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IoT-Enabled Platform for Sustainable Used Cooking Oil Collection in Culinary SMEs and Restaurants

Aska Juta Tafrika Putra, Alberto Donny Gunawan, Novella Susanto, Abdul Rohman
Affiliation (Management Department, Binus Business School, Bina Nusantara University)
Email: aska.putra@binus.ac.id, alberto.gunawan@binus.ac.id, novella.susanto@binus.ac.id, abdul.rohman@binus.ac.id
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ABSTRACT

Purpose – This paper aims to design an innovative business model through a sustainable used cooking oil (UCO/minyak jelantah) management platform as an alternative solution to improve the effectiveness of UCO disposal and collection among restaurants and culinary SMEs. The study is motivated by the generally low adoption of proper UCO management practices in Indonesia, which contributes to environmental pollution and potential public health risks. **Methodology/approach** – This research applies the Business Model Canvas (BMC) to develop a technology-enabled solution, namely Throily, an ecosystem that combines IoT-based automatic volume recording with a digital application that connects SMEs and restaurants with UCO collectors to support safer and more transparent collection processes. **Findings** – The proposed Throily business model offers a clear value proposition: safer handling, improved operational efficiency, and transparent UCO collection, while also providing financial incentives for participating businesses. The primary target segment consists of restaurants and culinary SMEs in West Jakarta that generate UCO regularly yet lack efficient storage and pick-up systems. Financially, the model demonstrates sustainability potential through diversified revenue streams, including device sales, subscription programs, in-app advertising, and collaborations/partnerships. **Novelty/value** – By integrating IoT-enabled tracking with a digital marketplace and community-based collection ecosystem, Throily strengthens circular economy implementation and offers a scalable approach to reducing improper UCO disposal while generating measurable environmental and socio-economic benefits.

INTRODUCTION

Used cooking oil (UCO), commonly referred to as minyak jelantah, is a consequential waste stream that sits at the intersection of environmental quality, public health, and local economic sustainability. As food consumption increases alongside population growth and expanding urban livelihoods, the volume of kitchen-related waste rises accordingly, including waste that is readily biodegradable and waste that is not (Rimporok et al., 20219). In Indonesia, the growth of the food sector—ranging from households to culinary micro, small, and medium enterprises (MSMEs) and restaurants—has been accompanied by steadily increasing cooking oil consumption. National household cooking oil consumption reached

approximately 2.66 million tons per year in 2023, increasing around 2% compared to 2022 (Ahdiat, 2024). This upward trend implies a parallel increase in UCO generation, which becomes increasingly difficult to manage when disposal practices remain informal and fragmented. Despite its routine availability, UCO is frequently discarded without adequate management. Common practices include pouring UCO into drains, mixing it with household waste, or repeatedly reusing it beyond acceptable quality. Improper disposal contributes to clogged drainage systems, contaminated soil and groundwater, and degraded aquatic ecosystems due to surface oil films that reduce oxygen transfer and light penetration (Food Standards Agency, n.d.; Octopus, 2025). In addition to environmental damage, unsafe repeated use of degraded oil has been associated with health risks related to harmful compounds, bacterial contamination, and degenerative disease concerns (Fadli, 2022). These impacts create a pressing need for practical and scalable mechanisms that can prevent irresponsible disposal while enabling safe downstream utilization.Importantly, UCO is not merely a waste problem; it represents a substantial economic opportunity within a circular economy framework. In Indonesia, UCO has been utilized for export, recycled cooking oil, and biodiesel feedstock, indicating significant market potential (Sekretariat Wakil Presiden Indonesia, 2020). However, the national collection rate remains low relative to consumption: only about 3 million kiloliters (approximately 18.5%) of the estimated UCO potential was collected from total cooking oil use of roughly 16 million kiloliters (Sekretariat Wakil Presiden Indonesia, 2020). Export trends also suggest a growing demand for UCO-derived products, including international markets (Sudaryadi et al., 2022). At the same time, Indonesia has begun strengthening its commitment to decarbonization pathways, including the development of Sustainable Aviation Fuel (SAF), with UCO highlighted as a strategic feedstock and regulations projected to be phased in during 2026–2027 (Oswaldo, 2025). These developments reinforce the urgency for reliable UCO supply chains that are environmentally responsible and operationally efficient.

Existing UCO collection in Indonesia is predominantly driven by small, informal collectors using traditional, location-by-location pickup methods. This approach is often unstructured, heavily dependent on interpersonal networks, and susceptible to logistical inefficiencies and supply uncertainty. From the source perspective, UCO generation is dispersed across households, warungs, MSMEs, and restaurants, particularly in dense urban areas such as Jabodetabek. Data indicate that the potential UCO supply is substantial: households and MSMEs contribute meaningful volumes, yet collection remains uneven across cities and constrained by the absence of standardized systems (Sekretariat Wakil Presiden Indonesia, 2020; Sudaryadi et al., 2022). For culinary businesses specifically, operational constraints are recurring: limited access to safe storage containers, uncertainty of pickup schedules, inconsistent collector availability, and a lack of transparent measurement and pricing. As a result, many producers perceive UCO as valueless or burdensome, prefer to dispose of it quickly, or remain unaware that it can be sold and converted into higher-value products. These behavioral barriers are compounded by technical concerns, such as filtration difficulty, storage hygiene, and uncertainty regarding what quality standards are acceptable for recycling or biofuel conversion (Sari, 2023). Prior work and practices addressing UCO management can be broadly grouped into three approaches. First, community and informal collection models rely on manual transactions and ad hoc logistics, which can reach dispersed sources but tend to face problems of coordination, traceability, and predictable service. Second, policy- and awareness-driven approaches emphasize sustainability education and proper disposal, which can improve knowledge but often fail to translate into consistent action when incentives and convenience are weak (Daly & Farley, 2010; Hawken & Solimene, 2017; Sachs, 2015). Third, technology-enabled waste systems including digital platforms and traceability mechanisms have gained attention for improving transparency and coordination; however, many implementations in practice still depend on manual volume estimation and irregular pickup arrangements, which limits reliability for both waste producers and downstream processors. Consequently, a key limitation across approaches is the absence of an integrated end-to-end operational mechanism that simultaneously addresses safe storage, accurate

volume recording, scheduled pickup, and transparent transactions especially for MSMEs and restaurants that generate UCO routinely but cannot afford operational disruption.

