

Legal and Economic Feasibility of Circular Economy Practices in Small-Scale Food Enterprises: Case Study from Mushroom Snack Production in Indonesia

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ABSTRACT

This study examines the legal and economic feasibility of small-scale mushroom crispy snack production as a circular economy strategy to reduce post-harvest losses in Indonesia. Using a case study approach, the research focuses on a mushroom-based micro, small, and medium enterprise (MSME) located in Cikarang, Bekasi Regency, which internally valorizes unsold or downgraded mushrooms into crispy snack products instead of discarding them as waste. The study applies an integrated analytical framework combining quantitative financial feasibility analysis using break-even point (BEP), return on investment (ROI), net present value (NPV), and payback period indicators with qualitative legal compliance assessment based on Indonesian food safety, licensing, and consumer protection regulations. The findings indicate that mushroom crispy production operates near its break-even point and does not yet function as an independent profit center. However, when evaluated within the enterprise's integrated production system, the activity contributes positively by preventing economic losses from unsold fresh mushrooms, improving resource efficiency, and strengthening overall business resilience. From a legal perspective, the enterprise is feasible at its current scale, as it complies with core regulatory requirements, including possession of a valid home-industry food production license (PIRT) and adherence to basic food safety and labeling standards. Overall, the study demonstrates that mushroom snack production from surplus mushrooms is economically rational and legally compliant as a circular economy practice, even when short-term profitability remains limited. The findings highlight the importance of integrating financial analysis with legal compliance in assessing the sustainability of food-processing MSMEs.

ABSTRAK

Studi ini mengkaji kelayakan hukum dan ekonomi produksi camilan keripik jamur skala kecil sebagai strategi ekonomi sirkular untuk mengurangi kerugian pasca panen di Indonesia. Dengan pendekatan studi kasus, penelitian ini berfokus pada usaha mikro, kecil, dan menengah (UMKM) berbasis jamur yang berlokasi di Cikarang, Kabupaten Bekasi, yang secara internal mengolah jamur yang tidak terjual atau berkualitas rendah menjadi produk camilan keripik daripada membuangnya sebagai limbah. Studi ini menerapkan kerangka analitis terintegrasi yang menggabungkan analisis kelayakan finansial kuantitatif menggunakan titik impas (BEP), tingkat pengembalian investasi (ROI), nilai sekarang bersih (NPV),

dan periode pengembalian modal dengan penilaian kepatuhan hukum kualitatif berdasarkan peraturan keamanan pangan, perizinan, dan perlindungan konsumen di Indonesia. Hasil penelitian menunjukkan bahwa produksi keripik jamur beroperasi dekat dengan titik impasnya dan belum berfungsi sebagai pusat keuntungan mandiri. Namun, ketika dievaluasi dalam sistem produksi terintegrasi perusahaan, aktivitas ini berkontribusi positif dengan mencegah kerugian ekonomi dari jamur segar yang tidak terjual, meningkatkan efisiensi sumber daya, dan memperkuat ketahanan bisnis secara keseluruhan. Dari perspektif hukum, perusahaan layak beroperasi pada skala saat ini, karena mematuhi persyaratan regulasi inti, termasuk kepemilikan lisensi produksi makanan industri rumahan (PIRT) yang valid dan kepatuhan terhadap standar keamanan pangan dan penandaan dasar. Secara keseluruhan, studi ini menunjukkan bahwa produksi camilan jamur dari jamur sisa merupakan praktik ekonomi sirkular yang secara ekonomi rasional dan sesuai dengan peraturan hukum, meskipun keuntungan jangka pendek masih terbatas. Temuan ini menyoroti pentingnya mengintegrasikan analisis keuangan dengan kepatuhan hukum dalam menilai keberlanjutan usaha mikro, kecil, dan menengah (UMKM) di sektor pengolahan makanan.

1. Introduction

Background

The global agri-food sector faces increasing pressure to reduce food loss and waste, a challenge formally recognized in the United Nations Sustainable Development Goal (SDG) 12.3, which aims to halve per capita global food waste by 2030. Perishable commodities such as mushrooms are particularly vulnerable to post-harvest losses due to their high moisture content and rapid respiration rate, resulting in a shelf life that often does not exceed one week under normal conditions (Royse, Baars, & Tan, 2017). When market demand fails to absorb harvested output, unsold mushrooms deteriorate quickly, leading to economic losses for producers and additional environmental burdens associated with organic waste disposal.

