

SUSTAINABILITY-LED INNOVATION (SLI) MODEL

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ABSTRACT

The article aims to examine the benefits of the Sustainability-Led Innovation Model, Sustainable Innovation & ESG (Environmental, Social, and Governance), and the role of technology in supporting innovation. Sustainability-led innovation has emerged as an essential approach to addressing global challenges related to the environment and society. This article explores how companies and organizations apply sustainability principles in their innovation processes and their impact on business performance and the achievement of sustainable development goals. Through in-depth literature analysis and case studies, it is found that sustainability-led innovation not only drives resource efficiency and reduces environmental impacts but also creates new opportunities for market differentiation and enhances corporate reputation. This article also identifies key factors that influence the successful implementation of sustainability innovation, such as management commitment, integration of social and environmental values in corporate strategy, and collaboration with external stakeholders. These findings provide valuable insights for decision-makers and practitioners in developing innovation strategies that are aligned with sustainability principles, which in turn can make positive contributions to society and the planet.

INTRODUCTION

In modern business, sustainability has become a top priority for an entrepreneur. This encourages many companies to better understand the concept of business sustainability, which illustrates that businesses prioritize profits and manage economic, social, and environmental impacts on the market and society. Sustainable innovation is becoming increasingly important because sustainable businesses meet several crucial criteria, including the ability to create long-term value for all stakeholders and the ability to adapt to changes in the social and economic environment. Therefore, the Sustainability-Led Innovation (SLI) model has emerged as a strategic approach to achieve these goals.

Sustainability-led innovation is an innovation approach that prioritizes sustainability as a key element in the development of products, services, and business models. Sustainability-led innovation involves three main areas: operational optimization, organizational transformation, and systems development. Operational optimization focuses on increasing the efficiency and reducing the environmental impact of existing processes. Organizational transformation involves shifting a company's values to create new, more sustainable products or markets. Systems development involves collaborating with the surrounding community to create positive change through jointly developed products or business models. By prioritizing sustainability in innovation, companies can not only reduce their environmental footprint but also create sustainable economic and social value.

A. Definition of Sustainability-Led Innovation (SLI) model

The Sustainability-Led Innovation (SLI) model is an innovation approach that places sustainability as the main driver in the development of products, processes, and business models. Unlike

conventional innovations that often only focus on economic benefits, Sustainability-Led Innovation emphasizes the importance of considering positive impacts on the environment and society (Carayannis et al., 2015). Thus, sustainability aspects are integrated into every stage of innovation, from idea identification to implementation and evaluation (Dhewanto, 2013). The main focus of this model is to create solutions that are not only economically profitable but also environmentally friendly and provide social benefits.

Sustainable Business Model Innovation involves changes in a company's operations to have a positive impact on the environment and society, which is in line with the Sustainable Development Goals (SDGs). Sustainable Business Model Innovation is a change in the way a company operates to reduce adverse external impacts and create new positive external impacts on the environment and society. The goal is to integrate sustainability into the business model to achieve sustainable development. Sustainable Business Model Innovation is characterized by "incorporation into the existing value proposition of sustainable principles or goals" (Nguyen, Kanbach, & Kraus).

Sustainability-led innovation can be achieved through three distinct approaches: operational optimization (doing what we do but better), organizational transformation (creating new opportunities), and systems building (enabling social change). Faculty play a role in enhancing innovation through research and can also expand research networks and bring insights from multiple perspectives by developing collaborations with other institutions. When implementing sustainability-led innovation, risk management is essential to ensure that "the uncertainties that arise from rapid innovation and creativity are maintained with adequate internal controls" (Nguyen, Kanbach, & Kraus).

Ecosystem brand recovery is possible through "reframing, blending, and proacting" (Dominidiato, Guercini, & Milanese). This involves integrating sustainability into business models to achieve sustainable development goals.

