The 1st International Conference on Eco Friendly and Zero Waste (ICEZ) 2024

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Conference Proceeding

Theme:

"Promoting Eco Friendly and Zero Waste in Holistic Business Process of SMEs and Entrepreneurial Startup"

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Table of Content

Greeting Message from the General Chair of ICEZ 2024

Dr. Mulyani Karmagatri S.Sn.,MM

Dear Distinguished Participants, Esteemed Colleagues, and Friends,

On behalf of the organizing committee, it is my great pleasure to welcome you to the **International Conference on Entrepreneurship and Zero-Waste (ICEZ) 2024**. This year's conference, themed *"Promoting Eco-Friendly and Zero-Waste Entrepreneurship for a Sustainable Future"*, brings together a dynamic community of scholars, practitioners, and innovators who are committed to advancing sustainable solutions through entrepreneurship.

ICEZ 2024 offers a unique platform for exchanging cutting-edge research, insights, and best practices from diverse fields. From groundbreaking eco-friendly products to innovative zero-waste business models, this conference showcases the forefront of sustainable entrepreneurship.

We are honored to have a wide range of keynote speakers, technical sessions, and discussions that will undoubtedly inspire new ideas and collaborations. Our heartfelt thanks go to all the participants, authors, and reviewers who have contributed to making this conference a success.

I would also like to extend my gratitude to our sponsors and partners who have supported us in organizing this event, as well as to the organizing team for their dedication and hard work.

We hope that this e-proceeding will serve as a valuable resource for researchers and practitioners alike and that the discussions sparked at ICEZ 2024 will continue to drive sustainable innovations for years to come.

Thank you for being a part of ICEZ 2024, and I wish you a fruitful and engaging conference experience.

Warm regards,
Dr. Mulyani Karmagatri S.Sn.,MM
General Chair, ICEZ 2024

About the Conference

The “1st International Conference on Eco-Friendly and Zero Waste (ICEZ) 2024” will be held over two days, on October 8-9, 2024, at BINUS @Bandung Campus. This international conference specifically aims to promote research results and products from academics and researchers that can be utilized by small business actors, entrepreneurs, industries, policymakers, and the general public.

This event aims to actively participate and respond to the crucial problems currently faced by Indonesian and global communities. The critical issue relates to the deteriorating environmental conditions that are increasingly unmanageable. This is a shared responsibility that cannot be solely placed on the end-users. Producers, entrepreneurs, researchers, and the government need to take collective steps toward resolving this issue to achieve a solution. The specific goal of this project is to provide a platform for researchers, enthusiasts, experts, and other stakeholders to raise awareness and promote concepts of eco-friendly and zero waste, particularly in a holistic business process from upstream to downstream. Through this event, various stakeholders will be involved, enhancing public trust in academics, researchers, and policymakers. Additionally, it aims to build and strengthen a network of researchers who have an interest in and concern for sustainability and its related issues.

This event has another important goal which is to promote and spread the word about research findings and products of academics and researchers that can be utilized by small business operators, entrepreneurs, industries, policymakers, and the general public. It is intended to serve as a positive step towards effecting change.

By creating this event “1st International Conference on Eco-Friendly and Zero Waste (ICEZ) 2024” we hope this event will have a good impact into community from the big and small ones, as we can see the environmental condition in our country is not a big topic itself and lacking of awareness, the lack awareness in this topic is very alarming that can impact our environmental situation. From that reason only we choose to spread this topic to gain awareness of people and by creating this ICEZ 2024 to fulfill our goal.

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Bridging the Gap: Understanding Attitudes and Behaviors in Sustainable Consumption

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Abstract: Sustainable consumption plays a pivotal role in addressing global environmental challenges. Despite the widely recognized significance of sustainability, a notable disparity continues to exist between consumer attitudes and actual behaviors in this regard. This study synthesizes the current literature to explore the complex dynamics of the attitude-behavior gap in sustainable consumption. Drawing on established frameworks, such as the Theory of Planned Behavior and the Value-Belief-Norm Theory, this study examines the cognitive, emotional, and behavioral factors influencing consumer decision-making. It reviews empirical evidence on psychological barriers, socioeconomic influences, and the impact of marketing strategies on sustainable choices. Additionally, this study analyzes the role of social norms, peer interactions, media influence, and cultural contexts in shaping consumer behaviors towards sustainability. Recommendations for future research and policy highlight the need for interdisciplinary collaboration, robust regulatory frameworks, and innovative technologies to globally promote sustainable consumption practices. Addressing these challenges is crucial for bridging this gap and advancing towards a more sustainable future.

Keywords: Sustainable consumption, Attitude-behavior gap, Environmental psychology, Social influence, Pro-environmental behavior

1. INTRODUCTION

Sustainable consumption is increasingly recognized as an essential component in addressing global environmental challenges such as climate change, pollution, and resource depletion (Trudel, 2018). It aims to fulfill present needs without compromising the ability of future generations to do the same (World Commission on Environment and Development, 1987). Despite the widespread recognition of its importance, achieving substantial environmental benefits remains challenging because of the disparity between consumer attitudes and behaviors, often referred to as the attitude-behavior gap (Göring-Lensing-Hebben et al., 2023; Martin & Väistö, 2016). This gap reveals that consumers frequently express positive attitudes towards sustainability, but struggle to consistently translate these into actions, which in turn affects global markets and policy agendas. Theoretical frameworks such as the Theory of Planned Behavior (Ajzen, 1991) and the Value-Belief-Norm Theory (Stern, 2000) offer valuable insights into the factors shaping sustainable consumption behaviors, including attitudes, norms, personal values, and perceived behavioral control. Recent research underscores the complex decision-making processes and situational factors that influence sustainable consumption behaviors (Göring-Lensing-Hebben et al., 2023), emphasizing the need for comprehensive strategies to bridge this gap.

This study synthesizes current research to provide fresh insights into the attitude-behavior gap in sustainable consumption. By integrating perspectives from the foundational and contemporary literature, this study offers practical recommendations for promoting sustainable consumer behavior in today's global context.

2. LITERATURE REVIEW

Understanding how attitudes translate into action is pivotal to advancing sustainable consumption. Despite broad support for sustainability, converting positive attitudes into tangible behaviors remains a persistent challenge (Göring-Lensing-Hebben et al. 2023). Sustainable consumption has evolved through global environmental movements and key policy milestones, such as the 1992 Earth Summit, highlighting the need to balance economic growth with environmental stewardship (World Commission on Environment and Development, 1987).

Theoretical frameworks such as the Theory of Planned Behavior (Ajzen, 1991) and value-belief norm theory (Stern, 2000) shed light on the cognitive, affective, and behavioral determinants of sustainable consumption behaviors. These frameworks emphasize the roles of attitudes, norms, perceived control, values, and ethics in shaping consumer decisions.

Factors contributing to the attitude-behavior gap include psychological barriers, socio-economic constraints, accessibility to sustainable options, perceived inconvenience, and entrenched consumption habits (Mont, 2021; Vermeir and Verbeke, 2006). Cognitive aspects involve rational evaluations and beliefs regarding sustainability issues, products, and practices, while affective aspects encompass emotional responses that can motivate eco-friendly behaviors (Bassili, 2008). Direct engagement with sustainable practices often shapes attitudes more effectively than indirect engagement (Fazio & Zanna, 1978; Moreira et al., 2022).

Recent trends indicate a growing consumer interest in sustainability, influencing preferences towards eco-friendly products and prompting businesses to integrate sustainability into their strategies (Göring-Lensing-Hebben et al., 2023). However, empirical studies highlight discrepancies between consumer attitudes and behaviors in sustainable consumption (Hughner et al., 2007; Asmuni & Ma'arif, 2015), underscoring the challenges of effectively promoting pro-environmental behaviors.

Critiques of existing research suggest that cognitive approaches dominate the study of sustainable consumption, potentially overlooking the impact of affective and behavioral factors (Bagozzi et al., 1979). Integrated frameworks are essential for capturing the multidimensional nature of attitudes towards sustainability and accurately predicting consumer behavior.

This literature review synthesizes seminal and contemporary research to provide a comprehensive understanding of attitude-behavior consistency in sustainable consumption. This serves as a foundation for exploring new insights and proposing effective strategies to bridge the gap between consumer attitudes and sustainable behaviors, which are crucial for promoting environmentally responsible lifestyles.

Social Influence in Sustainable Consumption

Social influence plays a crucial role in shaping individual decisions and behaviors towards sustainable practices. Social factors, such as norms, peer interactions, media influence, social networks, community engagement, and cultural context, significantly influence consumer choices regarding sustainability.

Social norms establish expectations for environmentally responsible behaviors within communities and guide actions such as recycling and energy conservation (Schultz et al., 2007). Conformity to these norms motivates individuals to adopt eco-friendly practices that are in line with community expectations. Peer influence rooted in social interactions also plays a crucial role in shaping consumer decisions regarding sustainable consumption. Studies indicate that individuals are more likely to engage in eco-friendly behaviors when influenced by their peers (Goldstein et al., 2008; Lazaric et al., 2020), fostering positive attitudes and collaborative efforts towards sustainability.

Media platforms amplify sustainability messages through advertisements, news coverage, and social media campaigns, thereby shaping consumer perceptions and preferences. Effective media strategies raise awareness of

environmental issues, advocate for sustainable products, enhance public engagement, and drive pro-environmental behaviors.

Social networks, both online and offline, serve as platforms for sharing information, experiences, and support for sustainability initiatives (Christakis and Fowler, 2007). Online platforms facilitate the dissemination of environmental messages and promote collective action, thereby extending the impact of sustainability efforts.

Communities play a vital role in promoting sustainable consumption through grassroots initiatives and local movement. Community engagement fosters collaboration among residents, businesses, and policymakers to implement sustainable practices and address environmental challenges effectively. Local efforts promote lasting behavioral changes and cultivate collective responsibility for environmental stewardship.

Cultural values and traditions influence attitudes and behaviors towards sustainability across diverse societies (Andersson et al., 2022). Understanding cultural dynamics is crucial in designing effective sustainability interventions tailored to different contexts. Comparative analyses explore variations in social influence strategies a cross regions and socioeconomic contexts and assess the effectiveness of approaches in promoting sustainable behaviors within diverse populations.

Social Influence Theories

Social influence theories, such as social identity theory and the diffusion of innovations, provide frameworks for understanding how social factors drive sustainable behavior. These theories elucidate the formation of social norms, spread of peer influence, and impact of cultural values on consumer choices (Dolan et al., 2019). Evaluating these theories enhances our understanding of effective strategies for promoting sustainable consumption through social influence.

Recommendations for Future Research and Policy Implications

The current research highlights significant gaps that require further exploration to effectively narrow the attitude-behavior gap in sustainable consumption. Future studies should integrate diverse aspects of attitudes, conduct longitudinal research to track behavioral changes, and analyze cross-cultural variations across demographic contexts. Addressing the complexities of sustainable consumption demands interdisciplinary collaboration among psychology, economics, environmental science, and marketing to gain holistic insights into consumer behavior drivers and effective strategies for promoting sustainable practices (Thøgersen, 2018).

Strong policies are crucial for incentivizing sustainable consumption behaviors, encompassing regulatory frameworks, economic incentives, and public awareness campaigns (Dietz et al. 2009). Global cooperation is essential for aligning policies and standards, whereas businesses can contribute by embracing corporate social responsibility (CSR) and integrating sustainability into their strategies (Bansal & Roth, 2000). Setting ambitious sustainability goals and leveraging technological innovations offer promising avenues for driving behavioral shifts towards sustainable lifestyles (Bocken et al., 2014).

Educational initiatives targeting educational institutions, workplaces, and communities can enhance consumer awareness and promote pro-environmental attitudes (Hartmann and Ibanez 2006). Technological innovations such as blockchain and IoT applications can facilitate transparent supply chains and sustainable product design, thereby supporting sustainable consumption practices.

Effective interventions should focus on subtle adjustments in decision-making contexts such as default options for sustainable products, leveraging social norms, and providing personalized feedback (Thaler & Sunstein, 2008). Developing robust metrics is essential for assessing the alignment between attitudes and behaviors in sustainable consumption, utilizing validated scales, and longitudinal studies to accurately monitor changes over time.

Proposals for Future Empirical Studies

Future empirical research should explore emerging topics, such as the impact of digital platforms on sustainable behaviors, cultural influences on green consumption patterns, and the effectiveness of communication strategies in promoting sustainable choices. Comparative studies across regions and sectors can provide insights into effective intervention strategies (Steg and Vlek 2009). This section offers strategic recommendations for advancing research and policy initiatives to enhance sustainable consumption practices and to contribute to global sustainability.

3. CONCLUSION AND LIMITATIONS

In conclusion, this study provides a comprehensive exploration of the complex interplay between attitudes and behaviors in sustainable consumption. It draws insights from foundational and contemporary research to underscore the enduring challenge posed by the attitude-behavior gap. Through interdisciplinary approaches, this study deepens our understanding of consumer decision making in sustainable contexts (Thaler & Sunstein, 2019; Thaler & Sunstein, 2008).

Policy recommendations emphasize the importance of regulatory frameworks, economic incentives, and educational initiatives to foster sustainable consumer behavior (Dietz et al., 2009; Bansal & Roth, 2000). Technological innovations offer promising avenues for facilitating sustainable consumption practices (Bocken et al. 2014).

Acknowledging the complexity of human behavior, this study identifies limitations such as the challenges in predicting and influencing sustainable consumption patterns across diverse cultural and socioeconomic contexts. Future research should explore emerging trends and conduct comparative studies to inform effective strategies for promoting sustainable consumption globally (IPCC, 2018; Steg & Vlek, 2009).

Addressing the attitude-behavior gap in sustainable consumption demands collaborative efforts from policymakers, businesses, educators, and researchers. A more sustainable future can be achieved by advancing interdisciplinary research, implementing robust policies, and harnessing technological innovations.

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Supply Chain Design of Leaf Waste Biomass Pellets (New Renewable Energy) Based on Waste Banks as Producers (Case Study: Ciamis Waste Bank)

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Abstract: Garbage is now a common problem that occurs in many places in Indonesia. Waste reduction activities are carried out with the aim that all levels of society, including the government, the business world, and the wider community, can carry out Reduce, Reuse, Recycle (3R) activities. The Ministry of Environment is developing a waste bank to carry out 3R activities by producing biomass pellet products from organic waste and biomass waste, namely leaf waste. Leaf waste biomass pellets for drive energy convection are able to support government programs to reduce coal consumption and become one of the solutions to replace coal in the future. Therefore, in this study there is a formulation of the problem, namely how much is needed for leaf waste biomass pellets to replace coal at PLTU Cirebon and how to design a supply chain for leaf waste biomass pellets to meet the need for new renewable energy to replace coal for PLTU Cirebon. Based on these needs problems, the objectives of this research are to find out how much leaf waste biomass pellets are needed and to design a supply chain for leaf waste biomass pellets to meet the demand for new renewable energy to replace coal for PLTU Cirebon. The research was conducted by researchers located at the Ciamis Main Garbage Bank and conducted at the Garbage Ecopreneur Training Center in Cimenyan, Bandung City. The data collection that was obtained started from the General Data of the Ciamis Main Garbage Bank to the method of making leaf waste biomass pellets. Furthermore, for data processing the method used is to use a supply chain design framework, namely the Framework for Network Design Decisions (Shunil Chopra-Peter Meindl), in which there are 4 stages, namely Stage 1 Supply Chain Strategy, Stage 2 Determining the Location of a Waste Bank as a Producer of Fuel Pellets , Stage 3 Data Allocation for 10 Waste Banks, and Stage 4 Meeting the Needs of the Cirebon PLTU, followed by the Strength, Weakness, Opportunities, and Threat (SWOT) method, 5W + 1H Method, Waste Management Method at the Source (TOSS), Pellet Calculation Biomass, Vehicle Operating Costs (BOK), Net Present Value (NPV), and Interest Rate of Return (IRR). The calculation results to meet the needs of the Association of Indonesian Private Electricity Producers (APLSI) which is almost 4.2 million tons per month, the Ciamis Garbage Bank can supply fuel pellets to meet the need for a substitute for coal for one month as much as 2,890,590 Kg or 2.8 million tons per month which means it can meet as much as 69% of the need for coalfired leaf waste pellets at PLTU Cirebon.

Keywords: Garbage, Waste Bank, Supply Chain Design, Biomass Pellets, Biofuels

1. INTRODUCTION

Waste is now a common problem that occurs in many places in Indonesia. There are many factors in the increase of waste generation in Indonesia, including economic growth and changes in people's consumption patterns, especially in urban areas. The composition of waste based on the source of the most waste comes from households, which is 40.9%, and the composition of waste based on the type of waste disposed of the most is food waste,which is 30.7%, in 2021.

Image 1. Waste Composition

Waste reduction activities are carried out with the aim that all levels of society, both the government, the business world, and the wider community, carry out activities to limit waste generation, recycling and reuse of waste or better known as Reduce, Reuse and Recycle (3R) through smart, efficient and programmed efforts. The Ministry of Environment is making efforts to develop the Waste Bank.

The role of the Waste Bank is to carry out 3R activities by producing products that use packaging that is easily decomposed by natural processes, which creates as little waste as possible, using raw materials for production that can be recycled and reused, and/or withdrawing waste from products and product packaging for recycling and reuse such as making biomass pellets from organic waste and the biomass waste produced can become biofuel.

To replace coal in the future, New Renewable Energy (EBT) will continue to increase because there will be a New Renewable Energy-based Power Plant that will add electricity capacity around 2.07%. New Renewable Energy (EBT) is energy that comes from sustainable natural processes, such as energy from solar power, wind power, water currents, and biological processes or biomass.

Image 2. Leaf Waste Burning Pellets

Biomass pellets, when compared to other solid biomass pellets, have several things to compare, namely the physical shape of the pellets, both in terms of diameter and length, has met the standard. In addition, the moisture content of the pellets needs to be kept below 15%. The ash and tethered carbon content of biomass pellets need special attention, especially when they come from domestic waste. Pellets from husks and bamboo tend to have relatively high ash content. The heating value of biomass pellets can meet the class 1 standard which requires between 3000-4000 kcal/Kg. The calorific value is close to the standard and can replace coal. A price and calorific value comparison for coal and biomass pellets can be seen in Table 1.1.

Table 1. Comparison of Coal Price with Pellets Biomass

Fuel	Current Price (IDR/Kg)	Calories Produced (kcal)	Fuel	Current Price (IDR/Kg)	Calories Produced (kcal)
Coal	6000	5000	Biomass Pellets	1500	2000-4000

Biomass pellets for Energy Conversion can support the government program in reducing Coal consumption. With the current coal price of Rp.6,000/Kg, the cost of biomass pellets is Rp.1428.57 or rounded up to Rp.1,500/Kg, making biomass pellets one of the solutions to replace Coal in the future.

Waste management if utilized as an energy source by looking at biomass waste and domestic waste in Indonesia, one of the motivations for the Waste Bank as part of the supply chain for leaf waste fuel pellets or organic waste is that the TPS has begun to not be able to accommodate more waste and the concept of the Waste Bank is not maximized, so the absence of supply chain management results in accumulation of waste and activities to convert leaf waste into organic leaf waste fuel pellets into vegetable coal whose use is to replace coal and is included in New Renewable Energy. So that the Waste Bank in each village will be the collection point of biomass waste in the city which will later be used as organic leaf waste fuel pellets, so in this study, the researcher wants to conduct research to design a supply chain so that the Waste Bank can meet the needs of leaf waste fuel pellets and how the Waste Bank contributes to the welfare of the community.

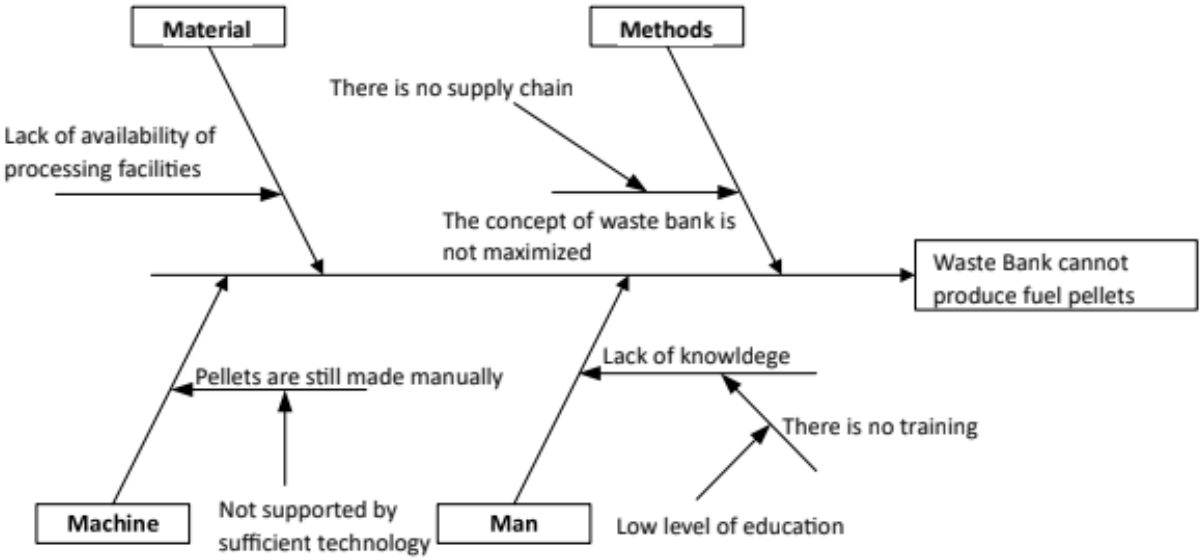


Figure 3. Cause and Effect Diagram

The touch of appropriate technology can be used as a source of new and renewable energy (EBT), namely community power plants or even for household energy needs. The initiation of converting organic waste into fuel pellets as an alternative raw material for power plants (populist electricity systems) and especially in growing ecopreneurs is a community service program of the Bandung Institute of Technology (ITB) in collaboration with the Indonesian College of Logistics Management (STIMLOG) and PT Comestoarra Bentara Noesantara (PT Comestoarra) using the organic waste and biomass processing method is Waste Management Technology at the Source (TOSS).

2. LITERATURE STUDY

Supply Chain Management

Supply chain management is an integrated and clear process. Its function is to help provide information to management regarding the procurement of goods. Not only that, this system also contains information about relationships with

external parties such as vendors or suppliers. The goal is of course to maintain the supply of products that are needed by the company. Thus all businesses can run optimally. This management system also concerns all aspects. For example, from order delivery, raw material procurement, information dissemination to the latest product development.

Reverse Logistics

Reverse Logistics is an often overlooked process that can help companies reduce waste and increase profits, as the name suggests, the opposite of what we have described so far in terms of planning and operations. It could be defined as the process of planning, executing, and controlling the efficient flow of recyclable and reusable materials, returns, and rework from the point of consumption for the purpose of repair, remanufacturing, redistribution, or disposal.

SWOT Analysis (Strength, Weakness, Opportunities, and Threats)

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. A SWOT analysis organizes your key strengths, weaknesses, opportunities, and threats into an organized list and is usually presented in a simple grid bar. Strengths and Weaknesses are internal to your company. things that you can control and can change. Examples include who is on your team, your patents and intellectual property, and your location. Opportunities and Threats are external things that affect your business or things that happen outside your company in the larger market. You can take advantage of opportunities and protect against threats, but you cannot change them. Examples include competitors, raw material prices, and customer spending trends.

Net Present Value (NPV) Calculation Method

Net Present Value analysis is a method of assessing an investment that will be made by emphasizing the net present value of expenditures compared to the present value of revenue.

Internal Rate of Return (IRR) Calculation Method

The Internal Rate of Return (IRR) method is one method of finding interest rates when NPV = 0. The information generated in this IRR method is related to the level of cash flow ability to return investment capital which is explained in the form of percent (%) of the time period and how much obligation must be fulfilled.

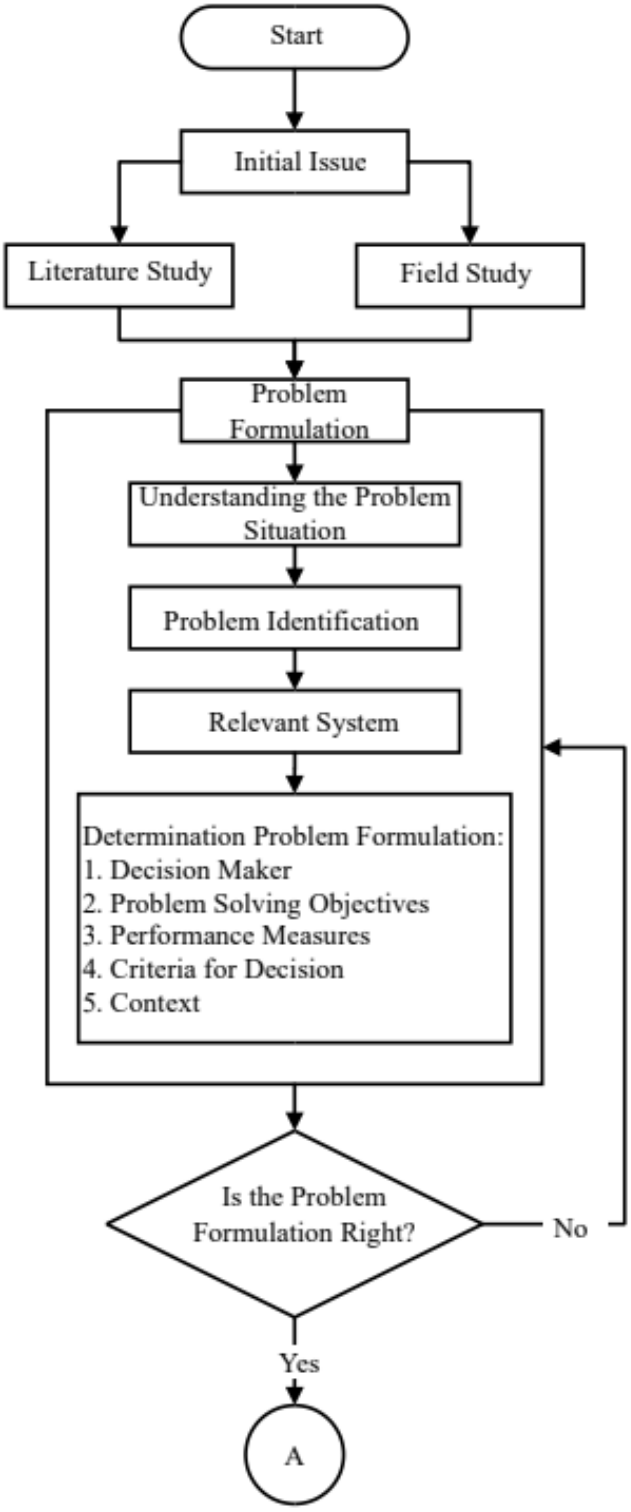
3. METHOD

Research Framework

For the research conducted by researchers, there are two supply chain actors. These actors are Waste Bank and PLTU. The two actors have a supply chain flow, starting from the Waste Bank which contracts with the PLTU to meet the PLTU's needs. After the PLTU contract occurs, the PLTU asks the Waste Bank to make fuel pellets as a substitute for coal. Waste Bank will start to collect organic waste which will become the basic ingredients of fuel pellets, after the availability of organic waste made from leaves, it is then ground until smooth and stirred with glue until it becomes flat and put into a mold. After molding the pellets, they are dried in the sun and oven for 2 days on a zinc base and drained, then when 50 leaf waste fuel pellets have been collected, they will be immediately packed to be sent to the PLTU.

Research Methodology

To launch the research, a research methodology is made, so that problem solving can be done properly and systematically. The following is the research methodology shown in the figure


Start
Initial Issue
Literature Study
Field Study
Problem Formulation
Understanding the Problem Situation
Problem Identification
Relevant System
Determination Problem Formulation:
1. Decision Maker
2. Problem Solving Objectives
3. Performance Measures
4. Criteria for Decision
5. Context
Is the Problem Formulation Right?
No
Yes
A

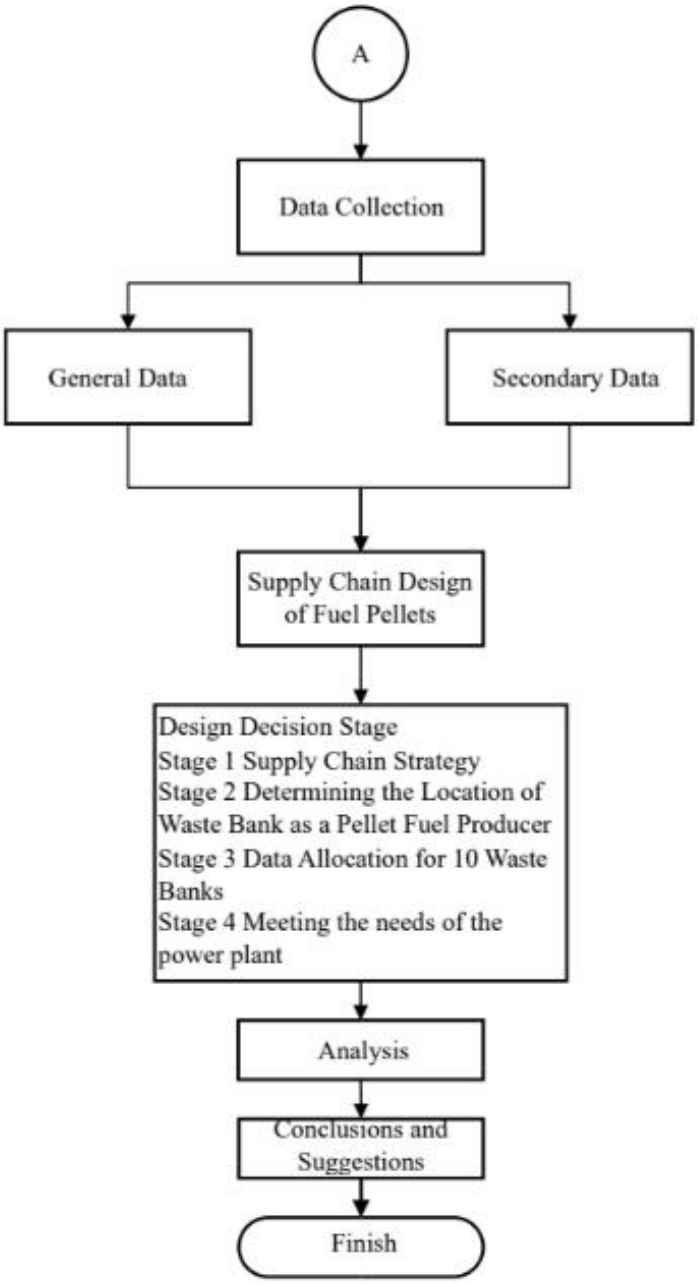


Figure 4. Research Methodology

Initial Issue

Waste is now a common problem that occurs in many places in Indonesia. There are many factors in the increase of waste generation in Indonesia, including economic growth and changes in people's consumption patterns, especially in urban areas. In urban areas, economic growth will go hand in hand with changes in people's consumption patterns. Where people's consumption patterns will show an increase.

Against the backdrop of this problem, waste management converts waste if it is utilized as an energy source by looking at biomass waste and domestic waste in Indonesia, one of the motivations for the Waste Bank as part of the leaf waste or organic waste fuel pellet supply chain is that the TPS has begun to be unable to accommodate more waste and the concept of the Waste Bank is not maximized, so the absence of supply chain management results in the accumulation

of waste and the activity of converting leaf waste into organic leaf waste fuel pellets into vegetable coal which is used to replace coal and is included in New Renewable Energy.

Literature Study

To find information and theoretical basis, the first thing to do is literature study. The information the author gets comes from books and journals. The purpose of the literature study is to support the problems that will be raised in the research. On the other hand, the knowledge that the author has can be developed even better. Literature study is carried out to find a theoretical basis related to Supply Chain Management, Waste Supply Chain, Types of Waste, Burning Pellets.

Field Study

The next step is to conduct a field study or observation. Field studies can see directly the situation that is happening. Interviews with Mr. Ervan as the Waste Bank Manager, collecting information and data, and observing how Mr. Ervan makes fuel pellets. The author conducts field studies to find out the problems faced in designing the fuel pellet supply chain at the Ciamis Garbage Bank.

Problem Formulation

The formulation of the problem is to raise the topic that will be researched by the author in this research. The formulation of the problem can refer to the results of the field study conducted by the previous compiler and complemented by references read in the literature study. Based on that, then the author determines the problem formulation of this research. The formulation of the problem in this study, namely:

a. Problem Situation Understanding

The existing problems must be understood so that the reader understands the problem in this study is to understand the situation of the problem to be studied by designing the fuel pellet supply chain in order to meet the needs of new renewable energy to replace coal for PLTU.

b. Problem Identification

Waste Bank as part of the supply chain of leaf waste fuel pellets or organic waste is that the TPS has begun to be unable to accommodate more waste and the concept of Waste Bank is not maximized, so the absence of supply chain management results in accumulation of waste and activities to convert leaf waste into organic leaf waste fuel pellets into vegetable coal whose use is to replace coal and is included in New Renewable Energy.

c. Relevant System

By using the relevant system, the supply chain design method is used.

d. Determination of Problem

Formulation The determination of the problem formulation must be done by answering the following problem formulation:

1. Decision Maker: Mr. Ervan and the Garbage Bank
2. Problem Solving Objective: to find out that the Waste Bank can fulfill the need for leaf waste fuel pellets to replace coal in the PLTU.
3. Performance measures: Design a supply chain for leaf waste pellets to meet the need for renewable energy to replace coal for power plants.
4. Decision Criteria: by designing a new renewable energy supply chain: organic waste biomass fuel pellets.

e. Context: Mr. Ervan and Bank Sampah Induk Ciamis as the context in this final project.

Data Collection

Information collection is used by researchers to obtain and collect data needed to act on findings about a problem. The data obtained from the object under study is then identified to obtain the appropriate data. The data collection process in this research is shown in Figure 5.

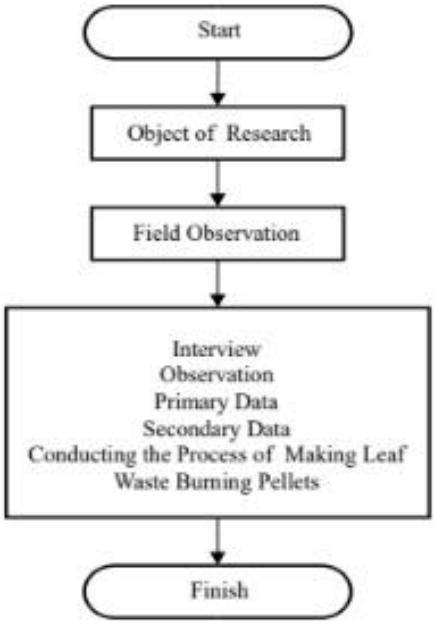


Figure 5. Data Collection

1. Interview
   Collect data by asking directly to Mr. Ervan as the source.
2. Observation
   Observation is a data collection technique carried out by researchers who see directly and review directly the existing conditions in the field. In this study, observation activities were carried out by looking directly at the Waste Bank.
3. Conducting the process of making leaf waste fuel pellets Watching and following the directions as taught by Mr. Ervan.

Supply Chain Design

The model development in this study uses the decision stage of supply chain design. The first stage is to create a supply chain strategy, by creating a competitive strategy and internal constraints that exist in Bank Sampah Ciamis. The second stage determines the location of the waste bank as a producer of fuel pellets and makes 10 Waste Bank Units as Waste Banks that have shredding machines. The third stage makes data allocation for 10 Waste Banks ranging from waste estimation to waste production. The fourth stage fulfills the needs of the PLTU by using fuel pellets as a substitute for coal.

Design Decision Stage

Designing the supply chain for leaf waste fuel pellets at Bank Sampah Ciamis so that the product can successfully replace new coal, four stages must be carried out in designing the leaf waste fuel pellet supply chain.

a. Stage 1 Supply Chain Strategy
   The first stage determines the supply chain strategy for leaf waste pellets to meet the needs of new renewable energy, then determines the ability to support competitive strategies with the SWOT method and Cause and Effect Table.
b. Stage 2 Determining the Location of Waste Bank as a Pellet Fuel Producer
   The second stage determines 10 waste bank units that are the center of the chopping machine to chop leaf waste into fuel pellets by knowing the types of plants in Ciamis City, green land in Ciamis City, the method of Waste Management Technology at the Source (TOSS), and the process of making leaf waste fuel pellets.

c. Stage 3 Data Allocation for 10 Waste Banks

The third stage selects locations based on the availability of infrastructure to support the design of the leaf waste pellet fuel supply chain so that it can be implemented, the location selection is selected based on the availability of 10 waste bank units that cover each village, one waste bank unit covers 20 villages and knows the distance from 260 villages to each waste bank and calculates leaf waste based on the area and green open space in each subdistrict.

d. Stage 4 Meeting the needs of the power plant

Stage four determines decisions based on the stages that have been carried out by knowing the calculation of leaf waste and knowing how much fuel pellets are needed to replace coal in the Cirebon PLTU.

Analysis

After processing the data, the author will analyze how much fuel pellets are needed to replace coal in the PLTU, and how to design the fuel pellet supply chain so that the need to replace coal can be met, and the results on the data processing. This is so that the author can describe all logical possibilities and provide an understanding that can be drawn from the results of data processing and summarize the overall results of the research that has been done in order to get a solution to solve existing problems.

Conclusions and Suggestions

Drawing conclusions is the final stage of the research. The conclusions drawn are based on the results of data processing and analysis carried out in the previous chapter and are also equipped with suggestions that might be useful for joint business farmer groups, so that they can apply what has been suggested by researchers. In addition, it is also equipped with suggestions for further researchers.

4. RESULT AND DISCUSSION

Problem Situation

Knowing the amount of leaf waste in each community environment, waste management changes if it is utilized as an energy source by looking at biomass waste and domestic waste in Indonesia, one of the motivations for the Ciamis Garbage Bank as part of the leaf waste or organic waste fuel pellet supply chain is that the local landfill has begun to not be able to accommodate more waste and the concept of the Garbage Bank has not been maximized, so the absence of supply chain management results in accumulation of waste and activities to convert leaf waste into organic leaf waste fuel pellets into vegetable coal whose use is to replace coal and is included in New Renewable Energy. So that the Waste Bank in each village will be the collection point of biomass waste in the city which will later be turned into organic leaf waste fuel pellets.