For small and medium-sized enterprises (SMEs), these challenges are exacerbated by limited cold-chain infrastructure, restricted access to processing facilities, and dependence on fluctuating fresh markets. In response, value-added processing has emerged as a strategic pathway to reduce food loss while improving income stability. Transforming unsold mushrooms into crispy snack products enables producers to extend product shelf life, increase value per unit of biomass, and access broader consumer markets. This approach reflects a practical application of circular economy principles, which emphasize waste prevention and value retention within production systems rather than end-of-pipe waste management (Kirchherr et al., 2017).

In the case examined in this study, circular economy practices are implemented at the enterprise level through an integrated production system. The SME cultivates its own mushrooms and directly channels unsold or downgraded harvests into mushroom crispy snack production instead of discarding them as waste. Such internal valorization aligns with the Food and Agriculture Organization's (FAO) recommendation that food loss reduction at the production and processing stages yields higher economic and environmental benefits compared to downstream disposal strategies (FAO, 2019). By closing the loop between cultivation and processing, the enterprise retains material value and reduces resource inefficiency.

Despite its economic and environmental potential, the commercialization of processed food products derived from surplus materials is subject to stringent legal requirements. In Indonesia, food safety and quality are regulated under Law No. 18 of 2012 on Food, Government Regulation No. 86 of 2019 on Food Safety, and technical regulations issued by the National Agency for Drug and Food Control (BPOM). Compliance obligations include business licensing (PIRT or BPOM MD), adherence to Good Manufacturing Practices (GMP/CPPOB), halal certification, labeling accuracy, and conformity with consumer protection standards under Law No. 8 of 1999. Non-compliance may result in administrative sanctions, product recalls, civil liability, and

reputational damage, all of which directly affect business feasibility.

Previous studies have explored food loss reduction strategies (FAO, 2019; Corrado et al., 2020), SME competitiveness in value-added food products (Tambunan, 2019), and the role of regulatory compliance in processed food markets (Nuraini & Daryanto, 2022). However, these studies generally examine economic and legal dimensions separately. Empirical research that integrates financial feasibility analysis with legal compliance assessment within a circular economy framework remains limited, particularly at the level of a single SME case study in Indonesia.

From a governance perspective, food loss reduction is not merely a technical or market-driven issue, but a matter of public policy and state responsibility. Indonesian food law positions the state as a key actor in ensuring food availability, safety, and accessibility, as reflected in Law No. 18 of 2012 on Food and its implementing regulations. Within this framework, micro and small food enterprises are not only regulated entities but also potential policy instruments for achieving broader food system objectives, including waste prevention and sustainable resource use. However, empirical evidence on how such enterprises navigate the intersection of economic feasibility, legal compliance, and circular economy practices remains limited.

Accordingly, this study is situated at the intersection of food law, MSME policy, and circular economy governance, addressing the legal question of whether surplus-based food processing can be conducted in a manner that is both economically rational and compliant with Indonesia's food regulatory regime.

Research Questions

This study addresses this gap by conducting an integrated legal-economic feasibility analysis of mushroom crispy snack production using unsold mushrooms in an Indonesian SME. The central research question is: *Can mushroom crispy production from internally generated surplus be economically feasible and legally compliant under current Indonesian regulatory frameworks?* This question is examined by:

1. Evaluating financial feasibility using BEP, ROI, NPV, and payback period indicators;

2. Mapping compliance with food safety and consumer protection regulations; and
3. Assessing the role of circular economy practices in supporting sustainable business operations.

Purpose of Research

This study aims to understand how small-scale mushroom snack production can contribute not only to business sustainability, but also to broader social and food system objectives. Specifically, the research seeks to examine whether converting unsold or downgraded mushrooms into mushroom crispy snacks can be a practical, safe, and legally compliant solution to reduce food loss, support small enterprise livelihoods, and provide affordable processed food options for consumers.

By combining economic feasibility analysis with an assessment of compliance with Indonesian food safety, consumer protection, and licensing regulations, this study evaluates whether such practices can realistically be adopted by small food enterprises without compromising consumer health or legal accountability. The research also explores how circular economy practices at the enterprise level can strengthen food security by ensuring that edible food resources are utilized efficiently rather than discarded.

