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CIRCULAR BUSINESS MODEL: DEVELOPMENT OF REUSABLE CAMERA TO REDUCE E-WASTE FROM DISPOSABLE CAMERA

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Abstrak: An increase demand for reusable cameras among the millennial and Z-generation in Indonesia has created a significant environmental dilemma, considering the consequently increasing production of electronic waste. Although the principle of circular economy has been adapted in various electronic industry sector, its implementation in particularly the camera industry is still left to explore. This study aims to design and validate a comprehensive circular business model for reusable cameras in Indonesia that can measurably reduce electronic waste from disposable cameras while maintaining economic and environmental value creation To achieve this objective, the study applies a circular business model canvas integrated with a qualitative case study on reusable camera usage in Indonesia, a systematic literature review on circular economy practices in the electronics sector, and a product sustainability assessment using quantitative metrics. This paper concludes that the proposed circular business model for reusable cameras represents the most suitable development option because it simultaneously reduces e-waste from disposable cameras and enhances economic and environmental value creation in Indonesia. This study also develops three hybrid business model strategies – 'ownership plus, 'try-before-you-buy', and 'community-based ownership pools' – all of which accommodate consumer ownership preferences in Indonesia while maintaining the circular economy principles. This paper concludes by highlighting the operability of the circular business model for camera and its potential contribution to the sustainable development goals. This notwithstanding, its implementation requires multi-stakeholder collaboration, investments in digital infrastructure, capacity building, and government support on regulations.

Kata kunci: circular economy, disposable camera, electronic waste, circular business model, SDG #12

I. INTRODUCTION

There has been a paradigm shift in how we do the economy: from linear to circular. Circular economy is a concept of economy in which activities are oriented towards the minimization of resource input, waste, emissions, and energy (Awan & Sroufe, 2022; Grafström & Aasma, 2021; Yang et al., 2023; D'Amato et al., 2017; Lee, 2021). By minimizing waste, promoting the flow of goods and resources, and nurturing the environment, the circular economy model represents an approach to progress that aims to support businesses, communities, and environmental sustainability. It envisions a framework that shifts away from the idea of disposal towards methods such as cutting down on waste, reusing items, recycling materials, and reclaiming resources in various stages of production and consumption (Upadhayay, 2024).

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Transitioning to a circular economy approach enables us to conserve resources, reduce waste and pollution, and, a larger context, address climate change and benefit the community (Morone & Yilan, 2020). In circular economy, the goal is to prolong product life cycle by reducing waste and minimizing resource use, which in the end enables us to restore our ecosystem. With an ever-increasing push towards sustainability, circular economy offers one important strategy for this (Huber, 2011). In the industrial sector, one important aspect to integrate circular economy in its business operations is by establishing circular business models. It support the industry to not only move towards sustainability, but also to create competitive advantages amidst the increasing resource constraints. Circular Business Model Canvas (CBMC) is a key method for implementing circular economy principles in business. In CBMC, a conventional approach of BMC (Osterwalder & Pigneur, 2013) is complemented by elements that facilitate sustainable practices and resource efficiency.

Implementing principles of circular economy in the electronics sector is considered a strategy for sustainable development and design of electronic products but also emphasizes the importance of comprehensive planning for transitioning to a circular economy and addressing research challenges when shifting towards circularity in the tech industry (Williams & Shittu, 2022). These approaches involve managing assets, recycling e-waste, trading in, or buying back devices and selling preowned or refurbished gadgets (Dejene et al., 2023). However, the research lacked in-depth exploration of end-of-life solutions. Research by Kleber et al. (2012) revealed that buy-back can be a good strategy for sourcing spare parts and reducing waste in the end-of-life stage of electronic products. This research also showed that this approach can be especially useful when original manufacturing of the products stopped. This buy-back strategy can increase manufacturing capabilities and reduce raw material sourcing at the same time. Another product management at the end-of-life can be in the form of refurbishment. Santana et al. (2020) demonstrated a case study that showed refurbishment in an electronic product, specifically cell phones, can generate profitability while reducing electronic waste at the same time.