Supply Chain Design Decision Stage

The decision stage carried out in the design of the leaf waste fuel pellet supply chain at the Ciamis Garbage Bank, to do something the decision is made in 4 (four) stages, including the first stage, namely the supply chain strategy, the second stage, namely determining the location of the Garbage Bank as a producer of leaf waste fuel pellets, the third stage, namely data allocation for 10 Garbage Banks that produce and estimate leaf waste fuel pellets, and in the fourth stage, namely meeting the needs of the power plant.

Stage 1 (Supply Chain Strategy)

The first stage of determining supply chain strategies for supply chain design oriented to fuel pellets can meet the needs of new renewable energy to replace coal in PLTU, namely by determining the company's competitive strategies for leaf waste fuel pellets. The following matrix analysis for each strategy:

SWOT Matrix for SO Strategy

To see the strengths used to take advantage of the opportunities owned by Bank Sampah Ciamis which can form a competitive strategy in the waste bank by improving the quality of human resources, expanding the marketing area of fuel pellets, maintaining good relations between waste banks, and increasing the production capacity of leaf waste fuel pellets in waste banks.

SWOT Matrix for WO Strategy

From the weaknesses and opportunities owned by Bank Sampah Ciamis, strategies can be developed to minimize existing weaknesses so that waste banks can take advantage of opportunities and find competitive strategies by improving the supply chain management system, optimizing pellet fuel promotion efforts, conducting supply chain design, increasing leaf waste fuel pellet production planning at Bank Sampah Ciamis.

SWOT Matrix for ST Strategy

Judging from the strengths and threats of Bank Sampah Ciamis, it uses its strengths to overcome threats that can come at any time, namely by developing products by improving the quality of fuel pellet products, participating in seminars or activities related to EBT in order to get new strategies, and increasing promotional activities on social media to expand the marketing of leaf waste fuel pellets at Bank Sampah Ciamis.

SWOT Matrix for WT Strategy

On the weaknesses and threats that exist in Bank Sampah Ciamis, internal weaknesses can be minimized to avoid external threats, namely by improving the production site, management system and supply chain management system, completing facilities such as shredding and pelletizing machines, and learning about New Renewable Energy.

Phase 2 (Determination of Waste Bank as a Center for Burning Pellets Production)

Knowing that Ciamis Regency has 258 waste bank units spread across sub-districts in Ciamis Regency. Of the many waste bank units scattered, there are only 10 waste bank units that are the center of the shredder to shred leaf waste. It is known that there are 37 types of plants in Ciamis City and there are 32 uses of green plant spaces in Ciamis Regency which are managed by the Ciamis Regency Public Housing, Settlement Area and Environment Office. After knowing the types of plants and green open spaces that exist, the appropriate method used is Tenologi Olahan Sampah di Sumbernya or (TOSS) which utilizes organic waste and biomass waste into biofuels in the form of biomass pellets. These biomass pellets can be an alternative material as a substitute for coal. The concept of processing with TOSS consists of several main steps such as the process of biodrying, shredding, pelletization, and handling of final products.

Stage 3 (Data Allocation for 10 Waste Banks)

Site selection is based on the availability of hard infrastructure requirements, and soft infrastructure requirements. Hard infrastructure requirements include: availability of suppliers, transportation services, communications, utilities, and machinery and warehousing facilities. Soft infrastructure requirements include availability of skilled labor, labor turnover, and community acceptance of the waste bank. The waste bank unit that is the center of the shredding machine to shred waste represents 20 village coverage or its closest area with the allocation of mileage data from 260 villages in Ciamis Regency to each of the 10 waste banks that have become producers to make leaf waste fuel pellets.

Stage 4 (Meeting the needs of the power plant)

As explained in the previous chapter, the results of the calculation of leaf waste from table 4.31 are 10 Ciamis Waste Banks produce leaf waste for one day as much as 96,438 Kg, one week as much as 674,471 Kg, one month 2,890,590 Kg, and in one year as much as 35,070,435 Kg to calculate the total production of organic waste into organic waste fuel pellets then knowing each waste bank can produce fuel pellets in one month is:

1. Waste Bank Unit Waluya produces leaf waste fuel pellets generated from the total leaf waste production of 590,460 Kg is 295,230 Kg of fuel pellets.

2. The Sayangkaak Unit Waste Bank produces leaf waste fuel pellets resulting from the total leaf waste production of 146,610 Kg is 73,305 Kg of fuel pellets.
3. The Compass Unit Waste Bank produces leaf waste fuel pellets generated from the total leaf waste production of 341,370 Kg is 170,685 Kg of fuel pellets.
4. Bank Sampah Unit Al-Huda produces leaf waste fuel pellets resulting from a total leaf waste production of 366,000 Kg is 183,000 Kg of fuel pellets.
5. Bank Sampah Induk Ciamis produces leaf waste fuel pellets resulting from a total leaf waste production of 211,830 Kg is 105,915 Kg of fuel pellets.
6. Unit Masagi Waste Bank produces leaf waste fuel pellets resulting from the total leaf waste production of 176,370 Kg is 88,185 Kg of fuel pellets.
7. Waste Bank Unit ABC produces leaf waste fuel pellets generated from the total leaf waste production of 363,330 Kg is 181,665 Kg of fuel pellets.
8. Bank Sampah Unit Mulung Untung produces leaf waste fuel pellets resulting from the total leaf waste production of 331,230 Kg is 165,615 Kg of fuel pellets.
9. Tumras Unit Waste Bank produces leaf waste fuel pellets resulting from a total leaf waste production of 200,280 Kg is 100,140 Kg of fuel pellets.
10. The Mawar Unit Waste Bank produces leaf waste fuel pellets generated from the total leaf waste production of 163,110 Kg is 81,555 Kg of fuel pellets.

The total leaf waste produced by 10 Waste Banks in 1 month to meet the need for coal to be used as fuel pellets is 2,890,590 Kg per month, and the fuel pellets that can be supplied by Waste Banks as producers are around 1,445,295 Kg per month. In one year the Waste Bank can produce 35,070,435 Kg of leaf waste, and the fuel pellets that will meet the needs of coal are 17,535,217 Kg per year.

So to meet the needs of the Indonesian Private Electricity Producers Association (APLSI) which is almost 4.2 million tons per month, Bank Sampah Ciamis can supply fuel pellets to meet the needs of coal substitutes for one month as much as 2,890,590 Kg or 2.8 million tons per month which means it can meet as much as 69% of the need for leaf waste fuel pellets to replace coal in PLTU.

Vehicle Operating Costs

After all are calculated from fixed costs to non-fixed costs, the total fixed cost and total variable cost are obtained.

Table 1. Vehicle Operating Costs

BOK / Unit / Year	BOK / Unit / Rit	BOK / Unit / Trip	BOK/Unit/Km
IDR156,854,000	IDR326,870	IDR156,178	Rp3,226

NPV (Net Present Value)

Calculation So the Net Present Value (NPV) can be said to be feasible if NVP> 0. And it has been calculated from the calculations above showing the NPV results of Rp.267,685,650. from these results, the investment to be made for 4 years is feasible.

Internal Rate of Return (IRR) Calculation

IRR calculates the rate of return from the investment in a chopping machine for biomass pellets, the calculation of IRR is a continuation of NPV, where NPV = 0 where IRR> cost of capital then the investment is feasible and if IRR < cost of capital then the investment is not feasible. So in the above calculation, the IRR is 82.1197%, so the investment for 4 years is feasible.

5. CONCLUSION

Leaf waste generated and processed by 10 Ciamis Waste Banks in one day is 96,438 Kg, one week is 674,471 Kg, one month is 2,890,590 Kg, and in one year is 35,070,435 Kg. to meet the needs of coal in the PLTU, the leaf waste

will be processed into leaf waste fuel pellets, knowing that the need for coal for steam power plants, aka PLTU in the country continues to increase by almost 4.2 million tons per month, then Bank Sampah Ciamis meets the needs and distributes these fuel pellets and the fuel pellets that can be supplied by Bank Sampah as a producer are around 1,445,295 Kg per month. In one year, Waste Bank can produce 35,070,435 Kg of leaf waste, and the fuel pellets that will meet the needs of coal are 17,535,217 Kg per year.

So to meet the needs of the Indonesian Private Electricity Producers Association (APLSI) which is almost 4.2 million tons per month, Bank Sampah Ciamis can supply fuel pellets to meet the needs of coal substitutes for one month as much as 2,890,590 Kg or 2.8 million tons per month which means it can meet as much as 69% of the need for leaf waste fuel pellets to replace coal in PLTU.

Designing the supply chain starts from sampling leaf waste and measuring and weighing leaf waste, then sending it to the Ciamis Unit Waste Bank as a producer of leaf waste fuel pellets, the Ciamis Unit Waste Bank will send leaf waste fuel pellets to the Ciamis Main Waste Bank for Finalization The product will be stored, the storage place must be protected from rain and humidity because otherwise the biomass fuel pellets will get wet and damaged. The supply chain route from the Ciamis Unit Waste Bank which has a shredding machine and sends it to the Ciamis Main Waste Bank for data collection which will later become leaf waste fuel pellets produced by Ciamis Regency which are then sent to meet the needs of replacing coal in the PLTU.

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Synergizing Traders and Consumer Roles in Circular Agri-Food Supply Chain

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Abstract: The present study investigates the respective contributions of traders and consumers in advancing sustainability throughout the supply chain, specifically examining the traditional marketplaces and small and medium enterprises (SMEs) located in West Bandung Regency, West Java, Indonesia. With its prominent position as a vegetable producer in the region, West Bandung Regency encounters notable obstacles with agricultural and food waste. This makes it an optimal site for studying circular supply chain initiatives. Utilizing a mixed-methods methodology, this study integrates qualitative and quantitative data to examine the present condition of sustainability in the local supply chain. The results indicate that although traders are making increasing attempts to embrace sustainable methods, formidable obstacles persist, such as restricted availability of resources and technology. Despite growing awareness of sustainability, consumers frequently exhibit purchase patterns that do not align with their expressed preferences. The study highlights significant prospects for improving cooperation between traders and consumers, principally through educational efforts and government-backed programs. This study enhances the comprehension of circular supply chains in developing economies by providing practical suggestions for stakeholders in West Bandung Regency to collaborate their efforts in order to establish a more robust and ecologically sensitive supply chain. The findings derived from this study also establish a basis for further investigation in comparable settings, emphasizing the significance of collaboration between traders and consumers in attaining sustainable objectives.

Keywords: Circular Supply Chain, Trader-Consumer Synergy, Traditional Markets, Small and Medium Enterprises (SMEs), Agri-food

1. INTRODUCTION

The issue of global waste throughout the supply chain is a complex challenge that has a substantial influence on food security, environmental sustainability, and economic efficiency. Some 33% of the food produced worldwide is lost or wasted along the food supply chain (FSC), spanning from production to consumption. This not only constitutes a squandering of precious resources but also worsens environmental deterioration and weakens food security (Corrado et al., 2019). Statistical estimates suggest that food waste incurs an annual cost of almost $750 billion to the world economy, a figure that is equivalent to the gross domestic product of several countries (Gruber et al., 2016).

Food waste occurs at several points in the supply chain, and its underlying factors are frequently interrelated. Inefficiencies in agricultural techniques, processing, and retail operations are primary contributors to substantial waste production (Mishra & Singh, 2018; Teller et al., 2018). Evidence suggests that only a small number of studies effectively tackle food waste at various levels of the supply chain, indicating a lack of comprehensive knowledge on the whole magnitude of waste production (Bernstad et al., 2017). Furthermore, the significance of packaging and consumer behavior cannot be overstated; insufficient packaging can result in heightened spoiling, while consumer habits have a substantial impact on waste reduction at both the retail and households levels (Porat et al., 2018; Verghese et al., 2015)

The concept of a circular agri-food supply chain (CASC) is becoming more acknowledged as a crucial strategy for augmenting sustainability, minimizing waste, and expanding resource efficiency in the agricultural industry. For example, the recycling of crop wastes and animal waste can greatly improve soil fertility, hence decreasing the need

for synthetic fertilizers (Nguyen et al., 2024; Rodino et al., 2023). By minimising environmental effects, this method not only enhances soil health but also enhances the overall sustainability of agricultural methods (Rodino et al., 2023). One crucial element of circular agriculture is the incorporation of local food systems, which serves to streamline supply chains and decrease emissions associated to transportation, so further improving sustainability (Jurgilevich et al., 2016; Nguyen et al., 2024).

The involvement of traders and consumers in CASC is crucial for the effective application of CE concepts, especially in the realm of agri-food systems. Agricultural by-products and trash can be used by traders as inputs for various processes, such as composting organic waste to enhance soil health or transforming food waste into bioenergy (Chiaraluce et al., 2021; Duarte et al., 2021).

The integration of these methods not only facilitates waste reduction but also enhances the economic viability of traders by generating cost savings and increasing productivity (Giudice et al., 2020). Nevertheless, consumers have an equally significant role in facilitating the shift towards CASCs. They exert a substantial impact on manufacturing processes and waste generation through their buying preferences and consuming habits. The increased consciousness of sustainability concerns has led customers to actively pursue items that are sourced and packaged in a sustainable manner. This, in turn, motivates traders to embrace circular methods (McCarthy et al., 2019). Moreover, the active involvement of consumers in waste reduction activities, such as volunteering in food recovery programs or engaging in composting, can greatly diminish food waste inside households (Duarte et al., 2021).

The study is carried out in West Bandung Regency, an area in West Java, Indonesia, distinguished for its significant agricultural output, namely in the growing of vegetables. It is a distinctive regional center for multi-commodity agriculture production. The region is renowned for its wide range of agricultural products, encompassing horticulture, fruits, and spices (Kemenko, 2024). With its prominent role as a primary provider of vegetables to both local and regional markets, West Bandung Regency produces a substantial quantity of agricultural and food loss and waste, which poses serious environmental issues (Perdana et al., 2023). The characteristics render it a very suitable site for investigating the incorporation of sustainable practices into the supply chain, namely within the framework of conventional markets and small and medium companies (SMEs).

Based on the research context provided, here are two research questions that align with the objectives:

1. How do traders and consumers in West Bandung Regency contribute to the development of a sustainable CASC within traditional markets and SMEs?
2. What are the key challenges and opportunities faced by traders and consumers in implementing sustainable supply chain practices in West Bandung Regency, and how can these be addressed to enhance synergy?

The aim of this study is to analyze and comprehend the interdependencies between traditional market traders, SMEs, and consumers in the sustainable CASC in West Bandung Regency. Explicitly, the study seeks to determine crucial elements that impact sustainable practices, examine the obstacles and possibilities encountered by traders and consumers, and suggest methods to improve cooperation among these parties. Applying a mixed methods methodology, this research aims to enhance the creation of supply chains that are both more robust and ecologically sustainable, especially in areas with substantial agricultural operations.

2. LITERATURE REVIEW

Circular supply chain

A circular supply chain (CSC) is defined by its capacity to integrate recovery activities such as reworking, remanufacturing, and recycling, therefore completing the cycle of product life cycles (Batista et al., 2018). This strategy not only tackles the environmental consequences linked to waste but also enhances economic advantages by resource utilization optimization and cost reduction in raw material acquisition (Dey et al., 2020). This shift from linear to CSCs is especially important for SMEs, as they typically struggle to reconcile economic success with environmental obligations (Dey et al., 2020). According to (Geissdoerfer et al., 2017), the adoption of CE concepts can improve the sustainability of SMEs by changing their operational methods and promoting innovation.

However, the implementation of CSCs is not without its challenges. Issues such as supply chain complexity, lack of transparency, and coordination among multiple stakeholders can hinder the effective adoption of circular practices (Gupta, 2024). To overcome these barriers, organizations must develop strategic partnerships and foster collaboration across their supply chains (Putra et al., 2023). Additionally, performance measurement systems must evolve to capture

the multifaceted nature of CSCs, addressing economic, environmental, and social dimensions (Vegter et al., 2021). This holistic approach is necessary to ensure that CSCs contribute positively to the overall sustainability agenda.

Consumer behavior in managing waste

Consumer behavior plays a pivotal role in managing waste, particularly in the context of food waste. In the realm of food waste, various studies have highlighted the impact of consumer attitudes and social norms on waste behaviors. For instance, established a causal relationship among social norms, consumer attitudes, and behavioral intentions, demonstrating that these factors significantly influence food waste behaviors in restaurant settings (Huang & Tseng, 2020). Similarly, 's research indicated that individual decisions and sustainable local food practices are crucial in addressing food waste, particularly among students in urban environments (Warshawsky, 2019). These findings underscore the importance of fostering positive consumer attitudes and social norms to mitigate food waste effectively.

3. METHOD

Research design

This study investigates the functions of traders and customers in the CASC in traditional markets and SMEs in West Bandung Regency using a mixed methods methodology. According to Creswell (2014), mixed methods are highly efficient in offering comprehensive and in-depth research by effectively integrating both quantitative and qualitative data. This method enables the gathering of survey data on food loss and waste (quantitative) and, by conducting subsequent interviews, a more profound comprehension of how stakeholders handle these problems (qualitative approach).

Research procedures

1. Literature Review: An exhaustive examination of current literature on sustainable supply chains, the responsibilities of farmers and consumers, and the particular environments of traditional market and SMEs in agricultural regions.
2. Data collection conducted by surveys and interviews to traditional markets, SMEs, and consumers in West Bandung Regency.
3. Data Analysis: Examination of qualitative and quantitative data to detect trends, obstacles, and possibilities for improving sustainability in the CASC.
4. Reporting: Consolidation of results into a cohesive storyline, together with suggestions for stakeholders to enhance the collaboration between traders and consumers in the chosen area.

Source and type of data collected

Data were collected by conducting surveys and interviews with traders and consumers, providing a comprehensive understanding of their responsibilities and viewpoints on sustainability throughout the supply chain. The interviews unveiled the pragmatic obstacles that traders encounter, including constraints in resources and the financial hurdles associated with implementing sustainable methods. From the perspective of consumers, the interviews underscored their consciousness of sustainability and their efforts in waste management. This analysis enhances comprehension of the present condition of sustainability initiatives and pinpoints areas where cooperation between traders and customers may be reinforced.

Sampling methodology

The study utilized a stratified random sampling technique to gather quantitative data from a total of 103 traders, comprising both traditional market dealers and SMEs, together with 145 customers. In order to obtain more precise and generalizable results, the study employed stratified sampling to ensure that major subgroups were represented proportionally (Singh & Mangat, 1996). The objective of the study was to record differences in food loss and agricultural waste produced among various business kinds by categorizing the population into these separate strata. In order to obtain qualitative insights into the management and mitigation of food loss and waste in business operations, interviews were performed subsequent to the quantitative phase.

Data testing and analysis

Descriptive statistics were used to succinctly characterize the attributes of the sample, offering a comprehensive summary of demographic data and sustainable behaviors among the participants. In addition, qualitative data obtained from interviews were subjected to thematic analysis. An in-depth analysis was conducted on the transcripts of these sessions to establish repeating themes and patterns, therefore facilitating a more profound comprehension of participants' views, behaviors, and issues pertaining to sustainability. These approaches collectively offered a thorough examination of both the quantitative and qualitative elements of the study.

4. RESULT AND DISCUSSION

Overview of current sustainable practices in West Bandung Regency

Figure 1. Efforts to increase capabilities to add economic value to products

Fig. 1 shows the distribution of efforts among traders to increase their capabilities in adding economic value to their products. According to the data, 52.8% of the respondents indicated that they are actively making efforts to enhance the value of their goods, signifying a majority who are focused on improving their products' marketability and competitiveness. On the other hand, 47.2% of the respondents reported that they are not taking such initiatives, suggesting that nearly half of the traders may face barriers or lack the resources or knowledge needed to implement strategies that could boost their products' economic value. This indicates a fairly even split between those who are working towards value addition and those who are not, highlighting potential areas for development or support within the trading community.

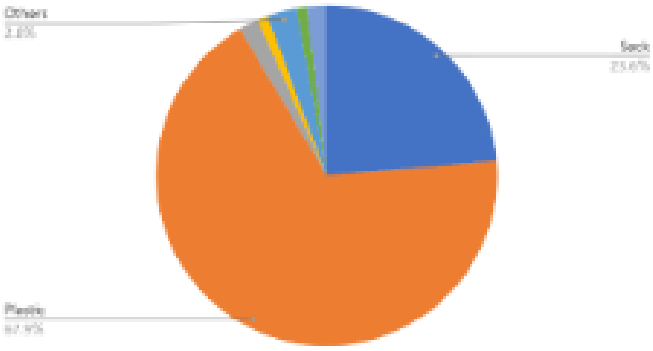

Figure 2. Packaging

Fig. 2 illustrates the distribution of packaging materials used by traders. Most traders, 67.9%, use plastic as their primary packaging material. This suggests that plastic is the most commonly used option, possibly due to its affordability and widespread availability. The second most common material is sacks, used by 23.6% of traders, which

could indicate its preference for bulk or larger products. A small percentage, 2.8%, use other packaging materials, highlighting some variety but on a much smaller scale. This chart suggests that while alternatives are available, the reliance on plastic remains dominant in the packaging practices of these traders. Small-scale traders sometimes have financial limitations, which hinders their ability to embrace more expensive sustainable packaging technologies without external assistance (UNEP, 2018).

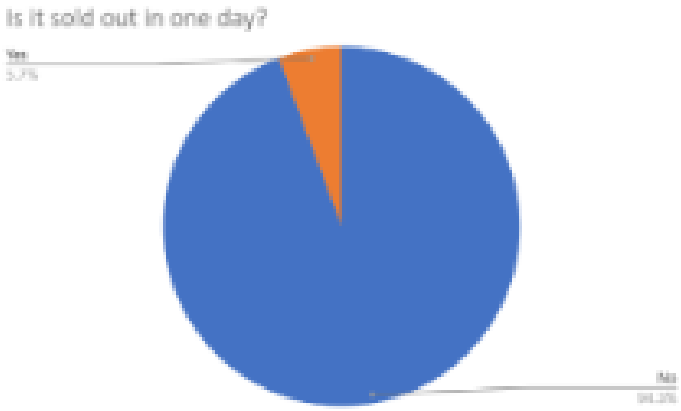

Figure 3. Items old out

The pie chart displays in Fig. 3 is the percentage of products sold out in one day. A significant majority, 94.3%, of traders reported that their products are not sold out in one day, indicating that most of the products remain unsold by the end of the day. The traders and SME owners in the traditional markets of West Bandung Regency employ many strategies to manage unsold merchandise. A significant number of retailers resell unsold merchandise the following day, employing refrigeration for perishable commodities such as meat and vegetables. Some traders categorize the remaining products, eliminating those that have been damaged while retaining the quality ones for the purpose of reselling. Another method to prolong the longevity of products is by reheating or storing them, particularly when commodities such as vegetables or meat are still in optimal condition.

Food loss, which constitutes around 10.5% of the total, takes place at many points in the supply chain, including as procurement, retail unloading, product presentation, shipping, and within the HORECA industry. Erroneous handling, incorrect storage, excessive purchasing, and insufficient preservation all contribute to this loss. Merchants and SME owners in West Bandung Regency suggest strategies such as exercising greater caution in product handling, implementing storage organization, preventing excessive inventory, and engaging in the exchange of unsold products with distributors. Nevertheless, a significant number of organisations still lack specific measures to decrease food waste. While some merchants reheat or distribute unwanted products, others dispose of them. Many propose purchasing only essential items and ensuring hygienic storage, but recognize the need for improved preservation methods. It is essential for the government to intervene through laws that ensure cheap access to technology and infrastructure, including cold chain systems and adequate waste management facilities. Collaborations with private enterprises and non-governmental organizations (NGOs) to implement cost-effective and adaptable solutions specifically designed for small-scale traders can contribute to the more effective reduction of food waste (KC et al., 2016).

Based on Fig. 4, most respondents, 97.2%, answered No, indicating that nearly all traders do not use any form of technology to manage or reduce product waste. Only 2.8% responded Yes, suggesting that a very small fraction of traders are utilizing technology. However, for those who answered Yes, the technology they rely on is limited to basic refrigeration, specifically using refrigerators to store perishable goods and extend their shelf life. This highlights a significant gap in the adoption of diverse technological solutions that could help reduce waste and loss in the agricultural supply chain, pointing to a potential area for improvement and investment in sustainable practices.

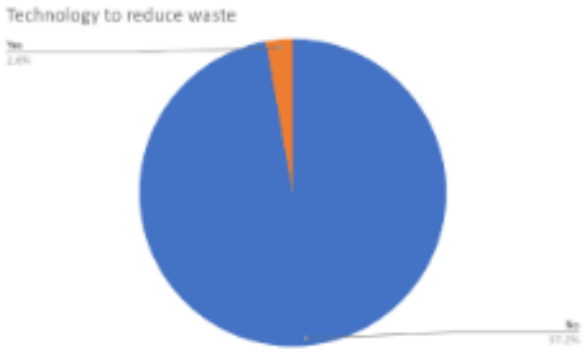

Figure 4. Technology to reduce waste

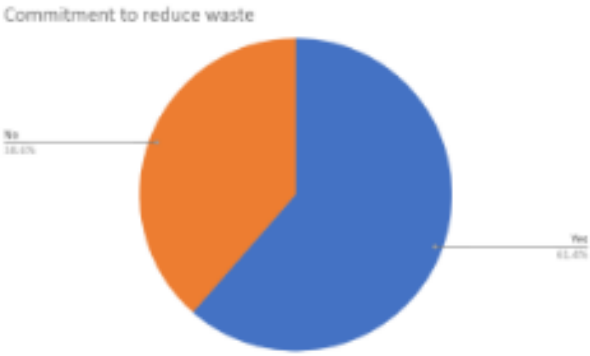

Figure 5. Commitment to reduce waste

The pie chart in Figure 5 illustrates the level of commitment to reducing waste at the household level. A majority, **61.4%**, of respondents expressed a commitment to reducing waste, indicating a positive attitude towards managing waste effectively and adopting practices that minimize waste generation. On the other hand, 38.6% of respondents indicated that they do not have a commitment to reducing waste. This suggests that while most households are aware of the importance of reducing waste and are actively trying to manage it, there is still a significant portion that may need more awareness or resources to implement waste reduction strategies.

Figure 6. Efforts to increase capabilities to add economic value to products

Figure 6 depicts efforts made by households to minimize waste through the use of sustainable packaging. A substantial majority, specifically 72.7%, of participants indicated that they employ sustainable packaging, demonstrating a firm dedication to embracing ecologically conscious methods that contribute to waste reduction. These findings indicate that a significant number of households possess knowledge regarding the ecological advantages of sustainable

packaging and are actively integrating it into their everyday routines. Nevertheless, a notable proportion of respondents, namely 27.3%, expressed their lack of implementation of sustainable packaging. This finding underscores the existence of households that may encounter obstacles related to the accessibility, expense, or knowledge of sustainable alternatives.

Challenges and Opportunities in Implementing Sustainable Practices

Food loss is a prevalent issue for many traders, mostly attributed to the perishable characteristics of items such as vegetables and fruits, which undergo rapid spoilage. Potential causes include extended shipping, inadequate handling, stacking, and unsold merchandise. Certain traders have reported repeated financial losses, particularly with delicate or perishable goods, while others have had less losses as a result of meticulous product selection, loyal consumers, or adequate refrigeration of unsold items. For certain individuals, losses are unavoidable, especially when managing substantial amounts or operating under unfavorable road conditions, resulting in damaged or unsold inventory.

The food waste generated by traders and SME owners is disposed of differently. Others dispose of their waste by depositing it in market or domestic garbage bins, or by delivering it to waste collectors or transporting it to local rubbish collection sites. Certain dealers convert organic trash into compost or dispose of it via burial. A number of traders have reported that waste is collected by either market personnel or municipal garbage collectors. In specific instances, organic waste is recycled for agricultural or fishpond purposes, while others discard it in adjacent vacant parcels of land. In general, food waste is handled using a variety of techniques, which include disposing of it in designated waste containers or reusing it for agricultural purposes. To support food waste reduction strategies for small traders, research highlights the importance of composting, storage technologies, and handling practices (Sharma et al., 2019; Waqas et al., 2023).

Considered the difficulties encountered by dealers and consumers, there exist multiple prospects to adopt sustainable practices. One significant possibility lies in enhancing food storage technologies, such as implementing refrigeration or natural preservation methods to prolong the longevity of perishable goods. Implementing this measure would effectively mitigate food deterioration and waste, especially for perishable commodities such as vegetables and meat (Nicastro & Carillo, 2021). Moreover, the implementation of sustainable packaging measures has the potential to mitigate the environmental consequences associated with the extensive use of plastic and improve the freshness of products (Afif et al., 2022). In addition, traders have the opportunity to reuse organic waste by converting unsold or damaged items into animal feed, compost, or bio-fertilizer, thereby further diminishing waste and so promoting sustainability (Martín et al., 2023).

The presence of price volatility offers an additional chance to enhance the efficiency of the supply chain by procuring locally sourced and seasonal products that are more cost-effective and lower carbon emissions by minimising transportation requirements (Hammond et al., 2015). Providing customers with information on appropriate food storage and management is of paramount importance in minimizing domestic food waste. Furthermore, the incorporation of technology, such as mobile applications or digital platforms, could facilitate the connection between merchants and customers more effectively, providing immediate updates on product availability, pricing, and freshness, therefore avoiding excessive inventory and wastage (Mah et al., 2024).

Strategic partnerships among traders, local governments, and sustainability organizations can equip traders with the necessary resources and expertise to embrace sustainable practices, including streamlined supply chain management, organic agriculture, and waste minimization techniques (Macedo et al., 2020). The integration of supply chain governance and the participation of farmers and cooperatives in coordinated production plans have enhanced its standing as a sustainable agricultural hub (Perdana et al., 2023). Through the utilization of these possibilities, both merchants and consumers have the ability to make valuable contributions towards a more sustainable supply chain, therefore mitigating waste, decreasing expenses, and fostering environmental and economic sustainability.

5. CONCLUSION

The challenges encountered by traders and consumers in effective management of fresh agricultural products underscore the necessity for the implementation of more sustainable practices throughout the supply chain. Significant challenges encompass the fast deterioration of commodities, the exorbitant price of perishable items, limited access to sustainable packaging, and a deficiency in technological integration for efficient waste management. Nevertheless,

there are evident possibilities for stakeholders to tackle these issues by implementing focused measures such as offering targeted training on food handling, enhancing availability of sustainable packaging, and advocating for local sourcing. Through the adoption of these strategies, traders and consumers can strive towards a supply chain that is more sustainable, efficient, and waste reducing. Adopting sustainable methods will yield advantages not only for the environment but also for enhancing economic profitability for all stakeholders.

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Promoting Eco-Friendly in the Workplace: Human Resource Management Perspective

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Abstract: This paper will highlight the important role of human resource management (HR) in an environmentally friendly workplace. The background of the idea of writing this paper is because of the increasing environmental problems, organizations are increasingly aware of the importance of integrating environmentally friendly issues into daily organizational activities. This paper will highlight examples and practices that companies have implemented to encourage an environmentally friendly workplace. This paper will provide benefits for further study on the extent to which organizations can contribute to environmental sustainability through employee involvement.

Keywords: eco-friendly, workplace, human resource management, perspective

1. INTRODUCTION

Nowadays, environmental awareness has emerged, and this phenomenon is increasing. The emergence of environmental awareness is manifested in the Movement that is considered to support environmental preservation, including recycling behavior in the work environment, where the practice that often appears is the use of paper for printing documents not only for single use but maximized for double-sided sheets. Historically, the Movement to recycle paper was first carried out in Japan, in the 1000s (Metal, 2024), several people or groups see the value of reusing paper, especially when triggered by scarcity. In the 20th century, paper recycling was one form of environmental awareness, especially in the workplace. According to research, paper recycling has significant environmental, economic, and societal implications, and should be integrated into global sustainable development goals (Wolska & Malachowska, 2023).

On the other hand, for companies, adopting initiatives on sustainability issues can generate economic benefits and corporate reputation. Research shows adopting sustainability initiatives, such as environmental innovation and cleaner production, benefits a firm's reputation by improving its legitimacy and stakeholders' perceptions of its commitment to environmental sustainability (Quintana-Garcia, Marchante-Lara, & Benavides-Chicon, 2022). To support this achievement, human resource management plays an important role in encouraging employees' desire to support the efforts built by the company, namely through policies and work culture that will shape employee behavior in efforts to support environmental sustainability.

In order to support environmental sustainability, human resource management must also ensure that all employees have DNA that motivates employees to contribute and take part in a positive environment. Research found the relationship between human resources management and environmental sustainability is demonstrated, as is the connection between human resources management and the social dimension of sustainability (Macke & Genari, 2019). As efforts to support the realization of a sustainable future increase, Human Resources (HR) is at the forefront facilitated by Human Resource Management. There is a trend that shows that managers engaged in Human Resource Management need to think of unique ways to realize a sustainable future through their employees. Studies show one form of human resource management practice that supports green efforts is training, and with training predictions can be made regarding individual environmental performance and the extent to which perceived organizational support can improve business performance (Paille, Valeau, & Renwick, 2020).

Human Resource Management managers develop innovative strategies to promote environmental responsibility, which is in synergy with business achievements. The concepts of CSR and HRM also have potential, where interest in these two concepts grows over time. in the last decade, with special projections on green management, stakeholders, commitment, competitive advantage, satisfaction, performance, and sustainability (Herrrera & Heras-Rosas, 2020). Sustainable practices need to be incorporated into the company structure. Incorporating three views of sustainability (market-industry, resource-based, and institutional-based) into a company's strategic plans can better position it for long-term performance and competitive advantages (Lloret, 2016). By having company strategic plans that include elements of sustainability, it is hoped that all parts of the company will have good environmental awareness. A

strategic approach to environmental challenges requires establishing a new mission, re-aligning the company's value system, and modifying behavior throughout the organization for competitive advantage (Hutchinson, 1992).

When human resource management succeeds in building environmentally conscious employee behavior, the organization's commitment to sustainability will be realized. Employee green behavior (EGB) is the core of organizational environmental sustainability (Zacher, Rudolph, & Katz, 2023). The organization's commitment to sustainability manifests in the symbols that the company wants to resonate with the public, both on the website and the workspace, namely the use of energy-efficient electrical equipment, and the beliefs held by employees. Indirectly, these things will impact the community's beliefs about the organization's commitment, both outside the company and within the company. Study found corporate environmental policy and line managers influence employee commitment to environmental goals, even when employees hold weak personal ecological beliefs (Raineri & Paille, 2016).

An environmentally friendly workplace is not only limited to physical appearance but also related to a culture of environmental responsibility. In this case, human resources play a role in terms of direct involvement in sustainability issues. SHRM plays a key role in developing a sustainable work environment and facilitating the attainment of sustainable development goals (Chams & Garcia-Blandon, 2019). Ways that can be taken are by implementing recycling activities, participating in reducing carbon footprints. With the implementation of programs, it is expected not only to contribute to efforts to protect the environment but also to improve employee morale. Study found, a holistic approach to waste management strategy development can help reduce environmental impact and improve employee morale (Zorpas, 2020).

2. LITERATURE REVIEW

Sustainable Human Resource Management

HRM plays a crucial role in corporate sustainability, and companies should apply sustainable principles to HR practices to achieve the 2030 Agenda's goals (Campos-Garcia, Alonso-Munoz, Gonzales-Sanchez, & Medina-Salgado, 2023). Sustainable human resources management focuses on leadership, environmental sustainability, and social responsibility, with four main categories identified in the review (Macke & Genari, 2019). Green human resource management practices can positively impact social sustainability, with employee green behavior at the workplace playing a key role in this relationship (Amrutha & Geetha, 2020). Sustainable Human Resource Management (SHRM) plays a key role in developing a sustainable work environment and facilitating the attainment of Sustainable Development Goals (SDGs) (Chams & Garcia-Blandon, On the Importance of Sustainable Human Resource Management for the Adoption of Sustainable Development Goals, 2019). Top managers prioritize four dimensions of sustainable HRM (justice, equality, transparency, profitability, and employee well-being) and four broader responsibility areas (legal, ethical, managerial, social, and economic), while largely ignoring ecological responsibility (Järlström, Saru, & Vanhala, 2018).

Ethical Leadership

Ethical leadership is an emerging construct with potential for new discoveries and improved effectiveness in organizations (Brown & Treviño, 2006). Ethical leadership has acceptable criterion-related validity and can predict job attitudes, performance, and trust in leaders, with trust mediating these relationships (Ng & Feldman, 2015). Ethical leadership will have a positive impact on followers which is shown in work results, this form is then understood as a form of perception of justice that occurs as a result of the interaction between leaders and their followers, and this is also related to a leadership style that values transformational and contingent concepts (Bedi, Alpaslan, & Green, 2016). Executives can develop a reputation for ethical leadership by demonstrating their visibility as moral persons and moral managers (Treviño, Hartman, & Brown, 2000).

Positive Organizational Psychology

Positive organizational psychology can significantly influence employee green behavior, but more research is needed to fill research gaps and develop effective interventions (Meyers & Rutjens, 2022). Positive organizational behavior (POB) focuses on developing and managing psychological strengths, promoting positive attitudes and enhancing organizational performance (Luthans, 2002). Positive organizational psychology has more than 100 years of experience, three productivity stages, and a decrease in visibility in recent years, with four popular study topics: well-

being at work, positive leadership, work engagement, and psychological capital (Martin-Del-Rio, Neipp, Garcia-Selva, & Solanes-Puchol, 2021).

Employee Green Behaviors

Employee green behavior is related to employee attitudes about being pro-environmental, and in addition is also related to the green psychological climate, where there are a number of related factors, including norms, perceived control, and intentions to predict green behavior (Katz, Rauvola, Rudolph, & Zacher, 2022). Employee green behavior positively impacts employee well-being by increasing self-esteem and perceived organizational support for environmental efforts (Zhang, Yang, Cheng, & Chen, 2021).
Ethical leadership practices will have a positive impact on employees' green behavior, and this also requires a number of factors including a green psychological climate, then employee enthusiasm for the environment that shows harmony, and commitment to the environment, so that the pro-environmental attitude shown by leaders is assumed to be able to strengthen the indirect impact (Saleem, et al., 2021).

Proposition 1: Ethical leadership practices will have a positive impact on environmentally friendly behavior among employees.Ethical leadership positively impacts employee green behavior through a green psychological climate, employees' harmonious environmental passion, and their environmental commitment (Saleem, et al., 2021).