This study responds to that limitation by proposing a platform-based business model that integrates operational design, incentives, and technology for sustainable UCO collection. The proposed solution, Throily, is conceptualized as an ecosystem combining (i) an IoT-enabled storage and measurement component for automated volume recording and (ii) a digital application to coordinate scheduling, connect culinary businesses with collectors, and enable transparent transactions. Rather than treating UCO management solely as a waste problem, this work positions UCO as a recurring resource stream that can support circular economy outcomes while offering tangible economic benefits to UCO producers. The platform is also designed to support community development by improving awareness and participation through a practical and financially attractive service model aligned with the triple bottom line (people, planet, profit).A few studies and initiatives have highlighted the large UCO potential and the environmental and health consequences of improper disposal, while others have discussed the opportunity of converting UCO into biodiesel or other derivatives. However, there have been limited studies concerned with the operational integration required at the collection interface particularly for culinary MSMEs and restaurants where challenges of safe storage, measurement accuracy, pickup certainty, and transaction transparency remain unresolved at scale. Therefore, this research intends to develop a technology-enabled business model and operational mechanism that reduces friction at the point of UCO generation and strengthens the reliability of UCO collection for downstream utilization. The scientific merit of this work lies in combining a structured business model design (Business Model Canvas) with an IoT-supported operational workflow to address persistent bottlenecks in UCO collection and retention among culinary businesses (Iskamto, Saputra, et al., 2025; Iskamto, Tory, et al., 2025). The objectives of this research are: (1) to identify the key operational and behavioral barriers experienced by culinary MSMEs and restaurants in managing UCO, based on qualitative insights; (2) to design an IoT-enabled platform ecosystem (Throily) that supports safe storage, automated volume recording, scheduled pickup, and transparent transactions; and (3) to develop a Business Model Canvas for the proposed platform, including value proposition, customer segments, revenue streams, and partnership structure, to demonstrate feasibility and sustainability of the solution in an urban Indonesian context.

LITERATURE REVIEW

Market Size

Indonesia is among the world's largest cooking-oil consumers, which results in substantial volumes of used cooking oil (UCO) and strong potential to convert it into an economically valuable commodity. Traction Energy Asia (2023) notes that Indonesia exports UCO, with European countries as major destinations, and estimates that annual UCO potential from households and micro-enterprises alone can reach around 1,200,000 kiloliters.

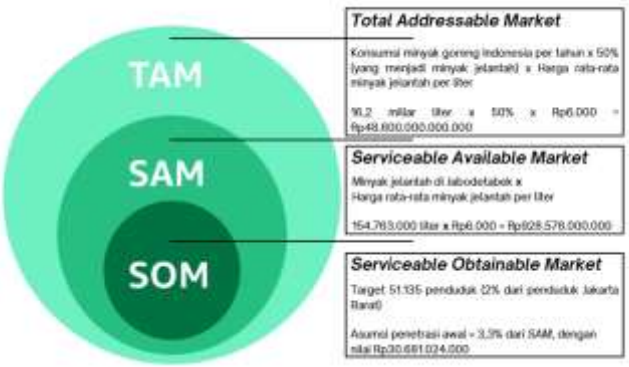

figure 1. Market Sizing Using TAM, SAM, and SOM

To estimate Throily's market opportunity, this study applies TAM–SAM–SOM sizing. The Total Addressable Market (TAM) is derived from national cooking-oil consumption reported by TNP2K at

16,200,000 kiloliters (16.2 billion liters) per year. Assuming 50% of consumed oil becomes UCO and using an average UCO price of Rp6,000 per liter, the TAM revenue potential is approximately Rp48.6 trillion per year. The Serviceable Available Market (SAM) narrows the focus to urban areas with higher sustainability awareness and relevant waste-management regulations, particularly Jabodetabek. Based on Databoks estimates, UCO availability from households and MSMEs in Jabodetabek reaches 154,763 kiloliters (154,763,000 liters). Using the same Rp6,000 per liter assumption, the SAM is estimated at approximately Rp928.6 billion per year.

The Serviceable Obtainable Market (SOM) is defined more conservatively for the early-stage rollout in DKI Jakarta. Traction Energy Asia estimates that 25–30% of national UCO supply comes from culinary MSMEs, restaurants, and related businesses. With 50,166 micro and small food businesses in DKI Jakarta (BPS), Throily sets a realistic initial adoption target of 20% (10,033 MSMEs), considering technology readiness, competition, and operational capacity. Using an estimated UCO generation of 2 liters/day (730 liters/year) per MSME and a service fee model of Rp500 per liter charged to collectors, the revenue potential per MSME is about Rp365,000 per year, resulting in an SOM of approximately Rp3.66 billion per year. This SOM represents about 0.65% of the SAM, which is consistent with typical early-stage penetration for technology-based environmental startups, where 0.5–2% of SAM is often considered a realistic initial range.

Competitor Analysis

Arkad operates in Indonesia's waste recovery sector by collecting and recycling both used cooking oil (UCO) and plastic waste. Its collection network covers multiple waste sources—such as households, restaurants, hotels, food factories, and hospitals—across major cities including Jakarta, Surabaya, Medan, and Pekanbaru. The collected UCO is processed into environmentally friendly biodiesel, while plastic waste is converted into pyrolysis oil using advanced pyrolysis technology. Arkad positions its services around reducing environmental pollution and preventing harmful reuse of degraded cooking oil, and it provides compensation to participating partners within its waste-collection programs. Strengths of Arkad include relatively stable operations and structured technical processes due to its longer market presence (operating since 2019), broader sector coverage (multi-waste streams), and higher credibility among investors. However, Arkad's limitations include relatively weak user accessibility through digital platforms, limited mobile-app enablement (often relying on WhatsApp), potential dilution of focus due to managing multiple waste categories, and comparatively low social media visibility and public awareness because of limited marketing and campaign intensity.