The transition to a circular economy in the electronics industry is still faced with challenges. One challenge is in the sustainability of material supply chain, wherein reliance on past material extraction still hinders the innovations of resource (O'Connor et al., 2016). The next challenge lies in forecasting e-waste flows where quick innovation progress in electronic products results in the increasing number of obsolete products, leading to an increased volume of e-waste where the circular economy practice could not keep up (Althaf et al., 2019). On the less technical side, innovations in business practices can also be a challenge. Innovations in circular business models still need to be explored to tailor specific needs of specific industries (Pollard et al., 2021). These studies underscored the obstacles faced in moving towards circular economic industries.

One product of the electronic industry with large potential in waste generation is the disposable camera. Although previously seemed to be out of demand, disposable cameras are making a comeback because they are affordable, easy to find, and provide an experience for consumers from the younger generation (McKay, 2024). The renewed interest in cameras can be credited to their

cost and accessibility, as well as the special tactile sensation they offer (Fan & Fujimoto, 2019). However, this renewed interest will ultimately generate problems from the additional production of e-waste. The traditional life cycle of cameras, from production to disposal, significantly contributes to waste problems due to their single use characteristics and the materials used in their manufacturing and disposal processes (Chuang & Liao, 2018). This trend also poses another threat when it finally dies out, leading to their spare parts become another waste that ends up in the landfill.

As mentioned earlier, incorporating circular economy principles into business strategies would offer a solution to address the waste issues associated with the use of cameras (Adam et al., 2018). These strategies focus on designing products cycles that optimize resource in a closed loop system (Veral, 2019). Essentially, this approach highlights the importance of extending the lifespan of products. By adopting this approach, not only can we reduce the impact of disposable cameras, but we can also promote a more responsible use of resources in alignment with circular economy values (Morone & Yian, 2020). The challenge, however, still exists in how the existing industries can adapt to, and adopt, circular business practices.

One way to help shift towards a circular economy is by utilizing tools such as the Circular Business Model Value Dimension Canvas (Islam & Iyer Raniga, 2023). Like in any business model canvas, Islam and Iyer Raniga (2023) argue that the Circular Business Model Value Dimension Canvas helps to envision strategies for business, but with a complementary feature that goes beyond merely production and consumption. In this canvas, the idea is to retain and reclaim value throughout the lifespan of a product. Although seems straightforward, this business model requires clearer definition of business process and frameworks, making sure that the processes would minimize resource use, waste generation, and emissions. A further elaboration of a circular business model was done by Faradilla et al. (2022), in which they test the integration of the business model with product concepts using product metrics, ensuring the linkage between waste and value products (Faradilla et al., 2022; Han et al., 2021). By combining these elements, the business model helps to rigorously evaluate product ideas against sustainability criteria.

Although studies on circular business models (CBMs) have rapidly increased over the last five years, the literature still indicates substantial gaps that need addressing to optimize these models for broader adoption. Notably, there is a lack of universally accepted definitions and frameworks that capture the diverse aspects of circularity in business practices (Geissdoerfer et al., 2020). Additionally, the operationalization of these models in various sectors remains uneven, with certain industries like manufacturing and services needing tailored approaches to effectively integrate circular principles (Upadhyay et al., 2019).

In relation to this operationalization challenge, there is a pressing need to translate circular business models into more practical, actionable formats that can be readily applied by businesses transitioning towards circularity (Bocken et al., 2019). Pieroni et al. (2019) and Santa-Maria et al. (2021), for instances, assert that a more robust integration of circular business model innovation with traditional business model frameworks is needed to foster seamless adoption and generate measurable sustainability outcomes. We

appeal to these assertions and offer a way to contextualize the circular business model implementation by looking into a specific case of integrating a circular economy approach to the reusable camera industry, using the Circular Business Model Value Dimension Canvas as a methodological framework. We address the stakeholders, activities, resources, value creation and delivery, value proposition, and value capture.