Proposition 2: Ethical leaderships impact employee green behavior through green psychological climate
Perceived corporate social responsibility directly impacts trust, identification, well-being, and green behavior, with employee well-being further driving green behavior (Su & Swanson, 2019). Corporate social responsibility positively impacts employee green behavior through pro-environmental attitudes, norms, perceived behavioral control, and intentions (Katz, Rauvola, Rudolph, & Zacher, 2022).

Proposition 3: corporate social responsibility impacts employee green behavior Pro-environmental attitude positively predicts employee green behavior, with controlled and autonomous motivations mediating this relationship, and green work climate perceptions moderating the effect (Tian, Zhang, & Li, 2020).

Proposition 4: pro-environmental attitude impacts employee green behavior

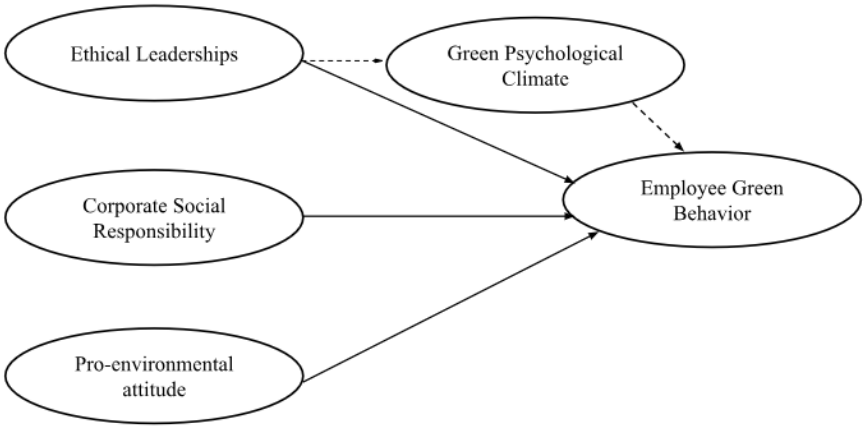

Figure 1. Visual Model

3. METHOD

This study's approach is deductive reasoning and is categorized as quantitative research. It uses dummy-coded variables and regression coefficients to measure and analyze research variables.

4. RESULTS AND DISCUSSION

Utilizing Generative-AI, gemini.google.com, author entered prompt as follow “how to calculate if the math formula if independent variables are ethical leaderships, corporate social responsibility and pro-environmental attitude, and dependent variable is employee green behavior and mediating variable between ethical leaderships and employee green behavior is green psychological climate”, the results shows as follow.

Model 1: Direct Effects

- Employee Green Behavior (EGB) = $\alpha + \beta1 * \text{Ethical Leadership (EL)} + \beta2 * \text{Corporate Social Responsibility (CSR)} + \beta3 * \text{Pro-Environmental Attitude (PEA)} + \varepsilon$

Model 2: Mediating Effect of Green Psychological Climate (GPC)

- $GPC = \alpha + \gamma1 * EL + \gamma2 * CSR + \gamma3 * PEA + \varepsilon$
- $EGB = \alpha + \beta1 * EL + \beta2 * CSR + \beta3 * PEA + \beta4 * GPC + \varepsilon$

Where:

- α = intercept
- $\beta1, \beta2, \beta3, \beta4$ = regression coefficients representing the direct effects of the independent variables on the dependent variable
- $\gamma1, \gamma2, \gamma3$ = regression coefficients representing the effects of the independent variables on the mediating variable
- ε = error term

Through Generative-AI, the suggestion to determine the mediating effect of GPC is through calculation of the indirect effect: Indirect effect = $\beta1 * \gamma1$, and assess the significance of the indirect effect by using bootstrapping or Sobel test to assess the significance of the indirect effect.
This article presented four propositions, as follow: 1) proposition 1: ethical leadership impacts employee green behavior positively, 2) proposition 2: Ethical leaderships impact employee green behavior through green psychological climate, 3) proposition 3: corporate social responsibility impacts employee green behavior, and 4) proposition 4: pro-environmental attitude impacts employee green behavior. However according to the equation modelling, the relationships between variables potentially positive related. More data is needed to prove whether this proposed formula is correct or in contrary.

5. CONCLUSION

The conclusion that can be drawn from this article is that some proposals can be made bycompanies, namely prioritizing sustainability issues in various management contexts, especially through human resource management, encouraging the implementation of policies and practices that encourage employee engagement in sustainability initiatives activities, the importance of encouraging a culture that supports sustainability issues and linking sustainability issues to the company's strategic planning.

ACKNOWLEDGMENT

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Reactivation of the Gumuruh Village Community in Bandung City Based on Creativity Through the Exploration of Plastic Waste into Commercial Products

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Abstract: Plastic waste is a huge environmental problem in lots of countries, and improper handling of this garbage puts ecosystems at risk. Upcycling plastic may help save natural resources, cut down on carbon emissions, and lessen waste and the need for new manufacturing. Significant economic benefits are also derived from recycling, which produces high-quality commercial goods, especially in the furniture sector. In order to create sustainable goods, people in Bandung's Gumuruh Village aggressively recycle rubbish, including biological waste. In order to design goods that will be offered to the community, academics and local SMEs collaborate using the Design Thinking approach to Service Learning.

Keywords: template, instructions, conference, publications

1. INTRODUCTION

One of the most pressing environmental issues faced by every country is the problem of plastic and paper waste. Although plastic and paper have remarkable benefits in various applications due to their lightweight, durability, and cost-effectiveness, they have become a serious threat to our planet's ecosystems. Every year, large amounts of plastic and paper are produced, and most of it ends up as waste. Poorly managed plastic and paper waste not only pollutes land but also oceans, causing irreparable damage to marine ecosystems, forests, and the wildlife within them. Given

that plastic is difficult to decompose naturally, its accumulation in the environment has become one of the biggest challenges to sustainability.

Recycling plastic emerges as one of the most effective solutions to address this issue. The recycling process involves collecting, sorting, cleaning, shredding, and processing plastic waste into new reusable materials (Berliana et al., 2022; Maitlo et al., 2022). By recycling plastic and paper, we not only reduce the amount of waste polluting the environment but also decrease the need for new plastic and paper production, which requires significant natural resources and energy. This reduction contributes to lower carbon emissions and the preservation of limited natural resources.
Recycling these materials also has significant economic impacts. Through the recycling process, used plastic and paper can be transformed into various high-value commercial products, creating new business opportunities and jobs in the recycling and manufacturing industries(Roslinda et al., 2022). These products span various sectors, from building materials and clothing to household goods. One rapidly growing sector in the use of recycled plastic and paper is the furniture industry, where they serve as alternatives or replacements for other materials and functions(Kurniasari et al., 2019; Yosianita, 2022).

Furniture made from recycled plastic and paper offers various benefits, not only related to sustainability but also in terms of economic and functional aspects. The use of recycled plastic and paper in furniture manufacturing allows for durable, lightweight, and easy-to-clean products that meet the needs of modern consumers. Additionally, furniture made from recycled plastic and paper is often more economical compared to furniture made from conventional materials, making it an attractive choice for environmentally conscious and budget-oriented consumers. This approach has been implemented by one of the neighborhoods in Bandung City, Gumuruh Village.

Kelurahan Gumuruh, one of the ten neighborhoods in Batununggal District, Bandung City, covers approximately 95 hectares with 12 community groups and 88 neighborhood groups, and has a population of around 18,538 people. This neighborhood demonstrates environmental awareness, with many residents actively involved in gardening and some running waste recycling businesses. Additionally, the neighborhood is active in recycling organic waste such as leaves, fruit peels, and branches into organic fertilizers.

Inspired by the activities carried out in Gumuruh Village, we are motivated to design a recycling method, particularly for inorganic waste such as paper and plastic. This is driven by the presence of two government offices in this neighborhood, namely the Gumuruh Neighborhood Office and the Batununggal District Office, which are expected to generate a significant amount of paper and plastic waste.

2. LITERATURE STUDIES

Plastic Waste

There are hundreds of distinct variants among around 50 main kinds of plastics. In order to facilitate better categorization, the American Society of Plastics Industry created a standard labeling code to assist customers in identifying and sorting the primary categories of plastics. Polyethylene Terephthalate (PETE), High Density Polyethylene (HDPE), Low Density Polyethylene (LDPE), Vinyl/Polyvinyl Chloride (PVC), Polypropylene (PP), Polystyrene (PS), and OTHER (Other types of plastic products) are the seven categories into which plastic products are classified and divided. Resin Identification Codes are the name given to this labeling system (RIC)(Yani et al., 2020).

Service Learning

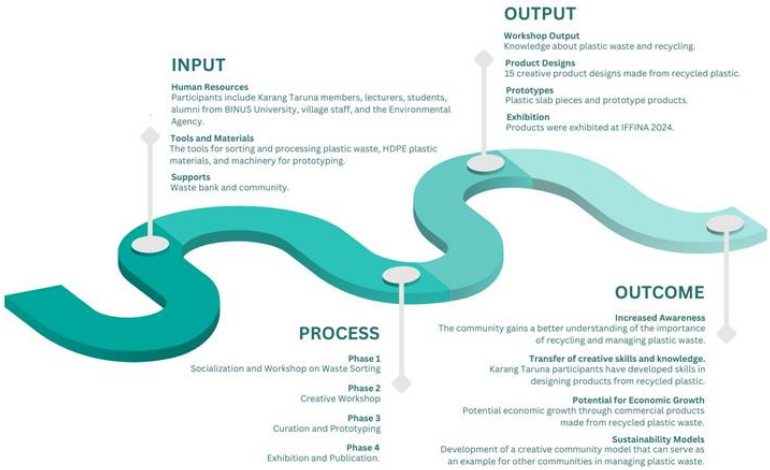
Service learning is an educational approach that bridges the gap between theoretical knowledge and practical application by addressing real-world issues within a community or organization. Service learning is a type of education that applies knowledge to actual issues within a community or organization (Darby et al., 2013). Service learning is education coupled with service that includes responsibility, character development, and intellectual learning (Lake & Jones, 2008). Howard (as cited in Bagerrly, 2006) highlights that service learning also incorporates volunteer activities into the curriculum, deepening students' understanding through active participation. Collectively, these perspectives underscore that service learning is a multifaceted educational method that emphasizes service to oneself, society, and the environment by applying theoretical concepts to practical, real-world scenarios.

3. METHODOLOGY

In this case study, design thinking is applied in conjunction with a service-learning methodology. Through service learning, BINUS academics collaborate directly with SMEs in Gumuruh Village to produce goods that will be sold to the public. Service Learning as applying knowledge to real-life situations within a community or group (Ani et al., 2022; Musa et al., 2017). This method combines useful applications that benefit society with theory(Darby et al., 2013). A teaching strategy known as "service learning" integrates theory with hands-on, community- and environment-serving activities. Additionally, in order to come up with creative solutions for the problem of plastic bottle waste, this exercise uses the five phases of Design Thinking: Emphatize (problem analysis and SME discovery), Define (field research and literature study), Ideate (design inspiration and development), Prototype (constructing chair prototypes), and Test (product testing).

4. DISCUSSIONS

The community service program in Kelurahan Gumuruh involves various inputs such as human resources, materials, and support from stakeholders like Karang Taruna participants, lecturers, students, and local agencies. The program is structured into four phases (as shown as picture 1): initial socialization and workshops on plastic waste education; a creative workshop focusing on design, color theory, and product development; prototyping recycled plastic into slabs and products; and finally, showcasing and testing products at IFFINA 2024. Outputs include enhanced knowledge on recycling, creative designs, prototypes, and exhibitions. The outcomes are increased public awareness, improved skills in recycling, potential economic benefits from commercial products, and the creation of a sustainable community model for managing plastic waste.



Picture 1. Process Diagram of Reactivation of The Gumuruh Village Community In Bandung City Based on Creativity Through The Exploration of Plastic Waste Into Commercial Products Activities (Source: Private Documentation, 2024).

Phase 1: Plastic Waste Socialization and Plastic Waste Sorting Workshop.

Begin with the results from Phase 1, which involved a seminar and workshop on plastic waste sorting held on June 22, 2024, at the Gumuruh Village Office in Bandung. The event was attended by 15-20 participants from Karang Taruna, a youth organization active in social and environmental activities. During the event, participants received educational material presented by the head of the community service team in collaboration with the Plastavfall community. The focus was on the negative impacts of waste on the environment and the significance of recycling, particularly plastic waste. Participants gained a comprehensive understanding of recyclable plastic types and how recycling can mitigate environmental harm.

Picture 2. Presentation of Material by a Partner from the Community (Plastavfall) on the Topic of Plastic Waste Categories (Source: Private Documentation, 2024).

In Phase 1, the material on waste types was presented by Rizqia from the Plastavfall community as shown in picture 2. Plastavfall is a waste management company that specializes in waste collection, processing, education, and consulting. One of the key components of Phase 1 was the seminar and workshop on waste management, which was crucial for understanding proper waste management practices from experts. As a result, the target audience, including the Karang Taruna participants and the Gumuruh community, gained a better understanding of waste management in the Gumuruh neighborhood.

The workshop aimed not only to raise environmental awareness but also to equip participants with practical skills applicable in daily life. It was hoped that with this new knowledge and skill set, participants would become change agents in their communities, promoting broader and more sustainable recycling practices. Additionally, the event sought to inspire participants to explore economic opportunities in plastic recycling, such as creating commercial products from the recycled plastic pellets.

Picture 3. The Plastic Waste Sorting Workshop (Source: Private Documentation, 2024).

The event also featured a practical session where participants engaged directly in sorting and shredding plastic to convert it into reusable plastic pellets. Under expert guidance, they learned the basics of plastic recycling, including sorting by type, shredding, and melting processes. The educational waste management workshop, held outside the Gumuruh village area, involved 14 participants from the local youth organization, Karang Taruna, who actively engaged in group activities. These included sorting various types of plastic waste, separating bottle caps, and categorizing them by color. The focus on sorting bottle caps was crucial, as they are made from HDPE plastic, an essential material for producing plastic slabs. The bottle caps were first shredded using the village's waste shredding machine. The waste shredding process is a crucial activity to assess the amount of collected waste and determine the quantity of shredded material that will later be melted into plastic slabs. Before reaching this stage, product design is carried out in Phase 2, which involves a creative workshop.

Picture 4. The Plastic Waste Shredding Process Workshop (Source: Private Documentation, 2024).

Phase 2: Creative Workshop Ideation Inspired by Plastic Slab Materials.

On July 21, 2024, a workshop began with a 15-minute presentation on color theory and entrepreneurship in design, delivered by lecturers and experts. The goal was to provide a foundational understanding of how color impacts design and how entrepreneurial principles can be applied to create innovative, marketable products. Following the presentation, participants from Karang Taruna Kelurahan Gumuruh explored various product types, including furniture, decorations, and fashion accessories, through creative brainstorming and initial sketching. They received

guidance from experts to refine their concepts, focusing on both functional and aesthetic aspects, as well as market potential. The workshop aimed to enhance participants' design skills while instilling an entrepreneurial mindset, helping them view their creations as both artistic works and viable commercial products.

Picture 5. Group Discussion for Ideation Process in Creative Workshop (Source: Private Documentation, 2024).

Phase 2 involves a creative workshop focused on designing product prototypes. Before the actual design process begins, participants are introduced to color theory, which helps guide the creation of plastic slabs that match the product designs. The workshop covers the significance of color perception and its application in commercial products, using color theory principles such as complementary, analogous, and triadic color schemes. The aim is to ensure that the colors used in the prototypes align with the desired product outcomes and their emotional impact, including warm, soft, cool, and bold colors. This approach is intended to enhance the final product's aesthetic appeal and usability.

Phase 3: Prototype Design Workshop for Finished Products.

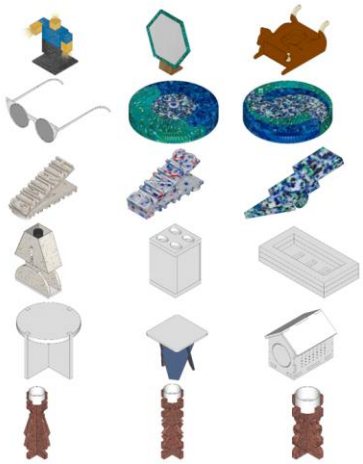
Picture 6. Plastic Slab Samples for Prototyping (Source: Private Documentation, 2024).

After the exploration and sketching phase of the creative workshop, the top 15 product designs were processed further. This involved sorting plastic waste by color to ensure uniformity and aesthetics in the final products. The sorted plastics were then shredded into small pieces and melted to a thickness of 5mm to 1cm, ensuring even distribution and no air bubbles. The melted plastic was cast into uniform slabs, which were then cut to match the initial design specifications. The slabs were assembled into various furniture and commercial products, paying close attention to detail and quality. The final products were tested for strength and quality before mass production, resulting in 15 innovative items ready for exhibition and commercial production. This structured process transformed previously worthless plastic waste into valuable, aesthetically pleasing products, creating new economic opportunities for the Karang Taruna Kelurahan Gumuruh participants.

Phase 4: Prototype Design Workshop for Finished Products.

After progressing through stages of material collection, creative design, and production, all curated products will be showcased at IFFINA 2024. This exhibition highlights the work of Karang Taruna Kelurahan Gumuruh participants, presenting plastic waste transformed into valuable items. The event provides a platform for publicizing these products and raising awareness about recycling and creativity in commercial design. Successful prototypes will be mass-produced with local artisans and manufacturers, ensuring high quality. Market testing through bazaars will offer consumer feedback and potential for new collaborations. Overall, this program demonstrates how creativity and innovation can convert environmental challenges into economic and ecological benefits, with the IFFINA 2024 exhibition marking a significant achievement.

5. RESULTS



Picture 7. 3D Modeling of Fifteen Curated Works from Ideation Workshops (Source: Private Documentation, 2024).

The potential research outcomes could reveal that frequent participant turnover in community programs hinders effective knowledge transfer, while identifying successful strategies like peer mentoring that mitigate these challenges. The study may demonstrate that sustainable product designs using recycled HDPE plastic are both durable and cost-effective, influencing broader adoption in product design. Additionally, it could show that community workshops significantly enhance environmental awareness and lead to long-term behavioral changes, while also highlighting gaps that need addressing. The research might further uncover the economic viability of upcycled products, especially in niche markets, and identify logistical challenges in material collection, offering solutions like improved collection systems or community incentives. Overall, these findings could advance understanding in community engagement, sustainable design, environmental education, and waste management, providing practical solutions to real-world challenges.

6. CONCLUSION

The community empowerment activities in Gumuruh Village achieved notable success in addressing local needs and challenges. The program effectively engaged the community through hands-on recycling workshops, enhancing participants' understanding of plastic waste management and its environmental benefits. By transforming plastic waste into reusable products, the initiative addressed pressing issues such as waste accumulation and provided practical solutions for sustainable living. The activities aligned well with the community's needs, such as improving waste management practices and creating economic opportunities through upcycling. The practical sessions not only educated participants on recycling processes but also involved them in meaningful, creative work that supports local environmental goals.

The impact of these activities has been significant, with increased awareness of recycling among the community and a demonstrated ability to convert waste into valuable products. This has not only improved waste management but also provided economic benefits through the potential commercialization of recycled products. For future community empowerment, it is recommended to continue expanding educational efforts, enhance collaboration with local stakeholders, and explore additional markets for the recycled products. Engaging more community members and diversifying recycling materials could further enhance the sustainability and economic impact of the initiative..

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Predicting Sustainable Supply Chain of Fruits Farming Agriculture Business

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Abstract: The production of superior, important, and prospective horticultural commodities in Bandung City during the 2015-2020 period shows a fluctuating pattern. This occurs not only in vegetable commodities but also in the fruit commodity group. The aim of this research is to analyze to the potential of superior agribusiness fruit commodities and to analyze the feasibility of developing superior agribusiness fruit commodities in Bandung City. The data used are primary and secondary data. The analytical tools used are the Location Quotient (production value) and the feasibility analysis of farming (Revenue Cost Ratio). The research results show that the leading agriculture commodities in most sub-districts in Bandung City are dragon fruit, watermelon, mango, papaya, banana, and melon. This research focuses on the fruit and vegetable processing process on a small scale. They discuss various processing techniques and products that can be produced from fruits and vegetables. However, our research differs because it focuses more on the business and marketing aspects of the fruit business.

Keywords: business, horticultural, fruits, commodities

1. INTRODUCTION

The agricultural sector is one of the sectors that supports the economy in Indonesia. This sector remains a mainstay as a driver of national development until now. Therefore, national economic development in the 21st century will still be broadly based on agriculture. However, in line with the stages of economic development, agricultural-based business activities are also increasing, namely agribusiness activities will become one of the leading activities in national economic development in various broad aspects. The further development of agriculture is aimed at the growth and development of agribusiness ventures from the family scale, medium scale, and large scale (Darmawan et al., 2021). One of the agricultural developments that can contribute to the economy is the development of horticultural commodities (Hernanto, 2007). The horticultural crop sub sector remains an important contributor to national economis development. Horticultural plants in Indonesia can be grouped into four, namely: vegetables, fruits, ornamental plants, and bio-pharmaceutical plants. Thus, fruits are one of the horticultural products that gave great potential to be developed in Indonesia. Fruit commodities have a diversity of types and have higher economic value compared to food crops. Because fruits not only have high economic value but are also location-specific, responsive to advanced technology, special products with great added value, and a continuously growing market, fruit crops are very suitable to be developed into agribusiness ventures.

Steady One of the fruit commodities that has good prospects in the future is dragon fruit. Dragon fruit is one of the commodities that has a good strategy for development in Indonesia. The development of dragon fruit agribusiness has bright prospects for export opportunities and its market is still wide open and has very good potential for the domestic market (Cahyono, 2009). Moreover, the development of dragon fruit plants is very good to be cultivated in tropical areas like Indonesia. Saragih (2002) emphasizes the importance of development with an agribusiness approach for several reasons: increasing competitiveness through comparative advantage, being the main regional economic sector that contributes to GDP formation and employment opportunities, and being a significant new source of growth. The agricultural sector, which is the main driver in the field of agribusiness in Bandung City, is the most important sector that can be improved to increase people's income. Soekartawi (1999) states that agribusiness is a set of business activities that includes one or all of the production, processing, and marketing chains related to agriculture in a broad sense. The fundamental and very interesting problem to be researched in this study is: What are the leading fruit and plantation commodities in Bandung City. What is the existing condition of the leading fruit and plantation commodity business in Bandung City. How is the allocation of production factors of fruit and plantation farming commodities in Bandung City.

2. LITERATURE REVIEW

The type of research used in this study is descriptive quantitative research. The variables in this study are the production volumes of fruits that are the leading sector in Bandung City. The data used in this research is secondary data with a time series from 2015 to 2020. Secondary data is data obtained from the Bandung City Government, the Central Statistics Agency (BPS) of West Java Province, and BPS Bandung City. The data used in this study are fruit production data from all sub-districts in Bandung City. The data collection methods in this research were conducted through literature study and documentation. The literature study was carried out by collecting information through in-depth literature related to the study object. The documentation technique was conducted by tracing and documenting data and information related to the study object. Data Mining is a term that is currently widely used to describe the process of mining or finding knowledge from a number of data that are owned. Data mining uses mathematics, artificial intelligence techniques, and statistics to identify and extract useful information and subsequent patterns or knowledge derived from large data sets. The pattern in question can be a business rule, correlation, trend, affinity, or prediction model.

EDM (Educational Data Mining) is a field of science that studies how educational data can be useful for improving the performance of educational institutions. EDM has the aim of finding and predicting hidden patterns that can support decisions from the management of an educational institution. EDM in the theoretical aspect is a combination of various fields of computing science, namely statistics, computer science, machine learning, and data mining. EDM focuses on the possibility for educational institutions to be able to analyze data using various tools and techniques to create useful insights for the activities of the educational institution. The data in question can be found in various systems, such as in administration systems, learning management systems, and others. This data also has several formats, namely structured, semi-structured, unstructured, and also binary. Modern systems that are currently developing can provide the possibility to connect to various different data sources using APIs (Application Programming Interfaces). Modern system provide many possibilities to connect to different data sources using application programming interfaces (APIs) or provide simple processes to export data in suitable formats (e.g. CSV). This data can be analyzed in various ways. CRISP-DM is an abbreviation for Cross-Industry Standard Process for Data Mining, which is one of the most frequently used models or frameworks in data mining. CRISP–DM consists of 6 steps starting from understanding the business and also the need for data mining, then ending with the deployment of solutions that can solve certain problems or business needs. The stages in CRISP–DM are stages that can be repeated because data mining relies on experimentation and experience. The following are the stages of CRISP – DM. The first phase is business understanding. This phase is the foundation of data mining because it is necessary to know first what the purpose of the study is. There are several steps that need to be taken in the business understanding phase, namely: Determining business goals, namely thoroughly understanding what the business/organization wants to solve, as well as determining the success criteria to be achieved. Assess the situation, namely determining data availability, resources, project requirements, and conducting cost-benefit analysis. Determining data mining goals, namely determining the goals or success criteria for the data mining being carried out, where these goals must be in line with the goals the business wants to achieve. Produce a project plan, namely selecting the technology and tools to be used, as well as determining a detailed plan for each phase of the project.

3. METHOD

The method used by the author in this research is to use a data mining classification model, namely the K-Means algorithm. The use of this method is proposed because it uses data that already has a target class. Through this method, research results will produce a fairly high level of accuracy with an easier process. The use of the K-Means method in this research will go through six stages, namely the business understanding, data understanding, data preparation, modeling, evaluation and deployment stages.

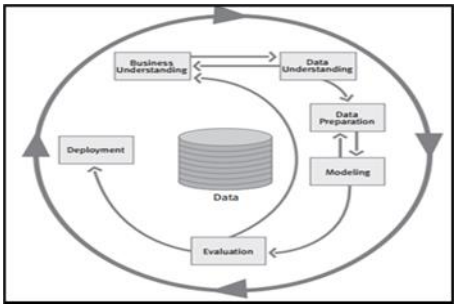

Fig 1. CRISP-DM Process

(Cross Industry Standard Process for Data Mining)

For Determining Business Goals, the party wants to increase sales of fruit so that it has good business prospects in the future. This phase aims to design a data mining model that can show patterns of fruit business prospects in the future. Assess the situation. A collection of fruit type data is available in the form of data sourced from kaggle.com. Determining data mining goals. The aim of conducting this research or data mining is to gain knowledge about the pattern of criteria that influence the prospects or future predictions of the fruit business. Carry out project planning. The research project was carried out within one week using several tools or supporting technology such as laptops, internet access, and RapidMiner software. For data understanding, there is collect data. In this data collection section, the author uses the Fruit Sales dataset in each country obtained from kaggle.com to become the object of analysis to determine the pattern of consumer buying interest in fruit.

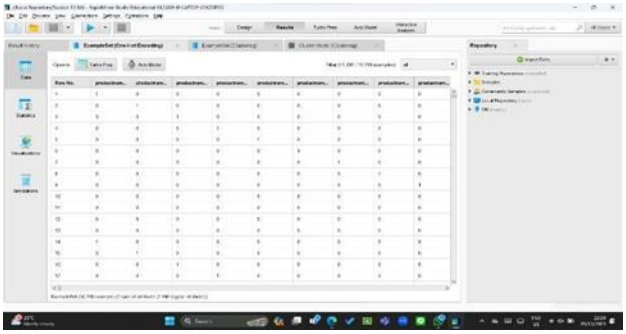

Fig 2. Dataset

After this, the next step is Data preparation. Select or data selection. The data chosen to be used is data on fruit sales and consumer buying interest over time. Clean Data. Based on the previously selected data, there are several unknown values or missing values. Therefore, this data needs to be cleaned first by eliminating it or replacing it with other data. The dataset is processed with the Filter Example operator found in the Rapidminer application to remove missing values in these two categories.

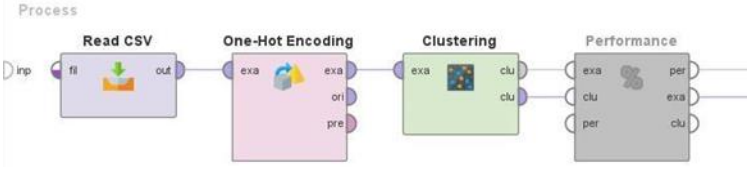

Fig 3. Operator Filter Example in Rapidminer

Through this data Operator Filter Example in Rapidminer. At this stage, is designated as a label, and acts as a marker in seeing the available attribute criteria.

	Attribute	Cluster_0	Cluster_1	Cluster_2	Cluster_3	Cluster_4	Cluster_5	Cluster_6	Cluste
2	productname = Strawberries	0.109547399234400666	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	productname = Romaine Lettuce	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
4	productname = Red Leaf Lettuce	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
5	productname = Potatoes	0.095811754109430481	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	productname = Oranges	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0
7	productname = Iceberg Lettuce	0.114163476694430819	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	productname = Green Leaf	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0

Fig 4. Cleaned Dataset

Through this data cleaning process, the research finally obtained the entire dataset. Build data. At this stage, a new attribute is created, namely Job Status, which is designated as a label, and acts as a marker in seeing the available attribute criteria.

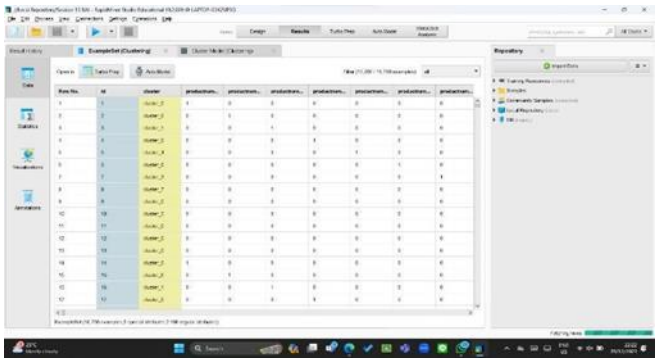

Fig 5. Role Attribute Format in Dataset

Next step is Modeling. Select a Modeling Technique. The data mining modeling technique in this research uses K-Means found in the RapidMiner application or software. Generating text designs. At this stage, the test planning is carried out (dividing the data into training, testing and validation sets). Building models. At this stage, the data mining algorithm is run using the RapidMiner application or software. Assesing models. The K-Means method is able to solve the problems and objectives of this research because it has reliable capabilities in processing data of both categorical, discrete, continuous types, and also in dealing with missing values and noise in the data.

Next step is Evaluation. The evaluation in this data mining study focuses more on the models or patterns produced by K-Means. The resulting model is then analyzed to determine its effectiveness and accuracy before the model is used to determine whether the model achieves the objectives previously set at the business understanding stage. At this stage, evaluation is carried out using the Cross Validation method (a method for validating the accuracy of models built based on certain datasets) using the operator in Rapidminer, namely Performance Classification. The data used to to build the model process is training data and testing data. Then the data used in validation is a dataset. Process review and determination of next steps. At this stage, , a decision is made whether the resulting model has met the objectives and can be continued, or whether it must be repeated, and a new project needs to be started.

Last step is Deployment. Planning implementation. After an evaluation is carried out to assess in detail the results of a model, the knowledge gained will then be presented in an easy-to-understand report. The prediction results from this data mining study are in the form of an analysis of the future prospects of the fruit business. Plan monitoring and maintenance. At this stage, a comprehensive monitoring and maintenance plan will be created to avoid problems during the operational phase. Final report conclusion. Documenting the final project regarding data mining will

analyze fruit business prospects. This final report is also a summary of the project and the experiences that have been carried out, after which we present the predicted results of this project. Conduct project reviews. Through the research that has been carried out, the results of research predictions can be used by Bina Nusantara University Bandung as consideration for making decisions in making learning process policies that are more effective and efficient to create business prospects or fruit businesses in the future. Apart from that, at this stage a retrospective is also carried out on the data mining projects that have been carried out. Namely what things went well, what could have been better, and how to improve in the future.

4. RESULTS AND DISCUSSION

The results showed that the dataset used is a fruit sales dataset using several attributes.

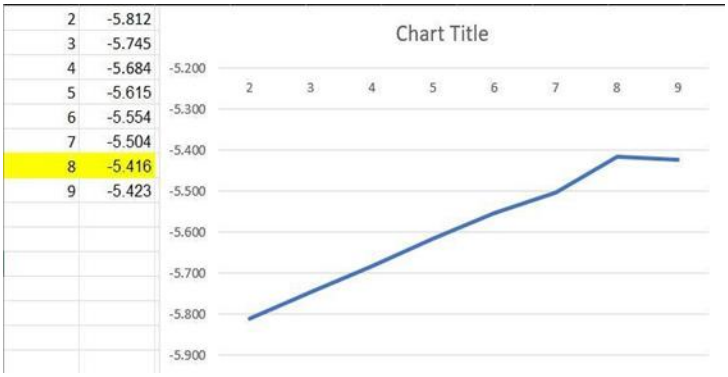

Fig 6. Data Graph

After knowing the average classification of each attribute that will be used, the dataset is then tested to see how the pattern of these attributes affects fruit business prospects or what kind of prospects will be generated with the average calssification. The series of processes are carried out through the Rapidminer application and use the K-Means algorithm method using the following operators: Read CSV. Reads a dataset that has been changed using CSV format to be run in the RapidMiner application. One-Hot Encoding. Converts a categorical variable into a number of new columns representing each category with binary values. For example, if you have a variable "color" with the categories "red," "blue," and "green," One Hot Encoding will create three new columns: "red," "blue," and "green." Each row of data will have the value 1 in the column corresponding to the corresponding category, and the value 0 in the other columns. Clustering. Dividing data into groups that have similar characteristics or patterns among them. Identify patterns or relationships. Performance (classification). See the accuracy of predictions with the model used with the classification method.

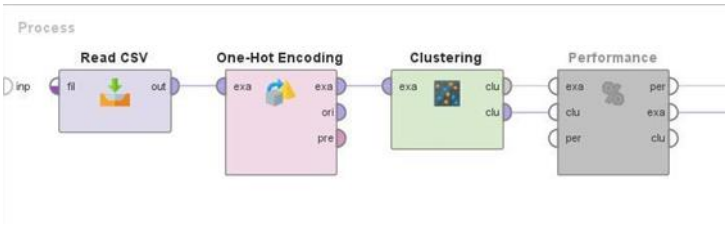

Fig 7. RapidMiner Process Series

In designing successful strategies to increase sales and marketing techniques, carefully collected data is a crucial element. In-depth research into the fruit market will provide a deeper understanding of consumer preferences, market trends, and other factors that influence purchasing decisions. By using this data effectively, companies can identify existing opportunities and challenges, which can lead to more appropriate solutions that have a positive impact.

Apart from that, an in-depth explanation of the research results is also very important. Careful analysis and deep understanding of research findings can provide valuable insights. By detailing the implications of research results, companies can formulate more targeted and effective action plans. This explanation can also help in communicating research findings to internal teams and external stakeholders, ensuring that all parties involved have a deep understanding of the strategy to be implemented.

Finally, integrating data and explaining research results into sales and marketing strategies is an important step. This can include developing marketing campaigns tailored to consumer preferences, optimizing supply chains to increase fruit availability, and adjusting prices based on market analysis. By making good use of information that has been collected and understood, companies can achieve better results in achieving their marketing and sales goals.

5. CONCLUSION

The conclusion that can be given from each explanation is the importance of conducting careful research. By researching carefully, a person can gain a deeper understanding of the topic or problem at hand. This can help in gathering relevant and accurate information, and provide a solid basis for decision making.

Apart from that, using the available tools is also an important step in solving a task or problem. Today's technology and software can be invaluable allies for increasing work efficiency and accuracy. By utilizing these tools, one can speed up work processes and overcome various challenges more effectively.

Finally, it is recommended to remain critical and selective in choosing research tools or methods. Not all tools or information may be relevant or reliable. Therefore, it is important to carry out a thorough evaluation of the resources used, so that the results obtained can be more reliable and make a meaningful contribution to solving the problems faced.

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Designing Lounge Furniture at the Rose of Sharon Church at West Jakarta with a Biomimicry Pod Concept

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Abstract: This proposal describes a visionary approach to improving the environment and functionality of the Rose of Sharon Church Lounge in West Jakarta through the innovative application of biomimetic principles. Inspired by the natural world, specifically the concept of pods found in various biological organisms, the project aims to revolutionize the interior design of the lounge. By harnessing biomimetics, the proposed furniture will not only provide ergonomic and aesthetic comfort but also promote sustainability and harmony with the church environment. This interdisciplinary effort will integrate biomimetic, design and engineering principles to create a unique and transformative space that promotes connection, relaxation and contemplation for the church community. Through this proposal, we seek to inspire a harmonious coexistence between the built environment and the natural world, while meeting the functional needs and spiritual aspirations of the Rose of Sharon Church congregation.

Keywords: Lounge, Furniture, Space, Pod, Biomimicry

1. INTRODUCTION

1.1 BACKGROUND

Rose of Sharon Church in West Jakarta, like many urban churches, faces the issue of limited and non-optimal space for social activities and gatherings after services. With a growing congregation, the need for a comfortable and welcoming area for congregants to interact and share becomes increasingly important. The cramped conditions often hinder community activities after services. Congregants often wish to mingle and discuss after services, but the lack of suitable and comfortable space can be a barrier. In this context, the design of a lounge with a biomimicry pod concept is expected to address this issue by creating a more functional and aesthetic space that optimizes the use of available space.

Additionally, the use of the biomimicry pod concept adds value to the interior design. Biomimicry, or the imitation of nature, offers inspiration from the structures and functions of living organisms to be applied in human design. In this case, biomimicry can be applied to create furniture structures and designs that efficiently use space while providing maximum comfort for users. This concept focuses not only on visual beauty but also on function and space efficiency, resulting in an environment that supports social interaction and community involvement in the church.

With this problem in mind, the design of lounge furniture is expected to provide innovative and practical solutions to enhance the congregants' experience of interacting and sharing within the church environment. Considering these aspects, the design outcome is expected to inspire the development of similar spaces in other churches facing similar challenges in maximizing available space for community benefit.

1.2 RESEARCH OBJECTIVES

The objective of this research is to respond to the lack of spatial identity at the Rose of Sharon Church in West Jakarta by designing lounge furniture that can optimize the space. Additionally, it aims to create a lounge that can be used by

all users and reflect the philosophical character of the Rose of Sharon Church. Furthermore, this lounge will be designed with a biomimicry pod concept to facilitate friendly activities within the church.