Cureah focuses specifically on UCO collection and management in Indonesia, with operations concentrated in the Jabodetabek region (Jakarta, Bogor, Depok, Tangerang, South Tangerang, Bekasi) and sources that include households, restaurants, hotels, and shopping centers. The collected UCO is primarily exported and processed into biodiesel, supporting sustainability goals by reducing reliance on fossil fuels. Cureahh's activities also contribute to public engagement and environmental awareness through community-oriented initiatives and service programs. Cureahh's key strengths are its single-sector focus (UCO only), strong partnerships supported by international market reach, and relatively strong investor confidence due to its established trajectory and global linkages. Nevertheless, Cureahh faces constraints in user accessibility because a dedicated smartphone application is not yet fully available, operational processes remain largely traditional with limited technological innovation in collection workflows, delivery logistics can be cost-intensive if handled via company-managed couriers, and social media marketing remains limited, resulting in lower public awareness. In addition, slower adaptation to new technologies and younger consumer behavior may increase competitive risk against more agile, tech-forward entrants.

PESTEL Analysis

PESTEL is a strategic framework to assess external factors affecting an organization across Political, Economic, Social, Technological, Environmental, and Legal dimensions. It helps Throily anticipate opportunities and constraints in the UCO industry shaped by sustainability and circular-economy trends (Kurakova & Safiullin, 2021).

Political
Indonesia's green-economy agenda, biodiesel mandates (B30–B40), and stronger waste governance support UCO valorization and structured collection. Corporate TJSL obligations (Law No. 40/2007) can also encourage partnerships with restaurants and hotels, while SAF policy momentum reinforces long-term demand for reliable low-carbon feedstocks.

Economic
Global demand for low-emission biofuels increases the economic value of UCO and intensifies competition for stable supply. Throily can improve MSME storage and distribution efficiency to strengthen supply reliability, while platform monetization (services, partnerships, CSR programs) supports business viability.

Social
Public awareness of UCO risks remains limited, but sustainable lifestyle adoption is rising. Throily's growth depends on behavior change, supported by convenient digital participation, incentives, and community-based engagement, especially in urban areas and ESG-oriented businesses.

Technological
Throily's differentiation lies in integrating an IoT-enabled Advanced Jerry Can with a mobile application. This enables accurate volume recording, real-time monitoring, and scheduled pickup coordination, reducing uncertainty and improving operational planning through data-driven insights.

Environmental
Unmanaged UCO causes pollution in waterways, soil, and drainage systems. Throily addresses this through safer storage and more structured collection, while enabling circular-economy pathways (e.g., biodiesel) that strengthen environmental impact and market relevance.

Legal
Throily must comply with waste and storage regulations (e.g., PP No. 22/2021; MoEF Regulation No. 6/2021) and Indonesia's Personal Data Protection Law (Law No. 27/2022). Legal compliance enhances trust, scalability, and partnerships, even though mandatory restaurant UCO recycling rules remain

limited.

Porter's Five Forces
Porter's Five Forces evaluates industry attractiveness through five competitive pressures: threat of new entrants, supplier power, buyer power, substitutes, and rivalry (Porter, 1979).

Threat of New Entrants (Moderate)
Entry barriers in UCO collection are relatively low, but rising environmental and renewable-energy standards increase operational requirements. Throily's integrated platform and IoT-enabled workflow create practical barriers through technology, compliance readiness, and ecosystem coordination.

Bargaining Power of Suppliers (Moderate–High)
Supplier power is moderate–high due to dependence on quality manufacturing and components for IoT-enabled containers. Price volatility in materials and local-content (TKDN) considerations can further strengthen supplier influence, making supplier partnerships strategic.

Bargaining Power of Buyers (High)

Buyer power is high because major buyers are biodiesel and chemical industries with strict quality, traceability, and sustainability requirements. Throily must ensure consistent collection quality and transparent data to compete in pricing and long-term contracts.

Threat of Substitutes (Low–Moderate)
UCO remains important for biodiesel and related industries, but future energy shifts could reduce demand. Diversifying UCO end-uses (e.g., oleochemicals, industrial wax, soap) improves resilience against substitution risk.
Industry Rivalry (Moderate–High)
Competition is moderate–high due to multiple players (e.g., Arkad, Cureahh) and increasing pressure for transparent, compliant supply chains. Throily's differentiation relies on integrated scheduling, digital transactions, and service reliability, supported by loyalty programs and long-term partnerships.

Consumer Behavior Analysis
Consumer behavior is critical for UCO programs because participation depends on how users perceive environmental impact, benefits, and operational ease. This study considers key motivators (e.g., financial incentives, convenient access) and barriers (e.g., limited information, logistical difficulty). Insights were informed by interviews with 30 respondents and members of environmentally concerned communities, focusing on awareness, willingness to participate, and service experience (e.g., accessibility and satisfaction). Data for this domain can be captured through surveys, in-depth interviews, observation, and secondary data analysis (Efdison, 2021; Hasan & Liana, 2022; Iskamto, Saputra, et al., 2025).

Price Sensitivity
Price sensitivity reflects how strongly consumer decisions are influenced by cost (Goldsmith, 1996). Prior studies show that price remains a major determinant in green-related decisions; consumers with high price sensitivity tend to avoid relatively expensive "green" options even if they hold pro-environmental attitudes (Erdil, 2018). This is relevant for Throily because many target users (lower–middle income MSMEs) prioritize cost efficiency and may disengage if incentives are perceived as insufficient.