Ultimately, the purpose of this study is to provide evidence that supports informed decision-making for small food producers, reassures consumers about the safety and legitimacy of processed mushroom products, and offers policymakers practical insights into how food loss reduction, legal compliance, and economic resilience can be aligned within everyday food production systems.

Research Gap

Although literature on food loss valorization, snack processing SMEs, and food law compliance is expanding, integrated analyses that combine economic feasibility with legal compliance within a circular economy framework remain scarce. Empirical case studies focusing specifically on mushroom crispy production from internally generated surplus mushrooms in Indonesia are limited. This study addresses this gap.

2. Research Methodology

a. Research Design

This study employs a case study research design with an integrated legal economic feasibility approach.

The design is suitable for examining real-world business practices where financial performance, regulatory compliance, and circular economy implementation interact. The study combines quantitative financial analysis with qualitative legal compliance assessment.

b. Research Object and Location

The research object is a mushroom crispy snack production unit operated by a small-scale enterprise anonymized as **XX**, located in **Cikarang, Bekasi Regency, Indonesia**. The enterprise cultivates its own mushrooms and utilizes unsold or downgraded harvests as raw materials for snack production. The unit of analysis is limited exclusively to the processed mushroom crispy product.

c. Circular Economy Framework in the Case Study

This study applies a circular economy framework to analyze how surplus mushrooms are internally valorized. In line with circular economy principles, unsold mushrooms are redirected into secondary processing rather than disposed of as waste. This internal loop reflects waste prevention and value retention strategies emphasized in circular economy literature (Kirchherr et al., 2017; FAO, 2019). The framework guides both economic and legal analyses.

d. Population, Sample, and Informants

A purposive sampling technique is used. Informants include the business owner/manager, production personnel, and administrative or financial staff. These informants were selected based on direct involvement in production, financial decision-making, and compliance activities.

e. Data Collection Techniques

Data were collected through semi-structured interviews, direct observation of production and hygiene practices, and document analysis of financial records, labels, and licensing documents. Methodological triangulation was applied to enhance data validity.

f. Data Analysis Techniques

Economic feasibility was evaluated using BEP, ROI, NPV, and payback period calculations based on monthly operational data. Legal feasibility was assessed through normative compliance mapping against Indonesian food and consumer protection regulations. Findings were interpreted through a circular economy lens.

g. Ethical Considerations

The enterprise is anonymized as **XX** to protect confidentiality. No personal data are disclosed.

3. Literature Review

This study adopts an integrated conceptual framework that links circular economy practices with economic feasibility and legal compliance. Within this framework, circular economy strategies, such as internal valorization of surplus food are expected to enhance economic efficiency by reducing losses and improving resource utilization. Economic efficiency, in turn, affects enterprise resilience and the capacity to absorb regulatory compliance costs.

Legal compliance functions both as a constraint and an enabling condition. While food safety, licensing, and labeling requirements impose obligations on enterprises, compliance also provides market legitimacy, consumer trust, and access to formal distribution channels. The interaction between circular economy practices, economic performance, and legal compliance ultimately determines the sustainability of small-scale food enterprises. This framework allows the study to move beyond descriptive assessment by analytically linking legal norms with economic outcomes and enterprise viability.

a. Food Loss Valorization and Processed Snack Products

Food loss and waste reduction has gained prominence following the adoption of the SDGs, particularly SDG 12.3. FAO (2019) emphasizes that reducing food loss at early stages of the supply chain production and processing offers greater economic efficiency than downstream waste treatment. In perishable commodities such as mushrooms, processing surplus into shelf-stable products is widely recognized as an effective valorization strategy. Circular economy theory frames such practices as mechanisms to retain value within production systems by extending product life cycles and minimizing waste generation (Kirchherr et al., 2017). Geissdoerfer et al. (2017) further argue that circular economy in agri-food systems prioritizes prevention and internal reuse over recycling or disposal. Applying this framework to mushroom crispy production enables SMEs to transform potential waste into marketable products while reducing environmental impacts.

b. Economic Feasibility of Small-Scale Snack Enterprises

Economic feasibility analysis is commonly applied to assess the viability of small-scale food processing businesses. Key indicators such as break-even point (BEP), return on investment (ROI), net present value (NPV), and payback period provide insight into cost recovery, profitability, and long-term sustainability (Nasir, 2016). Studies on Indonesian SMEs demonstrate that value-added snack processing can improve income stability compared to reliance on fresh product sales alone (Tambunan, 2019; Sari & Widyastuti, 2021).