2. METHODOLOGY

2.1. Lounge Furniture

2.1.1. Lounge Furniture Configuration

A lounge chair is designed for extra comfort, ideal for those who sit or relax for long periods. Its ergonomic design includes a low backrest and a wider seating surface compared to conventional chairs, creating a relaxed atmosphere and maximum comfort for users. According to Ken Coleman in his book "The Proximity Principle," proximity is defined as the closeness or distance from an object or living being that affects how a person feels and acts. This principle explains how the human mind interprets visual information more effectively when things are close rather than far away. This principle also shows that in social psychology, people who are physically closer to each other are more likely to form relationships than those who are farther apart.

2.2. Biomimicry Method

2.2.1. Definition of Biomimicry

According to Maibritt Pedersen Zari in her book "Regenerative Urban Design and Ecosystem Biomimicry," biomimicry means imitating life. Janine Benyus in her book "Biomimicry—Innovation Inspired by Nature" describes biomimicry as a way designers take inspiration from nature to create effective solutions for human problems.

2.2.2. Open and Close Mechanism in Biomimicry

Examples of biomimicry with the Open and Close mechanism include:

- Bristlecone Pine Seeds: Open when it's hot and close when it's cold.
- Manila Clams: Open to eat and close to protect themselves.
- Venus Flytrap: Closes its mouth to capture and digest prey.
- Pitcher Plants (Sarracenia): Capture prey with trap-like leaves.
- Eudicot Flowering Plants: Hibiscus: Open at high temperatures and close at low temperatures to save energy.

2.3. Church of Sharon Rose (GMS)

2.3.1. About the Church of Sharon Rose (GMS)

The Church of Sharon Rose (GMS) is a church with a Pentecostal Charismatic Theology. It began as the "Febe" Prayer Fellowship in 1984 in Surabaya and was officially established as a church under the Bethel Church Indonesia synod in 1990. GMS’s vision is to be an "Apostolic and Prophetic Cell Church," with a mission to build 1,000 strong local churches and 1 million disciples of Christ.

2.3.2. Mission and Vision of the Church of Sharon Rose

GMS’s vision is to be an "Apostolic and Prophetic Cell Church." Their mission includes evangelism and discipleship according to the Great Commission of Jesus Christ (Matthew 28:18-20).

2.3.3. Brand Identity of the Church of Sharon Rose

According to Raditha Hapsari et al. (2020:146), brand identity creates a unique identity for a brand by reinforcing the brand's perspective in representing concepts of society, organization, symbols, and products. This involves understanding the core identity of the product and aligning it with the needs of each market segment. Brand identity is formed through brand element design. According to Kotler and Pfoertsch (2008) in Adelia Efendy (2020), brand elements are visual efforts that identify and differentiate a company's product or service through name, logo, color, slogan, values, vision and mission, and other elements that support brand character development.

3.1. Project Analysis

3.1.1. Design Project Scope

This project involves designing built-in furniture to accommodate a mini-lounge accessible to the public, either individually or in groups of two to three people. The primary purpose of the mini-lounge is for conversations, categorized into two types: casual and private. Casual conversations are informal and safe to be heard by anyone, while private conversations contain sensitive information not meant for outsiders. Therefore, furniture needs to be designed to cater to both types of conversations.

3.1.2. Design Area Layout

The existing data is from the Church of Sharon Rose branch in West Jakarta, located at Tribeca Building Lt. 1, Central Park Mall, Podomoro City, Grogol Petamburan, West Jakarta. The church has a capacity of 2,000 people with facilities including 1 main hall, 1 additional hall, 3 chapel rooms, 2 broadcasting control rooms, office space, 2 meeting rooms, 1 prayer room, 2 baptismal pools, 2 offering areas, and 2 storage rooms. The design area is situated between the main hall and the access door to the broadcasting control room and prayer room.

Area Documentation:

- Side A: Facing two double doors leading to the main hall. The doors use double-swing hinges for side access to the hall.
- Side B: Facing a blank wall.
- Side C: Facing a wall with a camouflage door for church staff access to the prayer room and broadcasting control room.
- Side D: Facing the offering area with 3 booths for congregation members.

3.1.3. Activities and Facilities

Activities conducted in the existing area include:

- Circulation between public and private zones.
- Giving offerings and tithes.
- Conversations among church members.

3.2. Design Studies

3.2.1. Human Aspects

Operational Study: Observations and analysis of activities conducted in the design area and the facilities used. The operational analysis is summarized in scenarios that design the user activity flow.

Ergonomic Study: An ergonomic assessment is conducted to determine the appropriate distance between users for face-to-face seating, accommodating up to 3 people.

3.2.2. Technical Aspects

The mechanism of Hibiscus flower petals opening and closing is applied in the mechanism for opening and closing the lounge pod. Structural studies are conducted by exploring various possibilities for opening and closing mechanisms.

3.2.3. Visual Aspects

Drawing boards are used to illustrate the aesthetic design.

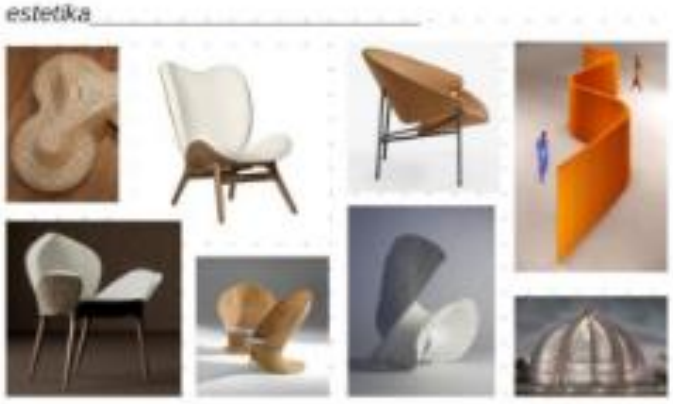


Figure 1. Aesthetic Study (Source: Personal document)

This structured approach ensures that all aspects of the project, from operational and ergonomic studies to structural and visual analysis, are thoroughly examined and addressed, leading to a comprehensive and functional design.

3. RESULT

3.1. Design Concept

Biomimicry of Hibiscus Flower

From the spatial analysis conducted, three main issues were identified:

1. Areas with good identity but not optimally utilized.
2. Accommodating additional activities, namely Loungepods for congregants to socialize.
3. Improving the offering box area for the church.

The solution to these issues is to use the biomimicry method of eudicot flowers implemented in furniture design. The room layout is designed using a petal pattern with walking areas for circulation, two mini lounge areas each with 3 chairs, and the offering area.

Lounge Mini:

- Designed as a pod that can transform using the blooming movement of flower petals.
- In open mode (blooming flower), the pod creates a relaxing space.
- In closed mode (closed flower), the pod provides a private space that dampens sound and visibility.

Offering Box Area:

- Designed as a semi-closed space mimicking eudicot flower petals.
- The elliptical shape allows privacy for users when making offerings.
- Facilities include offering envelopes, an EDC machine table, receipt disposal place, and offering box.

User Board

Displays user interaction activities with objects, illustrating how users interact with the lounge and offering area.

Technical Board

Displays the technical mechanisms used in the additional features of the lounge pod.

Mood Board

Displays the style and visuals to be achieved in the final interior.

3.2. Design Process

Determining Layout

Using scaled paper pieces to arrange the layout. From 25 arrangements, the selected one is:

Prototyping Mechanism

Using paper pieces to create chairs and pod mechanisms.

Sketching

Using tracing paper for furniture lounge pod and offering box design sketches.

Modeling

Creating 3D models using SketchUp version 2023 for visualizing the design in three dimensions.

3.3. Finalization of Design Results

Final Sketches

Final selected sketches to be developed:

Figure 2. In opened form (Source: Personal document)

Figure 3. In a closed form (Source: Personal document)

Application of Membrane Tension Mechanism

Using elastic materials such as nylon fabric for flower petals that can stretch, paired with an elastic frame.

Below are the appearances when the petals are open and when the petals are closed

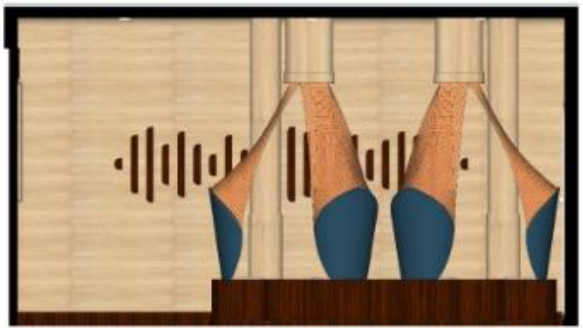


Figure 4. Appearance when open (Source: Personal document)

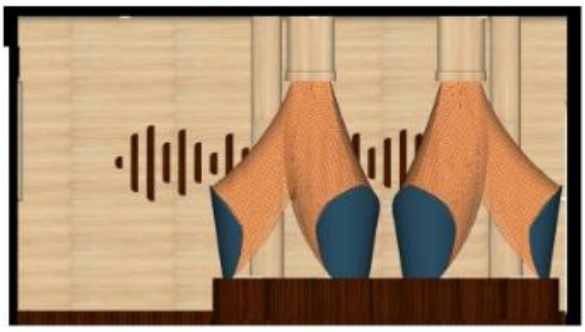


Figure 5. View when closed (Source: Personal Document)

3D Model Development

Perspective views of objects within the case study interior:

The following are perspective views of objects within the case study interior.:

Figure 6. Pod appearance when closed (left) and pod appearance when open (right) *(Source: Personal Document)*

Figure 7. Offering Booth Design (Source: Personal Document

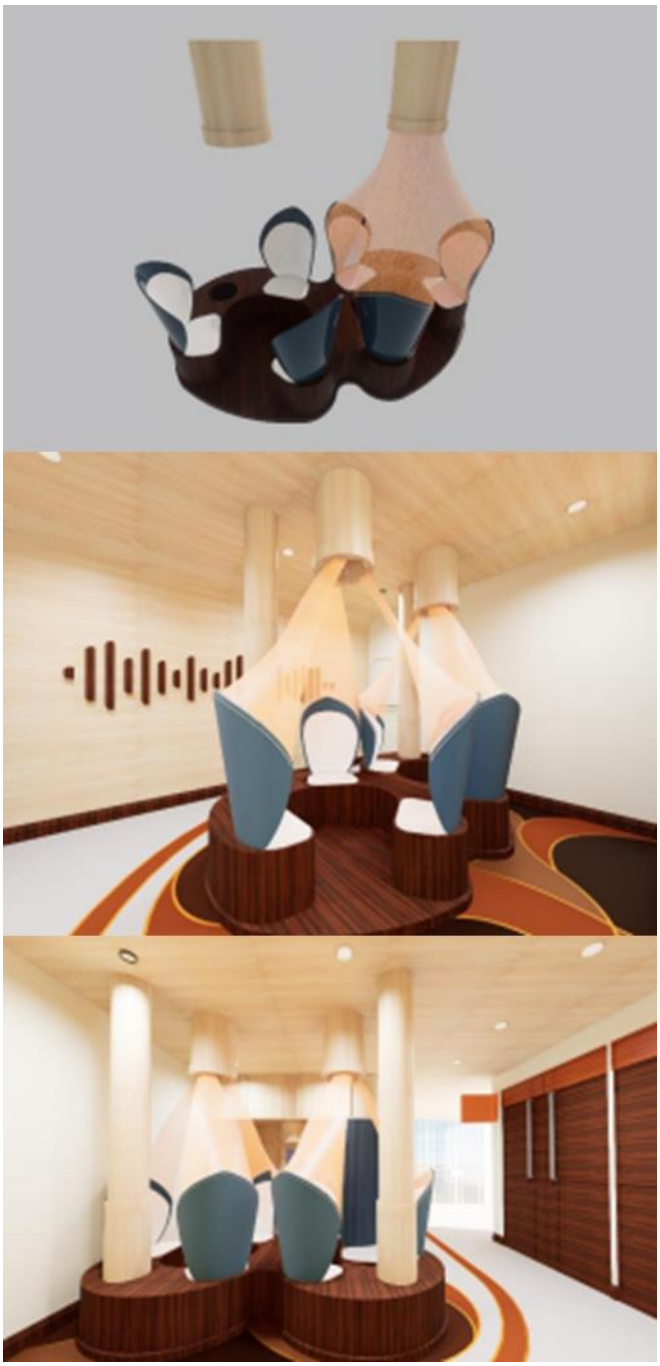
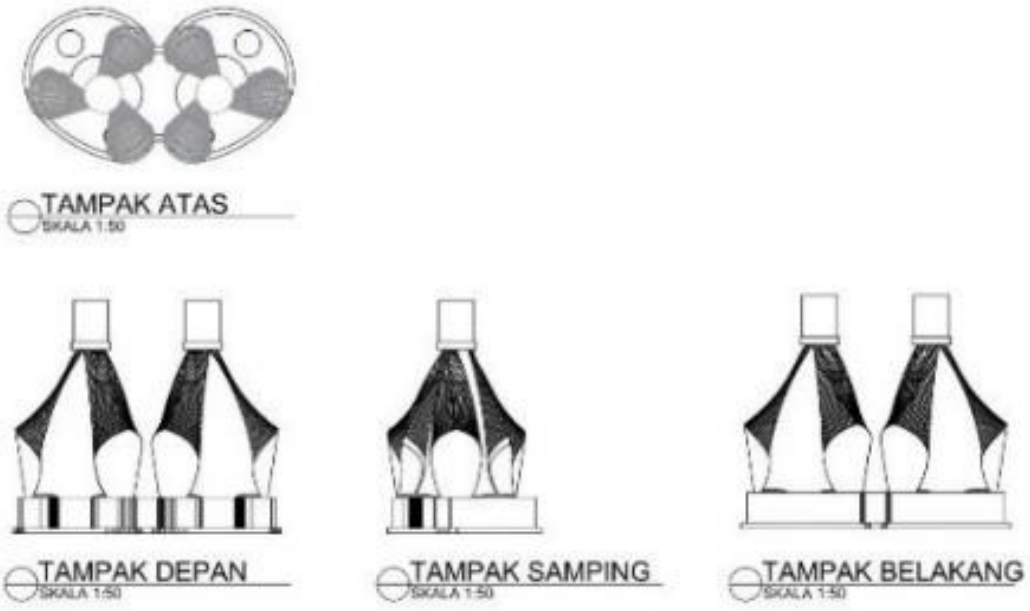
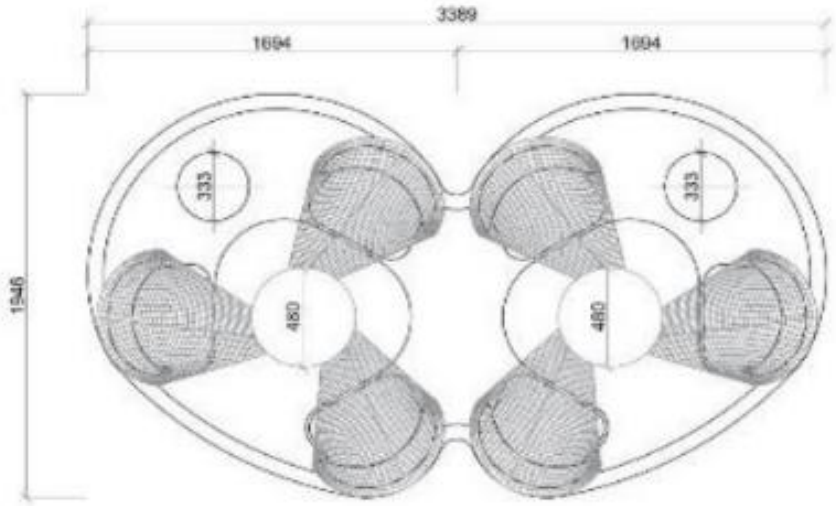


Figure 8. Pod Lounge Appearance (Source: Personal Document)

Detailed Engineering Drawing

Axonometric Drawing





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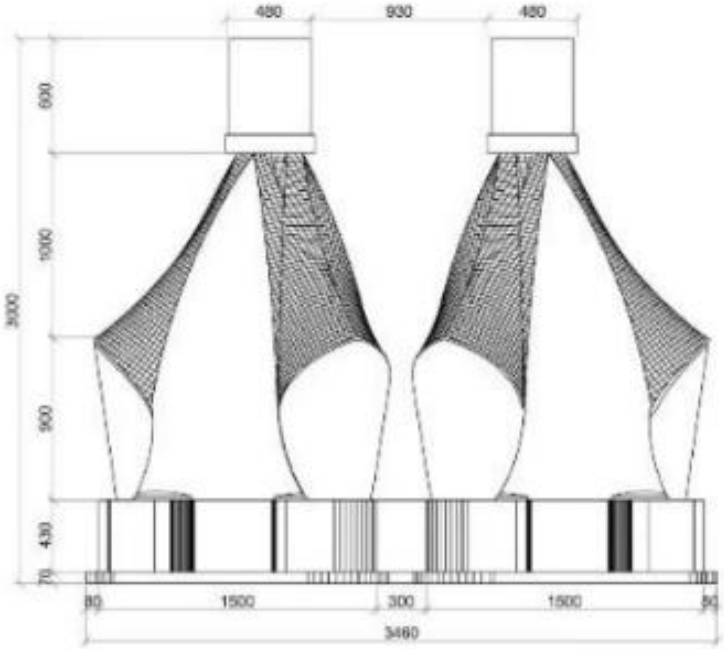

TAMPAK DEPAN
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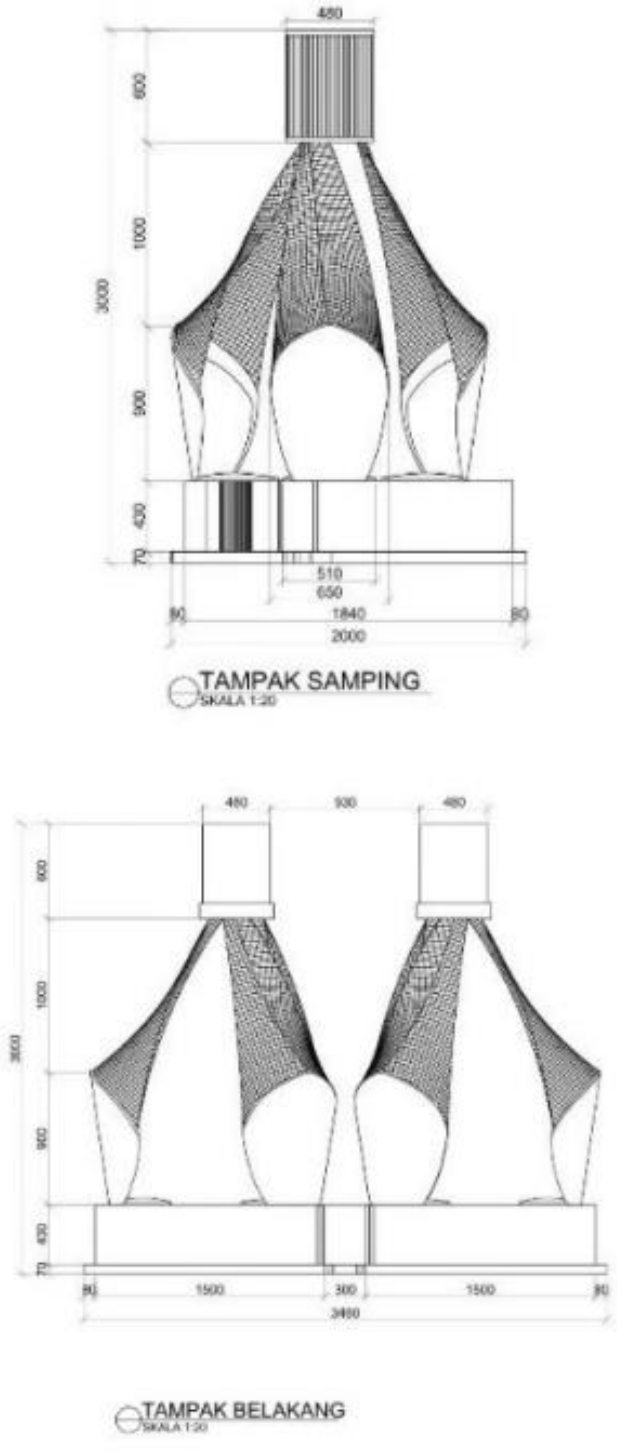

Figure 9. Working Drawing (Source: Personal Document)

The comprehensive approach taken in this project, from initial analysis and conceptualization to detailed design and final modeling, ensures a functional and aesthetic solution that effectively addresses the identified issues.

4. CONCLUSION

The Pod Lounge furniture design is intended to create better circulation direction and optimize the design space from previously only being used for offering activities and as a thoroughfare to the second floor. This Pod Lounge is designed to support the activities of church congregants who often use the design area as a place to chat or converse before and after services. The hope is that when casual and public conversations are conducted in the Pod Lounge, they can continue in a safe area when the Pod Lounge is activated to close.

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ABOUT WRITER

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Determining the Cost of Product Storage Services in a Refrigerated Warehouse Using Time-Driven Activity-Based Costing

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Abstract: Determination of the cost of goods sold in the services industry is an important part of a service company's business activities. Establishing the cost of goods sold at v Dingin Indonesia (Gudings) as a new company in the cold chain sector requires a long-term plan so that the business continues to grow. The current tariff setting has not been formed following service specifications therefore, this research was conducted to provide a cost suggestion for storage services by implementing a time-driven activity-based costing (TDABC) method based on the activities and resources used by calculating the time taken by the company to produce services and determining the cost of goods based on cubication. The results of calculations using the TDABC method for the two types of storage services offered by Gudings, namely Storage and Fulfillment services, yield the cost of services for Storage services with the formula (55.624x/CBM + 10.624xy/CBM per day) for products stored in the freezer and (55.624x/CBM + 4.943xy/CBM per day) for products stores in cold storage. As for the Fulfillment services, the cost is based on the formula (112.815x/CBM + 16.994xy/CBM per day) for products stored in cold storage.

Keywords: cold chain, storage, fulfillment, time-driven activity-based costing, and cost of goods sold

1. INTRODUCTION

Food loss and waste (FLW) was examined from the standpoint of logistics service providers (LSPs) in a study that offered sustainable solutions with case studies of Chinese market (Yan et al., 2021). They studied the 2008–2021 literature on cold chain logistics and FLW. They identified four categories of potential reasons for FLW: (i) inadequate management; (ii) improper operating procedures; (iii) high expense; and (iv) restrictions. The findings show that the two most significant risks for FLW in LSP are facility expenses and technological inefficiency, with the absence of rules and regulations ranking second. Therefore, they advised handling these risks using sustainable solutions in social, economic, and ecological aspects. Another study revealed several ways to reduce pollution in warehouse inluding practicing green initiatives for its management and operations (Oloruntobi et al., 2023) as also recommended by (Tseng et al., 2019). A study (Kokubu et al., 2023) explained material flow cost accounting's (MFCA) potential contribution to the SDGs accomplishment equipped with guidance provision on how to implement it in a business. Some targeted SDGs were acknowledged such as those related to waste generation (SDG 12.2), food loss (SDG 12.4), energy (SDG 7), and many others. One recommendation would be to comprehend extended MFCA under the system boundaries of carbon foodprints of product (CFP) covering scope of material flow from the stage of raw material acquistion, production, distributio, to product disposal. In addition, managers may make more accurate decisions by using the cost information on products and material losses that MFCA can provide. Cost-management strategies like MFCA, Activity-based Costing (ABC) or other methods can enhance decision-making (Hansen et al., 1997; Susilowati, 2023) then improve supply chain management by cutting waste, streamlining processes, and increasing productivity.

A refrigerated warehouse or commonly referred to as cold storage is a facility that handles perishable food materials at a certain cold temperature to maintain freshness and quality, and extend their shelf life (Krishnakumar, 2002).

Products that can be stored in a refrigerated warehouse consist of fruits, vegetables, processed meat, and other perishable food products. The storage procedure in the warehouse aims to always meet consumer demand appropriately (uncertainty demand) so that the company can respond to customer demand appropriately (Richards, 2017). Therefore, the warehouse is also useful for storing safety stock (buffer stock) to prevent inventory shortages when product demand conditions are uncertain (Haming, 2022).

According to data from the Indonesian Cold Chain Association (ARPI) which oversees the movement of the cold chain industry, starting in 2020 the implementation of the cold chain which is usually used by restaurant businesses, hotels, and tourist attractions has now shifted to small and medium-sized fresh-marts that provide frozen food products (Yasni, 2021). Based on ARPI's Indonesian cold storage growth data, the Indonesian cold chain industry will grow 25% in 2022, resulting in many competitors offering cold storage services, so companies must be able to improve their performance both in terms of service and increasing the number of customers.

According to the results of the Paxel Buy & Send Insight survey released in 2021, as many as 83% of sellers rely on social media as a place to (Paxel, 2021), MSME activists who market their products using online services and social media have grown significantly. Today, the cold chain business has also developed digitally, customer service now uses online-based services. This involves third party logistics (3PL) which acts as a storage provider on a small to medium scale. The role of 3PL in the cold chain business is a hub which is a temporary transit place to receive products that will later be sent back to another location. Hubs are needed to achieve cheaper logistics shipping costs and can reach wider points. Based on ARPI data, as of 2020 in the Jabodetabek area, 3PLs serving the cold chain business contributed 38% to the national GDP and the construction of new installations of 3.2% of the total national capacity (Yasni, 2021).

Table 1. Projection of Potential Demand for Cold Storage in Indonesia 2019-2024

Year	Cold Storage Demand Projection (Ton)	Unserved Potential (Tons & Percentage)	
2019	462,750	92,550	20%
2020	548,359	85,609	16%
2021	631,161	82,802	13%
2022	692,384	61,223	9%
2023	765,084	72,700	10%
2024	824,760	59,676	7%

As can be seen in Table 1.1, in the period from 2019 to 2024, there is a possibility of increasing demand for cold chain services by around 10% to 20% each year. In reality, in 2019 to 2020, the cold storage industry only met 34% of demand, although at the end of 2020, cold chain activity decreased by around 50,000 tons or around 58% of total demand due to the pandemic (Nurcaya, 2020), while in 2021, the cold storage industry actually needed more space than the demand projection in Table 1.1 so that according to (Puspa, 2022), it is necessary to add 105,000 tons of cold storage capacity from the previous year's available capacity of 1,875 metric tons. This is influenced by the increasing demand for frozen food, the development of retail and restaurant sector networks spread across various locations. Therefore, to maintain the demand for cold chain services, good and reliable product handling is needed in the storage process, timely delivery to customers so that product quality is maintained, especially for perishable food products (frozen food products). When refrigerated food products are damaged during the handling process, the possibility of the product not being usable becomes very high, resulting in a waste of resources. Product damage will also result in the product not being able to be traded and the product owner will experience losses because the quality of service to customers decreases. According to (Jerri, 2021) for logistics service providers (3PL), the calculation of warehouse storage costs is carried out to determine the storage service rates for customers. The determination of storage service rates from each cold storage service provider company will vary depending on the services they offer, although it may

not be significant, each company will bear different operational costs. In determining the cost price in a company, all aspects of the activities that occur greatly affect the policy in determining rates to customers, because all existing activities can incur costs. Determining the cost price is important for companies, by having an appropriate cost price, the strength of demand and supply in the market can be known and the costs involved in the process can be calculated accurately. In addition, by calculating the cost price, companies can determine the margin for rates that are in accordance with their target consumers so that the potential risk of loss can be avoided. The contribution of the cost of goods sold is 92% of the set rate, where 8% is influenced by other variables, namely demand and market competition (Dewi & Wirasedana, 2015). Gudings is a service company that provides refrigerated compartment rentals (cold storage) and deliveries that serve companies and MSMEs engaged in the frozen food industry (https://gudings.id/, 2020). Gudings stores various types of frozen food from various partners such as chicken carcasses, boneless chicken, otak-otak, dumplings, and others. The company has a policy that every order received must be received and handled properly to avoid product damage during storage until the product is finally sent out of the warehouse.

The fierce competition in the logistics business world today requires service providers to hone their accounting management system capabilities (Karmazin, 2014). In its storage services, currently Gudings at the Menteng Asri warehouse in Bogor, has 2 types of storage services, namely storage-only services and fulfillment services. Storage-only services are Gudings storage services where customers can store their products in Gudings storage facilities while fulfillment services are also storage services provided by Gudings where customers can store their goods and get additional services, namely packing (product packaging), stock-counting (counting the number of products that come out and remain in Gudings) and stock opname (adjusting the number of physical stock with the data). The following is a graph of the proportion of Gudings' gross income for 6 months for shipping and storage services in May 2022 - October 2022. It can be seen in the graph that in each month the largest proportion of gross income is obtained from storage services. Based on the results of this graph, the research was narrowed down to storage services because they are considered to have a greater influence on this company. In addition, based on observations made, it was found that Gudings' core business is storage services.

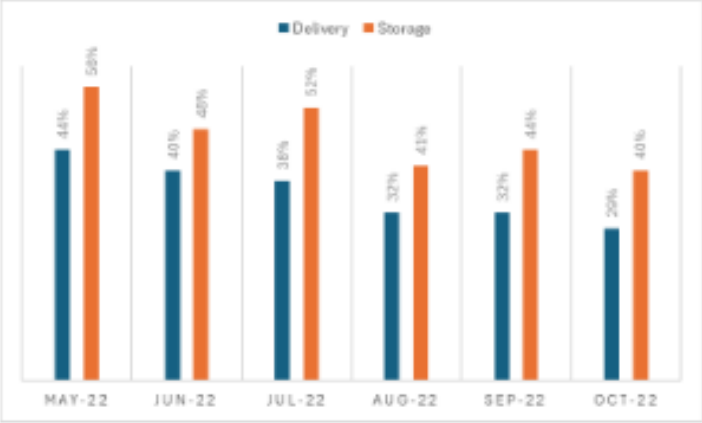

Figure 1. Gudings Income for May 2022

The company currently sets the cost of storage services by considering several things such as the amount of electricity used, worker wages, and equivalent competitor rates such as Fresh Factory. The current tariff determination is still set simply and conventionally through estimates only, not through quantitative calculations and determining cost factors randomly. In determining service costs, there are several cost components that should have an influence but are not considered, such as the time factor of the activities carried out based on the type of service chosen by the customer and the overhead cost in each service chosen by the customer (Cooper & Kaplan, 1988). Overhead costs are costs that are indirectly related to the process of making products or services (Tuovila, 2024) which in this study, overhead costs are found in every storage and packing activity carried out by Gudings. This cost is one of the things that needs to be

considered to determine the cost burden that must be borne by the company to be able to accurately determine rates to customers according to the services chosen to generate business profits and ensure the sustainability of the company. Overhead costs are costs that are indirectly related to the formation of services (Tuovila, 2024). Examples of overhead costs in storage activities are depreciation costs for refrigerated storage facilities and employee health insurance costs (CFI Team, n.d.). The difficulty in calculating overhead costs is because these costs are difficult to observe (unobservable) (Hakim, 2018) and it requires details regarding costs that are indirectly involved in service services so that good accounting bookkeeping is needed and minimizing expenses that are difficult to identify. Gudings as a new company in the cold chain sector needs a long-term plan so that its business continues to grow, but the simple tariff determination (traditional costing methods) carried out by Gudings currently does not always provide the information needed to make long-term decisions such as examples of complete historical sales data. The tariff determination currently given to customers does not yet reflect the actual costs incurred. This is related to the determination of the basic cost of service owned by Gudings has not been prepared according to the details of the services provided. It is important to know information about the amount of actual service costs and activity efficiency costs to reduce the total cost of the service process to generate optimal profit for the company. Considering the influence of cost calculations on service provision, profitability measurements are needed to determine the costs and rates of these services (Bokor & Markovits-Somogyi, 2015).

Gudings as one of the newly developing companies as a provider of refrigerated storage has a challenge to be able to compete in the cold chain industry. Gudings needs to think of ways to improve the quality of service but still be able to minimize costs incurred so that the company can still be trusted by customers. The determination of the cost price currently applied by Gudings is not in accordance with the existing theory, namely by benchmarking with its competitors, theoretically the determination of the cost price, especially in the service sector, involves overhead costs and the determination of the current cost price has never been reviewed by expertise. The lack of costs that should be considered can cause cost distortion so that the cost price owned is less than appropriate. Therefore, a proposal is needed to determine the cost price of services using the time-driven activity-based costing method that considers activities during the storage service business process and costs incurred during activities including overhead costs. To solve problems regarding costs and time spent by the company, it can be solved using the activity-based costing method. Activity-based costing is an accounting approach method by charging resource costs to objects. ABC can provide a clear understanding of how a company differentiates products, services, and activities that contribute to the long term. However, costing using the activity-based costing method has several weaknesses, including if resources work at full capacity without considering labor allowances during activities (Oktavia, 2015). So that the method is refined into time-driven activity-based costing.

The determination of the cost of goods sold with traditional costing is made simple, with costs determined based on the use of its resources (Satria, 2016) and is generally used for businesses with low product variations. With activity-based costing (ABC) and time-driven activity-based costing (TDABC), the price is determined on the activities carried out to produce services and the costs used, described in detail. However, the disadvantages of activity-based costing which are also found in traditional costing are that the determination of service costs is not flexible and there is also debated to respond to subjectivity in determining cost drivers (Hakim, 2018). Determination with traditional methods cannot reflect changes in situations, for example related to the elasticity of demand in business (Riediansyaf, 2014). Its rigid application to change makes this method take a long time to implement if there is a change in the business. So, it was refined into time-driven activity-based costing which added a time equation to answer the complexity of business activities (Kaplan & Anderson, 2007). In addition, in the ABC and TDABC methods there is a cost driver rate where the cost driver rate identifies the amount of resources consumed by business activities as a cost driver (Banton, 2023). The activity-based costing method considers the number of activities (activity cost driver) but does not consider the amount of activity time (time cost driver) as in the TDABC method. According to (Dejnega, 2011) the ABC method does not capture detailed activity specifications so that it affects the total cost while the TDABC method includes assigning costs to activities in detail but in some cases, time estimates are based on subjective assessments. In this study, a proposal will be made to determine the cost of Gudings' storage services more

systematically by considering the activities carried out and the overhead costs of each storage service variation, namely storage services only and fulfillment storage services using the time-driven activity-based costing (TDABC) method. The results of the proposed determination of the cost of services are expected to be a reference for Gudings in determining the rates for each of its storage services so that Gudings can determine the appropriate amount of profit and can also estimate the allocation for other costs such as research & development costs and owner salaries and evaluation of the current tariff prices compared to its competitors. This study will use the Time-driven activity-based costing method which is a development of the activity-based costing method approach developed by Kaplan & Anderson in calculating the cost of services or products that have higher accuracy in determining service costs (Cooper & Kaplan, 1988). The TDABC method is based on the time used by the company to carry out activities in producing services. The ABC method has two two-stage cost calculation systems, namely determining costs for activities and then the next stage charging them to services/products or customers (Tsai, 1998). While the TDABC method, cost determination is carried out by managers who will estimate the resources needed by each transaction. The concept of activity-based costing was developed to overcome problems regarding cost distortions that often arise with the traditional costing system (Cooper & Kaplan, 1988). The TDABC method is commonly used to calculate costs by allocating overhead costs which are considered as one of the cost components so that companies can determine appropriate prices for their cold storage service rates. So it can be formulated that the problem in this study is how to determine the basic price of storage services for perishable food products in a refrigerated warehouse, Gudings by considering the activities that make up its operational activities (activity pool), the time required (time equations) and other factors (labor, infrastructure) that affect the cost of storage services, using the Time-driven Activity-based Costing method.

2. LITERATURE REVIEW

Cold Storage

Cold storage according to Supply Chain Indonesia (Lestari, 2020) is a room that is specially designed using technology or a system used to store goods or products, especially those that have characteristics that are easily damaged with a cooling system. Generally, cold storage is used in the ice cream, fish, meat, fruit, vegetable and pharmaceutical industries. Cold storage is a storage room that is specially designed with a certain temperature with the main aim of maintaining the quality and freshness of the stored products and extending the storage life (Khan et al., 2022). According to (Bremer, 2018) products stored in cold storage are stored at a temperature range between -18 ° C (deep frozen) and up to 14 ° C. Today, customers demand the market by providing high quality, fresh, and healthy food ingredients, from which, cold chain is no longer an option but a necessity (Cerchione et al., 2018).

Cost of Services

Every company in producing products or services will carry out a process that incurs expenses in the form of expenses or costs. The accumulated results of these costs are called the cost price which is then used as a reference in determining the selling price set for customers. This is also the same as service companies, although the products produced are not in goods such as manufacturing companies or in the form of inventory sold in trading companies (Suharti, 2016). Service companies sell services in their business activities in exchange for products sold in manufacturing companies or trading companies. According to (Utami, 2023), the term HPP or COGS (Cost of Goods Sold) is not known in the financial statements of service companies. In service companies, the cost price is called the cost of revenue (COR) because service companies do not sell products in the form of tangible goods so there is no stock or inventory of goods. Cost of revenue according to (Utami, 2023) is the total cost arising from the service process for services provided to customers. Costs such as raw material costs, direct labor costs, shipping costs and sales or marketing commissions are components of the cost of services.

Components of Warehousing Service Cost of Goods Sold

According to (CFI Team, n.d.), the cost of goods sold is defined as the costs required to produce services or products. These costs include material costs, direct labor costs, storage costs, and direct overhead costs such as depreciation costs. The basic purpose of determining the cost of goods sold is to calculate the 'true cost' of a product or service in a period (CFI Team, n.d.).

According to (Lupiyoadi, 2014), something or an activity that is given by one party to another party is intangible and does not involve any transfer or ownership. For logistics service providers (3PL) that manage warehouses, it is necessary to determine the appropriate service tariff rate which has a calculation like the price rate of a product, but the difference is that there is no raw material price in services. Types of services and price components related to determining the cost of goods sold, namely:

a. Warehouse Storage Services. Storage services are the amount of costs charged to the warehouse. The amount of the costs charged is charged for warehousing service costs, in this case the use of resources. In general, activities in a warehouse start from the process of receiving goods (receiving), placing goods (put away) and sending goods (shipping) (Jerri, 2021). To carry out these warehousing activities, resources are needed such as warehouses, material handling equipment or supporting equipment for handling materials, equipment, human resources, and technology. The types of warehouse costs are distinguished based on the type of resources used in the warehouse according to (Richards, 2017), namely:
    1. Storage costs are costs incurred due to the use of space in the warehouse. The components of this storage cost consist of building rental costs or building depreciation, building taxes, maintenance costs, refrigeration equipment costs if the warehouse is refrigerated and others.
    2. Handling costs, costs originating from the process of handling products in the warehouse such as direct human resource costs (manpower), MHE costs and packaging costs are handling, costs originating from the process of handling products in the warehouse such as direct labor costs, MHE costs and packaging costs.
    3. Overhead costs, costs paid for supporting business process activities such as marketing costs, development costs.