Environmental Awareness
Environmental awareness refers to one's attitude and willingness to protect the environment and prevent human-caused damage (Sanjaya et al., 2023). It includes recognizing environmental problems and being willing to act (Cheng et al., 2023), as well as understanding local environmental vulnerability (Ariescy et al., 2019). For Throily, higher environmental awareness can increase participation, especially when the platform makes responsible disposal practical and financially attractive.
Daily Convenience
Convenience is the perceived ease and speed of accessing a service (Shankar, 2021). Accessibility influences platform preference (Duarte et al., 2018), and convenience is especially valued by time-constrained users because it supports efficient daily routines (Roy et al., 2018). In Throily's context, a user-friendly app integrated with a dedicated container supports smoother transactions, transparent pricing, and reduced effort, which can strengthen participation in responsible UCO handling.

Price Perception
Price perception concerns how users interpret price information relative to the value they receive. Zeithaml (Kusdyah, 2012) emphasizes that consumers evaluate price by comparing perceived sacrifice against expected benefits. For Throily, suppliers (restaurants/hotels/MSMEs) are more likely to participate when the offered price is perceived as fair compared to alternatives; low perceived value can reduce engagement and trigger switching behavior.

Social Influence
Social influence can significantly increase behavioral intention; consumers who interact with a brand often develop emotional attachment that supports future actions (Prastio & Rodhiah, 2021). For Throily, community-building and peer recommendations can encourage participation, strengthen trust, and improve retention, particularly when users observe visible benefits and positive environmental impact within their networks.

SWOT Analysis
Strengths
Throily offers an innovative business model by integrating a digital application with an IoT-enabled hardware solution (Advanced Jerry Can), creating clear differentiation from conventional UCO collectors. The container's features—such as digital volume measurement and safer, more secure storage support accuracy and reduce disputes between sellers and collectors. Throily also has potential regulatory alignment because its model supports local government priorities related to biodiesel and sustainable waste management.

Weaknesses
Technology-based operations may face slower adoption because many sellers and collectors are not yet familiar with IoT-enabled workflows and require time for adjustment. The Advanced Jerry Can also has higher production costs than conventional jerry cans, which may increase entry barriers for cost-sensitive users. In the early stage, Throily's operations are geographically limited to West Jakarta due to capacity constraints. In addition, the platform depends on adequate smartphones and internet access, which can be challenging for lower-income segments.

Opportunities
The growing institutional involvement of major actors such as Pertamina in UCO trading creates partnership potential and wider market access. Throily can also expand to other densely populated areas (e.g., Tangerang and North Jakarta) where UCO supply is likely high. Moreover, gamification features such as contribution points, supported by education on UCO health and environmental risks, can increase engagement and active-user retention.

Threats
A key external risk is export-restriction policy that halts UCO exports starting 8 January 2025, potentially leading to oversupply and weaker market demand. Competition may intensify if larger companies or well-funded startups enter the same sector with stronger networks and capital. Finally, as a digital platform, Throily faces cybersecurity risks that could threaten user trust if data security is compromised.

Market Analysis
Following Kotler's market analysis perspective (2022), which emphasizes market attractiveness through size, growth, trends, and consumer behavior, Throily operationalizes these principles by targeting culinary MSMEs that are still weakly organized in linking UCO sellers with collectors. Through a technology-based approach and behavior-driven segmentation, Throily delivers convenience and access while building a more sustainable relationship between users and the recycling ecosystem.

Segmentation
Demographic: Culinary MSMEs such as street food stalls, small–mid restaurants, fried-snack vendors, catering, and snack producers that generate UCO routinely. The segment spans micro to medium enterprises (annual turnover < Rp50 billion) producing roughly 5–500 liters/month, typically led by owners aged 25–50 in urban culinary clusters (e.g., West Jakarta).

Geographic: Initial focus on dense urban areas (West Jakarta and nearby) due to high culinary concentration, high oil consumption, and better digital readiness. Future expansion considers consumption patterns, logistics accessibility, and local waste regulations.

Behavioral: Users differ by disposal habits, storage discipline, environmental attitudes, and digital engagement. Many MSMEs still dispose UCO informally, while higher-volume businesses are more motivated to sell UCO for additional income. Throily also distinguishes active vs. passive app users to tailor reminders, education, and subscription features.

Psychographic: Targets users who value sustainability and circular economy, including those already environmentally aware and those who are willing to change once they understand the impacts and benefits. This segment responds well to community narratives and educational campaigns on health and environmental risks.

Targeting
Targeting is staged and selective based on UCO volume potential, technology adoption readiness, and alignment with Throily's sustainability mission. Priority targets include culinary MSMEs and restaurants with stable UCO output and high potential to shift from disposal to structured selling, either for additional income or CSR/ESG-related practices. Digital-behavior targeting also prioritizes users with higher retention potential, supported by education and community-based activation.

Positioning
Throily positions itself as a digital bridge between UCO sellers and collectors by combining an IoT-enabled Advanced Jerry Can with an integrated mobile application. The core promise is a more convenient, transparent, and reliable UCO collection experience that enables direct environmental contribution. Compared to competitors that rely on traditional workflows and limited digital systems, Throily differentiates through integrated scheduling, automated volume tracking, and ecosystem-based collaboration for a scalable, sustainability-driven model.

METHOD

Research design

This study employs a design science and conceptual business-model development approach to propose an IoT-enabled platform for sustainable used cooking oil (UCO) collection. The research focuses on developing and structuring the Throily ecosystem using the Business Model Canvas (BMC) as the primary analytical and design framework. BMC is a strategic management tool developed by Osterwalder and Pigneur that enables systematic visualization and evaluation of a business model through nine building blocks: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. In this study, BMC is used to translate the identified operational issues in UCO management into a coherent platform-based solution that is feasible, desirable, and viable.

Population and sample

The population targeted in this research is culinary business actors that routinely generate UCO, with emphasis on micro, small, and medium enterprises (MSMEs) and restaurants. The empirical input for the conceptual development was obtained from an in-depth interview process involving 20 individuals representing groups that use cooking oil for production and produce UCO as waste. The sample was selected purposively to capture practical constraints and real operational needs relevant to the platform design, with a particular focus on the West Jakarta context as the initial target market for Throily.