However, snack production is sensitive to variable input costs, particularly cooking oil, packaging, and energy (OECD, 2021). Kumar et al. (2020) caution that feasibility assessments that ignore these cost dynamics risk overestimating profitability. Therefore, economic analysis must be grounded in realistic operational data.

c. Legal Compliance in Processed Food SMEs

The regulation of processed food products in Indonesia is governed by a multi-layered legal framework that integrates food security, food safety, consumer protection, and business compliance objectives. At the core of this framework is Law of the Republic of Indonesia No. 18 of 2012 on Food, which defines food to include both processed and unprocessed agricultural products and establishes food security as a fundamental state responsibility. This law is operationalized through Government Regulation No. 86 of 2019 on Food Safety, which requires that all processed food circulating in the market meet safety, hygiene, and quality standards.

The protection of consumers is further reinforced by Law No. 8 of 1999 on Consumer Protection, which imposes liability on business actors for losses arising from unsafe or misleading food products. In addition, compliance with religious and ethical standards is mandated under Law No. 33 of 2014 on Halal Product Assurance, particularly for food products marketed to Muslim consumers. Technical obligations concerning product transparency and manufacturing processes are regulated through BPOM Regulation No. 31 of 2018 on Processed Food Labeling and BPOM Regulation No. 22 of 2021 on Good Manufacturing Practices for Processed Food (CPPOB), while market entry and distribution are controlled through BPOM Regulation No. 22 of 2018 on Guidelines for Processed Food Registration. For small-scale producers, licensing

requirements are further governed by Minister of Home Affairs Regulation No. 19 of 2017 on Registration of Home-Industry Food Products (PIRT). Collectively, these legal instruments form the regulatory environment within which mushroom-based snack enterprises must operate, shaping both the feasibility of production and the compliance strategies required to ensure sustainable and lawful business practices.

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4. Results And Discussion

a. Production Structure and Circular Economy Implementation at (XX)

The case study enterprise produces approximately 3,000 baglogs per week or 12,000 baglogs per month, with each baglog having a productive lifespan of approximately five months before becoming spent mushroom substrate (SMS). This production structure allows the enterprise to generate multiple outputs from the same biological resource, including fresh mushrooms, mushroom crispy snacks, and secondary products derived from spent baglogs.

The circular economy configuration observed in XX is consistent with empirical findings from small-scale oyster mushroom enterprises in Cikarang reported by Satwhikawara et al. (2025). Their study demonstrates that internal valorization of mushroom production residues particularly through secondary

processing and by-product utilization significantly improves resource efficiency and business resilience. Similar to the present case, circularity is achieved not through complex technological interventions but through practical integration of cultivation and processing activities at the enterprise level. This reinforces the argument that circular economy adoption in SMEs is most effective when embedded within existing production structures rather than introduced as an external sustainability add-on.

This production model reflects a production-level circular economy system, where waste prevention is achieved through internal valorization rather than disposal. Kirchherr et al. (2017) emphasize that circular economy practices prioritize maintaining materials within productive loops for as long as possible. Similarly, Geissdoerfer et al. (2017) argue that circularity in agri-food systems is most effective when implemented upstream, particularly at the production and processing stages.

By redirecting unsold or downgraded mushrooms into crispy snack production, Hanara applies what FAO (2019) classifies as food loss prevention, which provides greater economic and environmental benefits than downstream waste management. This finding is consistent with Corrado et al. (2020), who identify early-stage valorization as a key driver of sustainable food systems

b. Economic Performance of Mushroom Crispy Production

Mushroom crispy production utilizes internally generated surplus mushrooms, with an average output of approximately 50 kg per month, sold at IDR 100,000 per kg, resulting in a monthly revenue of IDR 5,000,000. Compared to fresh mushroom sales, this processing activity significantly increases value per unit of biomass.