By studying the case of the camera production industry, this study aims to clearly identify how a circular business model (CBM) can reduce electronic waste from disposable cameras while simultaneously enhancing economic and environmental value creation in the industry. We expect that this study can contribute to the understanding of how a circular business model (CBM) can address issues related to waste reduction and sustainability promotion through the specific case of the camera production industry.

II. METHODOLOGY

2.1. Research framework

This research used the Circular Business Model Canvas (CBMC) method and adapted it to the context of disposable camera production into reusable cameras. The canvasing steps were adapted from the framework developed by Islam and Iyer-Raniga in their 2023 study. The steps to develop the canvas incorporate qualitative study and literature review. To gain more insightful analysis on the potentials of reusable camera business in Indonesia, we also conduced sustainable product evaluation by using metrics for reusable cameras, as a combination of the approaches proposed by Faradilla et al. (2022) and Han et al. (2021). This step mostly involves a quantitative approach.

Creating a practical CBMC begins with understanding and integrating current frameworks, strategies, and best practices in circular business models. Thus, it begins by defining the scope and objectives, pinpointing the specific areas of the circular economy that resonate most with the business. This step recognizes the practicality of the CBMC as a tool to meet the unique needs of the reusable camera manufacturing segment and not just a theoretical concept. This was followed by a thorough literature search to document various models and frameworks of a circular business, along with real-world examples.

2.2. Primary data collection

We used a case study approach on the disposable camera industry as a way to understand the business practices and ways in which the operators view challenges and implement best practices. To formulate a well-defined CBMC, we collected primary data via 10 customer feedback related with supply chain data and environmental impact reports. This set of data was then cross-referenced with industrial and academic reports within the scope of this study. We also conducted questionnaire surveys and participant observations to obtain empirical data on circular business practices. In-depth interviews and focus group discussions were done with key stakeholders to acquire detailed insights into how circular strategies can be included in business models. In the process, we asked open-ended questions to get detailed responses and discover different viewpoints.

2.3. CBMC conceptualization and design

CBMC is designed to integrate all facets of a business under sustainability and circular economy principles. CBMC seeks to create a holistic approach to business operations. In a classic BMC approach (Osterwalder & Pigneur, 2013), the canvas consists of nine segments. It starts from the center of the canvas, which is about creating and proposing

value for the products. This value proposition is supported by demand (marketing) and supply (production) aspects. At the operational side, three segments are essential, which are key partnerships, key resources, and key activities. On the marketing side, identifying customer segments, customer relationships, and channels is also key. These activities will lead to two foundational segments at the bottom of the canvas, which are cost structure and revenue streams.

At the marketing aspect, we started by defining what our product's value propositions are for our customers. This value should be centered around eco-friendly products and practices, with the end goal of building consumer experiences in sustainability. After establishing the value propositions, we moved to the three right-hand segments in the canvas, which are customer relationships, customer segments, and channels. The customer relationships component of the canvas should detail strategies for engaging with customers and demonstrate the company's commitment to sustainability (Kristensen & Mosgaard, 2020). This can be done through consumer education, awareness building, and continued support on product quality. Customer Segments are identified to allow businesses to tailor their products to meet specific customer needs effectively. In CBMC, customers can be segmented based on their environmental values and behavior, such as educated youth or college students. Channels are defined to optimize the delivery of products and information, ensuring efficient communication and distribution. In CBMC, sustainable channels can be in the form of bulk delivery, closer distribution points, and drop points for reverse logistics. Lastly, the Cost Structure and Revenue Streams of the CBMC are structured to underline the financial dynamics of implementing a circular economy strategy, focusing on generating sustainable revenue through products and services that promote environmental and social responsibility.

2.4. Stakeholder Engagement and Sustainability Metrics

For a CBMC to work sustainably, this tool should be formulated collectively with all stakeholders (Urbinati et al., 2017). In the case of reusable cameras, forging key partnerships with camera manufacturers, recycling firms, and retailers is essential. Each stakeholder should agree upon their role in the grand design of the circular business model. As a circular business requires additional processes compared to the business-as-usual scenario, such as establishing reverse logistics and collection points for used cameras to effectively manage a closed-loop supply chain, each stakeholder (such as the recycling firms and retailers) should also be made aware of their new roles in the business process (Govindan & Hasanagic, 2018).