Techniques of data collection

Primary data were collected through semi-structured, in-depth interviews. The interviews explored participants' current UCO disposal practices, knowledge and attitudes toward UCO value and risks, and operational barriers such as storage limitations, inconsistent collector access, uncertain pickup schedules, and lack of transparent measurement and pricing. The interview findings were synthesized using an empathy map to structure insights into what participants think and feel, see, hear, say and do, as well as their pains and gains. These insights informed the functional requirements and operational workflow of the proposed platform.

Techniques of data analysis

Data analysis was qualitative and iterative. First, interview data were coded and organized into the empathy map dimensions to identify recurring problems and needs. Second, the identified pains and gains were translated into platform requirements and mapped into the BMC blocks to build the Throily business model. Third, the proposed value proposition and operational mechanism were refined by aligning the platform architecture with the desirability, feasibility, and viability perspective, particularly emphasizing the integration between the IoT-enabled Advanced Jerry Can for real-time volume recording and the Throily application for pickup scheduling, collector matching, transparent transactions, and contribution tracking. The final output of the method is a complete BMC for Throily, including target customer segments in West Jakarta, value proposition, channels, customer relationship strategy, revenue streams, key resources, key activities, key partnerships, and cost structure.

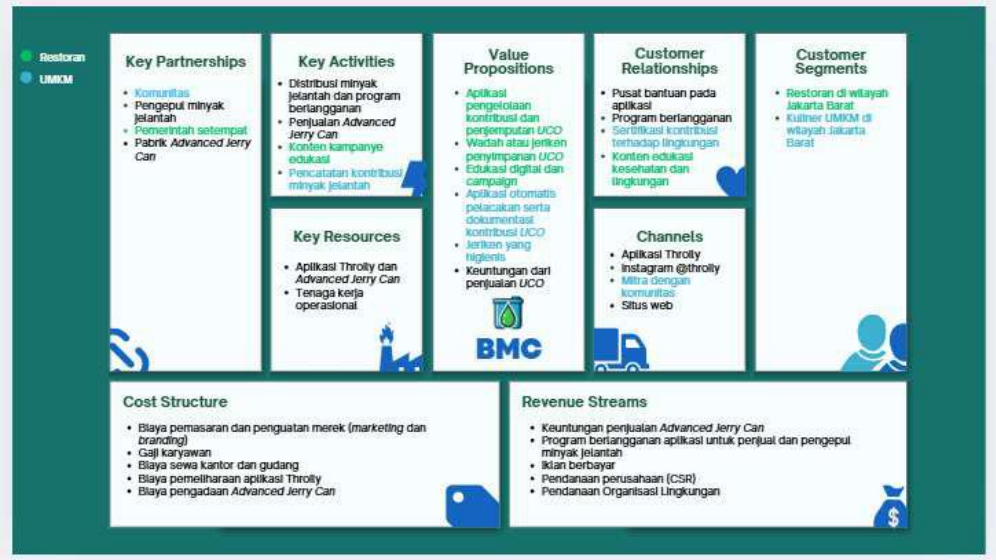

figure 2. Business Model Canvas Throily

RESULT AND DISCUSSION

Starting from the problem of unstructured used cooking oil management where it is often disposed of improperly Throily emerges as an innovative solution to help culinary businesses such as restaurants, hotels, and MSMEs manage used cooking oil more efficiently and sustainably in Indonesia. Throily was founded by Aska Juta Tafrika Putra, Alberto Donny Gunawan, and Novella Susanto, with a focus on driving digital transformation across the used cooking oil management chain through an Internet of Things (IoT)-based platform. Throily is not merely a "collector"; it serves as an integrated connector that links UCO generators, collectors, biodiesel industries, and lubricant industries within a single, more organized and measurable ecosystem. Through digital monitoring and traceability, Throily improves collection efficiency, reduces environmental pollution risks, and creates economic value from waste that was previously considered worthless.

figure 2. Logo Throily

Throily's brand identity is defined through a name that captures the essence of the business and its core message. The name "Throily" combines "throw," representing responsible disposal, and "oily," referring to oil positioning Throily as a modern way to dispose of used cooking oil without harming the environment. The Throily logo features an oil container icon that symbolizes a storage or collection unit, accompanied by an oil drop that represents the transformation of used cooking oil into valuable products such as biodiesel. The blue color conveys trust and professionalism, while green reinforces a commitment to sustainability and positive environmental impact. The tagline "Turning Oil into Prosperity" strengthens the message that Throily turns waste into economic opportunity and ecological contribution.

Throily's vision is to become a leading modern platform and device provider for used cooking oil storage and sales, contributing to environmental preservation and promoting sustainability practices among households, MSMEs, restaurants, and hotels in Jakarta and beyond. Its mission is to deliver innovative solutions through a digital platform and hardware that ensure transaction efficiency, safety, and ease of access; support environmental protection through responsible waste management; serve diverse user segments inclusively; and build a business ecosystem that creates positive impact for local communities. Throily's strategic objectives are measurable as follows:

1. Technology innovation: release one IoT-based Advanced Jerry Can and one integrated application (seller–collector) featuring real-time volume monitoring, notifications, transaction logs, and pickup scheduling, and achieve at least 5,000 recorded collection transactions in the system.
2. Service accessibility: establish scheduled operations in the West Jakarta beachhead area and reach at least 2,000 active MSME/restaurant users as regular participants through an easy-to-use service and structured onboarding support (deadline: 2027).
3. Engagement and education: conduct at least 12 education and community activation campaigns per year in partnership with environmental communities, culinary associations, and CSR programs, and issue contribution certifications for active users to encourage behavior change (2026–2027).
4. Platform and operational scaling: build an environmental contribution reporting dashboard, smart-routing for collectors, and an integrated help center; target core team growth from 10 to 25 people and stabilize recurring revenue through subscription and platform service models (target: 2029).
5. Market penetration and impact: achieve 5–10% of the MSME SOM in DKI Jakarta and expand gradually across Jabodetabek, with consistently increasing collection volumes and annual revenue growth projections supported by an expanding collector network and downstream industry partnerships (3–5 year horizon).
6.