This result supports empirical findings that value-added food processing enhances income stability and market access for SMEs by extending shelf life and product differentiation (Tambunan, 2019; Sari & Widyastuti, 2021). Furthermore, Siddiq and Dolan (2017) note that frying and dehydration are particularly suitable processing methods for small-scale enterprises due to their low technological barriers.

However, production costs remain sensitive to processing inputs, especially cooking oil and packaging. OECD (2021) highlights that volatility in these inputs often constrains profitability in snack-

based SMEs. In the Hanara case, the absence of detailed per-kilogram cost recording mirrors the limitations identified by Kumar et al. (2020), who observe that weak cost accounting practices reduce the precision of feasibility assessments in small food enterprises.

c. Break-Even Point (BEP) Analysis

Break-even analysis shows that mushroom crispy production operates at or near the break-even point. At the current production level of 50 kg per month, total revenue approximately equals total production costs, indicating that the activity does not yet function as a standalone profit center.

This finding aligns with Tambunan (2019), who argues that value-added processing in SMEs often initially serves as a loss-mitigation mechanism rather than a profit-maximizing strategy. From a circular economy perspective, Geissdoerfer et al. (2017) emphasize that the success of circular business models should not be evaluated solely on short-term profitability but also on their ability to enhance system resilience and reduce waste. In this context, even break-even performance contributes positively by preventing losses from unsold fresh mushrooms.

d. Return on Investment (ROI) within an Integrated Production System

The enterprise's total fixed investment, estimated at IDR 120,000,000, supports multiple production activities, including baglog production, fresh mushroom cultivation, and snack processing. As a result, ROI for mushroom crispy production cannot be isolated with high precision.

This condition reflects a common characteristic of integrated agri-food SMEs, where shared assets serve multiple outputs. The World Bank (2020) emphasizes that investment performance in such systems should be assessed at the enterprise level, rather than allocating capital rigidly to individual products. From this perspective, mushroom crispy production enhances overall investment efficiency by increasing revenue extraction from existing biological and physical assets, consistent with Nasir's (2016) argument that ROI analysis in SMEs must account for operational integration.

e. Net Present Value (NPV) and Long-Term Feasibility Considerations

Due to incomplete disaggregation of processing

costs particularly for oil, flour, and labor a precise NPV calculation for mushroom crispy production alone is constrained. Nevertheless, circular economy literature suggests that activities extending the productive use of materials generate long-term economic value even when short-term financial returns are modest (Kirchherr et al., 2017; FAO, 2019).

Corrado et al. (2020) further argue that NPV assessments in food loss valorization should incorporate avoided disposal costs and reduced loss-related risks. In this respect, mushroom crispy production contributes positively to the enterprise's long-term financial performance by converting surplus into revenue-generating products rather than waste.

f. Legal Feasibility and Regulatory Alignment

From a legal perspective, mushrooms and mushroom-based snack products are classified as food under Indonesian law and therefore fall within the national food security and food safety regulatory framework. Article 1 point (1) of Law No. 18 of 2012 on Food defines food as all biological products originating from agriculture, whether processed or unprocessed, intended for human consumption, a definition that clearly encompasses mushrooms and mushroom-based snack products (Republic of Indonesia, 2012). As a consequence, any enterprise producing mushroom snacks is legally categorized as a food business actor and is subject to obligations relating to food security, food safety, and consumer protection (Republic of Indonesia, 2012).

Based on the field visit conducted in this study, the mushroom snack Micro, Small, and Medium Enterprise (MSME) examined has already obtained a valid PIRT (Produk Industri Rumah Tangga Pangan) license issued by the local authority. This indicates that the MSME has satisfied minimum administrative and sanitation requirements for small-scale processed food production and is legally permitted to distribute its mushroom snack products within local markets (Republic of Indonesia, 2012). From a legal feasibility standpoint, the possession of a PIRT license confirms that the MSME is operating within Indonesia's formal food regulatory system.

However, the legal classification of mushrooms as food also means that food security and food safety obligations extend beyond licensing alone. Under Law No. 18 of 2012, food security is defined as a condition in which food is available, safe, nutritious, and accessible to the public (Republic of Indonesia, 2012).