B. Three Areas in Practicing Sustainability-Led Innovation

Danny Kosasih identified three main areas in implementing Sustainability-Led Innovation:

1. **Operational Optimization:** Focus on improving the efficiency of existing processes to achieve economic effectiveness and gradually reduce environmental impacts. "Operational Optimization" is the first step to reducing a company's environmental record through continuous improvement (Allen & Meyer, 2006).
2. **Organizational Transformation:** Involves changing corporate values to drive new product or market innovation that aligns with sustainability principles. This transformation requires a commitment from the entire organization to create more sustainable solutions (Hatten, 2012).
3. **System Development:** Focuses on creating positive change and impact for society through collaborative products or business models. Companies act as change agents in the social systems in their environment, contributing to solutions to broader social and environmental problems (Longenecker et al., 2001).

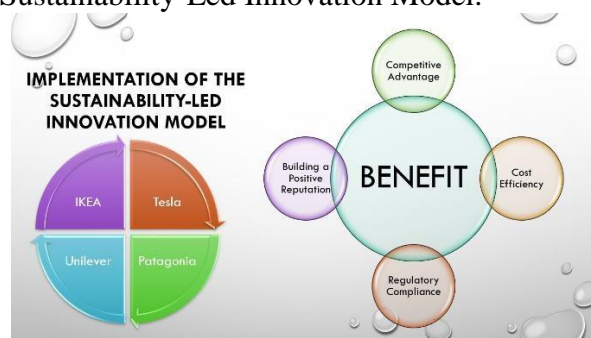
C. Characteristics of the Sustainability-Led Innovation Model

1. **Environmentally Based Innovation**
 - a) Reducing carbon footprint and production waste;
 - b) Using renewable energy and recycled materials;
 - c) Developing durable and easy-to-repair products.
2. **Circular Economy Model**
 - a) Encourage reuse and recycling of products;

- b) Adopt the cradle-to-cradle concept (products can be reused without waste;
- c) Develop service-based business models, such as product as a service.
- 3. Efficiency and Green Technology
 - a) Using digital technology to optimize resource use;
 - b) Using AI and IoT (Internet of Things) to improve energy efficiency and sustainable supply chains;
 - c) Developing more environmentally friendly materials and manufacturing processes.
- 4. Positive Social Impact
 - a) Ensuring fair and ethical business practices in the supply chain;
 - b) Empowering local communities through social innovation;
 - c) Reducing economic disparities with affordable products and services

D. The Examples of Implementation of the Sustainability-Led Innovation Model

Sustainability-led Innovation is an approach that integrates sustainability principles in the innovation process, with the aim of creating added value that is not only economically profitable but also environmentally and socially friendly. In Indonesia, the application of this model is increasingly relevant, considering the significant challenges related to climate change, environmental damage, and social and economic inequality. Through SLI, various industrial sectors in Indonesia, such as renewable energy, sustainable agriculture and circular economy, can transform to achieve a balance between economic growth and environmental sustainability. In this material, we will explore examples of the application of this model in Indonesia, as well as how sustainability-based innovation can have a positive impact on society and the environment. The following are pictures and explanations of several examples of The Implementation of the Sustainability-Led Innovation Model.



Pict. 1 - The Examples of Implementation of the Sustainability-Led Innovation Model

1. Tesla – Developing more environmentally friendly electric vehicles and battery technology
2. Patagonia – Implementing a recycling-based business and product repair program (Worn Wear Program)
3. Unilever – Creating products with environmentally friendly materials and reducing the carbon footprint in the supply chain
4. IKEA – Adopting a circular economy model with a used furniture buyback program.

E. Benefits of Sustainability-Led Innovation

1. Competitive Advantage – Attracting environmentally conscious customers
2. Cost Efficiency – Reducing energy and raw material consumption
3. Regulatory Compliance – Avoiding legal risks and carbon taxes
4. Building a Positive Reputation – Increasing customer loyalty and value

This model is a key point for future companies to stay relevant in an era that demands a

balance between innovation, profitability, and sustainability.

F. Model for Sustainability-Led Innovation

John Bessant explains that the Sustainability-Led Innovation model developed with the Network for Business Sustainability (NBS) emphasizes two main points: the level of innovation (incremental to radical) and the focus from the company to the broader multi-player ecosystem. This model allows for three innovation approaches to sustainability: operational optimization, organizational transformation, and system building. This model emphasizes the importance of collaboration and involvement of various stakeholders in the innovation process (Suryana, 2006).