Throily's business model targets three key stakeholders: culinary MSMEs and restaurants as consistent UCO generators, urban households seeking a safe and responsible disposal channel, and collectors who

require stable supply and more efficient logistics systems. Throily's unique value lies in combining a hygienic IoT-enabled Advanced Jerry Can, a real-time seller–collector connecting application, and an ecosystem of education and incentives that drives behavior change. With this approach, UCO management shifts from manual and fragmented practices into a more measurable, transparent, and economically valuable process, while reducing risks of water and soil pollution.

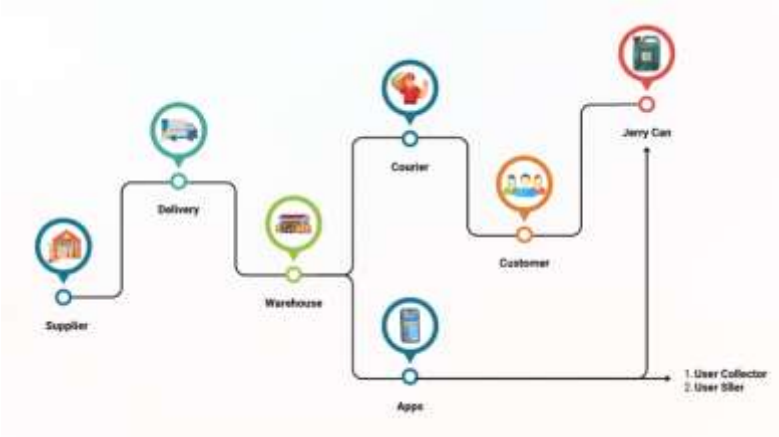

figure 3. Business Process Throily

Throily's process chain is designed end-to-end to ensure efficiency and value creation. It begins with the provision of Advanced Jerry Cans by manufacturing vendors, which are distributed to MSMEs, restaurants, or households as safe storage containers. When used cooking oil is poured in, sensors record the volume and transmit data to the application, enabling users to monitor capacity and receive notifications when the oil is ready for pickup. Through the app, users select the nearest collector, agree on pricing and a schedule, and the collector retrieves the oil using an optimized route. The collected oil is then delivered to downstream industry partners such as biodiesel producers, supported by transaction records and environmental contribution certification. This scheme relies on cross-actor collaboration to maintain quality, operational efficiency, and sustainability impact.

Throily's marketing strategy combines STP and the 7Ps to accelerate adoption and establish more disciplined UCO management habits. Segmentation includes (1) culinary MSMEs and restaurants in urban areas that generate UCO routinely, (2) sustainability-aware urban households, and (3) collectors who require stable supply and efficient pickup routes. Early-stage targeting focuses on MSMEs and restaurants in DKI Jakarta especially dense culinary clusters due to high UCO volume, urgent storage needs, and logistical proximity that enables consistent pickup services. Throily is positioned as a technology-enabled UCO management platform that integrates a smart Advanced Jerry Can with an end-to-end application, making storage, volume recording, and UCO selling transactions safe, easy, transparent, economically valuable, and environmentally impactful.

Within the 7Ps, Throily's product is an end-to-end solution consisting of an IoT-sensor Advanced Jerry Can, an application for logging and seller–collector matching, and built-in education and contribution certification features. Pricing applies a value-based approach to remain accessible for MSMEs and households, combining jerry can purchase with optional subscriptions for premium features. Place uses a hybrid distribution model through offline and online channels, leveraging community partners, culinary associations, and digital channels within the app. Promotion prioritizes education, behavior change, and user acquisition through social media campaigns, community collaborations, and referral programs. People include operations teams, customer support, and collector partners to ensure service consistency, while processes are kept standardized and simple. Physical evidence is reinforced through

the smart container itself, brand visual identity, user testimonials, and environmental contribution reports as social proof.

Value, satisfaction, and loyalty are built through "value for convenience and impact," where users experience practical transaction ease while seeing real environmental benefits. Satisfaction is maintained through short post-transaction surveys, fast responses via the help center, and reliable pickup schedules. Loyalty is strengthened through contribution points or badges, benefits for active users (priority pickup, referral bonuses, bundled promotions), and an educational community that makes users feel part of a circular-economy movement rather than occasional participants.Throily's operational strategy is structured end-to-end to ensure an efficient and sustainable UCO ecosystem. It starts with RDI that develops an Advanced Jerry Can that is precise, safe, and environmentally responsible, and an application serving as the control center for volume monitoring, transactions, and seller–collector connectivity. Procurement relies on local supplier partnerships and transparent e-procurement to manage costs and secure supply continuity. Device production involves assembly, calibration, and quality testing before phased distribution for market validation and serial tracking. Logistics are supported through courier/community partnerships, data-driven route optimization, and reverse logistics to return empty containers, clean them, and reuse them—reducing costs while reinforcing circular-economy practices.