In the context of the MSME studied, this implies that the production of mushroom snacks from surplus mushrooms contributes to food security only insofar as the products remain safe and suitable for consumption. Accordingly, food security in this research is understood not merely as increasing food availability, but as ensuring the lawful and safe utilization of mushroom-based food resources (FAO, 2019).

Food safety obligations for the MSME are further governed by Government Regulation No. 86 of 2019 on Food Safety, which requires continuous compliance with hygiene and safety standards throughout production and distribution processes (Republic of Indonesia, 2019). For the mushroom snack MSME, food safety is legally secured through adherence to Cara Produksi Pangan Olahan yang Baik (CPPOB), which regulates processing activities such as cleaning, slicing, frying, drying, seasoning, and packaging. Although formal CPPOB certification is not mandatory for all PIRT holders, its principles function as the substantive legal benchmark for processed food safety (BPOM, 2021; Sutedi, 2013).

In addition, because mushroom snacks are classified as processed food, the MSME remains subject to labeling and consumer protection obligations. Compliance with BPOM Regulation No. 31 of 2018 on Processed Food Labeling ensures transparency regarding ingredients, expiration dates, and production codes, while Law No. 8 of 1999 on Consumer Protection establishes liability for unsafe or misleading products (Aziz & Wicaksono, 2020; Sidabalok, 2010). These obligations reinforce food security by ensuring that consumers have access not only to food, but to food that is safe and accurately represented.

When violations occur in the production, labeling, or distribution of mushroom snack products, legal responses generally follow a graduated and risk-based enforcement approach, prioritizing public health protection. Initial enforcement typically involves administrative warnings, corrective orders, or temporary suspension of distribution until compliance is restored, particularly for small and medium-sized enterprises (Sutedi, 2013; Suryani, 2018).

Several cases reported by Indonesian media illustrate how violations involving plant-based snack products are sanctioned under Indonesian food law. *Tempo* reported that BPOM withdrew packaged vegetable-based snacks from circulation after inspections found expired products and misleading

labeling, with sanctions imposed in the form of product withdrawal and distribution bans pursuant to food safety and consumer protection regulations (Tempo, 2023). Similarly, *The Jakarta Post* documented BPOM's nationwide surveillance identifying unregistered vegetable chips distributed without valid permits, resulting in administrative sanctions including product recalls and suspension of distribution licenses (The Jakarta Post, 2022). In another case, *Tempo English* reported sanctions against plant-based snack producers whose products were falsely labeled as halal, leading to corrective orders and enforcement actions under halal product assurance law (Tempo English, 2024). These enforcement actions demonstrate that Indonesian food law applies administrative sanctions, recalls, and licensing consequences to non-compliant snack producers, a regulatory pattern directly relevant to mushroom-based snack businesses.

More serious or repeated violations, such as distribution without required licenses, misleading labels, or unsafe products, may result in administrative sanctions including product recalls, permit suspension, or revocation of business licenses. Civil liability may also arise if unsafe mushroom snack products cause consumer harm, while criminal sanctions are reserved as a last resort for intentional or grossly negligent conduct (Sidabalok, 2010; Hadjon, 2011; Marzuki, 2014).

From a business perspective, this legal analysis is positioned from the standpoint of the company or small and medium-sized enterprise (SME) that produces and markets mushroom-based snack products. The regulatory requirements discussed, ranging from food safety compliance and licensing to labeling and consumer protection, directly affect production costs, operational decisions, and market access. For producers, legal compliance is therefore not merely a regulatory obligation but a strategic consideration that influences product feasibility, risk exposure, and long-term sustainability. By integrating food security and food safety requirements into production planning, companies can transform surplus raw materials into legally compliant products while maintaining consumer trust and regulatory legitimacy.

From a preventive legal perspective, companies and mushroom snack producers are encouraged to integrate compliance into risk management strategies, including CPPOB implementation, staff training, traceability documentation, and cooperative-based

production models. Consistent legal compliance not only reduces exposure to sanctions and liability but also supports the broader objective of food security by ensuring that processed mushroom products remain safe, accessible, and sustainably utilized within national food systems (Republic of Indonesia, 2012; Arifin, 2018; Sutedi, 2013).