G. Relevance of SLI to Sustainable Development Goals (SDGs)

SDGs (Sustainable Development Goals) are a series of seventeen goals created by the United Nations (UN) to achieve sustainable development at the global level. These goals cover a wide range of aspects, including poverty eradication, inequality, environmental protection, and improving

well-being. Sustainable innovation should be aligned with the sustainable development goals (SDGs), which aim to end poverty, protect the planet, and ensure well-being for all by 2030. Sustainability-led innovation can contribute to the achievement of several SDGs, especially SDGs 2, 6, 8, 13, and 15 (Hisrich & Peters, 2002). By focusing on innovative solutions that meet people's needs without compromising the environment, Sustainability-Led Innovation helps create a more sustainable future.



Pict. 2 - seventeen Sustainable Development Goals

Sustainable Development Goals (SDGs) were initiated by UN member states as a joint movement to end poverty, protect the planet, and ensure that everyone lives safely and decently by 2030. SDGs are a vision of the overall state of the world by 2030, ensuring that no one is left behind through programs to eliminate poverty, hunger, AIDS, and discrimination against women and girls. SDGs, also called "Global Goals", contain seventeen goals with a total of 169 achievement indicators. These seventeen SDGs are integrated goals, where actions in one area will affect other areas, and development must be balanced between social, economic, and environmental so that it is sustainable. This will provide hope that the world will transform into a better place to live. The main principle of SDGs is universal, with development targets that apply to all underdeveloped, developing, and developed countries, along with every citizen.

H. Sustainable Innovation and ESG (Environmental, Social, and Governance)

Environmental, Social, and Governance (ESG) is a framework used to assess a company's environmental, social, and governance impacts. ESG is a concern for organizations around the world as awareness of environmental and social issues increases. ESG is essential

in the modern business world because it can help companies operate responsibly. Aspects of ESG include:

1. Environment

The company's efforts to reduce its impact on the environment include the use of clean energy and the conservation of natural resources.

2. Social

The company's interactions with the community include working conditions, human rights, and community involvement.

3. Governance

The company's policies and practices regarding risk management, transparency, accountability, and integrity.

The benefits of ESG are increasing transparency, strengthening reputation, accessing capital, reducing risk, and providing benefits to the environment and society. ESG is different from CSR (Corporate Social Responsibility), although the two are often used interchangeably. Sustainable innovation is very relevant in the context of environmental and social challenges and the demands of companies to operate responsibly. ESG principles are an essential framework for inspiring sustainable innovation. Companies that integrate ESG well into their business strategies tend to have lower financial effects and better overall performance (Carayannis et al., 2015). Thus, SLI is not only about creating better products and services but also about building a more responsible and sustainable business.

I. Measuring the Environmental Impact of Innovation

The ways to measure the environmental impact of sustainability-led innovation can be accomplished with several effective instruments and methods. Environmental performance measurement is a critical component of sustainability efforts, allowing for accurate monitoring and providing insights to manage the industry's impact on the environment. Here are some methods and tools that can be used:

1. Life Cycle Assessment (LCA): This method analyses the environmental impact of the entire life cycle of a product or process, from raw material extraction to disposal. LCA considers greenhouse gas emissions, natural resource use, and other impacts to provide a comprehensive evaluation. *Badan Riset dan Inovasi Nasional (BRIN)* also explains that LCA calculates the environmental impact of a product system from upstream to downstream.
2. Geographic Information System (GIS): GIS is used to map and analyse environmental data based on geographic location, helping to understand location-related impacts, such as water pollution or land use.
3. Sensors and IoT Technology: Sensors and the Internet of Things (IoT) are used for real-time environmental monitoring. These sensors can measure parameters such as air, water, and soil quality, as well as temperature, humidity, or radiation.
4. Satellite Imagery Mapping Analysis: Satellite imagery is used in large-scale monitoring to measure environmental changes from above, such as land cover changes, deforestation, and forest fire monitoring.
5. Big Data Analytics: Big data analytics is used to process and analyze large volumes of environmental data generated from multiple sources, helping in gaining in-depth insights into environmental impacts as well as long-term trends.
6. Emission Quantification: This method measures and quantifies the emissions of greenhouse gases, air pollutants, wastewater, and other hazardous substances resulting from industrial processes or human activities.
7. Environmental Risk Analysis: This method is used to identify and evaluate the potential

risks posed by industrial activities to the environment.