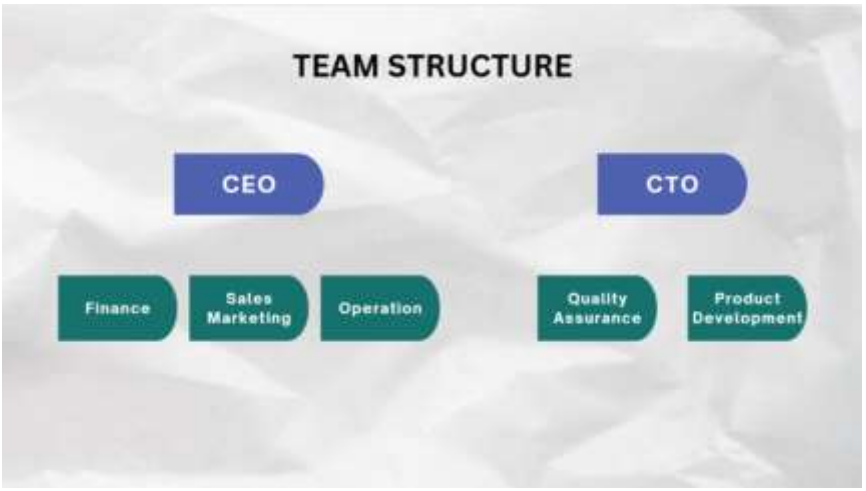

figure 4. Throily Organizational Structure

Throily's human resources rely on a cross-functional team that ensures efficient end-to-end execution across the value chain. The team includes product development and technology (app development, IoT integration, and analytics), quality assurance (quality standards and safety control), operations (collection coordination, pickup scheduling, and partner management), sales and marketing (user acquisition and brand building), and finance (budgeting and reporting). The organizational structure is lean and functional: the CEO leads strategy, the CTO drives technological innovation, financial management ensures accountability, and other teams support daily execution and growth. HR management prioritizes selective recruitment, continuous training, a collaborative work culture, and performance-based retention schemes to keep key talent during scaling.

Throily's technology roadmap focuses on an end-to-end ecosystem that combines a 10-liter smart jerry can equipped with high-precision sensors, automated notifications, and Bluetooth connectivity, with a multi-interface application for sellers, collectors, and customers. The application supports inventory logging, digital transactions, real-time pickup tracking, and automated route planning. IoT integration enables automated monitoring and efficiency analytics, while cybersecurity is maintained through encryption and layered authentication. Throily's early funding combines equity, investors, consortium funding, and bank loans totaling IDR 12 billion in Year 0, followed by an additional IDR 3 billion in Year 1. Early revenue projections rely on a service-fee model of IDR 500 per liter, targeting a SOM of 10,033 MSMEs in DKI Jakarta (approximately IDR 3.66 billion per year). Key CapEx includes jerry can production, IoT components, app development, and facilities, while OpEx covers marketing, logistics, and system maintenance. HR and marketing costs are expected to rise gradually in line with expansion and inflation.

Table 1. Financial Ratio

OPTIMISTIC					
Description	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Net Profit	Rp4.825.080.000	Rp5.418.238.800	Rp5.988.448.596	Rp6.185.809.269	Rp6.976.941.226
Revenue	Rp9.980.000.000	Rp10.856.000.000	Rp11.819.600.000	Rp12.879.560.000	Rp14.045.300.000
Total Assets	Rp6.482.000.000	Rp12.732.286.000	Rp19.330.114.820	Rp26.242.651.268	Rp34.730.423.248
Total Equity	Rp6.482.000.000	Rp12.732.286.000	Rp19.330.114.820	Rp26.242.651.268	Rp34.730.423.248
ROE	74,00%	43,00%	31,00%	24,00%	20,00%
NPM	48,35%	49,91%	50,67%	48,03%	49,67%
ATR	1,539648257	0,852635575	0,611460413	0,490787301	0,404409123
ROA	74,44%	42,56%	30,98%	23,57%	20,09%
REALISTICS					
Description	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Net Profit	Rp3.467.880.000	Rp3.818.934.600	Rp3.684.370.638	Rp3.931.798.067	Rp4.321.824.187
Revenue	Rp1.058.000.000	Rp1.034.000.000	Rp1.658.000.000	Rp1.838.000.000	Rp1.874.000.000
Total Assets	Rp5.763.800.000	Rp6.108.062.000	Rp6.469.299.550	Rp6.839.221.275	Rp7.272.271.538
Total Equity	Rp5.763.800.000	Rp6.108.062.000	Rp6.469.299.550	Rp6.839.221.275	Rp7.272.271.538
ROE	60,00%	63,00%	57,00%	57,00%	59,00%
NPM	327,78%	369,34%	222,22%	213,92%	230,62%
ATR	0,183559457	0,169284464	0,256287406	0,268744046	0,257691148
ROA	60,17%	62,52%	56,95%	57,49%	59,43%
PESSIMISTIC					
Description	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Net Profit	Rp1.870.829.999	Rp2.803.320.000	Rp2.566.626.777	Rp2.613.115.061	Rp2.658.039.422
Revenue	Rp1.061.000.000	Rp1.097.000.000	Rp1.698.500.000	Rp1.748.000.000	Rp1.802.000.000
Total Assets	Rp4.361.000.000	Rp4.526.810.000	Rp4.699.512.500	Rp4.879.113.125	Rp5.066.289.181
Total Equity	Rp4.361.000.000	Rp4.526.810.000	Rp4.699.512.500	Rp4.879.113.125	Rp5.066.289.181
ROE	43,00%	62,00%	55,00%	54,00%	52,00%

NPM	176,33%	255,54%	151,11%	149,49%	147,50%
ATR	0,243292823	0,242334006	0,361420466	0,358261831	0,355684395
ROA	42,90%	61,93%	54,61%	53,56%	52,47%

Financial projections (income statement, balance sheet, and cash flow) indicate a healthy trajectory: gross profit and net profit increase across all scenarios, with earlier profitability under the optimistic and realistic cases and a slight delay under the pessimistic case. The balance sheet shows current assets and equity growing faster than liabilities, supporting liquidity and a sound capital structure. Ratio analysis confirms strong margins (up to GPM ~76% and NPM ~59% in the optimistic scenario), ROE approaching ~100% by the end of the period in the first two scenarios, and ROI turning positive from Year 2–3. Investment feasibility is also robust, with NPV of ~IDR 9.8 billion, IRR ~155%, and PI ~17 (optimistic); NPV ~IDR 5.1 billion, IRR ~91%, and PI ~9 (realistic); and feasibility remaining positive even under the pessimistic scenario (NPV ~IDR 2.7 billion; IRR ~58%; PI ~5).