There are two aspects that play a critical role in the design and implementation phases of the CBM: integrating sustainable design principles and applying recycling metrics. The former can be achieved through what Niero and Olsen (2016) call modular designs. A modular design is a way to compartmentalize the design and operational processes in such a way that makes production more sustainable. Normally, it consists of two important elements: ease of disassembling and environmentally friendly materials. The latter, as Kristensen and Mosgaard (2020) argue, requires setting up dedicated facilities for the refurbishing and recycling of cameras, utilizing advanced technology for material recovery, and continuously monitoring and evaluating the CBM's performance.

Monitoring and evaluating the CBM's

performance can be done through a comprehensive assessment of product's sustainability metrics. Faradilla et al. (2022), in this case, offer a four-phase approach that includes identifying customer needs, developing a sustainable House of Quality (HoQ), conceptualizing product design, and evaluating sustainability metrics across the product's lifecycle. This method helps to examine materials, production processes, usage, and end-of-life aspects, with the goal to ensuring that the product design aligns with eco-friendly principles. Alternatively, Han et al. (2021) propose specific metrics to evaluate sustainable product designs and validate their approach through an assessment of the sustainability of product concepts. This extensive evaluation process ensures that products not only meet customer expectations, but also adhere to stringent environmental standards. The two proposed methodologies emphasize the importance of integrating sustainability into every facet of product design and development, thereby reinforcing the principles of the circular economy within the business model.

III. RESULTS AND DISCUSSION

This study resulted in a comprehensive circular business model to tackle challenges of electronic waste produced by disposable camera industry in Indonesia. By applying an adapted Circular Business Model Canvas, which we developed using information gathered from reusable camera users / customers as a pilot sample, we identified four integrated strategic dimensions to create a sustainable circular economic system (Figure 1). Each dimension offers a unique contribution to the formulation of a business ecosystem that is able to shift the production and consumption paradigm within the camera industry.

Figure 1. Circularity goals and scope for reducing e-waste from disposable cameras

3.1. Circularity goals and scope definition

Our study shows that a clear definition of circularity goals provides a fundamental basis for the design of a sustainable business model. The main objective of this is to reduce electronic waste from disposable camera beyond merely an environmental aspiration, but also a calculated strategic decision to respond to the complex reality of the industry.

Indonesia has been a significant distribution center for disposable cameras, particularly since the phenomenon of revitalizing the use of analog equipment began to take form among the millennial and Z generations (McKay, 2024). However, this phenomenon also came with a challenge. When the demand for disposable cameras rises, there is also an increase in the potential generation of e-waste. Studies have shown that every unit of disposable camera contains hazardous materials and electronical components that require special treatments, including alkaline batteries, electronic circuits, and complex optical lenses. The definition of scope includes a product design based on the design for recycling principle, thus demonstrating an in-depth comprehension of how sustainability talks not only about what to do after the product is used, but more importantly, about how the lifecycle of the product is designed from the very beginning. Chuang and Liao (2018) have found that consumers, particularly the younger generation, have a strong affinity towards environmentally friendly electronic products, despite the fact that many producers still disregard this factor in their product development. Collaboration between camera producers, the government, and environmental organizations, as stated in the scope definition, reflects this understanding that transitioning to circular economy requires multi-stakeholder participations. This approach aligns with the study by Awan and Scroufe (2022) that found that sustainability in circular economy could not be achieved merely through unilateral and business approach, but requires an integrated ecosystem that included regulatory support and social commitments. There are, however, challenges in implementing these goals, thus requiring us to ground-check these goals and scope to what the companies face in their daily business processes.

3.2. Sustainability and action

In our study, we then underpin the importance of aligning the above-mentioned scope and goals with concrete actions. In order to do so, we design a framework that helps to translate this commitment into operational business practices. We highlight one particular goal among the 17 Sustainable Development Goals (SDGs) that specifically aligns with our sustainability scope, which is SDG number 12 on responsible consumption and production, as can be seen in Figure 2.