8. **Water and Soil Quality Monitoring:** This method involves regular measurements of water and soil quality to identify changes that may occur due to human activities, including measuring the levels of pollutants, chemicals, and heavy metals.
9. **Sustainability Measurement Methods:** This method involves measuring parameters such as energy efficiency, resource use, and socio-economic impacts to evaluate the contribution of an activity or company to environmental, social, and economic sustainability.
10. **Modelling and Simulation:** This method uses software and mathematical models to predict the environmental impact of a given scenario, helping in making better decisions regarding planning and development that impacts the environment.

In addition, environmental taxes can also be an effective instrument in reducing negative impacts on the environment by providing incentives for more efficient innovation and green technologies. Environmental taxes encourage behavioral changes in economic actors towards more efficient and environmentally friendly use of resources. This measurement is essential to identify areas where companies or organizations can reduce their environmental footprint, manage risks, and increase positive impacts on the surrounding environment. Integration of these methods is necessary to gain a holistic and in-depth understanding of environmental performance.

J. Successful Sustainability Leadership Innovation in Indonesia

The Sustainability-Led Innovation (SLI) model has been implemented in Indonesia and various successful examples show great potential for creating economic value and positive impacts on the environment and society. Below is an image containing a summary of this section.



Pict. 3 - Successful Sustainability Leadership Innovation in Indonesia

Sustainable Innovation in Indonesia

1. **Green Polymer Lab - ITB:** This laboratory develops sustainable products based on Indonesian natural resources. For example:
 - a) **Biomass Briquettes from Water Hyacinth and Cocoa Husk:** Overcoming the problem of water hyacinth and cocoa husk waste by creating environmentally friendly briquettes. "With a composition of 25% water hyacinth and 75% cocoa husk, Green Polymer Lab has succeeded in creating biomass briquettes that have the same performance as coal briquettes".
 - b) **3D Printing Filament from Manau Rattan:** Manau rattan is utilized as an environmentally friendly 3D printing filament material and provides a solution for relatively complex rattan processing. "This innovation opens up new opportunities in the utilization of rattan and provides a more sustainable alternative in the 3D printing industry".
 - c) **Lignin-Based Anti-Corrosion Coating from Paper Industry Waste:** Overcoming the

problem of paper industry waste by developing environmentally friendly anti-corrosion coating. This innovation addresses the problem of paper industry waste but also provides an environmentally friendly coating alternative".

- d) Utilization of Masks for Shoemaking Fabric: Reducing mask waste by converting it into fabric that can be used to make shoes. This innovation is a fundamental step in reducing mask waste while creating a valuable product.
2. Indofood: Innovating air holder pouch design packaging for Freiss syrup products for consumer convenience.
3. Innovation in Kerta Village: Utilizing livestock waste into biogas as an alternative energy source.

Sustainable Agriculture

1. Organic Agriculture: Supports human health and environmental sustainability by growing crops without harmful chemicals. With crops grown without harmful chemicals, the business encourages consumers to move to a healthier and more sustainable lifestyle.
2. Technological Innovation in the agricultural sector: Technological innovation and genetic engineering in the agricultural sector can help improve the quality of agricultural products.

Waste Management and Recycling

Bank Sampah: Managing waste and electronic waste by sorting and recycling waste. By sorting and recycling waste, this business not only reduces the negative impact on the environment but also contributes to the production of innovative products from recycled materials.

The Role of Leadership and Collaboration

1. Sustainable Leadership: Leadership that prioritizes sustainability goals plays a critical role in driving sustainable development initiatives.
2. International Collaboration: Collaboration with other countries strengthens Indonesia's position in sustainability innovation.

These examples illustrate how sustainability-led innovation can create economic value, reduce environmental impacts, and deliver social benefits in Indonesia.