Throily's net profit remains positive in all scenarios, accelerating fastest in the optimistic case (IDR 4.83 billion in Year 1, increasing to IDR 6.98 billion by Year 5) and remaining consistently strong in the realistic case (around IDR 3.47–4.32 billion per year), while the pessimistic case is lower but still stable (around IDR 1.87–2.66 billion per year). Payback is achieved sooner in the optimistic scenario (approximately 3 years 10 months) and realistic scenario (approximately 4 years), but is not reached within five years under the pessimistic scenario. Equity grows rapidly and assets expand alongside IoT investments, sustaining liquidity even as asset turnover (ATR) declines. Under the optimistic case, ROE is high early (~74%) and then moderates to ~20% by Year 5, with relatively stable NPM (~48–50%) and declining ATR. In the realistic case, profitability remains stable (ROE ~57–63%, ROA ~56–62%), with high NPM driven by larger projected net income. The pessimistic case shows competitive ROE (~43–52%) and a declining NPM (approximately 176.33% to 147.50%). Overall feasibility is reinforced by positive NPVs across scenarios (optimistic ~IDR 6.92 billion, realistic ~IDR 14.45 billion, pessimistic ~IDR 9.38 billion), IRR around 68%, 48%, and 28%, and positive PI values, indicating the project remains viable. Throily's risk management approach is designed to protect operational stability and long-term sustainability. Strategic risks such as weak market acceptance, competitive pressure, and regulatory shifts are addressed through market education, product differentiation, IP protection, and revenue diversification. Operational risks are mitigated through standardized SOPs, IoT-based monitoring, AI-supported route optimization, and quality control. Financial risks are managed through budgeting discipline, cost controls, cash reserves, and longer-term partnership contracts. Compliance risks are handled through permit updates, employee training, and routine audits. Human-capital risks are reduced through competency-based recruitment, continuous training, and incentive systems. Technology risks are mitigated through encryption, 2FA, cloud auto-scaling, backups, and strengthened cybersecurity. Reputational risks are managed through responsive service delivery, fast complaint handling, and a consistent commitment to transparency and ethical business practices.

figure 5. Prototype Advance Jerry Can Throily

The Throily Jerry Can prototype is designed for used cooking oil collection and recycling with a 10-liter capacity. Made from a transparent, chemically resistant material, the container has an ergonomic form and a sturdy handle, allowing MSMEs, hotels, and restaurants to move it easily. It is equipped with an LED/LCD display that shows real-time oil volume, supported by weight and quality sensors, along with alerts when the container is approaching its maximum limit. Integrated with IoT via Wi-Fi or Bluetooth, the device enables monitoring of total collected oil, pickup scheduling, disposal history, and waste-reduction contribution reports. For safety, the jerry can uses an airtight cap, a particle-filter system, a practical dispensing mechanism, and a non-slip base. All materials are selected to be eco-friendly, durable, and recyclable, reinforcing Throily's sustainability principles.

figure 6. Throily Customer App Prototype

The Throily Customer app serves as the main gateway for individual users, MSMEs, and the hotel/restaurant sector to sell or donate used cooking oil. The interface begins with a front page displaying the logo, a loading animation, and login access. The home page shows total oil collected, a contribution chart, a Community menu featuring environmental campaigns, events, and community updates, as well as the three most recent transactions. The geolocation-based Collector Finder feature provides a real-time interactive map of the user's position and nearby collectors, including distance estimates and a pickup request option. The app also includes News and Community pages in a feed-style layout that present environmental programs, educational articles, and community activities. The Transaction History page displays transaction details in table/card format, while the Profile page allows users to manage personal data, security settings (PIN/authentication), notifications, and reward or environmental contribution information.

figure 7. Throily Merchant and Collector App Prototype

The Throily Collector & Merchant app functions as an operational control center for collectors and merchants to manage oil pickups, track user locations, and plan efficient routes. After login, the home page displays total oil collected, a performance chart, the three most recent transactions, and quick access to “Pickup Schedule,” “Today’s Route,” or “New Requests.” The Customer menu provides a location map, order details, payment method information, and action buttons such as “Start Route” and “Contact Customer” to minimize coordination errors. The app also offers News and Community pages with information on environmental programs, education, and community updates. The Transaction History page stores operational records with search and filter functions. The Profile page includes account data, security settings, a performance summary, and access to the help center.

CONCLUSION

Throily is considered feasible to implement because it combines digital technology, circular-economy principles, and cross-sector partnerships to manage used cooking oil efficiently and sustainably. Its user-centered approach addresses the needs of multiple segments households, MSMEs, restaurants, hotels, collectors, and the biodiesel industry through an integrated system that strengthens transaction transparency, process standardization, and the creation of economic and environmental value from waste that has previously been underutilized. The key differentiation lies in the integration of an IoT-based smart jerry can with a multifunctional application, enabling convenient oil collection through high-precision sensors, automated tracking, and logistics route optimization.From a financial perspective, Throily’s feasibility is supported by positive indicators across all scenarios. NPV remains positive in every scenario (optimistic IDR 6.92 billion; realistic IDR 14.44 billion; pessimistic IDR 9.38 billion), and IRR exceeds the discount rate (optimistic 68%; realistic 48%; pessimistic 28%). Cumulative net profit over five years reaches IDR 29.39 billion (optimistic), IDR 19.22 billion (realistic), and IDR 12.51 billion (pessimistic). Profitability and payback occur faster in the optimistic and realistic scenarios, while in the pessimistic scenario, payback is expected to extend beyond the five-year horizon—indicating the need to accelerate adoption and improve cost efficiency.

Despite limitations related to early-stage data, technology adoption assumptions, and resource constraints, further research should be conducted across five priority corridors: deeper market segmentation, technology innovation using AI/ML for optimization, environmental impact assessment of IoT devices, user behavior and experience studies, and regulatory and compliance analysis. Overall, Throily demonstrates desirability by meeting market needs and creating value, feasibility through technology that enables automation and operational control, and viability through positive financial indicators. With continued development and targeted follow-up research, Throily has a clear pathway to scale from pilot implementation to a wider multi-city network, strengthen end-to-end traceability and quality assurance of used cooking oil, secure long-term offtake partnerships with biodiesel processors, and become a trusted, integrated ecosystem that advances a measurable circular economy impact in Indonesia.

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