    Meanwhile, according to (Utami, 2023), the components included in the cost of services or cost revenue in service companies are:
    1. Raw Material Costs. Service companies generally do not use this component as the main component in producing their services. Usually owned by companies that produce products.
    2. Direct Labor Costs (BTKL). This cost is the salary given to workers who are directly involved in the service process created.
    3. Shipping Costs. Costs incurred during shipping activities or transportation costs, one of which is the gasoline cost component.
    4. Marketing Costs. Cost components related to business marketing, such as advertising costs. Packing Services.
b. Packing activities are carried out as value-added activities that add value to services to customers. Especially for food products, good packaging techniques are needed so that the product is protected from external causes of damage such as oxygen, humidity, shocks during shipping and maintains product quality (Sucipta et al., 2017). In the packaging process, the costs involved include raw materials and human resources.

3. METHOD

Working Time Measurement and Determination of Standard Time

Frederick W. Taylor was the first developer in measuring working time with the stopwatch method. This method is a method that is suitable for work that takes place repeatedly (repetitive). According to (Wignjosoebroto, 2000), the output of the measurement activity is standard time. Standard Time is the standard time for all workers to complete a

work cycle. Characteristics in measuring working time with a stopwatch include (Astuti & Iftadi, 2016): the work activities carried out are homogeneous, the activity is carried out repeatedly (repetitive), the output is real so that it can be expressed quantitatively.

The steps when conducting a measurement with a stopwatch are as follows.

1. Measuring and recording the observation time of each activity element with a certain number of repetitions.
2. Conducting a data uniformity test which aims to determine the homogeneity of the data, data sources from the same population and extreme data are equalized in the calculation.
3. Data adequacy test is carried out. Data adequacy testing will greatly affect the level of accuracy and confidence. If the level of accuracy is 5% and the level of confidence is 95%, it means that the measurer provides an average limit for the measurement results that deviate by 5% from the actual average and the probability of success is 95%.

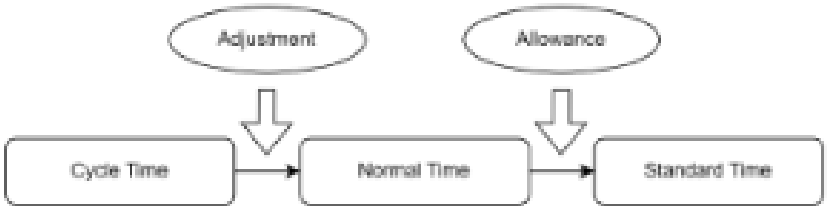

Figure 2. Standard Time Calculation Stages

According to (Wignjosoebroto, 2000), standard time is the time required for a worker where the worker being studied has the ability within the average limit to complete a job. Determining standard time is very useful in scheduling work where the duration of an activity is also stated how many workers are needed when completing the job. Standard time can be determined through two stages, namely: adding adjustments to cycle time to produce normal time and adding allowance to normal time to produce standard time (Figure 2).

4. RESULT AND DISCUSSION

Storage services are Gudings' services that have the largest income. Considering the research time, the object of observation is limited to storage services. Currently, Gudings offers two types of storage services, namely storage-only services and fulfillment storage services. In storage-only services, Gudings provides product storage services at Gudings storage facilities. While for fulfillment storage, Gudings provides storage services with additional activities as value-added services such as product packaging (packing), recording products leaving the storage area (stock-counting) and customer stock availability reports (stock opname). Since Gudings provides storage services to business actors, there are various types of perishable products handled by Gudings. The following are the products currently handled by Gudings: Chicken Carcass, Potato Wedges, Potato French Fries, Fried Cassava, Meatballs, Fish Roll, Dumplings Wonton, Okado, Ebi Furai, Chicken Spring Roll, Samosa, Shumai, Chicken Gyoza, and many more that stored at varied temperature between -25o to -18oC. The products handled by Gudings are perishable goods that have a short life cycle, are vulnerable to time and place, which means they require special handling to maintain the quality and freshness of each product stored using two main storage facilities of cold storage and freezer.

To support its business process in storage services, Gudings has 2 human resources consisting of Admin Staff and Warehouse Staff with a monthly cost incurred by Gudings of Rp 4,800,000. Gudings is a start-up service provider for small-scale industrial logistics services that is still developing, all operational activities are carried out simply, do not yet have clear business management, and its financial balance bookkeeping is not properly archived. This results in Gudings' inaccuracy in determining the amount of expenditure, confusion in seeing the profit and loss of services and determining the number of services that must be performed to generate profits. The determination of the rates currently given to customers does not reflect the total costs actually incurred. This is related to the determination of the cost of services owned by Gudings which has not been prepared in accordance with the details of the services provided. Based on these problems, the use of the time-driven activity based-costing method can provide a more detailed calculation of the cost of goods sold, so that it can help Gudings determine the amount of profit desired based on its cost.

Data Collection

The data requirements for determining the cost of storage services at Gudings consist of the storage service business process obtained through interviews with the owner of Gudings and conducting direct field observations, calculating standard time, workers and operational costs. Gudings operates from Monday to Saturday. Working hours at this company start at 08.00 to 18.00 GMT+7 with 1 hour break on Monday to Friday, while on Saturday working hours start at 08.00 to 12.00 without any break.

Business Process

The service process Gudings is carried out from Monday to Saturday and storage for 24 hours. In making an order for product storage, customers contact the Gudings admin via telephone call or send a message via WhatsApp media. Customers convey the type of product to be stored, product packaging, quantity and length of storage. The availability of warehouse space will be ensured by the admin staff and then its availability will be confirmed to the customer via the admin. The next process regarding the rates set for customers will be carried out by the Gudings owner in the rate negotiation activity followed by a rate agreement and cooperation agreement and payment. Orders that have been formed will be prepared in place while waiting for the product to arrive at Gudings. Products that have arrived will be unloaded in the inbound area by the sender while checking the conformity with the delivery note and PO. When the product sent is found to be not in accordance, the product is recorded as not in accordance and sent back to the customer. Furthermore, the product that has been in accordance is calculated in quantity and the condition of the product is checked. If the product is found to be damaged or defective, the product will be returned to the customer. Furthermore, the admin will issue a product receipt letter, responsibility for the product will be transferred to Gudings. The products are then classified into storage areas based on packaging form and weight. Products that come to Gudings can be in tally units, cartons or bags, making it easier to determine the appropriate storage area (cold storage or freezer). During the storage process, periodic monitoring of the storage area temperature is carried out to keep the area temperature cool and product checks are carried out during storage to ensure that the product does not fall and is safe.

The process of leaving the product from the warehouse begins when the customer sends a request to remove their product from the storage area, the request is received by the admin and then processed immediately. If the service is a storage-only service, the admin will process the request into a picking list order which will later be submitted to the warehouse staff. The warehouse staff will carry out the product picking process according to the picking list and give an okay mark on the product that has been taken. The products that have been taken will be checked for both SKU and quantity, if there is a discrepancy, the warehouse staff will return to pick up the appropriate product. When the product is in accordance with the picking list, the product is ready to be picked up by the customer. The customer can pick up the product by a party that has been verified or previously informed. When the product's outbound request is a fulfillment service, the warehouse staff will carry out the same picking process as the storage service and then continue with the product packing process. After the product has left the warehouse, the admin will record the type of product, day, date and number of products that have come out (stock-counting). In the fulfillment service, the products that are stored will be stock taken as a report on the availability of customer stock. After knowing the flow of product storage services from the ordering process to the product leaving the warehouse, the next step is to create a resource matrix. In the resource matrix, you can see the series of activities carried out by each party and their responsibilities.

Cost Identification

The fixed assets owned by Gudings support the operational business process of storage services in its company. Each asset owned has an economic life which means that during a certain period it is expected to contribute to the company. The economic life of each asset owned is based on the Decree of the Minister of Finance of the Republic of Indonesia No. 295 / KM.6 / 2019. It is hoped that these assets will be able to support the services provided to generate maximum income.

The total cost is the total cost used for the storage activity process at Gudings outside of fixed assets. There are two cost components involved, namely direct cost components and indirect costs. For direct costs, the cost components consist of labor costs (admin, warehouse staff, allowance, operational manager) and consumable costs, then for indirect costs consist of investment costs (freezer, cold storage, laptop, printer, hand pallet trolley, scales) which experience depreciation from facilities and other costs (internet, office electricity, freezer electricity, cold storage electricity, office supplies, cleaning, wareohuse maintenance, Zahir software, website). The proportion of costs is divided into activities carried out by each service. This is because resources and facilities are used simultaneously.

The division is done by dividing the number of activities in one service by the total number of activities. The storage service only has a 38% proportion of the total cost, and the fulfillment storage service has a proportion of 62% of the total cost. We estimate the costs incurred by Gudings in one year to carry out the storage service only and the fulfillment storage service respectively in which for the second, we also consider packing raw material cost under direct material of direct cost type.

Activity Pool

Activity pool is a step in mapping activities based on a company's business activities. The output of the activity pool is as input (input result) for the classification of standard time calculations. The creation of the activity pool is based on the business process unit currently run by Gudings, namely storage services. Activity grouping is determined based on the main activities in the warehouse according to (Richards, 2017) which consist of receiving, putting away, storage, picking, packing, stock-counting, and stock opname. Activities in Gudings start from order creating activities, namely recording incoming orders, checking the availability of storage areas, negotiating rates, to recording incoming payments. In the receiving activity group, the activity begins when there has been cooperation between Gudings and the customer. The activity begins with printing out the purchase order letter from the customer, preparing the storage area, checking the product until signing the delivery note. In the put away activity group is the activity of placing products into the storage area. There are two activities, namely checking the products to be put away and the put away activity itself. Furthermore, the products that have been put away at the storage location will be checked and their temperatures monitored to maintain the quality of the stored products. Both activities are storage category groups. Next is the picking activity which is the activity of taking products according to the storage area. If the request from the customer to remove the product has been received by Gudings, then recording and confirmation of the product to be removed, picking the product from the storage area, until confirmation of picking complete as a group of picking activities.

For customer products with fulfillment services, there are additional services, namely packing, stock-counting, and stock opname activities. So that the series of fulfillment storage service activities consist of order creating, receiving, putting away, storage, picking, packing, stock-counting and stock opname activities. In the packing activity, there is the activity of packaging the product to be taken, attaching the product description, and confirming readiness when the product is ready to be picked up which is categorized as the packing activity category. Next, there is the activity of recording outgoing product stock and updating product stock as a group of stock-counting activities. Then, the activity of calculating the number of physical stock products in Gudings and adjusting it with digital data becomes a stock opname activity group. The results of the stock-opname activity will be given as a report on the availability of goods to the owner of the goods (customer).

Standard Time

After observing this activity, a data uniformity test was conducted statistically using Microsoft Excel. The data uniformity test is conducted and produces data output based on observations that are said to be uniform if the observed data values obtained are not outside the upper and lower limit control. The next step is the data adequacy testing statistically then determine whether the observation data that has been taken is sufficient to represent the population. In this study, a 90% confidence level (k = 2) and a 10% accuracy level (s = 0.1) were used. The calculation of the standard time and normal time of a job needs to consider the allowance and performance rating. Based on the time data that has been taken using the time study method for 0.1 CBM of the product, we can calculate the standard time using a 10% allowance for each activity pool.

Economic Resources Identification

Identification of resources in this study is needed to determine the resources available at Gudings in carrying out all activities in the storage service every day. Resources at Gudings consist of labor, infrastructure, office equipment and supplies, technology, and others to support activities. To calculate the cost (unit cost) is done by first calculating the total capacity cost or the cost incurred to finance the capacity at PT Gudang Dingin Indonesia for one year. In this study, resources are identified into 2 groups, namely labor resources that are directly related to labor and storage facility resources. The two resource groups will be divided into direct costs and indirect costs. Direct costs consist of direct labor wages, and consumable costs. Indirect costs that are calculated are overhead costs in the form of internet usage costs, electricity, office supplies, warehouse maintenance, Zahir software (accounting recording application) and cleaning costs. The cost components of the labor resources group consist of labor, technology and information,

and tools while the cost components of the storage facility resource group consist of electricity costs for freezers and cold storage and their depreciation costs.

Practical Capacity

Practical capacity is the actual amount of time available for workers to run business processes by considering productive and non-productive conditions. The process of calculating practical capacity produces the total time available (available time) in the company to run its business processes which is then used for the capacity cost rate input. The calculation of practical capacity for Gudings is done by calculating the working hours applied by Gudings multiplied by the number of workers. Gudings applies nine hours of working time and for storage facilities it is calculated as 24 hours because it is a refrigerated storage facility. The calculation of practical capacity is done for both resource groups that have been determined by calculating the difference between working hours and holiday hours and then multiply it by the number of workers. For practical capacity of technology & information and equipment & tools, it is assumed that their use is linear with the effective working time of the workforce. Next is calculating the practical capacity of the storage facility. Because Gudings is a cold chain business, its storage facilities will always operate 24 hours a day throughout the year without being affected by holidays. So, the practical capacity for the storage facility was calculated for 24 hours.

Capacity Cost Rate

Capacity cost rate is the ratio of the total cost calculation of each resource to its practical capacity. The purpose of calculating the capacity cost rate is to find out the total cost incurred by the company in a unit of time. The capacity cost rate calculated by dividing the total cost by the practical capacity. Next, the capacity cost rate calculation is carried out for each service that is the subject of the research. The total cost incurred by Gudings for the labor resource group is IDR 86,046,154 with a total practical capacity of 17,094 hours/year therefore the capacity cost rate is IDR 5,034 per hour. Meanwhile, the total cost incurred by Gudings for the storage facility resource group is divided into two based on the type of facility, namely freezer and cold storage, so there are two capacity cost rates for storage facilities. From the calculation, the freezer capacity cost is IDR184 per hour, IDR 4,425 per day and the cold storage capacity cost rate is IDR 2,832 per hour, IDR 67,966 per day.

In the fulfillment service, the total cost incurred to run this business service for the labor resource group is IDR 138,933,846 with a total practical capacity of 17,094 hours/year, so the capacity cost rate for the labor resource group is IDR 8,128 per hour. Furthermore, the capacity cost rate for the freezer storage facility resource is IDR 295 per hour, IDR 7,081 per day and the capacity cost rate for cold storage in this service is IDR 4,531 per hour, IDR 108,746 per day.

Time Equation Model

The determination of the time equation model aims to determine the total time needed by Gudings to carry out storage service activities to its customers as can be seen in Table 2. The time equation model uses predetermined standard time as input for determining the model.

Table 2. Summary of Time Equation Model for Each Activity

Activity (hour)	Equation Model
Order Creating	$0.066X_1 + 0.064X_2$
Receiving	$0.069X_1 + 0.46X_2$
Put Away	$0.007X_2$
Storage	$0.32X_1 + 0.029X_2$
Picking	$0.025X_1 + 0.104X_2$
Packing	$0.17X_1 + 0.038X_2$
Stock-counting	$0.003X_2 + 0.03X_3$
Stock-opname	$0.059X_1 + 0.066X_2$

In which:

X_1 = number of order

X_2 = number of product

X_3 = number of product type

Calculation of Cost of Goods Sold Using Time-Driven Activity-Based Costing Method

The cost of service for fulfillment storage services depends on the number of products handled with additional activities such as packing, stock-counting and stock-opname. These activities will affect the total time of the overall activity. The details of cost calculation for every service as shown in Table 3.

Table 3. Gudings Storage Service Cost Formula

	Facility Type	Equation Model
Storage Service	Freezer	$46.353x + 8.851xy$
	Cold Storage	$46.353x + 4.119xy$
Fulfillment Service	Freezer	$102.346x + 14.162xy$
	Cold Storage	$102.346x + 6.591xy$

In which:

X = total of product volume (CBM)

Y = storage duration (day)

The determination of storage rates is based on the type of storage service, product volume (CBM), number of products, and storage time (days). So that the storage rate formula obtained using the time-driven activity-based costing method in Gudings is as follows in Table 4, assuming a margin of 20%.

Table 4. Gudings Storage Service Rate Formula

	Facility Type	Equation Model
Storage Service	Freezer	$55.624x + 10.621x$
	Cold Storage	$55.624x + 4.943xy$
Fulfillment Service	Freezer	$122.815x + 16.994xy$
	Cold Storage	$122.815x + 7.908xy$

Discussions

The proposed service cost using this method maps each work element that occurs during storage activities into an activity pool. The standard time is taken using the direct-stopwatch time study method which is carried out for 0.1 CBM based on the results of the Standard Time calculation and data uniformity checks. It is known that there is a tendency for fluctuation because the activity is carried out by human resources where many factors may occur so that consideration components need to be included in the standard time calculation. The estimated total cost required for storage services is only IDR 112,469,231 and fulfillment services are IDR 181,210,769 in one year. This total cost estimate has considered the amount of facility depreciation and manager salaries which in existing conditions have not been determined so that the total cost incurred by the company in units of time for each type of storage service is obtained.

The proposed service cost price obtained is then implemented against the rate with a margin of 20% to see the position of the proposed service cost price against the current Gudings rate. Currently, Gudings sets the storage rate given to customers based on the actual weight of the product itself. However, in the storage business, the determination of warehouse costs is determined based on the cubic volume of the product to be stored. For example, there is a product that will be stored weighing 500 kg for 30 days with certain product characteristics that will be stored in a freezer using a fulfillment service with 2 stock takes and 7 stock counts. The following Figure 3 shows a comparison of Gudings storage rates based on the actual weight of the product and the cubic volume of the product using the TDABC method and the current Gudings rates.

Figure 3. Storage Rate Comparison

The current Gudings rate is the highest rate when compared to the rate using the TDABC method, both calculated by actual weight and cubic. The current Gudings rate with the TDABC actual weight rate has the same calculation of storage rates based on the actual weight of the stored product. The final rate difference between the Gudings rate and the TDABC method is the number of activities used. The Gudings rate does not consider the number of activities carried out because of the number of products handled, although the basic rate per kilogram of Gudings is lower. While the rate based on cubic is calculated based on the dimensions of the product handled, not based on the actual weight of the product. Calculations based on cubic are considered more appropriate because in the case of warehouse storage, there is a correlation between the size of the warehouse and the dimensions of the product stored in the same area unit.

5. CONCLUSION

Storage services at Gudings are divided into 2 service variations, namely storage services only and fulfillment storage services. The cost of services is based on cubic or equal to cubic meters. With cost components consisting of labor costs and raw material costs for the packing process, where the components are direct costs, then indirect cost components at Gudings such as freezer/cold storage depreciation costs and electricity costs. So that the Gudings service cost formula is determined which consists of the sum of service costs and storage costs. The use of the time-driven activity-based costing method in calculating the cost of Gudings storage services can describe the activities during the storage business service process and detailed cost components. The cost of services offered using the TDABC method is expected to be a proposal and consideration for companies to determine their cost to minimize the potential for cost distortion and determine profit projections. Due to time constraints in the research process, further research is expected regarding the determination of tariffs for storage services using other methods as a comparison to obtain a better understanding of the business.

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Presenting Green Purchase Intention Model as a Breakthrough New Marketing Strategy

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Abstract: Companies are starting to realize the importance of sustainable environmental management and are trying to implement environmentally friendly business practices. Which has adopted various initiatives to become a more sustainable company. So, Green Purchase Intention is needed which supports sustainable purchasing practices as well as factors that can support Green Purchase Intention in an effort to improve marketing strategies. There are supporting factors including Long Term Orientation, Perceived Consumer Effectiveness, and Environmental Knowledge. This research aims to determine the influence of these factors on Green Purchase Intention. The population in this research are all consumers who have experience buying Starbucks Coffee products in DIY,using of 65 samples. Hypothesis testing in this research uses Structural Equation Modeling (SEM-PLS). Based on the results obtained from this research, it indicates that long term orientation and environmental knowledge has influence on green purchase intention, perceived consumer effectiveness has no influence on green purchase intention. Discovery of Green purchase intention model can serve as a guide for companies in developing more effective marketing to target consumers who care about the environment. This research contributes to the Company as a marketing strategy and is beneficial for researchers for the development of science.

Keywords: long term orientation; perceived consumer effectiveness; environmental knowledge; green purchase intention.

1. INTRODUCTION

In an era that is increasingly developing and aware of environmental issues, consumers are increasingly paying attention to the impact of the products and services they buy on the environment. Likewise, companies are starting to realize the importance of sustainable environmental management and are trying to implement environmentally friendly business practices to meet the needs of consumers who are increasingly concerned about the environment(Chairul et al., 2019).

One company known for its environmental commitment is Starbucks Coffee, a global coffee shop chain known for its efforts to reduce negative impacts on the environment. Starbucks coffee has adopted various initiatives to become a more sustainable company Starbucks Coffee has adopted various initiatives to become a more sustainable company. So, factors are needed that can support green purchase intention in an effort to improve marketing strategies (Rohmah et al., 2022).

Green Purchase Intention refers to consumers' tendency to buy environmentally friendly products or products that are produced in a sustainable way and do not damage the environment. This concept has become increasingly important in recent years as society's awareness of environmental issues and the impact of human activity on the planet increases. By better understanding consumer characteristics and behavior, companies can influence them to purchase environmentally friendly products. To be successful in good promotions related to environmentally friendly products, the determinants of consumers' environmentally friendly purchasing behavior need to be explored. Before green purchasing behavior is formed, there must be an intention to buy environmentally friendly products (Jamal et al., 2021).

In this context, it is important to understand the factors that influence consumers' intentions to purchase environmentally friendly products at Starbucks Coffee. Several factors that might influence consumers' intentions to buy environmentally friendly products are long-term orientation, perceived consumer effectiveness, and environmental knowledge. It is one of the dimensions of cultural orientation that is related to time - past, present and future (Chekima et al., 2015). (Zhuang et all., 2021) showed in their research that real utilization efficiency decides to influence green purchase intention. According to Putri et al. (2021), environmental knowledge is a person's fundamental understanding of what they can do to preserve the environment, which strengthens their behavioral commitment to environmentally friendly shopping. For certain purposes, such as teaching people how to behave in these situations, environmental knowledge is essential as environmentally friendly behavior.

2. LITERATURE REVIEW

Eco-friendly marketing or eco-marketing refers to ecological products such as healthy food, phosphate-free, recyclable, refillable ozone that are eco-friendly and environmentally friendly (Kushwaha & Kumar, 2014). According to Polonsky (1994), environmentally friendly marketing is aligned with all activities that design services and facilities to satisfy consumers' needs and desires without impacting their environment. According to the American Marketing Association (AMA), green marketing is the development and marketing of products designed to reduce negative physical impacts on the environment or to improve its quality American Marketing Association (AMA). Marketing Associate Editor). With increasing serious environmental problems, environmentally friendly consumption is receiving increasing attention by companies and consumers. Consumers are enthusiastic about purchasing environmentally friendly products due to environmental considerations (Chen et al., 2014). The increasing demand for environmentally friendly consumption encourages companies to develop environmentally friendly marketing strategies to show consumers a good corporate image and their social responsibility (Zhang et al., 2018).

Green Purchase Intention

According to (Zhang et al., 2018) "Green Purchase Intention (GPI)" is a condition that encourages consumers to actually buy goods and services. According to (Sandi et al., 2019), environmentally friendly purchasing intentions are consumers' desire to purchase environmentally friendly products whose motivation is related to ecological quality and the environmental impact of consumer purchasing behavior. According to (Kotler & Keller, 2009), the main reason for environmentally friendly marketing (green marketing) is influencing consumers to realize their environmentally friendly purchasing intentions. Before making a purchasing decision, customers must go through several steps, such as gathering information and participating in activities. This means that buyers ultimately show interest in purchasing. The intention to purchase environmentally friendly or environmentally friendly products is considered an

environmentally friendly purchase. Society is increasingly paying attention to climate, which has a direct impact on changes in lifestyle and individual quality. Understanding the importance of climate, many customers understand that their purchasing behavior influences the biological climate (Zhuang, et al. 2021). Environmentally Friendly Purchase Intention: It is known that consumer purchase intention is a subjective and broad area of consumer behavior and is a component of the decision-making process when making a purchase. (Jamal, et al. 2021).

Long Term Orientation

Bearden et al. (2006) stated that long-term orientation influences a person's level of ethical values which refers to the extent to which individuals consider accepted norms of right and wrong in their decisions. Therefore, it is hoped that all those who plan for future success will be less likely to engage in conventional purchasing behavior because if this behavior is known to have very negative long-term consequences because it will impact the damage to the surrounding environment. Customers who have a higher level of information regarding ecological issues will have a higher level of natural awareness which will then lead to a more favorable view of environmentally friendly goods (Aman et al., 2012). There is an assumption that a person's information and data about the climate will determine their profits in environmentally friendly products. Therefore, it is estimated that those who plan for future success will be less likely to engage in conventional purchasing behavior because such behavior if found to have very negative long-term consequences impacts environmental damage (Jamal et al., 2021).

Preceived Consumer Effectiveness

Perceived consumer effectiveness is the belief that every activity has an important role in maintaining the climate (Emekci, 2019). The buyer's perceived adequacy can be characterized as the client's assessment of their capacity to overcome and augment natural problems (Roberts, 1996). Buyer viability is a customer's belief that their efforts to preserve the climate can have an impact on the climate. (Antonius, 2018) found a positive impact between buyers' actual execution on purchasing expectations that do not harm the ecosystem.

Environmental Knowledge

Environmental knowledge is the capacity to influence customer attitudes towards environmentally friendly products. Ecological information is created in two structures: 1) Buyers must be taught to understand the effect of goods on the climate, and 2) buyer information about the actual goods, which are made using techniques that are not harmful to the ecosystem (Saputri and Rahman, 2021). Increasing concerns about environmental sustainability and climate change have led all companies to face the challenge of integrating environmental issues into business strategies and activities (Jamal et al., 2021). Research by Putri et al. (2021) found a positive effect of environmental knowledge on green purchasing intention and compliance.

Hypotheses Development

The influence of Long Term Orientation on Green Purchase Intention is analyzed based on the findings, it can be stated that cultural values play an important role in determining customer preferences for environmentally friendly products (Ansari et all., 2020). Long Term Orientation was found to have a significant effect on young consumers' attitudes buying environmentally friendly products, which in turn impacts Green Purchase Intention (Chowdhury et all., 2021). Based on the explanation above, the hypothesis used is: H1: Long Term Orientation (LTO) has a positive effect on Starbucks coffee's Green Purchase Intention (GPI).

In research (Antonius, 2018) it was found that Perceived Consumer Effectiveness has a positive influence on Green Purchase Intention. These results are in line with research (Gleim et al., 2013), namely that Perceived Consumer Effectiveness has a positive influence on Green Purchase Intention. Based on the explanation above, the hypotheses used are: H2: Perceived Consumer Effectiveness (PCE) has a positive effect on Starbucks coffee's Green Purchase Intention (GPI).

Environmental knowledge is a person's basic knowledge about what they can do to protect the environment, which supports their behavioral commitment to green shopping. In research conducted by Hariyanto et al., 2019, the results showed that the higher the customer's Environmental Knowledge, the better it supports the customer's Green Purchase Intention. Based on the explanation above, the hypothesis used is: H3: Environmental Knowledge (EK) has a positive effect on Green Purchase Intention (GPI) of Starbucks coffee.

Based on the obtained literature review, the factors influencing green purchase intention for environmentally friendly products at Starbucks Yogyakarta are examined. The variables used in this study are a combination of several studies conducted previously. These variables include Long Term Orientation, Perceived Consumer Effectiveness, and Environmental Knowledge. This is the conceptual model in Figure 1 below:

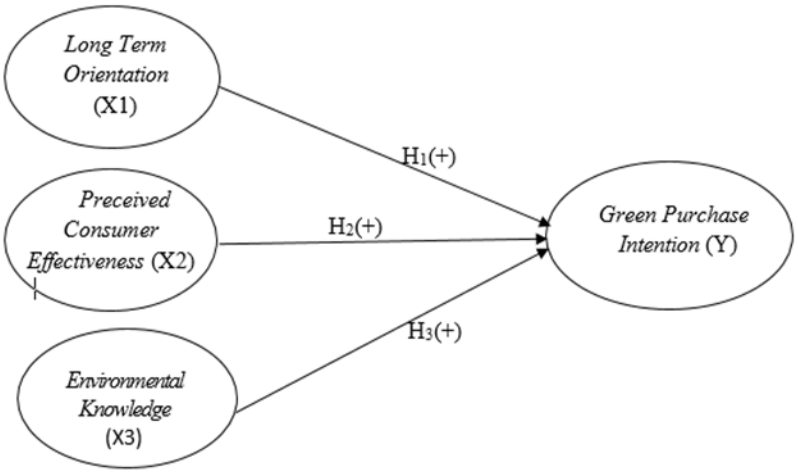

Figure 1. Conseptual Model

3. METHOD

Population, sample, and sampling method

The population of this study includes users of Starbucks Yogyakarta consumer products. In this case the sample was 65 respondents. Sugiyono (2016) defines the term "population" as "a general area consisting of subjects and objects that have certain qualities and characteristics determined by researchers to research and then draw conclusions. In this research, the population used is all consumers who have experience buying Starbucks Coffee products in DIY. The sample in this research is part of consumers at Starbucks Coffee. Determination of the sample size is calculated based on the formula (Hair et al., 2010). In this research, 65 samples or respondents were obtained.

Data Collection Method

The questionnaire method is used in this study. The source of survey questions via questionnaires was obtained from each indicator for each variable in this research. Questionnaires are used to collect data and various software programs such as Microsoft Office Excel and Word are used to manage the data. The researchers collect the data on site using an online questionnaire. The questionnaire is structured with answer options in the form of a Likert scale. This type of research data is quantitative. The Likert scale ranges from 1 to 5 (Sugiyono, 2016).

Data Analysis Method

Questionnaires were used to collect data for this research. To determine the level of legitimacy and reliability of polls, experts used the SmartPLS 3.0 program. Convergent validity is a validity testing method, where item scores

(component scores) are correlated with construct scores to produce factor loading values. If the component or indicator corresponds to the construct to be measured at more than 0.70, the Loading Factor value is considered high. However, for research in the early stages of improvement, an array variable of 0.5 to 0.6 is considered adequate (Jaw, 1998; Ghozali, 2008). The extent to which a result or measurement can be trusted and provides relative consistency in the measurement results after several measurements is known as reliability. To measure the level of quality of the unwavering exploration factor, alpha coefficient or Cronbach's alpha and composite dependence are used. Something that is estimated should depend if it has an alpha coefficient value of more than 0.6 (Malhotra, 1996). The reason for testing the main model is to see the relationship between the estimated buildings which is an incomplete t squared test itself. The underlying or internal model can be estimated by looking at the R-Square value of the model which shows how big the impact is between the factors in the model. Then the next stage is to assess the means coefficient which is the incentive assessed for the means relationship in the underlying model using a bootstrapping strategy with a value that is considered critical assuming the measured t valuation is more important than 1.96 (5% level of importance) or more important than 1.65 (10% level of importance) for the relationship in each direction.

4. RESULTS AND DISCUSSION

Structural Equation Model (SEM) with the Partial Least Square (PLS)

Measurement Model (Outer Model)

Measurement model evaluation is used to measure variables that reflect a construct. Empirical analysis is useful as a validity test and construct reliability test which shows the parameters of a latent variable based on theory and empirical studies. This research uses indicators through a reflective model by carrying out convergent validity, discriminant validity and composite reliability tests.

Validity Test

Convergent validity is a test used to determine the magnitude of the relationship between unemployment factors and the factors that build it. To measure the decision-making criteria in this test using loading factor values, all indicator variables in this study are included in reflective indicators. This marker should be valid assuming a stacking factor value > 0.7 (Hair et al., 2017).

Table 1. Convergent validity value

Konstruk	Kode Item	*Loading Factor*	Kesimpulan
Long Term Orientation	X1.1	0.738	Valid
	X1.2	0.877	Valid
	X1.3	0.783	Valid
Perceived Consumer Effectiveness	X2.1	0.887	Valid
	X2.2	0.875	Valid
	X2.3	0.865	Valid
Environmental Knowledge	X3.1	0.703	Valid
	X3.2	0.759	Valid
	X3.3	0.798	Valid
Green Purchase Intention	Y.1	0.804	Valid
	Y.2	0.881	Valid
	Y.3	0.837	Valid
	Y.4	0.789	Valid

Discriminant validity is a valuable guide in estimating the development of instruments in research. In this test, the usage value depends on cross loading. An indicator is said to have met discriminant validity if the cross-loading value for each variable must be > 0.7 (Hair et al., 2017). it can be said that contrast Long Term Orientation, Perceived Consumer Effectiveness, Environmental Knowledge, and Green Purchase Intention has met convergent validity standards because of all loading factor value > 0.7. Thus, it can be concluded that all valid construct.

Table 2. Discriminant validity value

Indikator	Long Term Orientation (X1)	Perceived Consumer Effectiveness (X2)	Environmental Knowledge (X3)	Green Purchase Intention (Y)
X1.1	0.738	0.471	0.460	0.347
X1.2	0.877	0.535	0.498	0.494
X1.3	0.783	0.481	0.501	0.617
X2.1	0.545	0.887	0.640	0.545
X2.2	0.516	0.875	0.616	0.606
X2.3	0.561	0.865	0.657	0.631
X3.1	0.342	0.558	0.703	0.391
X3.2	0.456	0.572	0.759	0.421
X3.3	0.538	0.546	0.798	0.714
Y.1	0.525	0.598	0.576	0.804
Y.2	0.523	0.502	0.671	0.881
Y.3	0.532	0.492	0.562	0.837
Y.4	0.524	0.659	0.576	0.789

Based on the table above, it shows that all cross values. The loading of each latent variable itself has more value high compared to the cross-loading values on other variables. This matter shows that each latent variable has good discriminant validity.

Cronbach Alpha and Composite Reliability

According to Hair et al. (2017), a condition of a variable is said to be reliable if the Average Variance Extrad (AVE) value is greater than 0.5, the Composite Reliability value is greater than 0.7, and the Cronbach's Alpha value is greater than 0.7. According to Ghozali (2016), a research instrument is said to be reliable if its Cronbach's Alpha value is greater than 0.60. Thus, the dynamic standard in the dependency test is as follows: If the Cronbach's Alpha value is > 0.60, then the question in the poll is solid. Questionnaire items are said to be unreliable if the Cronbach's Alpha value is less than 0.60.

Table 3. Cronbach Alpha dan Composite Reliability

Konstruk	***Cronbach Alpha***	***Composite Reability***	***AVE***	**Kesimpulan**
LTO (X1)	0.733	0.843	0.642	Reliabel
PCE (X2)	0.848	0.908	0.767	Reliabel
EK (X3)	0.654	0.798	0.569	Reliabel
GPI (Y)	0.847	0.897	0.687	Reliabel

Based on table 3 above, it shows that the variables LTO, PCE, EK, and GPI have Cronbach's alpha and composite reliability values > 0.6 and Averge Variance Extraced (AVE) values > 0.5. So the resulting value shows that the variables studied state that all variables are stated to have good reliability and the questionnaire used in this research is reliable and consistent.

Structural Model (Inner Model)

Evaluation of the inner model structural model can be evaluated using the R-square test for the dependent variable and the t test as well as the significance of the structural path coefficients (parameters).The following are the results of the bootstrapping process on the structural model:

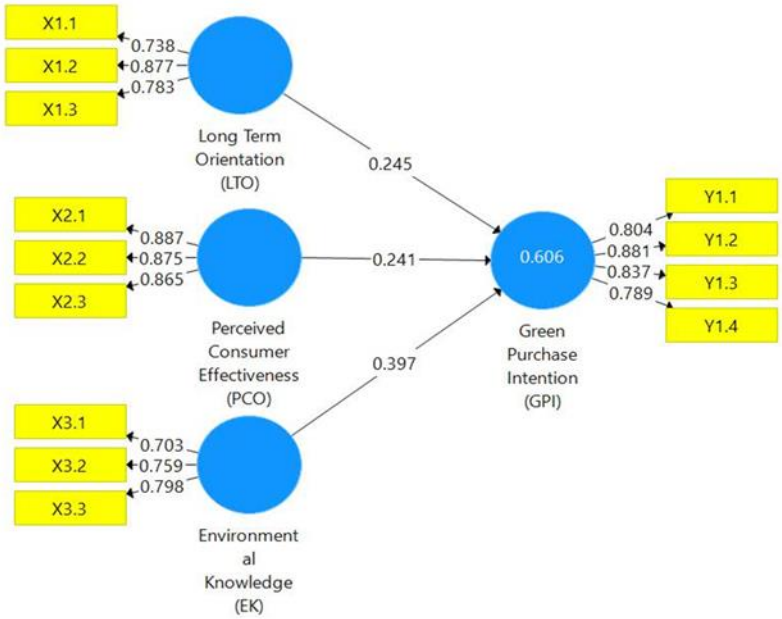

Figure 2. Structural Model

R-square

This R-Squares value is used as an explanation of the influence of the independent latent variable on the dependent latent variable as proof of ownership of the substantive influence. According to Hair et al., (2011) the R-Square value in three classifications, namely 0.75 (strong), 0.50 (moderate), and 0.25 (weak). The following is the R-Square value in table 4.

Table 4. R-Squares value

Variabel Penelitian	*R-Square*	*R-Square Adjusted*
Green Purchase Intention (Y)	0.606	0.587

The R-Square results in table 2.14 show that the R-Square value is 0.606. This value shows that the Long Term Orientation variable, Perceived Consumer Effectiveness and Environmental Knowledge have an influence the Green Purchase Intention variable is 60.6% and the rest is influenced by other variables outside this research.

Hypothesis testing

Hypothesis testing is used to determine the relationship between research variables. Hypothesis testing uses smartPLS 3.0 through a bootstrapping process. The hypothesis in this research is based on the p value and t-statistic.