K. The Role of Technology in Supporting Innovation

Technology plays a crucial role in supporting sustainability-led innovation. This role spans a wide range of aspects, from optimizing operations to enabling entirely new and sustainable business models. Here are some of the key roles of technology in supporting sustainability-led innovation:

1. Accelerating Sustainability Strategy: Technology acts as a key accelerator for companies looking to advance their sustainability initiatives. The technology eco advantage approach enables the use of advanced technologies that benefit companies while having positive environmental, social, and governance impacts.
2. Protecting the Environment: Technology helps reduce water, air, and land pollution and reduces the consumption of finite natural resources. In addition, it supports the preservation of biodiversity.
3. Energy Efficiency: Technology plays a role in increasing the efficiency of energy use and creating more sustainable energy solutions. IoT and AI-based solutions can optimize energy efficiency in real time, reduce emissions, and save costs.
4. Reducing Greenhouse Gas Emissions: Technological developments in the energy production, transportation, and industrial sectors can reduce greenhouse gases that

- contribute to global climate change.
5. Supply Chain Transparency: Sustainable technologies provide end-to-end transparency in a company's supply chain. AI can be used to track upstream carbon emissions, identify ESG opportunities and risks, and predict downstream demand for more optimal and energy-efficient fleet utilization.
6. Data-Driven Decision Making: Advanced software and analytics generate data and insights into the environmental and social impacts of a product, service, or process. Tools such as automated data capture and analytical dashboards help companies identify opportunities to operate more sustainably and reduce their carbon footprint.
7. Data Collaboration and Sharing: Digital platforms integrate capabilities, share data, and create transparency and accountability among partners. Data sharing enables new collaboration models and accelerates business process efficiencies.
8. Circular Economy: Adopting sustainable technologies enables companies to shift from the traditional linear economic model to a circular economy, which emphasizes recycling, repair, reuse, and sharing of materials and products.
9. ESG Reporting: Sustainable technologies help companies measure, refine, and report on their progress toward achieving ESG goals. This allows companies to see how their ESG initiatives compare to more significant sustainability trends through ESG scores.
10. Sustainable Business Models: Technology empowers organizations to reimagine their business models to balance financial performance with sustainability goals. Examples include using the cloud to reduce energy consumption, robotic process automation to reduce waste, and electronic health records to reduce paper use.
11. Digital Optimization: By creating more sustainable operations and processes, companies can win stakeholder preference, become industry standards, or improve business resilience. Innovations in textile dyeing technologies that reduce water, energy, chemicals, and pollution are examples.

Research results from various sources show that Sustainable Business Model Innovation (SBMI) is an essential strategy for companies and small and medium enterprises (UMKM) to achieve sustainability and competitive advantage in the digital era. "Digitalization allows companies to increase efficiency, transparency, and responsiveness to market demands and regulations related to sustainability" (Nguyen, Kanbach, & Kraus). Business model innovation in the circular economy can also improve the sustainability and operational efficiency of small and medium enterprises (UMKM). SBMI allows companies to integrate economic, environmental, and social aspects into their operations beyond simply pursuing profit. Sustainable business models help companies adapt to complex environments and achieve sustainable competitiveness. The application of sustainable principles can reduce carbon footprints, reduce waste, and implement more efficient production methods. Open innovation contributes significantly to the growth of digital companies, with "significant effects on company performance and increased revenue after two years" (Dominidiato, Guercini, & Milanesi). Service design also plays an essential role in supporting SBMI by revealing strategic and operational synergies. Important factors influencing the success of digital technology integration include visionary leadership, a culture of innovation, and organizational readiness to adopt change.

Sustainability-oriented business model innovation helps "conserve and leverage natural, social, and financial resources into the core business" (Nguyen, Kanbach, & Kraus).