The commitment of the action plan is to reduce environmental impacts of disposable cameras by reducing hazardous waste and adopting environmentally friendly technology, but with additional actions towards consumer empowerment through education. This endeavor recognizes that transformation towards circular economy would not have succeeded without a change of consumer's mindset and behavior. Recycling initiative that is designed to be user-friendly demonstrates an in-depth analysis of behavioral hindrance which is often disregarded in sustainability programs. Chuang and Liao (2018) identify that although consumers show good intentions to participate in sustainability practices, the complexity of the recycling system often becomes a physical block for the consumers to participate actively. This being said, a simple and accessible recycling program design becomes a crucial factor to increase consumer participations.

Partnership strategies that include the collaboration between environmental NGOs and government are more than simply a public relations tactic, but a profound strategic decision based on the regulatory landscape in

Indonesia. The Indonesian government has, through many initiatives, shown a commitment to the reduction of e-waste, albeit its implementation is still hindered by limited regulatory capacity and law enforcement.

As one of the main actions, public education campaign aims to increase the awareness of the negative impact of e-waste. Data shows that the awareness level of Indonesian consumers over the health risk of e-waste is still relatively low, particularly outside of large urban areas. Therefore, there is an urgent need to invest in consumer education. Such an investment will help in creating a demand for sustainable products. However, a large-scale educational campaign requires a significant budget that may not be readily available among small and medium enterprises. In addition, the effectiveness of this form of campaign depends on the effectiveness of media channels and their ability to reach a diverse range of market segments, be they geographically or demographically.

Figure 2. Sustainability and action

3.3. Value creation and delivery: constructing a complex business ecosystem

In value creation, we emphasize the importance of balancing environmental sustainability and financial viability by identifying a comprehensive cost structure for the business model (Figure 3). This includes investments in recycling technology and maintenance, operational costs for reverse logistics, and a systematic processing material. These elements have to work in synergy to ensure that a sustainable business model is attainable (Figure 4).

Investment in recycling technology is a crucial element that determines the efficiency of material recovery from used cameras. There is a range of technological options that we can consider for investments. From traditional mechanical recycling to advanced separation technology, each of these solutions should be considered based on any trade-offs between capital expenditure, operational efficiency, and

environmental benefits. For example, in the context of Indonesia, an overly advanced technology may offer higher recovery rate, but require a substantial initial investment and limited expertise. This indicates that technological options need to be adjusted with the local capability.

