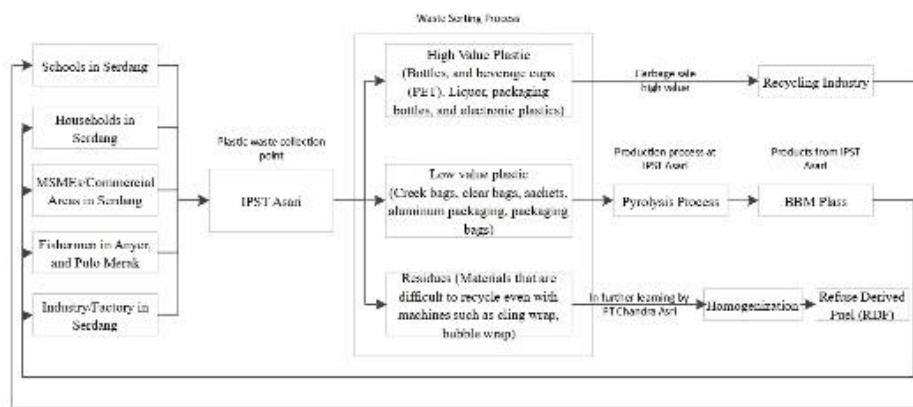
No	Description	Investation Cost (Rp)	Fixed Cost (Rp)	Variable Cost (Rp)
1	Scenario Normal	1,079,214,000.00	107,211,200.00	1,673,100,000.00
2	Scenario Quiet	1,079,214,000.00	107,211,200.00	1,254,825,000.00
3	Scenario Crowded	1,079,214,000.00	107,211,200.00	2,091,375,000.00

Table 11 Benefits of IPST Asari Proposed Three Scenarios.

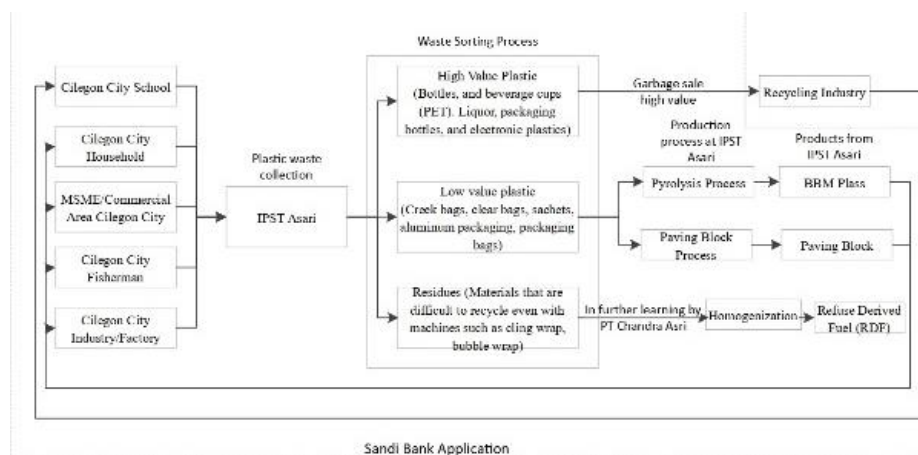
No	Description	Benefit Sampah Plastik High Value (Rp)	Benefit Paving Block (Rp)	Benefit Aplikasi Bank Sandi (Rp)
1	Scenario Normal	2,563,600,000.00	556,683,636.36	1,248,000,000.00
2	Scenario Quiet	1,922,700,000.00	417,512,727.27	936,000,000.00
3	Scenario Crowded	3,204,500,000.00	695,854,545.45	1,560,000,000.00

Tabel 13 BCR of IPST Asari Proposal

No	Description	Normal	Quiet	Crowded
1	Main Waste Bank	1.79	1.7	1.84
2	Unit Waste Bank	1.07	1.05	1.09



(a)



(b)

Figure 5 (a) Circular economy concept in the existing Asari IPST (b) Redesign Circular Economy based on Expert Opinion

**Validation for Feasibility Analysis of IPST Asari proposal**

The following Table 13 is a validation result of a feasibility study based on financial IPST Asari for IPST Asari proposal and waste bank units:

The financial feasibility test was conducted in three different scenarios, as shown in the table. The quiet scenario has a BCR value of 1.05, the normal scenario is 1.07, and the bust scenario is 1.09. These data indicate that the waste bank unit is feasible in the financial feasibility test using the BCR method. Meanwhile, the proposed results for

the financial feasibility test are obtained in three scenarios for the main waste bank/IPST Asari. In the quiet scenario, the BCR value is 1.7, the normal scenario is 1.79, and the bust scenario is 1.95. These data indicate that the waste bank unit is feasible in the financial feasibility test using the BCR method

**Circular Economy (CE)**

In Figure 5. (a), IPST Asari only focuses on the Serdang Community of Cilegon City as its customer segment. After IPST Asari carries out the waste collection, a sorting process will be divided into high value, low value, and plastic

residue waste. After the sorting process, the production process of low-value plastic waste will be carried out using a pyrolysis process which will produce Plasse fuel (diesel, kerosene, and gasoline). Recycling industry companies will buy good quality plastic while the rest of the plastic waste is re-evaluated. Gasoline, diesel, and kerosene, resulting from the pyrolysis process, will be purchased by people in need.

In Figure 5(b), the market share of IPST Asari is expanded, and several innovation programs are proposed to optimize the processing of plastic waste in Cilegon City. First, the customer segment is expanded to cover the City of Cilegon. Second, providing convenience in buying and selling plastic waste using the Digital Waste Bank Application (Bank Password). Third, customers are given the convenience of selling directly to the unit waste bank or the main waste bank (IPST Asari) with an adjustable purchase fee. The fourth difference is that the additional products produced are paving blocks and can be purchased through the Digital Waste Bank Application. Some of these things will make it easier for companies to develop.

### CONCLUSION

Based on the data processing results, it is necessary to redesign using a circular business model canvas, seek product diversification from processing plastic waste, and calculate the feasibility test of the paving block business as a new revenue stream. In addition, several conclusions were obtained. First, the existing BMC from IPST Asari only covers the Serdang community of Cilegon City. Promotion of the environment is only through socialization. IPST Asari has not been able to sell the pyrolysis products because they do not have SNI (Indonesian National Standard). Second, the circular economy-based business model redesign is carried out using the CBMC method. The redesign of the canvas business model resulted in a proposal to produce paving blocks due to new product diversification. Socialization and promotion of the handling of plastic waste are carried out using social media and the Digital Waste Bank Application (Bank Sandi). Third, the potential for new revenue streams for processing plastic waste in Cilegon City is divided into two business divisions: the main waste bank (IPST Asari) and the unit waste bank. The main waste bank and the unit waste bank can be declared

feasible using a financial feasibility test using the BCR method. In the quiet, crowded, and normal scenario, the BCR value is  $>1$ . Fourth, the potential of the newest product proposed is the manufacture of paving blocks.

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