If the MSME intends to expand distribution beyond local markets or to enter international markets, the legal consequences of food classification become more extensive. National-level distribution would require BPOM MD registration, while export activities would necessitate compliance with international food safety standards such as Codex Alimentarius and the food regulations of importing countries (BPOM, 2018; FAO/WHO, 2019). In this context, food security obligations extend beyond national availability and encompass cross-border food safety assurance, traceability, and quality control (HLPE, 2014).

Overall, the classification of mushrooms as food under Indonesian law provides the legal foundation for assessing both the feasibility and obligations of the mushroom snack MSME examined in this study. The findings indicate that the enterprise is legally feasible at its current scale due to its existing PIRT license, while food security is legally secured through layered compliance involving food law, food safety regulation, CPPOB standards, labeling requirements, and consumer protection norms (Republic of Indonesia, 2012; Nuraini & Daryanto, 2022).

g. Integrated Legal–Economic Discussion

Overall, the findings indicate that mushroom crispy production at XX functions as a strategic circular economy intervention. Although short-term profitability remains limited, the activity enhances resource efficiency, reduces food loss, and strengthens enterprise resilience. This integrated outcome supports the argument by Geissdoerfer et al. (2017) that circular economy initiatives should be evaluated through combined economic, environmental, and institutional lenses rather than narrow profit metrics.

5. Conclusion

From a theoretical perspective, this study shows that legal compliance should not be viewed simply as an external burden for food MSMEs, but as an integral part of whether circular economy practices can realistically function. Food laws and regulations play an important informational role, enabling governments

to determine which food products are safe for consumption and under what conditions surplus ingredients may be processed and marketed. Examining circular economy practices through combined legal and economic perspectives therefore provides a more complete understanding of sustainability, one that captures not only financial performance but also consumer protection and regulatory legitimacy (FAO, 2019).

From a policy perspective, the findings suggest that food loss reduction initiatives can be more effectively implemented when embedded within existing MSME regulatory frameworks and supported by active government involvement. International experience illustrates that food safety governance for small food businesses does not rely on enforcement alone. In the European Union, small and artisanal food producers are supported through simplified hygiene requirements and official guidance that take business scale into account (European Commission, 2016). In Japan, local governments emphasize food safety training, advisory inspections, and certification schemes that help consumers identify compliant food businesses (MAFF, 2020). Australia similarly applies a risk-based food safety system that allows small food enterprises to meet regulatory obligations in proportion to their scale and level of risk (Food Standards Australia New Zealand [FSANZ], 2018).

These approaches highlight the importance of governments providing clear information, guidance, and risk-mitigation support for MSMEs engaged in food processing, including those utilizing surplus raw materials. Beyond licensing and inspections, policymakers may also consider modest but meaningful incentive mechanisms such as public recognition, compliance labels, or priority access to training and assistance programs for MSMEs that consistently maintain food safety standards. Such measures can strengthen consumer trust, reduce regulatory uncertainty for small businesses, and encourage wider adoption of circular economy practices without compromising public health objectives (OECD, 2021; FAO, 2019).

6. SUGGESTION

Implications for SMEs

The findings suggest that snack processing based on surplus or downgraded produce can function as an effective loss-reduction and value-retention strategy for small food enterprises, particularly those handling

highly perishable commodities. However, the feasibility of such practices depends on the availability of accurate cost information. Improved recording of processing inputs, including raw materials, packaging, energy, and labor, would enable SMEs to better evaluate economic performance and make informed decisions regarding production scale and business integration.

Implications for Policymakers

The study indicates that circular economy practices in food MSMEs can be supported within existing regulatory frameworks when complemented by appropriate governance measures. Local governments may enhance policy effectiveness by providing technical guidance, food safety and good manufacturing practice (GMP/CPPOB) training, and clearer regulatory information tailored to small-scale food processors. In addition, food loss reduction policies could more explicitly recognize on-farm and on-site processing as legitimate circular economy activities. Modest incentive-based mechanisms, such as public recognition or facilitated access to training programs, may further encourage consistent compliance with food safety standards without lowering regulatory thresholds.

Implications for Future Research

Given the case study design, further research is needed to examine surplus-based food processing across multiple SMEs to assess variability, scalability, and contextual differences. Future studies may also incorporate quantitative environmental indicators, such as food waste reduction and potential emission savings, to complement legal and economic feasibility analysis and provide a more integrated assessment of sustainability outcomes.

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