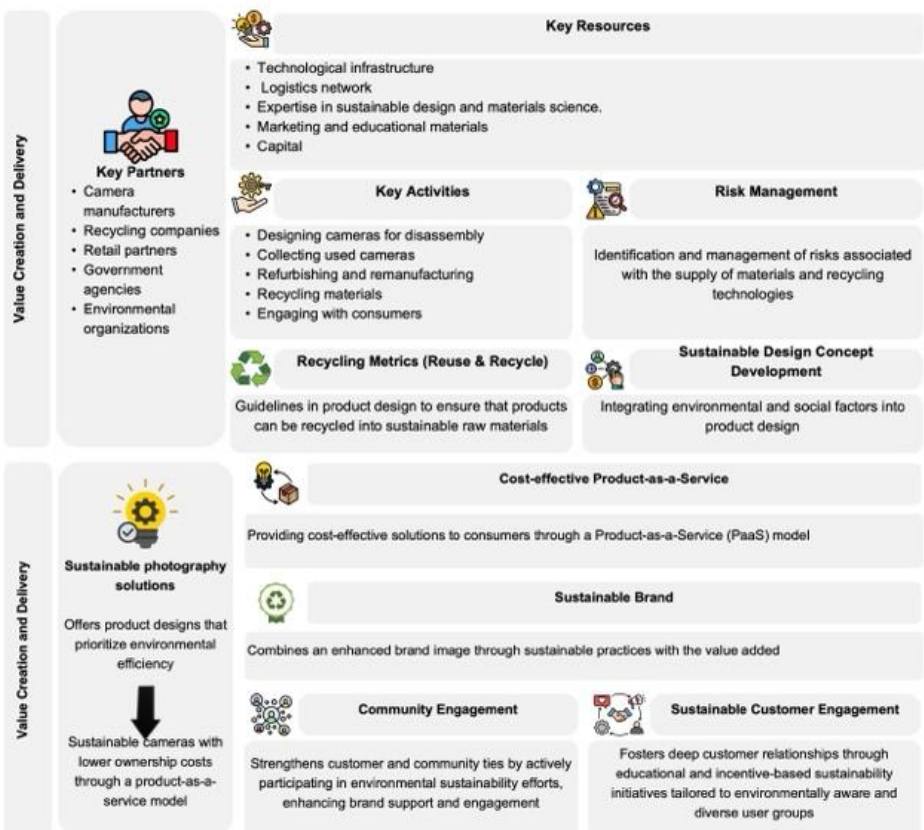

Figure 3. Value creation and delivery

Figure 4. Value capture

Another key element that needs attention is building a reverse logistics operation. This is a significant driver in value capture, but often neglected. Reverse logistics requires efficient collection systems, such as distributed collection points, transportation to collection hubs, and refurbishing and recycling facilities. All these necessitate a robust infrastructure network, which has been a key cost driver. Reverse logistics must be both economically

viable and environmentally beneficial; if the operational cost exceeds the recovered material value, the model becomes unsustainable.

Based on analyses and information gathered from users, our study identifies three main revenue streams with different financial characteristics. The sale of refurbished camera offers a reasonable profit margin (50-70% from the new price), but limited market size due to a negative consumer perception on refurbished products. A subscription model for sustainable usage promises recurring revenue, albeit rather speculative and highly dependent on the product's perceived value and service quality. The revenue from recycled materials is the most uncertain due to being highly volatile and dependent on available market prices of secondary materials. When the prices of virgin materials are low, the value of recycled materials can drastically decline.

One critical aspect of this is that the early implementation phase requires a patient capital in waiting for the ROI to be attained over the next few years. Again, in the context of Indonesia, a limited access to long-term financing for sustainability initiatives can pose a significant hindrance that requires out-of-the-box solutions, such as through creative financing, green bonds, or impact investments.

3.4. Synergy and conflict in a circular business model

When we integrate the four dimensions of a circular business model (i.e., circularity goal and scope, sustainability and action, value creation, and value capture), we can observe that there may appear to be powerful synergies and potential conflicts that need to be carefully managed. The first synergy is between design for recycling (value creation) and product-as-a-service model (value capture). When a customer does not have any sense of ownership to the camera, there is a stronger incentive for the manufacturer to design a product that is robust and easily maintained and recycled. This creates a natural alignment between design decisions and business sustainability. The second synergy is between community engagement initiatives (sustainability and action) and brand positioning (value creation). When a company actively involves the community in its sustainability endeavors, this creates not only an improved brand image, but also assigns new advocates that will promote the products organically. This will reduce marketing costs and improve effectiveness of the marketing communications.

However, we also identified tension points requiring some form of mitigation. Firstly, the tension between demand for increased material efficiency (circularity goal) and profitability goals (value capture). Increasing material efficiency through design changes may require a substantial investment in R&D and tooling, which consequently increases production costs. If these costs are not passed to consumers due to price sensitivity, then profitability may be compromised. Secondly, the tension between aspiration for circular economy (main objective) and the reality of consumer behavior. Although our study shows that consumers have preferences for sustainable products, in practice, purchasing decisions are still mostly influenced by price. Consequently, offering camera with an optimum design for recycling but with a higher price may not result in a sufficient market traction. Thirdly, a tension between goal to reduce e-waste through sustainable design (circularity goal) and revenue from the sale of

recycled materials (value capture). If the design is truly sustainable and highly durable, then the available material volume for recycling will be lower, and revenue from sales of recycled materials will also be lower.