Table 5. Direct Effect Boostraping Results

Contruct	*Original Sample* (O)	*Sample Mean* (M)	*Standard deviation* (STDEV)	*T-statistics*	*P-values*
LTO (X1)-> GPI (Y)	0.245	0.247	0.120	2.043	0.042
PCE (X2) -> GPI (Y)	0.241	0.247	0.157	1.536	0.125
EK (X2) -> GPI (Y)	0.397	0.399	0.132	3.016	0.003

Based on table above, the t-statistic value for Long Term Orientation towards Green Purchase Intention is 2.043 > 1.96 and has a p-value of 0.042 < 0.05, apart from that it has an original sample value of 0.245, this value shows a positive value. Based on this meaning that long term orientation has a significant positive effect on green purchase intention. Long Term Orientation was found to have a significant effect on young consumers' attitudes towards purchasing environmentally friendly products, which in turn had an impact on Green Purchase Intention (Chowdhury et all., 2021). By having a long-term orientation, consumers tend to care more about the environment and sustainability. They may pay more attention to how their purchases support the company's environmentally friendly practices. Starbucks, which is known to be active in carrying out sustainable initiatives such as the use of environmentally friendly materials, recycling programs, can be an attractive choice for consumers who have a long-term orientation. Thus, consumers who have a long-term orientation tend to be more inclined to choose green products from Starbucks, because they see the long-term value of the company's environmentally friendly practices. This can increase green purchase intention at Starbucks and strengthen the relationship between the company and consumers who care about the environment. Consumers with a high long-term orientation tend to prepare environmentally friendly products as more effective in achieving their sustainability goals, thereby increasing green purchase intentions.

Based on table above, the t-statistic value for Perceived Consumer Effectiveness towards Green Purchase Intention is 1.536 < 1.96 and has a p-value of 0.125 > 0.05. Based on this, meaning that Perceived Consumer Effectiveness has no effect on Green Purchase Intention. The research results show that the Perceived Consumer Effectiveness variable has no influence on Green Purchase Intention in the case study of purchasing Starbucks Coffee in DIY. The results of this research are still rare because they are different from several previous studies, namely research (Antonius, 2018) and (Gleim et al, 2013). Perceived consumer effectiveness has a positive effect on green purchase intention. Starbucks Coffee, as a popular and influential company, can also play a role in strengthening consumers' perceived effectiveness by promoting environmentally friendly initiatives and sustainable practices. By demonstrating its commitment to sustainability and providing information about the positive impact of environmentally friendly purchasing decisions, Starbucks can further encourage consumers to believe in their own effectiveness and make environmentally conscious choices.

Based on table above, the t-statistic value for Environmental Knowledge towards Green Purchase Intention is 3.016 > 1.96 and has a p-value of 0.003 < 0.05, apart from that it has an original sample value of 0.397, this value shows a positive value. Based on this, meaning that Environmental Knowledge has a significant positive effect on Green Purchase Intention. The results of this research strengthen previous research, namely in research conducted by (Hariyanto et al., 2019), the results showed that the higher the customer's Environmental Knowledge, the better it supports the customer's Green Purchase Intention. Starbucks Coffee has made efforts to promote sustainability and environmental responsibility in their supply chain, such as investing in ethical sourcing practices, supporting farmers with fair trade certification, and implementing recycling and waste reduction initiatives. Consumers who have environmental knowledge will be more appreciative and supportive of these efforts, thereby increasing their intention to purchase environmentally friendly products from Starbucks. They may actively seek out Strabucks for their sustainable practices and are willing to pay a premium for eco-friendly options. Starbucks coffee promotes its products as environmentally friendly and emphasizes that its products reduce negative impacts in three areas, including coffee sourcing, paper, product and employee transportation, store design, and operational methods for managing water, waste, and electric power. Through interior design, energy and air conservation, forest protection, and environmentally friendly advertising campaigns such as the tumbler day program, Starbucks coffee fulfills several of its commitments. Starbucks carries out environmentally friendly ideas in showcasing its products with the aim of encouraging buyers to do the same, especially commitment.

5. CONCLUSION

Based on the results obtained from this research, it indicates that long term orientation and environmental knowledge has influence on green purchase intention, perceived consumer effectiveness has no influence on green purchase intention. Discovery of Green purchase intention model can serve as a guide for companies in developing more effective marketing to target consumers who care about the environment. This research contributes to the Company as a marketing strategy and also Continuously innovating products by using environmentally friendly materials, recycling programs, can be an attractive choice for consumers who have a long-term orientation. As a popular and influential company, it can also play a role in strengthening consumers' perceptions of effectiveness by promoting environmentally friendly initiatives and sustainable practices. And for companies continue to be committed to protecting the environment, and educating consumers about the importance of protecting the environment and is beneficial for researchers for the development of science. see flaws in this research, the object only focuses on Starbucks Coffee, while in other coffee shops it focuses on its products. There are many types and similar brandsFor future research, continuously carry out research on similar topics and adding other variables for research in this study, to find out more about variables that might influence this research.

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Supporting Factors the Success of Waste Management Replication in Banyumas Regency, Central Java, Indonesia

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Abstract: Effective waste management needs to involve stakeholders so that it can create a clean, healthy, beautiful environment, and become a model for other regions. This research aims to provide an overview of the waste management system in Banyumas Regency which has three levels from upstream to downstream. This study uses a qualitative approach, primary data is obtained through in-depth observation and interviews with TPST/TPST3R/PDU managers managed by KSM, and BLE landfills. Data validation was carried out by confirming the results of primary and secondary data acquisition, and analysis using the help of Atlas. Ti software. The results show that the factors that support the success of replication are location attributes, water availability, wage rates, and machine capacity, while the challenges are human resources, regions, and communities. Understanding the replication factors of waste management is a valuable consideration for regions that want to adopt it.

Keywords: replication aspect; success; challenge; waste management

1. INTRODUCTION

Waste that has not been managed properly in many regions in Indonesia has an impact on disasters and even results in fatalities. This crisis can be used as an opportunity to restructure and increase the strength of a better waste management system (Fan et al., 2021) thereby contributing to human development and health (Sarkodie & Owusu, 2021). Mismanagement of waste (Lebreton & Andrady, 2019), incompetence, and inefficiency of waste management systems, as well as increased dependence on plastics (Vanapalli et al., 2021), unreliable recycling techniques, and low percentage of waste utilization, as well as management systems including inadequate recyclers (Ardusso et al., 2021) can trigger a new environmental crisis.

An economic model known as a "closed-loop economy" (Circular Economy) aims to minimize waste, retain long-term value, reduce the use of primary resources, and produce closed-loop products, product parts, and materials while maintaining environmental protection and socioeconomic benefits (Morseletto, 2020). The discipline of managing solid waste involves controlling its generation, storage, collection, transfer, and transportation as well as its processing and disposal. This is done in a way that adheres to the highest standards of engineering, economics, public health, conservation, aesthetics, and other environmental and public concerns (Vergara & Tchobanoglous, 2012). All administrative, financial, legal, planning, and engineering functions are included within this scope.

The transition to a Circular Economy (CE) can be done in several ways, for example by reducing waste, closing the production cycle, using resources more efficiently, or maximizing the retention of the economic value of materials and products (Morseletto, 2020). Increase awareness of sustainability and technological advances for solid waste management to reduce unnecessary waste. Organic waste recycling can be applied to produce organic matter that can be used as fertilizer or to improve soil structure (Chew et al., 2019).

Every individual will produce waste in their daily lives therefore it is necessary to understand the 3R (Reduce, Reuse, and Recycle) principle as an effort to reduce waste. A safer and greener environment needs to be supported by various measures considering the complexity of various issues that are important goals for each individual (Klemeš et al., 2020). 3R efforts need to be constantly reminded because they are related to changing habits. The demand for plastics by end-users is dominated in areas with temperate climates, and it is projected to shift one of them to Southeast Asia

(Lebreton & Andrady, 2019). Furthermore, increasing knowledge about waste management that can improve financial performance, economic growth, competitive advantage, and sustainable development also needs to be carried out (Derhab & Elkhwesky, 2023). Temporary waste storage and reduction sites are places with special logistical characteristics that make it possible to store waste and debris while waiting for final disposal (Kulkarni & Anantharama, 2020). Sustainability assessments to obtain the best available technology are required by considering technical, social, economic, and environmental performance. Processing approaches can be more flexible (various raw materials), decentralized, and sophisticated, such as internet-based (Hantoko et al., 2021).

Most of the plastic produced each year is used to make single-use packaging and other short-lived consumer products that are thrown away quickly, increasing the volume of waste. This requires waste management that is managed appropriately by the principles of the circular economy (Jeswani et al., 2021). Waste recycling and energy efficiency not only have an impact on economic growth but also significantly reduce carbon emission levels in both the short and long term (Razzaq et al., 2021). Furthermore, the target can be used to determine the roadmap to properly implement CE (Morseletto, 2020). Lack of environmental awareness, education, and inappropriate policies can pose a threat to the environment through waste and plastic pollution. Significant efforts are needed to shift to sustainable waste management, or new alternatives by redesigning goods based on biodegradable plastics and recycling plastics into liquid fuels through pyrolysis (De-la-Torre et al., 2021).

Plastic reduction policies and innovations for sustainable and green plastic solutions, as well as developing dynamic and responsive waste management systems need to be done immediately (Patrício Silva et al., 2020). The same thing was also stated by Vanapalli et al. (2021) that reducing the use of plastic along with the use of sustainable plastic waste processing technologies can be achieved by prioritizing policies to embed individual, social, and institutional behavior change. Furthermore, the results of the research by Jeswani et al. (2021) showed that compared to the energy recovery option, pyrolysis recycling of chemicals offers a 50% reduced life cycle energy consumption and impact on climate change. If the quality of the recyclate is taken into consideration, the energy consumption and climate change impact of pyrolysis and mechanical recycling of MPW (multiplastic waste) are comparable. Moreover, pyrolysis-recycled MPW has a substantially smaller climate change impact than its virgin fossil resource-based counterpart. On the other hand, pyrolysis has much greater external implications than energy recovery, mechanical recycling, and virgin manufacture.

Banyumas Regency has a waste system with three levels, starting from the upstream, namely households. In the middle, there is TPST/TPST3R/PDU (Tempat Pengolahan Sampah Terpadu/ Tempat Pembuangan Sampah Terpadu Reduce, Reuse, and Recycle/Pusat Daur Ulang/ Integrated Waste Processing Place/ Integrated Waste Processing Place Reduce, Reuse, Recycle/Recycling Center) managed by KSM (Kelompok Swadaya Masyarakat/Non-Governmental Group). Downstream there is a TPA BLE (Tempat Pengolahan Akhir Berwawasan Lingkungan dan Edukasi/Environmentally and Educational Sound Final Processing Place) managed by the Regency Government. The collaborative model in handling the waste problem, the aspect of leadership with a collaborative style at the community level is the key to the success of handling the household waste problem (Ngambut et al., 2022).

KSM as the manager of TPST/TPST3R/PDU is a service organization that collects contributions from residents' needs to pay attention to perceived service value, perceived service quality, perceived service recovery, and perceived service price fairness which is an important success factor to form and measure customer satisfaction and customer delight (Alzoubi et al., 2020). Inconsistent and less adaptive management practices as a barrier to waste management (Stegmann et al., 2020). The success of waste management in Banyumas Regency can be adopted by other regions by paying attention to the replication aspect, including challenges and factors that support success. The integration of different approaches to waste management can be done by accommodating existing systems and then adapting them to be able to implement new waste management systems (Kulkarni & Anantharama, 2020). Significant efforts are needed to transition to sustainable solid waste management (De-la-Torre et al., 2021).

Each region has a waste management system to the policies of their respective local governments but has not shown success because it is not accommodated in the local landfill (Final Disposal Site). An understanding of the factors that support the success and challenges of waste management in Banyumas Regency can be used as a consideration for regions that want to replicate so that they do not face problems in their implementation. The waste management model includes a management team, treatment plan, technology, financing, utilization, and collaboration. This waste management model involves various parties and inclusive community participation has been proven to reduce poverty and stunting (Rahmawati et al., 2023)

Replication carried out immaturely is feared to result in waste management through TPST/TPST3R/PDU and TPA BLE being detrimental for various reasons. This research is important because good waste management has an impact on improving environmental cleanliness, health, and welfare. Proper management by utilizing existing processing and recycling facilities can avoid adverse effects that may occur. Waste needs to be handled using innovative ideas and technologies (Sharma et al., 2020), which directly depends on the level of the budget. Management can assess the level of resources needed to support the success of the waste management system (Tirkolaee et al., 2021). Successful replication needs to be linked to time, budget, project management, system quality, user satisfaction, and economic value, and subsequently engagement, support, communication, and commitment. This shows that soft skill support in replication is indispensable (Iriarte & Bayona, 2020). Replication of waste management in Banyumas Regency allows local governments to manage waste by local environmental conditions effectively, considering the large investment and requires commitment from managers. An understanding of the factors that support the success and challenges of waste management replication in Banyumas Regency provides consideration for local governments who have the desire to replicate.

2. METHOD

The research method used is qualitative descriptive to determine the challenges and factors that support the success of waste management replication in Banyumas Regency. Primary data collection was carried out through in-depth interviews and direct observation with the manager of TPST Patikraja, Kedung Randu, and TPA BLE Wlahar Wetan, Kalibagor, Banyumas in July 2024, followed by recording and coding. Secondary data was obtained through the results of previous research, books, and journals related to the replication and effectiveness of waste management in an area. The validity test was carried out by the triangulation method, and data analysis using the Atlas-ti software.

3. RESULTS

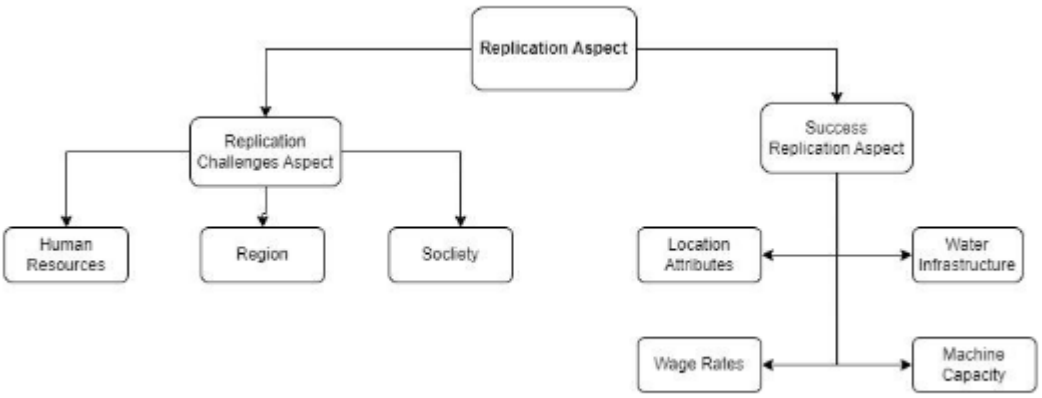
Banyumas Regency, Central Java Province has an area of 132,758 hectares, 27 sub-districts, 301 villages, and 30 sub-districts, as well as 1,878,746 residents. The amount of waste generated in 2023 is 522,937 kg/day of waste from 624,523 households. Then waste outside households reaches 10-15 tons, and total waste per day is 450-500 tons or 143 trucks (brin.go.id, 2024). The local government issued a policy after the closure of the landfill in Banyumas Regency with the name 'Sumpah Beruang' (Sulap Sampah Menjadi Uang/Magic Waste into Money). Waste processing is carried out from upstream to downstream. Communities in the upstream are required to sort organic and inorganic waste. The middle of waste processing is carried out by KSM in six TPST/TPS3R/PDU, the equipment and machines owned include three-wheeled motorcycles, conveyors, gibrig machines, compost, sieves, presses, plastic choppers, non-insenator pyrolysis to burn residues. Waste downstream is processed in one BLE landfill managed by the local government and does not use the landfill method or open landfill which smells bad. The TPA BLE is a place for the final processing of residues sent from TPST/TPST3R/PDU. In addition, the Banyumas Regency Government also collaborated with PT. PLN (Persero) and PT. Sinergi Utama to Utilize Waste as Biomass Co-firing Raw Material.

All waste is processed into products of economic value using circular economy principles, absorbing local labor, and residues are processed at the BLE landfill which was inaugurated in 2022 with a waste processing capacity of 75 tons/day. The waste levy regulation was eliminated, and the community paid waste contributions directly to KSM, the amount of which was determined based on the agreement. KSM as a waste manager at the village/village level carries out waste management activities including waste banks. KSM management is formed through village/sub-district deliberation, then determined by the decision of the head of the village/lurah and ratified by the head of the agency. The purpose of the establishment of KSM is as an operator/implementer in waste management activities in villages/sub-districts with its task of carrying out socialization about waste management to the community and collecting customer data. The next task is to determine the amount of waste management fee contributions, and collect, transport, and manage waste. Make implementation reports and financial reports regularly every month to customers, as well as village heads and agencies that handle waste management.

The waste sent to the processing site is sorted into several parts, which are organic for maggots, then the plastic waste is processed into Refused Derived Fuel (RDF) for fuel, paving blocks, and plastic ore, while the final waste residue is burned using pyrolysis. KSM's human resources are mostly former scavengers in former landfills by receive remuneration from UMKs (Upah Minimum Kabupaten/District Minimum Wage) and health allowances in the form

of daily feeding of whole milk. The provision of hangars or TPST/TPST3R/PDU in Banyumas Regency requires an investment in buildings and equipment of Rp 1.5 billion. The equipment provided in each hangar is a manual waste sorting machine (conveyor) and a plastic waste washing machine (gibrik). TPST/TPST3R/PDU with an area of 1,200 m2 can be used to accommodate 6-8 dump trucks/day. KSM's source of income is from residents' contributions and the sale of high-value waste, such as plastics, crackers, plastic packaging, and bottles. Income from 8 trucks/day generates an income of Rp 30 million/day. The addition of tools can be done, for example with hot extruders and hydraulic machines that can be used to produce liquid plastics and print them into various products. Waste that cannot be used is burned with a pyrolysis machine that has met the provisions (https://jatengprov.go.id, 2024).

Figure 1 shows the factors that support the success of waste management replication in Banyumas Regency, including location attributes, wage rates, water infrastructure, and machine capacity.



Source: Atlas-ti output

Figure 1. Aspects of Waste Management Replication in Banyumas Regency

The challenges of waste management in Banyumas Regency are human resources, areas, and communities. The support of human resources from upstream to downstream who commit to sorting and managing waste continuously until it is completely exhausted is a big challenge because waste is synonymous with dirty, smelly, and disgusting. Furthermore, the area for waste processing often receives rejection from locals because it causes unpleasant odors, reduces comfort, and is unhealthy for residents, as well as the traffic of large, smelly, and noisy garbage trucks. This also happened in Banyumas Regency in the early days of processing, protests by residents and even road access to the processing site was closed

Community participation at this time is still a problem for waste managers in Banyumas Regency, namely not sorting organic and inorganic waste, so the local government continues to remind the importance of sorting, and then handling waste that sells through 'Sampah Online Banyumas'/Salinmas and 'Ojeke Inyong'/Jeknyong (https://www.banyumaskab.go.id, 2024)

4. DISCUSSION

Good waste management needs to be carried out consistently and structured. Banyumas Regency through its leadership policy manages waste by involving the community, the government at the village, and district level. 'Sumpah Beruang' become principles instilled in the community, TPST/TPST3R/PDU, and TPA BLE managers. TPST, which is generally used as an abbreviation for Tempat Pembuangan Sampah Terpadu/Integrated Waste Disposal Site and TPA stands for Tempat Pembuangan Akhir/Final Disposal Site, does not apply in Banyumas Regency, but becomes an Integrated Waste Processing Site and Final Processing Site, which is a place to process waste to realize zero waste management. As an organization, TPST/TPST3R/PDU and TPA BLE have objectives, carry out management functions (planning, organizing, staffing, directing, and controlling), have functional management (human resources, finance, operations, and marketing), and have six management elements (human, money, material, machine, method, and market).

The government, TPST/TPST3R/PDU managers, and TPA BLE, NGOs. and the community that cares about the environment must still socialize the 3Rs consistently and continuously to reduce the quantity of waste because this concerns behavior. 'Sumpah Beruang' is a unique motto, turning the image of waste into something that generates income. This is in line with Rahmawati et al. (2023) that waste can be transformed from a 'problem' to a 'potential source' because well-organized waste management will create a prosperous society. A collaborative model in overcoming the waste problem at the community level is an important step in solving the waste problem produced (Ngambut et al., 2022). The source of funds for the initial investment of the TPA BLE is the Ministry of Public Works and Public Housing (Pekerjaan Umum dan Perumahan Rakyat) of Rp 44 billion from the State Budget and the Regional Budget of Rp 6.3 billion, with a land area of 3.5 hectares (https://www.banyumaskab.go.id, 2024). Unlike TPA landfills in general which focus on 3R, this TPA BLE will be equipped with swimming pools, plastic factories, fish ponds, and others. Comprehensive waste management policies present multilateral issues with a multi and interdisciplinary approach to solving them, including planning and awareness of legal, institutional, technical, economic, land use, environmental education, and community participation (Drahansky et al., 2016).

The source of funds for the initial investment in the establishment of TPST/TPST3R/PDU is the district government, then for operational activities sourced from the community who pay a certain amount of contributions based on the agreement, as well as the proceeds from the sale of high-value waste and processed products in the form of paving blocks, compost, and RDF. KSM as an organization in the service sector needs to be managed consistently and professionally to increase customer satisfaction and customer delight which is influenced by perceived service value, perceived service quality, perceived service recovery, perceived service price fairness (Alzoubi et al., 2020). Location attributes support the successful replication of waste processing in an area, but solar radiation and qualitatively high ambient temperatures are expected to encourage faster weathering (Lebreton & Andrady, 2019). Local government policies can be carried out through a system of consultation, study, and intensive discussion with the community (Drahansky et al., 2016). The characteristics of the location and waste allow each region to use various waste treatment methods, ranging from low to high technology. Generally, high-income cities use more technological methods for waste management – collection, separation, and mechanical processing – while lower-income cities tend to rely on more labor with lower technology options (Vergara & Tchobanoglous, 2012).

For comparison, the final waste disposal location in Kupang City is in Alak District, Kupang City, with a distance of 1 KM to the nearest community settlement. At the landfill location, there are 46 households as scavengers with family members of two to three people. In addition to scavengers who settle down, the surrounding community also looks for leftover food for their livestock (Ngambut et al., 2022). The selection of locations like this overcomes the challenges of human resources, regions, and communities. Furthermore, it also supports location attributes and wage rates. Human resources at waste treatment sites are given wages by the UMK of Banyumas Regency, which is Rp 2,195,690,- (https://jatengprov.go.id, 2024). This is an attraction for scavengers in landfills who are used to being close to waste but do not earn a fixed income, attracting human resources from the informal sector to formal. Furthermore, there is the provision of whole milk as an effort to support the health of employees, even though health insurance cannot be financed yet. The management of TPS/TPST/PDU and TPA BLE strives to increase revenue to cover operating costs, through community contributions and product sales. Incentives to collect recyclable materials are economical, as their wages come from resale rather than through district government contracts. This shows that waste treatment sites provide livelihoods for residents as well as environmental and waste management services (Vergara & Tchobanoglous, 2012)

Results Jeswani et al. (2021) demonstrate that the technology of processing or recycling plastic waste is needed to address current and future global environmental challenges, namely climate change and the limited availability of non-renewable resources, as well as sustainable production and business. It is difficult to accurately measure the rate of potential generation of microplastics in a given location, but solar radiation and high ambient temperatures qualitatively encourage faster weathering (Lebreton & Andrady, 2019). The inorganic waste that has been sorted is then separated for sale, and further processed into RDF, plastic ore, and paving blocks. This process requires adequate water supply support to wash the garbage until it is clean, then the laundry wastewater drain is also a serious problem because it is a key element for the control of soil contamination of the surrounding environment and the source of water pollution (Drahansky et al., 2016). Plastic pollution is a planetary threat, affecting almost every terrestrial, water, and air ecosystem globally (Borrelle et al., 2020) Likewise, technologies designed to minimize the environmental impact of waste (Vergara & Tchobanoglous, 2012). Borrelle et al. (2020) stated that the understanding of the transportation, storage, and washing of plastic waste needs to be improved so as not to pollute water sources, rivers, and seas.

The development of new and sustainable technologies for recycling plastics and other materials requires the integration of humans with machines, from sorting and recycling processing to higher product quality. Nicer, layered, and complex plastic packaging needs to be separated from those that are not economically viable for recycling. In addition, incentive policies that encourage homogeneous plastics, environmentally friendly bioplastics, and circular technologies must be formulated and implemented effectively (Sharma et al., 2020). Stegmann et al. (2020) stated that inconsistent and less adaptive management practices are obstacles to waste management. An approach that involves the community as a waste producer to participate in managing and contributing to overcoming problems. This is in line with the statement of Ngambut et al. (2022) that it is very important to involve or participate in the community in planning and decision-making to overcome the waste problem. The government that is given responsibility has limitations in waste management, both in terms of budget, human resources, and technology. The form and model of community participation, from different layers, are influenced by various external and internal factors.

Consideration of strategies to minimize the impact of plastic by utilizing it needs to be focused on the community with the right use and post-consumption plastic care, not on the plastic (Klemeš et al., 2020). Reducing the negative impact of waste management needs to work with all levels of society through intensive socialization (Rahmawati et al., 2023). The involvement of academics, governments, communities, and entrepreneurs is needed in waste management decision-making to form an adequate network of relationships between generations and knowledge transfer (Drahansky et al., 2016). The same thing was also stated by Ngambut et al. (2022) that waste management is a shared responsibility of all parties. The transition to a circular urban economy requires a cultural shift to innovation in all sectors, and changes in government organization, business strategy, and educational structures that will determine the supply of products and services, as well as society

The replication of a project must contribute to increasing productivity in various dimensions, namely economic, social, and environmental through the optimization of materials, technologies, systems, products and services, reuse, recycling, and repair, recycling production sites, and regeneration of entire regions (Gravagnuolo et al., 2019). The selection of waste treatment locations is a tough challenge faced because residents will refuse, through demonstrations and road closures. Globally, waste management needs to be more formal and regional (Vergara & Tchobanoglous, 2012) the same thing was also stated by Klemeš et al. (2020) as an effort to optimize waste management planning. Next Razzaq et al. (2021) Suggesting waste management is heterogeneous in different regions, therefore, no single treatment option is recommended for all waste streams. Recycling of organic solid waste is carried out through the study and quantification of food ingredients to produce quality compost to fertilize soil and plants (Drahansky et al., 2016).

5. CONCLUSION

Location factors, water availability, wage rates, and machine capacity are aspects that support the success of waste management replication in the Banyumas Regency so that they do not experience obstacles during operation. The challenge factors are human resources, regions, and communities. 'Sumpah Beruang' is a motto that is embedded in the residents of Banyumas Regency as an effort to utilize waste that has an impact on increasing income and environmental cleanliness. An understanding of the replication aspects of waste management needs to be considered before investing in facilities and infrastructure with the support of human resources who are committed to managing it. The results of this study cannot be generalized, but provide valuable input for the region to prepare various aspects, especially community support so that they are willing to participate in waste management replication. The aspects that were successfully identified were obtained based on the results of interviews with KSM and TPA BLE managers in Banyumas Regency, further research is needed using quantitative analysis and participation of MSMEs can also be carried out by placing its contribution to waste management.

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Design of a Board Game Product Business Model as a Learning Media for Environmental Care for Primary School Children

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Abstract: Currently the environment is one of the big problems that concern us. The phenomenon of indifference to the environment has a negative impact on human life. One of the efforts to prevent environmental damage is to provide environmental education to elementary school children. Through the observations that have been made, there are triggers for children's indifference to the environment, including difficulties in growing motivation to care about the environment and the ineffectiveness of learning media in providing understanding about the environment. The purpose of this study is to create additional learning media in the form of board game which can increase environmental awareness. The design of this business model uses the method design thinking, value proposition, lean canvas, blue oceans strategy, validation test, and business feasibility test. Design thinking aims to help understand the problems and desires of children aged 7-12 years related to environmental concern. Value proposition canvases aims to offer a design board game with the theme of caring for the environment to help elementary school children understand their surroundings and increase their enthusiasm for environmental learning.Blue oceans strategy aims to create product innovations that are different from competitors including the suitability of educational aspects and suitability for elementary school children's lessons. validation showed that around 79.8% of respondents agreed with the board game concept design. The business feasibility test shows that the profit earned is 5,100,000, - per month. BEP units of 6,39 and payback period of 0,51 months.

Keywords: Board Game, Environmental, Design Thinking, Blue Oceans Strategy, Business Worthed

1. INTRODUCTION

Currently, environmental problems are one of the major problems that concern us. In 2012 World Risk Report released German Alliance for Development Works (Alliance), United Nations University Institute for Environment and Human Security (UNU-EHS) and The Nature Conservancy states that environmental damage is one of the important factors that determine the level of disaster risk in an area [1]. Most of the environmental damage occurs due to deforestation. According to Indonesia's Environmental Status, over the last five years (2014-2019 period), the area of forest land in Indonesia has decreased from 95.7 Ha in 2014 to 94.1 Ha in 2019. One of the factors causing forest logging is due to a lot of new land development instead of planting trees to prevent natural disasters [2].

One effort that can be done in instilling a caring attitude environment, namely environmental education from an early age. This environmental education focuses on building the character of early childhood to understand the importance of the environment in life and how love and care for the environment become values embedded in everyday life [3]. The phenomenon of indifference to the environment in elementary school students can be observed in everyday behavior. For example, children know about environmental damage but they still damage plants and don't take care of them, litter, and don't take part in caring for plants in the school yard [4]. Based on an interview with the MI Al-Wahda teacher in Baubau City, he said that "Not all students are aware of the importance of protecting the environment, so teachers need to constantly remind students, sometimes even students have no will at all to protect the environment."

According to data on the results of implementing the environmental education curriculum in elementary schools, only 50% of students have not been able to realize the results of environmental learning [5]. This data was also strengthened by observations through interviews with MI Al-Wahda teachers in Baubau City who stated that only 50% of the learning media used were not effective in increasing environmental care attitudes. For this reason, in an effort to improve environmental care attitudes for elementary school students, a learning media is needed that can combine learning and playing. Elementary school students (7-12 years) are included in this phaseconcrete operational According to Piaget, this age is characterized by the development of logical and rational thinking [6]. It would be better if children were given games that have a positive impact on the development of children aged 7-12 years by using the concept of gamification. Gamification is a game-based learning method that aims to foster learning motivation and change children's behavior for the better [7]. According to research conducted by University of Colorado Denver stated that people who studied using the gamification method were able to score 14% higher than those who studied using traditional methods. This is because gamification has 3 main principles that can increase student confidence, be more involved with subject matter and provide responses quickly [8]. The principles and elements of gamification can be seen in the media board game. Board games is a game non electronic which uses boards as the main component, and is supported by other supporting components such as cards, tokens, and so on [9]. As is board game with the theme of caring for the environment can train students in responding to situations about problems in the surrounding environment.

Game goals

This education is a means so that elementary school children can increase their sense of concern for the surrounding environment, especially planting trees in the form of board game. Problems that originate from environmental damage, so that it has a negative impact on human life. One of the efforts to prevent environmental damage is to provide environmental education to elementary school children. Through the observations that have been made, the results of triggering elementary school children's indifference to the environment include the ineffectiveness of the current learning media for elementary school students aged 7-12 years in providing an understanding of environmental concern and difficulties in motivating children aged 7-12 years to care about the environment around. Therefore the purpose of this research is to design a product business model board game as a learning medium to increase environmental awareness for elementary school children.

2. LITERATURE REVIEW

Learning media is a tool to support the learning process in students. The use of instructional media can increase students' interest in learning new things in the material presented by the teacher so that students can easily understand. Interesting learning media for students can stimulate the learning process [10]. Board games is a type of game where tools or game parts are placed, moved, or moved on a surface that has been marked or divided according to a set of rules [11].Board games included in educational game facilities which can support aspects of child development, for example increasing children's imagination and creativity by detecting game patterns, planning and game strategies to win, and can improve children's brain development including logic skills, communication skills, and develop the ability to focus in the long term long time.

A business model is a planned set of assumptions about how the company will create value for all of its stakeholders. A business model describes the rationale for how organizations create, deliver, and capture value [12]. Design thinking is a method of thinking and acting to find creative solutions. Design thinking very attached to humans in the innovation process which emphasizes observation, collaboration, quick grasp of new things, visualizing ideas, and business analysis, which have a major impact on innovation and business strategy [13]. There are five stages in design thinking namely Empathize, Define, idea, Prototype and test. Value proposition canvases is an analytical method used to explain and create value and benefits for consumers. Value proposition canvases consists of two blocks business model canvas that is value proposition and customer segment. On the left block in the form of a box there is pain relievers, gain creators, And product or service. Meanwhile, in a circle- shaped block there is customer jobs, pain, and gain.

Lean canvas is a tool used to rapidly design and develop business models. Lean cavas consists of 9 blocks consisting of problem, customer segments, unique value proposition, solution, channels, revenue streams, cost structure, key metrics, and unfair advantage[14]. Blue Oceans Strategy aims to identify and explore new market opportunities that have not been realized by other players. This strategy makes it possible to create a market space that is free from competitors. There is an analytical framework blue oceans[15] namely strategy canvas, Four-step framework,

Remove-Reduce-Upgrade- Create scheme, and Utility map. Minimum Viable Product aims to validate business ideas, evaluate consumer experiences, and obtain product-related feedback. The results of this feedback will be used to improve and develop the final product [16].

Validation test is an important component because it is a method that aims to prove whether the designed business is valid or not. Data collection in this validation test was carried out using a questionnaire to assess the design minimum viable product (MVP) that has been pre-designed. The business feasibility test aims to consider whether a business is feasible or not to run from a financial perspective. In this study using calculations by looking for fixed costs, variable costs, costs start up, break event point and payback period.

3. METHOD

The research methodology explains the stages in the research to solve existing problems so as to obtain the expected results of the new product design. The initial stage of the research was preliminary research which aimed to identify problems related to learning media regarding environmental awareness for elementary school children aged 7-12 years including collecting information related to complaints from students' parents, elementary school teachers, and information relating to elementary school children. Then data collection was carried out on prospective users using a questionnaire. The next stage of literature study is used for activities to collect information in accordance with the theoretical basis, the methods used in research through various reference sources including those from journals related to the research topic. Problems that start from a lack of concern for elementary school children towards the environment, so that it has a negative impact on the surrounding environment, especially in plant conservation. Through the results of observations made on the parents of students and elementary school teachers, it was obtained that elementary school children's indifference to the environment in everyday life as they know about environmental damage but they still damage plants and don't take care of them, litter, and don't participate in maintain plants in the school yard, so needed thus having a negative impact on the surrounding environment, especially in plant preservation. Through the results of observations made on the parents of students and elementary school teachers, it was obtained that elementary school children's indifference to the environment in everyday life as they know about environmental damage but they still damage plants and don't take care of them, litter, and don't participate in maintain plants in the school yard, so needed thus having a negative impact on the surrounding environment, especially in plant preservation. Through the results of observations made on the parents of students and elementary school teachers, it was obtained that elementary school children's indifference to the environment in everyday life as they know about environmental damage but they still damage plants and don't take care of them, litter, and don't participate in maintain plants in the school yard, so needed tools which can help elementary school children understand the importance of protecting the environment.

Therefore, to form a caring attitude towards the environment, a solution is needed that can help parents and elementary school teachers increase children's awareness and interaction with the environment by creating additional learning media in the form of board game which raised the issue of environmental concern, especially tree preservation. Therefore, designed a product board game as a learning medium to increase environmental awareness for elementary school children. The next stage of data collection is carried out to obtain the data needed to achieve the research objectives. The data needed includes primary data and secondary data. Primary data including the results of the questionnaire empathy map, questionnaire customer job, and questionnaires solution validation. Secondary data includes the results of interviews with elementary school teachers and elementary school students. At the data processing stage, starting with the stage empathize which at this stage discusses the problems of parents and teachers related to elementary school children who do not care about the surrounding environment and look for what these parents and teachers want by using empathy map. Stage define, aims to introduce elementary school children in detail by distributing questionnaires to find out the problems faced by them so as to produce results jobs to be done. Stage ideate, designing value proposition canvas with the aim of creating value that suit consumer needs. Stage prototype, develop the concept of a business model using the method lean canvas, competitor analysis, and blue ocean strategy. Blue ocean strategy used to develop strategies to determine the uniqueness of products designed to compete with other competitors.

Stage testing, make arrangements minimum viable product (MVP) includes product mechanics, product components, and gameplay. The validation test phase, at this stage testing is carried out on the product to ensure that the solution chosen is in accordance with the wishes of parents, teachers and elementary school children. The business feasibility

test phase is reviewed from the financial aspect to find out whether this business can run or not by carrying out calculations to find the amount of fixed costs, variable costs, startup, break event point and payback period.

4. RESULT AND DISCUSSION

4.1 Emphatize

The empathize stage is carried out by identifying the needs of the target community group. This stage is very important to do to explain the problem to be solved. The data used comes from the results of questionnaires distributed online to parents and elementary school teachers with a total of 18 respondents. The distribution of this questionnaire aims to find out the problems that are felt by parents and teachers while teaching environmental awareness to elementary school students aged 7-12 years both at school and at home.

Table 1. Problem Based Research Subject

Parent	Children	Teacher
Parents can't wait to accompany their children to learn	Feeling bored with the education system provided	Lack of student attention during environmental lessons in class
Lack of time with children	Lack of focus in participating in environmental education learning	The lack of learning media provided by schools to support environmental care education
Difficulties in growing children's learning interest prefer to play	Children	Students lack discipline in implementing environmental education
Home environment that does not support the implementation of protecting the environment	Lack of children's exploration of the surrounding environment	Lack of practical activities in environmental education

Table 2. Problem Based Development of Children's Learning

Psychomotor	Cognitive	Affective
Fulfilled	**Fulfilled**	**Unfulfilled**
Practical activities directly in implementing environmental subject matter	Limitations of educational learning materials care for the environment	Students are less interested in explaining the theory
Lack of interaction between children, teachers and parents in the application of enviromental awareness	The environmental education subject matter is in the form of theory	Students lack discipline in applying environmental care attitudes

The results of distributing questionnaires to 18 respondents resulted in problems for parents and teachers related to environmental education, including:

Parent: Children have not found the motivation to care for the environment so there is still much to be directed to care for the environment, applying the discipline of disposing of trash in its place, classifying waste based on its type, and the lack of time for parents to teach environmental care to children.