L. Relevant Research

1. Supplier-Customer Relationships for Sustainability-Led Innovation In The Textile

Industry (Matteo Dominidiato)

- a. Research Objectives
 - This study aims to investigate sustainability-led innovation, focusing on the relationship between product and process innovation to achieve sustainability goals and the underlying supplier-customer relationship.
 - This study aims to analyze how sustainability-oriented innovation affects the relationship between suppliers and customers and vice versa.
- b. Research Methods
 - This study uses a qualitative research approach with an exploratory study. Data were collected through in-depth semi-structured interviews with entrepreneurs, managers, and experts in the textile industry.
 - The textile industry was chosen as the empirical context of the study
- c. Research Findings
 - In the textile industry, sustainability-oriented product innovation is mainly related to product durability and performance, product recyclability, and the use of waste for new product development. Process innovation focuses on the circular economy, traceability, and minimization of water and chemical use.
 - This study also shows how sustainability-oriented innovation is implemented in more technical terms.
- d. Advantages of the Study
 - This study adopts an original perspective on how processes occur in supplier-customer relationships, where there is no dominance of one actor, but innovation emerges from interdependence and interaction.
 - This perspective allows for an in-depth analysis of supplier-customer relationships and the underlying dynamics that influence sustainability-oriented innovation. The added value of this study lies in delivering an accurate representation of innovation processes rooted in the textile industry
- e. Weaknesses of the Study
 - Since this study is exploratory and qualitative, the results may not be generalizable to all industry contexts or all types of supplier-customer relationships.
 - Further research may be needed to test these findings on a larger scale and in different industry contexts.

2. Facilitating Corporate Sustainability Integration: Innovation In Family Firms (Linh H. Nguyen and Dominik K. Kanbach)

- a. Research Objectives
 - This study aims to understand the relationship between family-driven innovation and the integration of corporate sustainability (CS) in German family firms.
 - The main objective of this study is to investigate how family firms integrate CS with innovation and to identify the reasons behind this integration.
- b. Research Methods
 - This study used a qualitative methodology by conducting 26 interviews with 22 German family firms. The collected data were analyzed using thematic analysis, which resulted in five main themes.
 - This qualitative approach was chosen because it was considered appropriate to extend existing theories to study how family firms integrate CS into their business using innovation.
- c. Research Findings
 - Measuring corporate sustainability performance.

- Building corporate sustainability-oriented infrastructure.
 - Stabilizing/optimizing operations.
 - Increasing operational flexibility/independence.
 - Knowledge management and development.
- d. Advantages of the Study
- This study is the first to empirically investigate the relationship between family-driven innovation and corporate sustainability integration at each level of corporate sustainability maturity.
 - This study provides an activity-based guide for family firms to use innovation to achieve corporate sustainability goals.
- e. Weaknesses of the Study
- Although this study provides valuable insights, the abstract of the journal does not mention the limitations of the study. Further research may be needed to test these findings on a larger scale and in different industry contexts.

CONCLUSION

Sustainability-led innovation can be practiced in three areas, including a) Operational Optimization, which is the first step to reduce the company's environmental footprint through continuous improvement; b) Organizational Transformation, which requires commitment from the entire organization to create more sustainable solutions; and c) Systems Building, which focuses on creating positive change and impact for society through collaborative products or business models.

Sustainability-led innovation has several benefits, namely: a) competitive advantage - attracting environmentally conscious customers; b) cost efficiency - reducing energy and raw material consumption; c) regulatory compliance - avoiding legal risks and carbon taxes; d) building a positive reputation - increasing customer loyalty and their value.

Environmental, Social, and Governance (ESG) is the environment, Social, and Governance. ESG is a framework used to assess a company's impact on the environment, society, and governance. ESG is a concern for organizations around the world due to the increasing awareness of environmental and social issues. ESG is essential in the modern business world because it can help companies operate responsibly. Aspects of ESG include environment, social, and governance. Technology plays a critical role in supporting Sustainability-Led Innovation by providing tools and solutions that can improve resource efficiency, reduce environmental impact, and encourage the use of renewable energy.

Technological innovations, such as artificial intelligence (AI), the Internet of Things (IoT), and new material technologies, enable companies to design greener and more sustainable products and processes. For example, renewable energy technologies enable the replacement of fossil fuels, while digital technologies facilitate data analysis to monitor and optimize resource use. In addition, technology can also increase transparency in the supply chain, helping companies to be more responsible in selecting environmentally friendly raw materials and ensuring more sustainable business practices.

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