One critical hurdle that we identified is institutional tensions. In Indonesia, the regulatory framework for circular economy is still developing. Government supports are still inconsistent across different regions, which renders any attempts to implement a circular business model blocked by hindering policies, such as a strong tariff of imported recycling technologies or the lack of subsidies for sustainable products.

3.5. Contributions to Sustainable Development Goals and some practical implications

The circular business model formulated in this study contributes to at least two sustainable development goals. SDG #12 (responsible consumption and production) is perhaps the most significant and reflected on multiple levels. For example, CBM enables the promotion of sustainable consumption practices, particularly through educational campaigns and community engagement initiatives. At the same time, it also promotes sustainable production practices that are integrated with design and manufacturing processes. The reduction of waste via design for disassembly and comprehensive recycling programs also clearly contributes to this goal. In addition to SDG #8 (decent work and economic growth) is indirectly addressed via the creation of jobs in refurbishing and recycling sectors.

Although a circular economy approach will strongly be related to climate action, we have not been able to quantify a direct correlation between our data and climate goals. We rely on the logic that by reducing the production of virgin cameras and increasing the percentage of recycled materials, this model will be able to reduce GHG emissions and embed carbon over the product lifetime. A study by Macarthur Foundation (2024) shows that transition to circular economy can potentially reduce carbon emission and decrease primary material consumption as much as 32%. This means that if this is applied in the camera industry, it will surely provide non-trivial impact. From a practical point of view, this business model provides a blueprint to be adapted by manufacturers and entrepreneurs in Indonesia. However, successful implementation requires at least three aspects.

Firstly, it needs a strong investment in capacity building to establish an expertise on sustainable design and recycling technologies. Government, through technical institutions, can facilitate training programs to prepare engineers and technicians to work in the circular economy sectors.

Secondly, there is a need for the development of a regulatory framework that will support circular economy businesses. This includes providing incentives for companies to adopt circular practices, developing standards for recycled materials, and issuing mandates for extended producer responsibility.

Thirdly, there is a need for financing mechanisms that can support long-term investments in the circular businesses. This can take the form of green bonds, impact investment, or government subsidies for early-stage circular economy companies.

IV. CONCLUSION

This study has developed a comprehensive circular business model to tackle the problem of electronic waste from reusable cameras in Indonesia and has pilot-tested this model through an initial market test, providing early validation for its future implementation in the reusable camera industry. Using four strategic dimensions – circularity goal and scope definition, sustainability and action, value creation and delivery, and value capture – this model demonstrates that transformations towards a circular economy in the camera industry is achievable and can contribute significantly to SDG #12 (responsible consumption and production).

The model was designed to reduce electronic waste through design for recycling and comprehensive recycling programs, while integrating sustainable consumption practices via consumer education and community engagement. In connecting multiple revenue streams (including the sale of refurbished cameras, subscription models, and sale of recycled materials), this study has also demonstrated that both sustainability and profitability can be simultaneously achieved. This model offers an adaptive blueprint that can be implemented beyond the specific case of the camera industry, to include other electronic sectors, with the potential to reduce e-waste, convert primary materials, and create new economic opportunities.

The success of this model, however, relies on several key aspects. Firstly, there is a need to build a multi-stakeholder collaboration between producers, recycling companies, government, and environmental organization to agree upon, and commit to, the implementation of circular economy in the wider practices of the business ecosystem. This includes taking the government's commitment to create a supportive regulatory framework, investing on digital infrastructure, and ensure capacity building processes across the stakeholders. Secondly, consumer engagements are also essential. There are a few strategies identified to integrate the business models with consumer preferences, such as through approaches like 'ownership plus, 'try-before-you-buy', and 'community-based ownership pools'. These approaches seek to build some senses of psychological ownership among the consumers. Lastly, this study identified a few critical challenges that need to be addressed for the whole circular business model to be operable. This includes limited recycling infrastructures, consumers' price sensitivity, and regulatory uncertainties. Overcoming these hurdles would require patient capital, state support, and long-term commitments from all the stakeholders.

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