Teacher: Learning systems related to environmental concern are still not running effectively due to the lack of subject topics that focus on the environment, lessons that have not been scheduled consistently, facilities in schools that are less supportive and a lack of student discipline in implementing the importance of protecting the environment. This results in the appearance of laziness and indifference in protecting the surrounding environment.

Primary school children: The learning system is still not effective because teachers in schools still use the lecture method, this results in a feeling of boredom in children. In addition, information related to environmental concern is less understood by students.

Then proceed with studying further the consumer characteristics of the product board game and assist in solving product problems related to consumer needs by using Empathy Maps. Empathy Maps using the concept of a square which is divided into six quadrants.

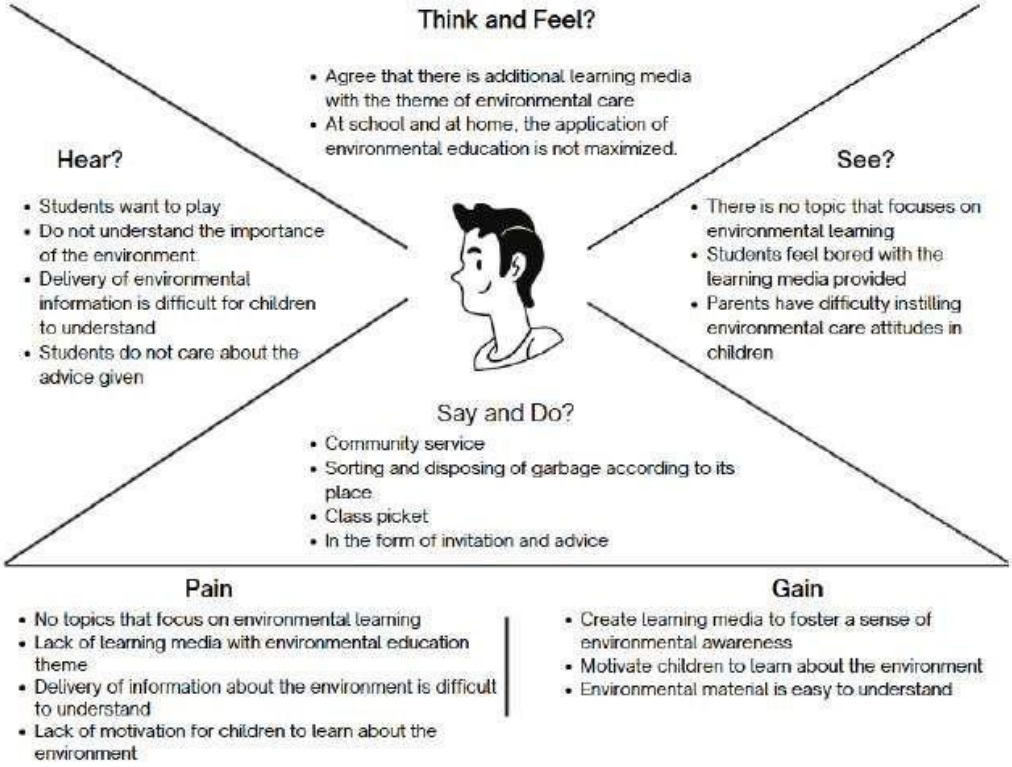

Figure 1. Emphaty Maps Environmental Care Education

4.2 Define

Stage define the process of analysis and understanding of the problems that exist in customers. At this stage using the method job to be done and data from questionnaires filled in by elementary school children aged 7-12 years with a total of 25 respondents aged 7-12 years and using problem data that has been concluded at the empathize.

Table 3. Job To Be Done product board game environmental education

Emotional Criteria		
Designing board game with the theme of caring for the environment which can support aspects of education for elementry school students		
(Personal)	**(Social)**	**(Objective)**
Educational media made with the theme of games that can increase a sense of self-discipline to care for the environment and can support affective, psychomotor, and cognitive aspects for elementry school students	Educational media that can eliminate boredom in students while studying, become a means of entertaiment, and student can actively interact with each other both among friends, teacher, and family	Educational media that is easily understood by elementry school students to help develop character and an understanding of the importance of caring for the environment

From table 2 above it was obtained through the results of a questionnaire distributed to 25 elementary school child respondents. For terms personal, students need additional learning media that can increase students' sense of discipline in applying a caring attitude towards the environment and can support these aspects of student education. For that it

is necessary board game environmental education theme. For terms social, students need additional learning media that can eliminate boredom while studying, become a means of entertainment, and students can actively interact with each other with friends, teachers, and family in learning about the environment. For terms objective, students need additional learning media that are easy to understand at the elementary school level to help them grow character and understanding of the importance of caring for the environment.

To understand the target audience, customer personas are then created. The customer persona of this board game product design is elementary school students in grade 2 aged 8 years, parents who have children aged 7-12 years and elementary school teachers who need tools in teaching environmental awareness to children aged 7-12 years.

4.3 Ideate

The third stage is to make a transition from the formulation of the problem that has been described in the first stage define be a solution. At this stage creativity is needed to produce ideas or ideas as the basis for the next stage. This method is used to design in detail about a product or service that will be made so as to create value and benefits for customers.

Figure 5. Value Proposition Canvas

In the pains obtained, it is difficult to provide an understanding of the environment because there is no topic that focuses on environmental learning, children feel bored learning the environment, learning media with environmental education themes are less interesting, and the language used in conveying environmental information is difficult for children to understand. On gains, environmental material is easy to understand, motivates student learning, and can foster a sense of environmental awareness. The customer job(s) contains the desire of parents and teachers to teach their children understand the environment using games and children want a learning atmosphere that wins while playing.

The value proposition block there are gain creators, pain creators, and product and service. In the gain creators section, a board game is obtained that can combine learning activities while playing interactively, can support educational aspects, and environmental information in accordance with the understanding of elementary school children. In the

pain creators section, educational media is obtained in the form of an environmental theme board game, an explanation of the environment is easy to understand, and the game can be played at any time with challenging gameplay and attractive design. In the product and service section, a boardgame product with the theme of environmental care is obtained with an attractive design and gameplay that is easily understood by elementary school students.

4.4 Prototype

Lean canvas aims to identify problems to develop effective solutions. In this method, 2 kinds of lean canvas are made with 2 customer subjects, namely parents and teachers. This is because parents and teachers are directly related to the main customer, namely children aged 7-12 years old at the elementary school level.

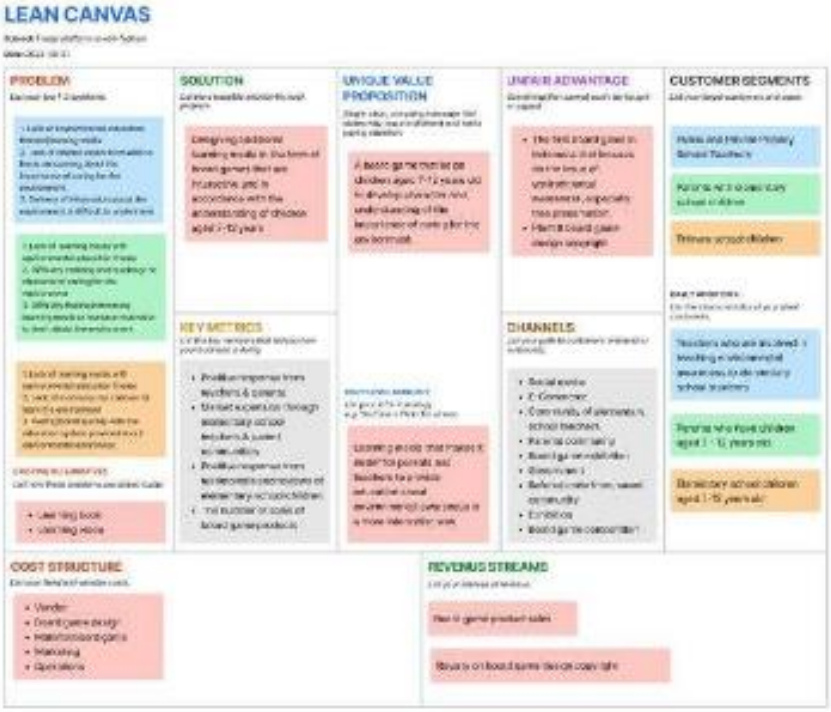

Figure 6. Lean Canvas

Competitor analysis is used to compare the product developed with several other competing products. Competitors that have similar products with environmental themes are Eco-funopoly, and Wilah!.

Table 4. Initial Competitor Analysis

Indicator	Plant It	Wilah!	Eco-funopoly
Price	IDR 600.000	IDR 150.000 - 300.000	IDR 350.000 - 2.000.000
Design	Snackes and ladders	Card	Monopoly
Material	Cardboard	Paper	Recycled material
Game Components	Card, board, tokens, spinners	Card	Card, board, dice, tokens
Rules Book	Complete	Quite complete	Complete
Age Range	7-12 years	7+ years	9+ years
Number of Players	2 - 4 Players	2 – 4 Players	2 - 4 Players
Game Duration	30 minutes	5 - 15 minutes	30 minutes

Blue ocean strategy is a method of creating new market segments that have not been carried out by other competitors in order to create new competition.

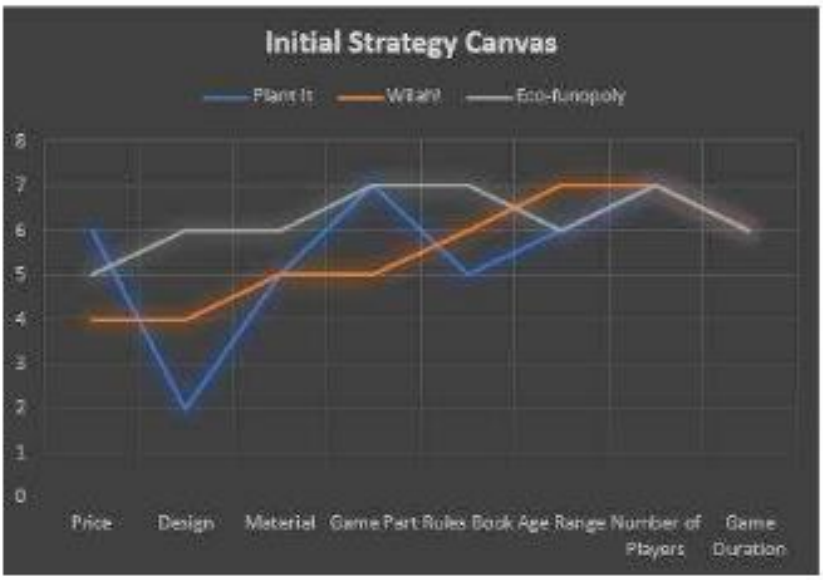

Figure 7. Initial Strategy Canvas

Table 5. 4 Step Framework

4 STEP FRAMEWORK STRATEGY	
Eliminate	**Raise**
Eliminate the notion that environmental lessons are boring	Materials used in the game
	Design board game
	Product price
Eliminates complicated rules and instructions to ensure simplicity and accessibility for children	Game rules book
	Raise awareness about environmental issues by integrating real-world examples and stories about their impact
	Increase the level of excitement in learning about nature and environmental conservation
Reduce	**Create**
Reduce emphasis on competencies to minimize stress and foster a collaborative learning environment	Add information related to environmental damage factors in language that is easy to understand
	Learn to group colors and add new vocabulary, as well as count in a simple way
	Can train children's fine motor skills and hand and eye coordination
	Added information regarding organic waste that can be converted into fertilizer for plants
Reduces the complexity of environmental concepts, breaking them down into child-friendly themes	Train children's sensitivity to phenomena regarding environmental damage
	In accordance with environmental lesson topics for elementary school children
	Create a compelling storyline with characters, challenges, and mysteries that revolve around environmental issues
	Create interactive activities, encouraging children to explore nature and make environmentally friendly decisions

After conducting competitor analysis, proceed with drawing the initial strategy canvas. In the figure Plant It is represented in blue indicating that the product Plant It have a shortage of design, materials, rules book so that improvements are needed to improve product development board game Plant It.

Table 6. Final Competitor Analysis

Indikator	Plant It	Wilah!	Eco-funopoly
Price	IDR 700.000 - 1.300.000	IDR 150.000 - 300.000	IDR 350.000 - 2.000.000
Design	Snackes and ladders	Card	Monopoly
Material	Wood	Paper	Recycled material
Game Components	Card, board, tokens, spinners	Card	Card, board, dice, tokens
Rules Book	Complete	Quite complete	Complete
Age Range	7-12 years	7+ years	9+ years
Number of Players	2 - 4 Players	2 – 4 Players	2 - 4 Players
Game Duration	30 minutes	5 - 15 minutes	30 minutes
Cognitive Aspect	Yes	No	No
Affective Aspect	Yes	No	No
Psychomotor Aspect		Yes	No
Elementry School Subject			No
		Yes	No
			No

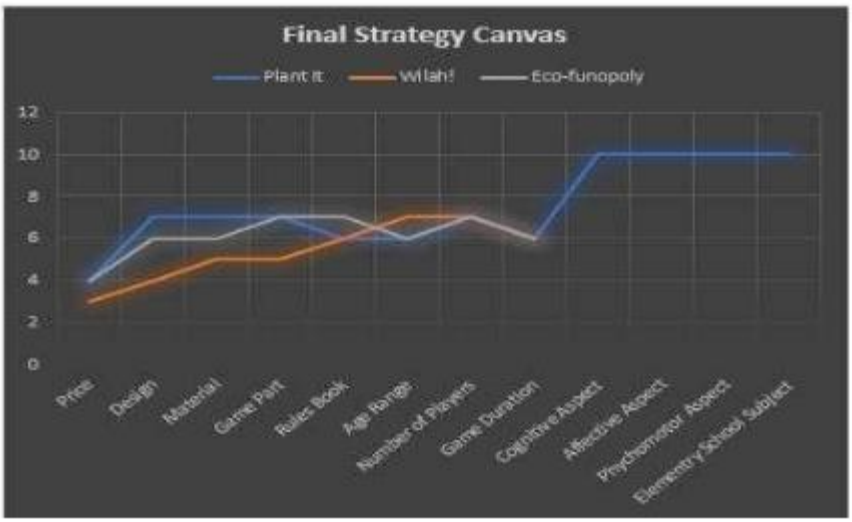

Figure 8. Final Strategy Canvas

In the final strategy canvas image above, after the repairs were made there was an increase in the graphic where the product Plant It superior to the indicators design, materials, and part game. Besides that product Plant It designing new innovations that involve all aspects of education (cognitive, affective, and psychomotor) for children aged 7-12 years and suitability for Elementary School level subjects so that the overall product Plant It superior to other competitors.

4.5 Testing

Minimum Viable Product

Minimum viable product aims to provide an overall picture related to products designed to consumers. MVP is delivered to consumers by explaining it directly to elementary school children and complete with trial documentation prototype. The results of the trial are used as a reference whether they are interested in the product designed in the learning activities later.

Figure 9. Prototype Whole

In the picture above is the result of the design prototype overall. Prototype it covers all the main components in the game. Prototype this will then be used to validate the experience of the elementary school child as a whole.

Product Components

Figure 10. Board

Figure 11. Token Tree

Figure 12. Spinner

Figure 13. Token Rubbish

Figure 14. Rules Book

Figure 15. Card Game

Board rectangular in shape, consisting of 4 areas on each side with visualization empty land. Spinners used by playing to determine the pace of the game. The game cards consist of water cards and fertilizer cards that can fill barren lands as well as opportunity cards that contain interesting information about the environment. The tree token is used as a tree symbol. Garbage tokens are used to exchange for fertilizer cards. And the rules book as a guide to the flow of the game.

Product Mechanism Board Game

Mechanism *board game* Includes game components *board game* that is *action, goals,* and *resources*: The following is a diagram of the game mechanism *board game*:

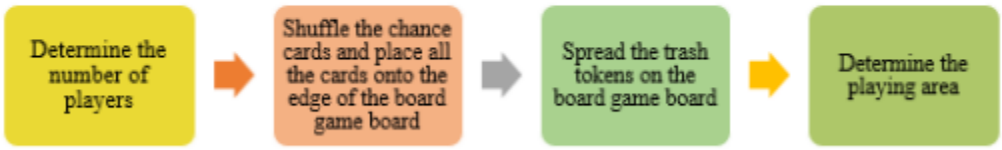

Figure 16. Early Stage Game

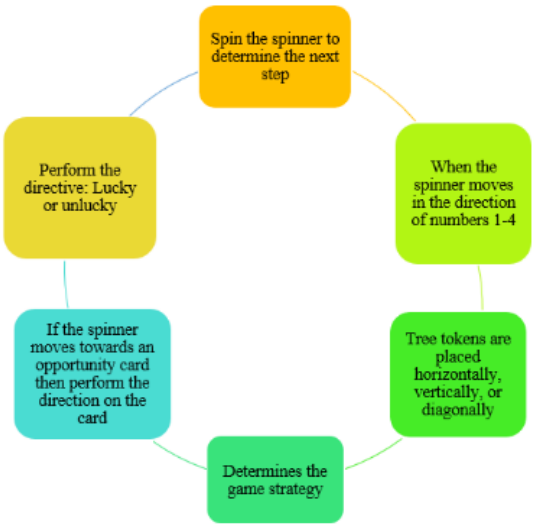

Figure 17. Game Core Stage

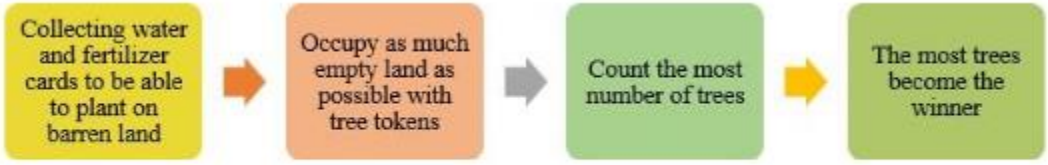

Figure 18. Final Game Stage

4.6 Validation Test

Validation test is a stage in product development where the prototype design is tested as a whole to ensure that the product being developed is in accordance with the needs of the target user. The validation test carried out directly carried out by 3 elementary school students directly related to product introduction and game testing.

Figure 19. Validation Test (1)

Figure 20. Validation Test (2)

Figure 21. Validation Test (3)

Figure 22. Validation Test (4)

Figure 23. Validation Test (5)

Figure 24. Validation Test (6)

Table 7. Explanation of Product Trials on Aspects of Children's Education

	Figure	Instruction
Affective	19, 20, 23	Children mutually respond to phenomena related to the causes of environmental damage and the benefits of trees for the environment. The child is sad when the tree is lost due to information on illegal logging on the chance card.
Psychomotor	19, 22, 23	Train hand and eye coordination, fine motor skill of children such as the ability to hold tokens, rotate spinner.
Cognitive	21, 24	When they read the chance cards they find new sentences that can 19, increase vocabulary, count the number of trees, group colors on tree tokens.

Furthermore, parent and teacher validation questionnaires were distributed aiming to find out whether consumers were interested in the designed product. This questionnaire uses a Likert scale to measure the level of consumer acceptance of the product. This questionnaire was distributed for a week in order to get accurate results.

Table 8. Validation Questionnaire

No	Question	Strongly Disagree	Don't Agree	Neutral	Agree	Strongly Agree
1	Can the board game Plant It help you give children an understanding of the environment?					
2	Is the game play of the Plant It board game easy to play and understand for children aged 7-12 years?					
3	Does the Plant It board game design have an attractive appearance?					
4	Does the Plant It board game have a complete game component?					
5	Is the material ised in the Plant It board game of good quality?					
6	Can the board game Plant It get rid of children's boredom while studying?					
7	Does the Plant It board game help children learn whilw playing?					
8	Can the board game Plant It be used as additional learning media for children at home/school?					
9	Can the board game Plant It be played with friends and family as a means of interaction?					
10	Do you agree to buy Plant It products as a medium for children's learning at home/school?					

Table 9. Respondent Decision Results

Question	Scale					Total	Total / Respondents	Information
	5	4	3	2	1			
1	70	56	6	0	0	132	4.13	Strongly Agree
2	55	60	12	0	0	127	3.97	Strongly Agree
3	55	60	12	0	0	127	3.97	Strongly Agree
4	50	56	18	0	0	124	3.88	Agree
5	50	60	15	0	0	125	3.91	Strongly Agree
6	75	56	3	0	0	134	4.19	Strongly Agree
7	75	56	3	0	0	134	4.19	Strongly Agree
8	75	48	9	0	0	132	4.13	Strongly Agree
9	75	56	3	0	0	134	4.19	Strongly Agree
10	50	24	15	18	0	107	3.34	Agree
Total	Percentage of Overall Questionnaire						3.99	Agree
							79,8%	Agree

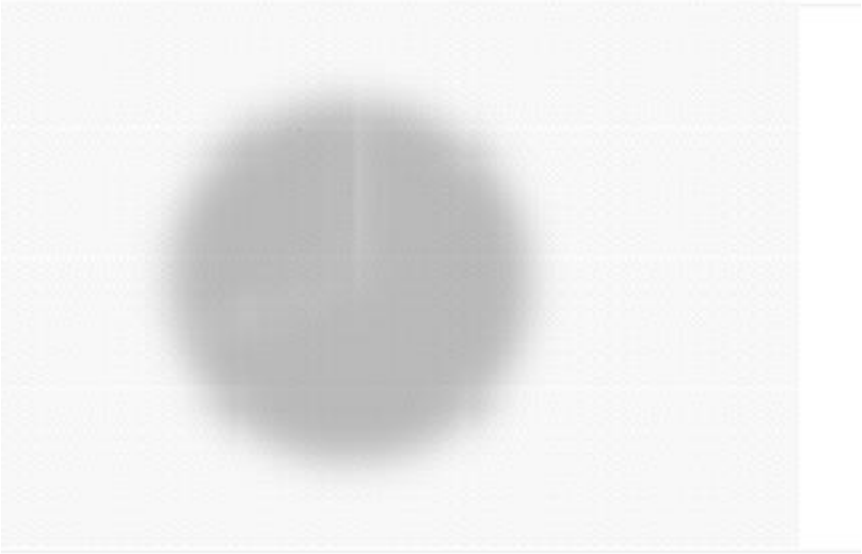

Figure 25. Percentage willing-to-pay

From the results of distributing the questionnaires, it was obtained 30 elementary school child respondents consisting of 66.7% parents and 33.3% elementary school teachers. The results of the questionnaire obtained were then processed using a Likert scale to produce the table above. Of the 10 questions it was concluded that 8 questions the respondents stated "strongly agree" and 2 questions stated "agree". With a total average number on each question as a whole of 3.99 or 79.8%. For the "Agree" scale, it means that the respondent agrees to buy this product at a percentage willing-to-pay by 70%.

Board Game Product Business Model

The business model canvas is a framework used to comprehensively describe the key elements of a business or business idea in a single view. The business model framework includes nine key elements that form the foundation of a business:

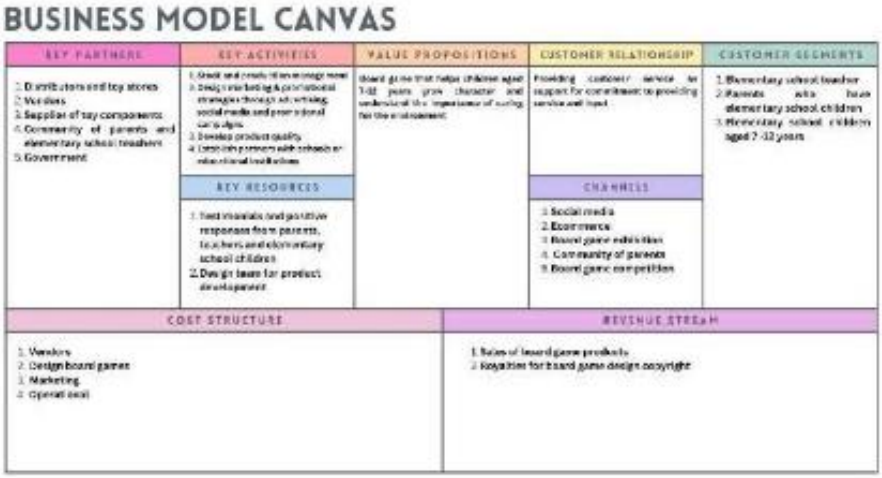

Figure 26. Business Model Canvas

4.7 Marketing Strategy

Market segmentation is the process of dividing an overall market into smaller, more targeted groups based on similar characteristics, needs, or behaviors. Plant it board game market segmentation includes:

1. Market segmentation for parents :

Demographics:

a. Age: 25-45 years old
b. Education: Varies, but usually with higher or secondary education.
c. Income: Middle to upper class.
d. Location: Urban or suburban with high environmental awareness.

Characteristic:

a. Parents who care about their children's education and development.
b. Parents who are very busy
c. Looking for alternatives to toys that support learning and positive values.
d. Desire products that teach environmental awareness.

Desired Benefits:

a. Educational products with strong environmental values.
b. Games that can be played together with children and support family interaction

2. Market Segmentation for Elementary School Children (7-12 years old):

Demographics:

a. Age: 7-12 years old.
b. Education: Elementary school.
c. Location: Various, but more focused on urban and suburban areas.

Characteristics:

a. Active children who want to learn in a fun way.
b. Those who have an interest in the environment and care about global issues.

Desired Benefits:

a. Educational and attention-grabbing games.
b. Products that provide opportunities to learn about environmental issues and how they can contribute.

3. Market Segmentation for Schools:

Demographics:

a. Level: Elementary school.
b. Position: Teacher or staff involved in curriculum development and extracurricular activities.

Characteristics:

a. Products support the curriculum and teach environmental values.
b. Looking for educational materials that can be integrated into the curriculum.

Desired Benefits:

a. Products that support the education curriculum and teach environmental values.
b. Games that can be used in classroom learning activities or as extracurricular activities.

Proposed Board Game Product Creation

1. Selection of more affordable materials: Identify the main components of the board game and review the type of material used. The use of thick cardboard material with attention to the best quality of the board game board.
2. Design simplification: Simplify the design of the board game and other components. Reduce elements that are not critical and tend to increase production costs. This can help reduce production costs and production time.
3. Reduction of additional components: Revisit additional elements such as packaging, or bonus components that do not really matter. Focus on core components that actually add value to the gaming experience
4. Use of lighter materials: Consider lighter materials for components such as cards, tokens, and spinners. Lighter materials can reduce shipping and production costs
5. Use of lighter materials: Consider lighter materials for components such as cards, tokens, and spinners. Lighter materials can reduce shipping and production costs.
6. Determining the right production quantity: Choose realistic production quantities based on market demand and business goals. Reducing production quantities where necessary can help avoid wasting materials and costs.

The business feasibility test aims to calculate the financial aspects of a business plan that has been designed and passed the validation stage.

Table 10. Variable Cost

Variabel Costs					
Item	Unit Cost		Qty	Total Cost	
Sticker 30x30	IDR	30,000	1	IDR	30,000
Board	IDR	50,000	1	IDR	50,000
Cutting Wood	IDR	100,000	1	IDR	100,000
Sticker A3	IDR	30,000	1	IDR	30,000
Fun Fact Card	IDR	2,000	33	IDR	66,000
Water Card	IDR	2,000	20	IDR	40,000
Fertilizer Card	IDR	2,000	20	IDR	40,000
Rule Book	IDR	2,000	8	IDR	16,000
Red 3D Token	IDR	3,000	50	IDR	150,000
Blue 3D Token	IDR	3,000	50	IDR	150,000
Yellow 3D Token	IDR	3,000	50	IDR	150,000
Green 3D Token	IDR	3,000	50	IDR	150,000
Trash Token	IDR	3,000	18	IDR	54,000
Total				IDR	1,026,000

Table 11. Fixed Cost

Fixed Costs (for a month)		Cost
Customer Service	IDR	1,500,000
Electricity & Cleaning	IDR	175,000
Promotion	IDR	75,000
Total	IDR	1,750,000

Table 12. Start Up Cost

Startup Costs		Cost
Design Services	IDR	2,100,000
Legality	IDR	500,000
Total	IDR	2,600,000

The total costs incurred include costs startup, fixed costs, and variable costs. The total spent to run the business is IDR 5,376,000,-.

Table 13. Number of Customers

Customers (per day)	No. of days
1	25

Table 14. Revenue Stream

Revenue		
Number of customers		25
Unit per customer purchased		1
Price per unit (in your currency)	IDR	1,300,000
Purchase frequency during month		1
Total sales in units		25
Total sales revenue	IDR	32,500,000

Table 15. Summary

SUMMARY		
Variabel Cost	IDR	1,026,000
Startup Cost	IDR	2,600,000
Fixed Cost	IDR	1,750,000
Total	**IDR**	**5,376,000**
Revenue	IDR	32,500,000
Profit	**IDR**	**5,100,000**
Breakeven		**6.39**
Pay back period (months)		**0.51**
Contribution (margin)		**274000**

In table 15, you can see a summary of the financial flow, where the profit (Profit) you get in a month is IDR 1,075,000.-. Expenses of IDR 5,376,000,- and income of IDR 32,500,000.-.Break Event Points(BEP) will be achieved if 6,39 units of products are sold. Payback period of business is estimated for 0,51 months. So it is concluded that the business is feasible to run.

5. CONCLUSION

The game model for environmental education is intended to solve problems in the introduction, understanding and application of learning to elementary school children. This game model fosters a love for the environment so that cognitive, affective and psychomotor effects are in accordance with the development of elementary school children in the digitalization era. At stage empathy map there are 4 main problems namely there are no topics that focus on environmental learning, lack of learning media themed environmental education, delivery of information about the environment that is difficult to understand and lack of motivation to learn about the environment. On value proposition canvas, designing gain creators in order to be able to integrate learning activities while playing interactively, information about the environment is adapted to the understanding of elementary school children and supports cognitive and psychomotor aspects. Pain relievers made to overcome pain obtained from customers. then on products & services create an educational game in the form of board game about environmental concern for elementary school children with an attractive appearance and gameplay. On lean canvas hows that product design board game This is so that it can assist teachers and parents in overcoming problems faced related to the lack of environmental concern for elementary school children. On blue ocean generate a plan board game Plant It which is superior to support aspects of education (cognitive, affective, and psychomotor), and in accordance with the lessons of elementary school children. Apart from that, in terms of design, materials, game components, the number of games are stated to be superior compared to other competitors. The validation test shows that the results of the respondents' decisions on the 10 statements distributed stated 8 questions "strongly agree" and 2 questions "agree". It can be concluded that the scale strongly agree means board game Plant It can help parents and teachers to provide an understanding of the

environment, relieve boredom, and be easily understood by elementary school children. So that the validation test is declared valid, with an average total respondent weight of 3.99 or 79.8%. The business feasibility test shows that the selling price of the product is IDR 1,300,000,- per unit, with a monthly profit of IDR 5,100,000. Break Event Points (BEP) will be achieved if 6,39 units of products are sold. Payback period of business is estimated for 0,51 months. So it is concluded that the business is feasible to run.

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Digital Orientation as a Mediator in Achieving Competitive Advantage in Coffee Shops: Insights from Bukittinggi

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Abstract: This study explores the impact of human capital and social capital on the competitive advantage of coffee shops in Bukittinggi, with digital orientation acting as a mediating factor. Human capital, which includes creativity, skills, and knowledge, along with social capital, encompassing trust and networking, are examined for their role in enhancing a business's competitive positioning in today's digital age. The research adopts a quantitative methodology, collecting data from 88 coffee shop owners through structured surveys. The analysis was conducted using Structural Equation Modeling (SEM) to understand the relationships among the variables. The results reveal that both human capital and social capital significantly influence digital orientation, which subsequently strengthens the competitive advantage of coffee shops. These findings highlight the critical role of digital strategies in improving small business performance and emphasize the importance of investing in human and social capital for long-term success. This study provides practical implications for coffee shop owners and stakeholders, particularly in the context of supporting small businesses in the tourism sector through digital transformation.

Keywords: human capital, social capital, digital orientation, competitive advantage, coffee shops

1. INTRODUCTION

Bukittinggi is a major tourist destination in West Sumatra, attracting 1,231,306 visitors in 2022, the highest in the region. The city offers a variety of attractions, including natural, historical, and man-made sites, as well as numerous dining options, both traditional and modern. One rapidly growing business type is coffee shops, which began expanding in the 2000s alongside similar trends across Indonesia. These coffee shops, featuring diverse concepts from vintage to minimalist designs, not only focus on aesthetics but also on offering unique coffee flavors and quality service. This growth has led to intense competition, prompting the need for a competitive advantage.

Previous studies, such as those by Tipu & Arain (2011) and Afifah, et al. (2023), have explored factors like human capital in enhancing competitive advantage in coffee shops. However, Afifah's study indicated that human capital only accounts for about 20% of the competitive advantage, suggesting other factors are also influential. This study builds on Afifah et al.'s model by adding social capital as a key factor, emphasizing the importance of networking in the success of coffee shops. Social capital is critical in establishing connections with various stakeholders like coffee enthusiasts, baristas, and suppliers, as supported by studies from Fitriyah, et al. (2022) and Haron (2020).

Bukittinggi was chosen as the research location for several reasons: its proximity to Padang with similar cultural and business characteristics, the growth of coffee shops during the pandemic, and the local government's support of these businesses as tourist attractions. The study introduces a new model of competitive advantage mediated by digital orientation, highlighting the increasing relevance of digital strategies in today's business environment. This model aims to provide practical policies for coffee shop development, not only in Bukittinggi but also in other cities.

In response to these concerns, businesses, including coffee shops, are increasingly expected to adopt eco-friendly and zero waste practices. The concept of sustainable business operations is now a critical factor in achieving competitive advantage, particularly for businesses in tourist-heavy areas like Bukittinggi. Coffee shops that embrace sustainability

by reducing waste, utilizing recyclable materials, and adopting energy-efficient processes not only align with global environmental goals but also appeal to the growing eco-conscious consumer base.

This study builds upon previous research on competitive advantage in the coffee shop industry by incorporating eco-friendly strategies and zero waste initiatives into the framework of digital orientation. By investigating the impact of human and social capital on competitive advantage through the lens of digital strategies, this research highlights how environmentally responsible practices can be integrated into digital transformation. The findings offer valuable insights for coffee shop owners and stakeholders in supporting sustainable development within the hospitality sector, while also advancing their competitive positioning through innovation and responsible business practices.

The research aims to examine the influence of human capital and social capital on competitive advantage, mediated by digital orientation. The findings are expected to offer practical insights for developing coffee shops based on the tested model, contributing to the strategic research plan of Politeknik Negeri Padang and supporting the strengthening of MSMEs in the digital era.

2. LITERATURE REVIEW

This research is grounded in the evolution of strategic orientation studies, which traditionally focused on dimensions like market orientation, entrepreneurial orientation, and technological orientation, all linked to business performance. Recently, attention has shifted towards digitalization, known as digital orientation, a concept introduced by Kindermann, et al. (2021), which affects how businesses operate. Previous studies in West Sumatra's small businesses, especially in tourism, primarily explored market, entrepreneurial, and technological orientations.

This study advances these previous works with key modifications: it positions strategic orientation as a mediating variable rather than directly linked to business performance, focuses on digital orientation relevant to current marketing conditions, and integrates human capital (Iqbal, Mawardi, Sanawiri, Alfisyahr, & Syarifah, 2023) and social capital (Widyawati, Soemaryani, & Muizu, 2023) The research emphasizes how strategic orientation, particularly digital orientation, can enhance competitiveness and business resilience.

The developed model has been adopted in various studies, such as Iqbal et al. (2023) in East Java's traditional furniture industry, focusing on how human capital, through strategic orientation, impacts business performance. Similarly, Widyawati et al. (2023) examined social capital and organizational health in small food and craft businesses in Samarinda, showing its link to competitive advantage.

This approach aims to deepen the understanding of how strategic orientation, especially digital orientation, can help small businesses improve competitiveness in the digital era.

Competitive Advantage

The marketing landscape has evolved significantly from product-focused Marketing 1.0 to consumer-focused Marketing 2.0, value-driven Marketing 3.0, and technology-driven Marketing 4.0. This evolution demands businesses to enhance competitive advantage (CA) to thrive in the digital marketing era. CA, central to business performance, is defined by Kuncoro & Suriani (2018) as market control and difficult-to-replicate advantages. Kotler et al. (2020) describe CA as the superiority a company holds over competitors, particularly in delivering value to customers.

CA arises from the value or benefits a company creates for its consumers, achieved through strategies that are hard to imitate, durable, and adaptable (Farida & Setiawan, 2022). Previous studies have shown a positive correlation between CA and business performance. For instance, Farida and Setiawan (2022) found that effective business strategies contribute to CA, with performance and innovation acting as mediators. Similarly, Kuncoro and Suriani (2018) highlighted the impact of product innovation and market driving on sustainable CA.

Correia et al. (2020) examined the relationship between market orientation and business performance through CA, using three main aspects: imitability, durability, and ease of matching. Their study of 1,190 Portuguese companies found that CA mediates the relationship between dynamic capabilities and business performance.

In the digital orientation-CA relationship, Berawi et al. (2020) found that digitalization offers new ways for companies to add value for consumers, with technology, resources, creativity, and innovation playing critical roles. However,

Karina and Astuti (2022) found that digital orientation did not significantly impact CA in Indonesian MSMEs, attributing this to a lack of understanding of digital orientation and established business strategies.

Human Capital

The Human Capital Theory, introduced by Becker (1962) and expanded by Rosen (1976), argues that individuals possess skills and abilities that can be enhanced through training and education, thereby increasing their value to an organization. Human capital (HC) is an intangible asset comprising the knowledge accumulated by organizational members. Vargas et al. (2016) identify three main components of HC: intellectual capital (knowledge-based components), structural capital (systems and processes), and customer capital (relationships with business partners). In this study, HC is defined as creativity, knowledge, and the ability to develop new ideas contributing to the organization (Prajogo & Oke, 2016).

Entrepreneurship studies consistently show that HC is a key variable in determining company growth and innovation, ultimately driving entrepreneurial success. HC's importance extends to digital orientation, where it enhances organizational capabilities in leveraging technology for business activities. HC is closely related to digital capabilities, which are essential for optimizing human resources and knowledge through digital technologies (Kindermann et al., 2021).

Individuals with strong HC can strategically use their knowledge and experience to manage company resources, significantly contributing to organizational success (Iqbal et al., 2023).

Social Capital

Social capital has been extensively discussed since the 1980s, with contributions from Bourdieu (1986), Coleman (1988, 1990), and Burt (1992). Nahapiet and Ghoshal (1998) define social capital as potential and actual resources embedded in social networks, categorized into structural, relational, and cognitive dimensions. Structural social capital refers to the overall connection patterns among actors, facilitating communication and cooperation, ultimately fostering trust. Relational social capital focuses on personal relationships formed through historical interactions, with key elements including trust, reciprocity norms, and identification. Cognitive social capital relates to shared systems of meaning and representation.

Social capital, or SC, is a resource derived from networks, considered a strategic asset in building competitive advantage (Gedajlovic et al., 2013; Wahyudi et al., 2023). Studies, such as Al-Daibat (2017), show that competitive advantage is developed through social approaches based on SC, which facilitates knowledge transfer within organizations, especially in MSMEs. SC also contributes to productivity by mobilizing physical, financial, and human resources (Indriani et al., 2022).

Digital Orientation

Digital orientation (DO) is conceptualized as a strategic approach that empowers and leverages digital technology in products and services while digitizing internal processes to achieve competitive advantage. DO, which includes market, entrepreneurial, relationship, and technological orientations, is considered a strategic priority for maintaining competitiveness (Saunila et al., 2021).

DO is a strategic position designed to capitalize on opportunities offered by digital technology (Kindermann et al., 2021), requiring integration between technology and organizational strategies. Resource orchestration theory (ROT) explains that competitive advantage can be developed and sustained through managing resources and individual capabilities, emphasizing the role of managers in digital transformation (Badrinarayanan et al., 2019).

Small businesses, often focused on local markets, may not feel the urgency of digitalization, but the current business dynamics push them to adopt digital orientation to find resources, build new relationships, and access broader markets. Digital platforms enable businesses to transition from traditional practices to digital channels, enhancing overall business success (Qiu & Man, 2021).

Based on the literature review discussed in the previous sections, the research model is illustrated in Figure 1 Research Model

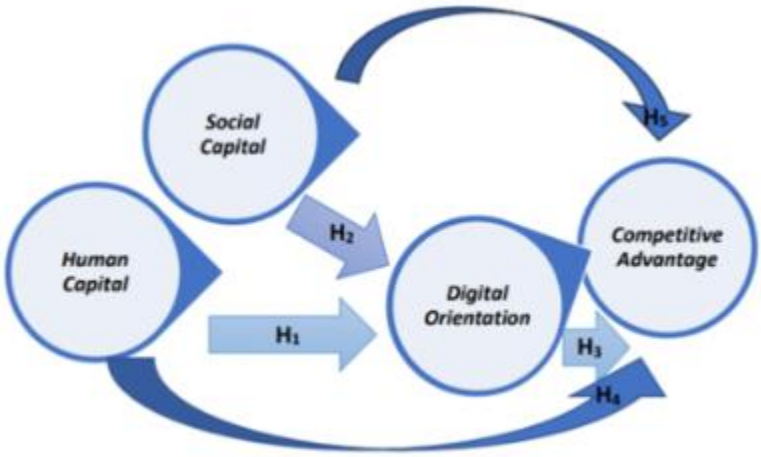

Figure 1 Research Model

Research Hypotheses

The formulated research hypotheses are:

H1: Human capital has a positive and significant effect on digital orientation.

H2: Social capital has a positive and significant effect on digital orientation.

H3: Digital orientation has a positive and significant effect on competitive advantage.

H4: Digital orientation mediates the relationship between human capital and competitive advantage.

H5: Digital orientation mediates the relationship between social capital and competitive advantage.

3. METHOD

This study examines competitive advantage (CA), human capital (HC), social capital (SC), and digital orientation (DO) using coffee shop owners or managers in Bukittinggi as the unit of analysis. It is a quantitative study, with a sample size determined using G-Power and a 5% error margin, resulting in a minimum of 77 respondents selected through simple random sampling. Data was collected via a survey using a structured questionnaire divided into four sections: respondent profile, HC, SC, DO, and CA, with both closed and open-ended questions. The closed questions used a Likert scale from 1 to 5.

Data Analysis. The collected data was processed and analyzed through several tests, including validity and reliability tests, hypothesis testing using Structural Equation Modeling (SEM), and mediation analysis.

Measurement Model Testing. Validity Test: Convergent validity was assessed using loading factors (0.5-0.7) and AVE values above 0.5. Discriminant validity was tested through cross-loadings. Reliability Test: Reliability was verified through Composite Reliability and Cronbach's Alpha values above 0.7.

Structural Equation Modeling (SEM) / Hypothesis Testing. The structural model or inner model was evaluated to predict relationships between latent variables. R-squares values were used to assess variance explained. Hypotheses were tested using SEM with SmartPLS 4.0, with a hypothesis considered accepted if the T-statistic exceeds the T-table value.

Mediation Analysis. Mediation was tested by evaluating both direct and indirect effects between independent variables and dependent variables through the mediator. The analysis followed a three-step model: (1) testing the direct effect of HC and SC on CA, (2) testing the effect of HC on DO, and (3) testing the effect of DO on CA.

Research Variables

In detail, research variables are described in Table 1 Research Variables, Definitions, and Indicators.

Table 1 Research Variables, Definitions, and Indicators

Variables	Definition	Indicators
Human capital	The level of creativity, knowledge, and ability to develop ideas used by individuals in an organization	▪ Skills ▪ Industry recognition ▪ Creativity and intelligence ▪ Specialized expertise ▪ Development of new ideas and knowledge (Prajogo & Oke, 2016)
Social capital	Actual and potential resources obtained through a network of relationships formed by individuals or groups. (Schlepphorst, Koetter, Werner, Soost, & Moog, 2020)	▪ Trust, ▪ Norms, ▪ Networks (Vipriyanti, 2017).
Digital Orientation	The strategic orientation of a company to promote the empowerment and use of digital technology in products and services for customers and to digitize internal processes and infrastructure as well as inter-company processes to achieve competitive advantage	▪ Use of digital channels ▪ Connecting customers and operational processes in new ways ▪ Integrated view of operational and key customer information ▪ Better use of operational decision analysis ▪ Use of digital technology for product and service value addition ▪ Launch of new business models based on digital technology (Abou-foul, Ruiz-Alba, & Soares, 2021)
Competitive advantage	Anything that an organization/company can do and possess better compared to competitors and the ability to produce goods and services of higher quality	▪ Ability to minimize production costs (Cost leadership) ▪ "Non-price" attributes that make the company superior to competitors (differentiation) (Correia, Dias, & Teixeira, 2020)

4. RESULT AND DISCUSSION

Instrument Testing Summary

The validity test results indicate that the Average Variance Extracted (AVE) values for each variable are greater than 0.5, confirming the validity of the indicators used to measure each variable. The outer loadings for all indicators are also above 0.5, further validating the measurement model. For example, the AVE for Competitive Advantage (CA) is 0.559, Human Capital (HC) is 0.64, Digital Orientation (OD) is 0.546, and Social Capital (SC) is 0.524. The validity of specific questions related to these variables was confirmed, with most questions achieving outer loading values above 0.5.

The reliability test shows that all constructs have Composite Reliability and Cronbach's Alpha values above 0.7, indicating that the questionnaire is reliable. Specifically, the Composite Reliability values are as follows: Competitive Advantage (0.835), Human Capital (0.876), Digital Orientation (0.878), and Social Capital (0.923). These results confirm the internal consistency and reliability of the measurement instruments used in the study.

The initial target sample size for this study was set at 77 coffee shops located in the central area of Bukittinggi. However, after the survey was conducted, it was found that many coffee shops had either closed or switched businesses. As a result, the researchers decided to expand the sampling area to the outskirts and borders of Bukittinggi

to meet the required sample size. Following this expansion, a total of 88 coffee shops were included in the sample, allowing for the subsequent testing of the research instruments.

Formation of the Research Model

The collected data were analyzed using Structural Equation Modeling (SEM) with the assistance of SmartPLS version 4.0 software. The data processing resulted in a model as shown in Figure 2 Research Model Testing.

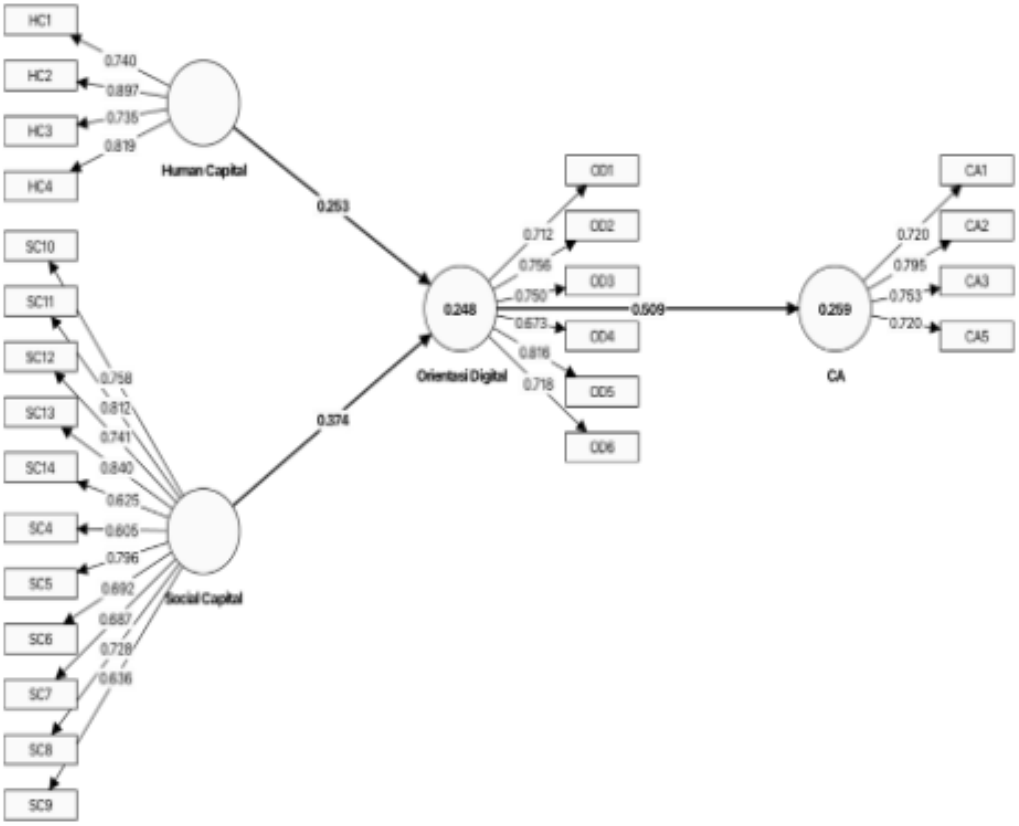

Figure 2 Research Model Testing

General Discussion

The study reveals that human capital has a positive and significant impact on digital orientation. Higher levels of skills, knowledge, and creativity among employees enhance an organization's ability to effectively adopt and utilize digital technology. This finding underscores the importance of strong human capital, which includes both technical and non-technical competencies, in enabling organizations to adapt quickly to technological changes and seize digitalization opportunities. Skilled employees can better implement new technologies and explore digital applications that boost competitiveness, aligning with Prajogo & Oke (2016), who highlight human capital's role in innovation and technology integration. Similarly, Iqbal et al. (2023) emphasize that strong human capital provides greater flexibility in responding to market and technological shifts.

The study also demonstrates a positive and significant influence of social capital on digital orientation. Social capital, encompassing trust, norms, and networks, fosters an environment that supports collaboration, idea exchange, and innovation. In the context of digital orientation, social capital facilitates the adoption of technology by providing robust internal and external network support and building trust among stakeholders. High levels of trust encourage employee support for digital initiatives and reduce resistance to change, while supportive norms and strong networks enhance the ability to adapt to digital advancements. These findings are consistent with Nahapiet & Ghoshal (1998)

and are further supported by Handoyo (2015) and Riza (2018), which highlight social capital's role in driving competitive advantage and innovation.

Digital orientation serves as a crucial mediator linking human and social capital with competitive advantage. It enables organizations to effectively integrate these resources into their business operations and strategies. By optimizing the use of human and social capital through effective digital orientation, organizations can enhance business processes, improve efficiency, and create superior customer experiences. This supports Berawi et al. (2020), who assert that digitalization is vital for creating value and maintaining a competitive edge in today's technology-driven market.

Practically, coffee shops in Bukittinggi should prioritize developing **human capital** by investing in employee training, particularly in **sustainable practices** and **digital skills**. Training employees on how to implement eco-friendly methods, such as waste reduction, energy conservation, and the use of biodegradable materials, can significantly enhance their contribution to both the business's competitive advantage and environmental sustainability. **Strengthening social capital** by building robust networks with stakeholders, including local suppliers of eco-friendly products, waste management services, and environmental advocacy groups, is also crucial for fostering collaboration on zero waste initiatives.

Moreover, adopting **digital technologies** can not only improve operational efficiency and customer experience but also support **sustainability efforts**. For example, digital platforms can streamline processes for monitoring waste output, optimizing resource usage, and reducing unnecessary consumption, all of which contribute to a zero waste approach. Coffee shops can use these technologies to promote their eco-friendly practices, such as digital receipts, waste tracking apps, and online marketing campaigns that emphasize sustainability, attracting environmentally conscious consumers.

However, the study acknowledges limitations such as a limited geographic scope and small sample size, which may not fully represent conditions in other Indonesian cities. Future research should expand geographically and consider additional factors like organizational culture, **local environmental regulations**, and **government policies** on sustainability to further validate and extend these findings. Overall, the study provides valuable insights into how human capital, social capital, digital orientation, and **eco-friendly practices** can jointly contribute to **competitive advantage**, particularly in Indonesia's tourism and service sectors, where sustainability is becoming increasingly important.

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5. CONCLUSION

This study highlights the significant role that human capital and social capital play in enhancing the competitive advantage of coffee shops in Bukittinggi, with digital orientation serving as a key mediating factor. The findings reveal that creativity, knowledge, trust, and networking not only impact digital orientation but also offer opportunities to integrate eco-friendly and zero waste practices into everyday business operations. Coffee shop owners can enhance their business performance by developing their workforce's skills in sustainable practices, fostering strong networks that support environmentally responsible initiatives, and embracing digital strategies that facilitate these transitions.

By incorporating eco-friendly principles into their digital orientation, coffee shops can optimize resource usage, reduce waste, and improve operational efficiency. This aligns with the growing demand for sustainable business models, especially within the SME sector. The integration of zero waste practices—such as reducing single-use plastics, utilizing biodegradable materials, and adopting energy-efficient processes—can strengthen customer loyalty and competitive positioning, as eco-conscious consumers increasingly favor businesses that demonstrate environmental responsibility.

For SMEs and entrepreneurial startups, particularly in the tourism and service sectors, embracing holistic business processes that prioritize sustainability and zero waste is essential for long-term success. The findings of this study provide practical insights for coffee shop owners, policymakers, and other stakeholders on how to merge digital

innovation with sustainable business practices, creating a path toward both environmental stewardship and competitive advantage.

Future research should explore the implementation of these practices in various industries and geographical areas to broaden the understanding of how eco-friendly strategies, alongside human and social capital, contribute to business success. By promoting eco-friendly and zero waste initiatives, businesses can not only enhance their profitability but also contribute meaningfully to the global sustainability movement.

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Implementation of Contract Employee Status to Improve Employee Performance

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Abstract: This study investigates the impact of motivation on employee performance and examines whether employee status moderates this relationship. The research employs a quantitative approach, using surveys and statistical analysis to collect and analyze data from 144 employees. The findings indicate that motivation has a significant and positive effect on employee performance. However, the study also reveals that employee status does not moderate the relationship between motivation and performance. In other words, the level of motivation experienced by employees, regardless of their employment status (contract or permanent), significantly influences their performance. The results suggest that organizations should focus on enhancing employee motivation as a primary strategy to improve overall performance without being influenced by the distinction between contract and permanent employees. Management can change employee status from permanent to contract employee to increase agility and avoid potential cost loss.

Keywords: Contract; Employee status; Employee performance; moderating; Motivation

1. INTRODUCTION

Employee performance was essential to the sustainability of the Company. Besides accounting profits, employee performance affects company performance(Khare et al., 2023). They also emphasize the importance of sustainability in every situation and condition of the company (Silva & Pålsson, 2022). The three pillars of company sustainability are (Hansmann et al., 2012), i.e. Economic, Environment, and Social. Economic, Environmental, and Social. Economic: Aspect for Exploring income, growing economic value and future impacts. Environment: Activities that focus on the sustainability of renewable resources, environmental protection. Social: protecting social health, safety, harmonization, social responsibility, local organisations, policies and regulations.

Enhancing company performance leads and increasing company sustainabilities. Good communication will present a clear discourse that encourages new technologies in optimizing the company's performance, making employees and production conditions visible and integrated (Rossi & Sangster, 2023). Company should consider all impact from managerial decision, in term of social and environment view (Hidayah & Raihan, 2024). Green recruitment of employees is also essential to ensure company sustainability and encourage employees to understand the environment (Barakat et al., 2023). Psychological Capital positively effect to Employee performance (Daswati et al., 2022). Therefore, company management should consider effect of changing regulatory on Human Resources, if any cganging of employee status as well.

Employee performance is influenced by motivation and many aspects (Gross et al., 2019; Parker & Kulik, 1995). Motivation is the spirit in which people perform their job hard and others do not (Skrzek-Lubasińska & Malik, 2023). Improper leadership oversight can hinder employee motivation and cannot improve employee performance (Cheng et al., 2023). Communication between stakeholders is an essential component within a company regarding motivation (Cori & Purnama, 2019). Emphasis on factors that influence motivation is vital to organizational success (Bińczycki et al., 2023). Highly motivated employees tend to perform well, Always want to establish relationships with colleagues and leaders, behave ethically, and improve self-efficacy (Akaarir et al., 2021).

External factors such as technological advancements can also affect employee performance. This is related to changes in individual and group behaviour as a reaction concern (Jiang et al., 2023). Government regulations related to labour can potentially affect employee performance, causing Human resources Management to be practised (Mahfouz et al., 2021). It is about how to get lean management to increase efficiency and avoid loss of resources (Zaheer et al., 2020). In the last decade, company trend to apply lean management and contract system. The main aim of lean management is to get agile and efficient structure (Alzahrani, 2024).

The effect of contract employee status on employee performance is a complex and diverse topic. Research shows that contract employees, who often do not have the security and benefits of permanent employees, can still show high-performance levels due to their motivation to get permanent jobs in the future (Fantinelli et al., 2023; Irawan et al., 2019). However, the lack of job security and benefits associated with contract status can also lead to lower job satisfaction and productivity among contract workers (Liu & Zhang, 2022). In other studies on certain types of jobs, these contract workers became more competitive and motivated to excel in their roles in their jobs, potentially leading to better performance compared to permanent employees (Kuchits et al., 2019). Ultimately, the relationship between contract status and employee performance is influenced by a variety of factors, including the terms of the specific contract, the level of job security, the understanding of the employment contract as well as the motivation of individual employees (Rousseau, 1989; Samson & Swink, 2023; ZHAO et al., 2007)

However, commonly employees are not adequately informed or engaged with the company policies. It will lead to confusion and potential non-compliance. This lack of adequate policy socialization can result in lower employee understanding and adherence to company guidelines, which in turn can negatively impact employee performance and overall organizational efficiency (Bertram & Brown, 2020). Proper policy socialization involves direct staff feedback loops, workforce development, and the use of technology to support client engagement and collaborative decision-making, as seen in the implementation of telehealth services during the pandemic (Proctor et al., 2022). When policies are not effectively communicated, employees may feel disconnected from the organizational goals, decreasing job satisfaction and productivity (Ripamonti & Galuppo, 2016). Adequate policy socialization ensures employees are aligned with the company's objectives and can contribute to its success. Usually, companies are worried about replacing permanent employees with contract employees. This study very important to guide managemen level to understand the potencial problem in term of contract employee performance.

2. MATERIAL AND METHODS

This study uses a descriptive quantitative method. A quantitative approach is a way of approaching quantitative data that involves numerical measurements (Mustafa et al., 2020). Descriptive statistics refers to the collection, submission, description, analysis, and interpretation of data collection (Franzese & Iuliano, 2019). The research population in the form of factory employees in Bogor city at all levels/levels amounted to 144 people or with saturated sampling techniques. The data used in this study was obtained from the questionnaire method. In this data collection technique, the researcher makes a list of questions or written statements that are systematically compiled. All Questions collected through an offline survey involve the employees of the ceramic factory in May 2024. Respondent consists of 101 contract employees and 43 permanent employees. Before making a list of questions on the questionnaire, the researcher identifies instruments related to or related to the variables to be studied, namely by describing these

variables into several sub-variables to obtain alternative answers. For the contract status variable, category indicators are used, namely permanent employees with the number 1 and contract employee status with the number 2. For the other variables, use a bipolar adjective scale of 5, a rating scale from 1 to disagree to 5 to agree on the questionnaire. After one month, 144 responses were received.

Furthermore, the analysis will be done using Smart-PLS software by following all data processing. Validity and reliability testing is carried out before studying the influence between variables. This study uses a descriptive quantitative method. A quantitative approach is a way of approaching quantitative data that involves numerical measurements (Mustafa et al., 2020). Descriptive statistics refers to the collection, submission, description, analysis, and interpretation of data collection (Franzese & Iuliano, 2019). The research population in the form of employees of a factory in Bogor city at all levels/levels amounted to 144 people or with saturated sampling techniques. The data used in this study was obtained from the questionnaire method. In this data collection technique, the researcher makes a list of questions or written statements that are systematically compiled. All Questions collected through an offline survey involve the employees of the ceramic factory in May 2024. Respondent consists of 101 contract employees and 43 permanent employees. Before making a list of questions on the questionnaire, the researcher identifies instruments related to or related to the variables to be studied, namely by describing these variables into several sub-variables to obtain alternative answers. For the contract status variable, category indicators are used, namely permanent employees with the number 1 and contract employee status with the number 2. For the other variables, use a bipolar adjective scale of 5, a rating scale from 1 to disagree to 5 to agree on the questionnaire. After one month, 144 responses were received. Furthermore, the analysis will be done using Smart-PLS software by following all data processing. Validity and reliability testing is carried out before studying the influence between variables.

3. RESULT AND DISCUSSION

3.1 Result

3.1.1 Demography of Respondent

Table 1
Employee Status

Employee Statue	Number	%
Permanent Employee	43	29,86
Contract Employee	101	70,14
Total	144	100%

The proportion of respondents' education levels can be seen in the table below:

Table 2
Respondent Education Level

Education Level	Number	%
High School/equivalent	135	93,75
D3	0	0
S1	8	5,55
S2	1	0,7
Total	**144**	**100**

Based on the results of questionnaire answers during the employee's working period

Table 3
Respondents Employment Period

Working Period	Total	%
Less than three years working period	54	37.5
Working period three up to 5 years	14	9.7
More than five years working period	76	52,8
Total	144	100.00

Based on the results of the questionnaire answers in the department/section where the employee works it can be seen in the table below:

Table 4
Employee Job Section

Section	Number	%
Production	89	61,8
Maintenance/Engineering	22	15,28
Supporting	33	22,92
Jumlah	144	100

Source: Author Data Processing, 2024

3.1.2 Data Analysis

Structural Equation Modelling (SEM) approach was used to analyse all data received. This approach provides more comprehensive evidence about the extent to which the model is supported by data and provides robust estimation for un-normal data and small sample size. The PLS-SEM approach uses Smart-PLS software was to analyse the causal relation between constructs, as it can produce sensible results. However, with few outliers, the data would not be discharged (Ghozali & Latan, 2015). These hypotheses were tested leveraging a two-step approach (i.e., the measurement and structural model (Hair et al., 2019).

3.1.3 Measurement Model assessment: Construct Validity

PLS path model was built leveraging SmartPLS software between Motivation and Employee Performance. All outer loading is acceptable (above 0,4) (Hair et al., 2019). All construct items sufficiently achieved the convergent validity (i.e., Cronbach's Alpha, CR, AVE).

Table 5
Reliability Test

Construct	Item	Outer Loading	Cronbach's alpha	CR (rho_a)	CR (rho_c)	(AVE)
Employee	K1	0.842	0.765	0.810	0.845	0.535
Performance	K2	0.683				
	K3	0.866				
	K4	0.418				
	K5	0.759				
Motivation	M1	0.788	0.842	0.843	0.888	0.612
	M2	0.759				
	M3	0.789				
	M4	0.775				
	M5	0.800				

Furthermore, all discriminant validity is also satisfied, where the Fornell & lacker Criterion, HTMT, and loading values are acceptable, as shown in Tables 6, 7, and 8. Therefore, the construct validity of reflective measurement modelling is valid and reliable.

Table 6
Discriminant Validity Fornell and Larcker Criterion

	K	M	z
Employee Performance(K)	0.731		
Motivation (M)	0.595	0.783	
Employee Statue (z)	0.295	0.346	1.000

Table 7
HTMT

	K	M	z
Motivation (M)	0.733		
Employee Statue (z)	0.338	0.377	
Employee Statue (z)x Motivation	0.584	0.813	0,145

Table 8
Discriminate Validity: Cross Loading

	K	M	z	z x M
K1	**0.833**	0.462	0.147	0.412
K2	**0.691**	0.472	0.145	0.452
K3	**0.869**	0.529	0.343	0.307
K4	**0.410**	0.252	0.183	0.257
K5	**0.761**	0.401	0.244	0.408
M1	0.443	**0.788**	0.232	0.633
M2	0.494	**0.765**	0.174	0.619
M3	0.486	**0.797**	0.323	0.525
M4	0.437	**0.773**	0.273	0.574
M5	0.458	**0.789**	0.353	0.569

3.1.4 Structural Model Assessment: Hypotheses Testing

The structural model assessment contains the effects and relation between the construct, typically the latent variable. Additionally, this interpretation of coefficient of determination (R2), effect size (f2), and PLS prediction are provided. The last bootstrapping approach is used to test the significance of the structural path. The result of the hypothesis test is summarised in Table 9. These three hypotheses involved are the relation between Motivation (M) and Employee Performance (K), Employee Status (z) and Employee Performance (K), and lastly, the moderation role of employee statue (z) in the relationship between Motivation (M) and Employee Performance (K). Based on the results in Table 9, only one hypothesis is supported.

We can see the result of Bootstrapping in Figure 1. For a more straightforward interpretation, different types of lines are given. The thicker line indicates the stronger the relationship value. The dotted line shows the moderating relationship model.

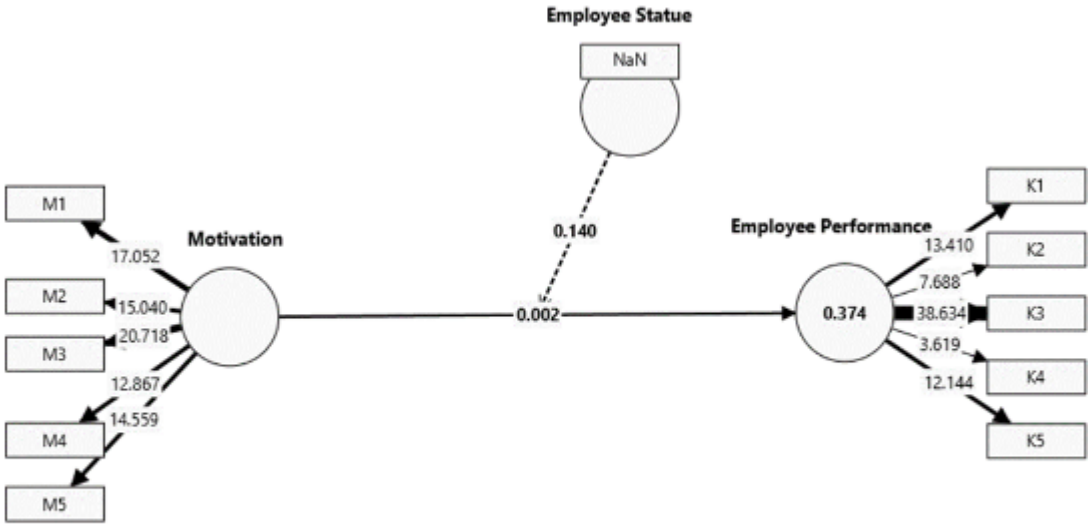

Figure 1: Bootstrapping operation

It was proven that Motivation affects employee performance. Employee status doesn't affect employee performance. Finally, It can be seen that employee status does not moderate the relationship between motivation and employee performance.

Table 9
Summary of Hypothesis Testing

Path	Std Beta	Std Error	T value	P values	Bias	Confidence interval 5,00%	Confidence interval 95,00%	F2	R2	Keputusan
M -> K	0,433	0,151	2,866	0,002	0,016	0,165	0,663	0,065	0,374	Supported
z -> K	0,273	0,173	1,579	0,057	0,006	0,009	0,572	0,007		Not Supported
z x M -> K	0,225	0,208	1,08	0,14	- 0,005	-0,12	0,564			Not Supported

3.1.5 Managerial Implication

For implication managerial, it used the Importance-Performance Map (I.P.M) operation on SmartPLS software. As shown in Figure 2, the most substantial item to reflect construct is Item Number 3 for employee performance and Item 3 for Motivation. It means the company should prioritise maintaining its as shown in Figure 2.

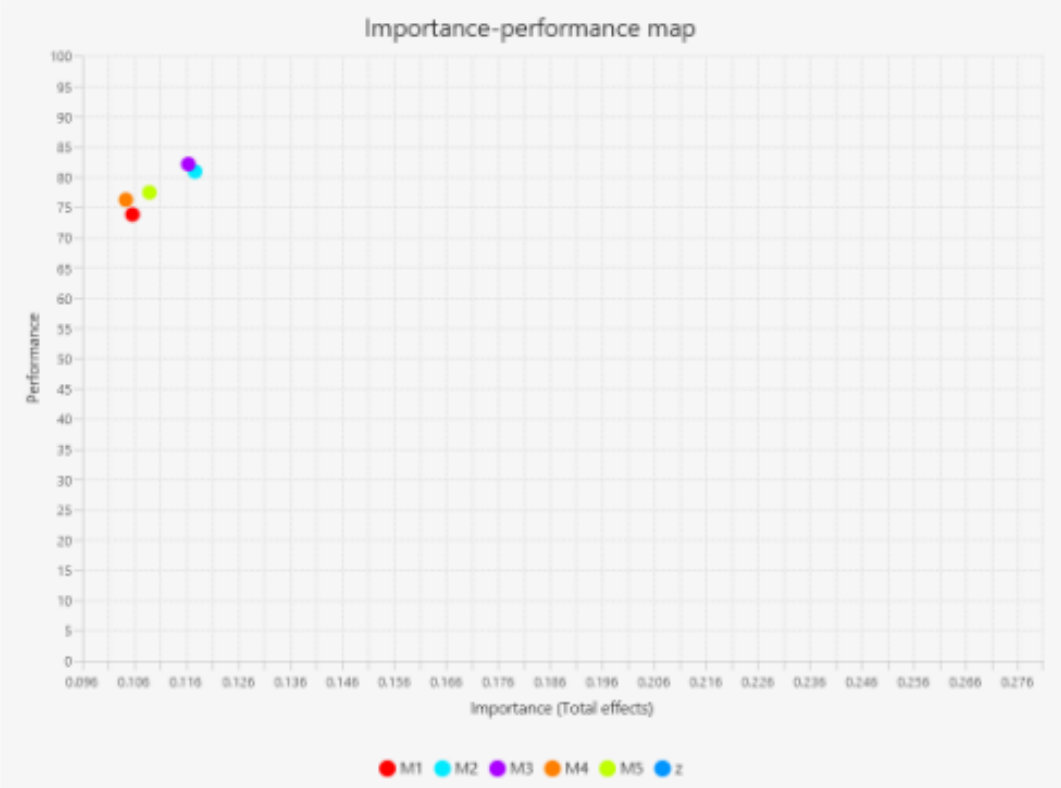

Figure 2: Importance-Performance Map

Figure 2 shown the most importance Item for each Construct. M3 has the highest performance value, 82,118. This item represents the statement: I am happy as an employee because my social needs are met.

3.2 Discussion

The first hypothesis stated that Motivation has a significant effect on the performance of factory employees. However, the analysis showed that the t-statistic value was 2.866, with a p-value of 0.002, which is smaller than the significance level of 0.05. Therefore, this hypothesis is accepted, with f2 at 0,065 (and R2 at 0,374. Efect size (f2) indicate in low level, It means low level in term of relative impact of Motivation Construct on Employee Performance construct. By the influence criteria of Table 9, it is classified as small with an original sample of 0.433 , which means an influence of 43,3%. The study found that Motivation has a significant effect on the performance of factory employees, as evidenced by the analysis results.

The Second Hypothesis stated that Employee Status has no significant effect on the performance of employees. However, the analysis showed that the t-statistic value was 2.248, with a p-value of 0.057, which is higher than the significance level of 0.05. Therefore, this hypothesis is not accepted, with an f2 value of 0.007 (table 9). It's indicates a minimal influence. The study found that Employee Status has no significant effect on the performance of employees. The third hypothesis stated that employee status does not moderate the relationship between motivation and employee performance. The analysis results show that the t-statistic value is 0.761, with a p-value of 0.14, which is more

significant than the significance level of 0.05. Therefore, this hypothesis is rejected, also based on the f2 value of 0.007 in Table 4.19 and the criteria of Table 3.4, so it is classified as having no effect, which means that there is no moderation by employee status in the relationship between motivation and performance.

4. CONCLUSION

These findings suggest that Motivation is an essential factor in determining the performance of factory employees and that organizations should focus on strategies to enhance employee motivation to improve overall performance. These findings suggest that Employee Status is not critical in determining the performance of employees in this context. Employee performance does not depend on the status, whether contract employees or permanent employees. These findings suggest that the relationship between motivation and employee performance is not influenced by the employee's status or position within the organization.

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QUOTATION

The best article is which has been submitted.

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Digital Transformation in Circular Economy: Enhancing Plastic Waste Collection Efficiency and Effectiveness

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Abstract: Efficient plastic waste collection on data management and reward calculation are essential for effective downstream recycling. An efficient system is needed to manage plastic waste collection data and calculate commissions or rewards based on the amount of waste collected by waste managers. BijakBerplastik, a web and mobile device-based application, aims to simplify storing plastic waste collection data and help calculate commissions or prizes for waste managers. This application was developed through context analysis, application use case design, application development, and feedback evaluation. Currently, it serves 345 users, including scavengers, waste banks, small stalls, kiosks, large stalls, and waste presses. BijakBerplastik is proven to improve data accuracy, streamline commission calculations, and enhance user experience. Users recommend adding transaction recording features and integrating the customer loyalty system. On the other hand, digitalization also improves productivity by 20% in the decision-making process and saves buying price by about 1.5% by the loyalty program.

Keywords: digitalization, data management, plastic recycling, decision-making, waste management

1. INTRODUCTION

Recycling is the most widely used circular approach and is highly relevant to plastic materials, up or downcycling (Sitadewi et al., 2021). Plastic waste recycling is a vital component of sustainable waste management, playing a crucial role in addressing environmental concerns associated with plastic materials (Tejaswini et al., 2022). However, the global recycling rates for plastic still need to improve, particularly in developing nations where challenges related to infrastructure, governance, and economic disparities pose significant obstacles to effective waste management. Global plastic recycling rates are currently estimated at approximately 9%, with developed countries exhibiting higher rates of around 30% due to stringent regulations, while developing countries often lag at close to 0% (Singh & Walker, 2024). Notable progress has been observed in the European Union, India, and China, with recycling rates reaching 12-13% by 2019, whereas the United States reports a significantly lower rate of approximately 4.5%. The surge in plastic production from 2 million tons annually in 1950 to over 500 million tons in 2020, with projections to reach 1 billion tons by 2050, underscores the urgent need for global efforts to curtail this trend and address the resultant waste management challenges (Woldemar D'ambrières, 2019). Nonetheless, international efforts are underway to combat the plastic waste crisis through initiatives to bolster recycling infrastructure and reduce plastic production. These efforts serve to provide assurance and instill confidence in the global community.

Moreover, managing plastic waste in developing nations presents various challenges, including inadequate infrastructure, improper waste disposal, and environmental pollution (Kibria et al., 2023; Mihai et al., 2022; Yang et al., 2018). However, there are opportunities for improvement, mainly through integrating the informal sector, particularly waste pickers, which plays a pivotal role in managing plastic waste and presents an opportunity for enhancing efficiency and yielding economic benefits. Integrating these workers into formal waste management systems can improve efficiency and yield significant economic benefits (Buch et al., 2021). Essential to this effort are

effective policies, including bans on single-use plastics and incentives for recycling (Cowan et al., 2021). However, enforcement can be hindered by limited resources and governance issues. Raising awareness about the importance of recycling and proper waste disposal is crucial. Educational campaigns can be instrumental in reshaping public behavior and reducing plastic waste (Torres-Pereda et al., 2020).

Furthermore, implementing advanced recycling technologies and digital management systems can streamline plastic waste management by tracking waste, optimizing collection routes, and improving recycling processes (Kannan et al., 2024). Providing financial incentives for recycling can also spur greater participation in waste management programs, such as offering subsidies for recycling businesses or rewards for individuals who recycle (Kibria et al., 2023). By addressing these key areas, developing countries can enhance their plastic waste management systems and mitigate environmental pollution.

Plastic waste management and reuse have become very popular among recycling communities due to their high selling value and the availability of clear trade regulations. The plastic waste recycling supply chain stretches from scavengers, collectors, shredders, and plastic factories to the bottled drinking water industry that utilizes it as part of its supply chain. However, managing plastic waste, which is very scattered and sporadic, has resulted in the need for more transparent economic distribution information between stages of the recycled plastic production process (Bhubalan et al., 2022). Although the amount of public plastic consumption continues to increase, there is a gap in the middle chain where the plastic recycling processing factory is always undersupplied and underutilized. Meanwhile, the profession of scavengers, which has always been considered unprofitable, is one of the biggest beneficiaries, so it is possible to earn an income that exceeds the income of ordinary office workers. A consistent supply of recycled plastic has always been a problem for recycling plants due to its uncertainty (Hahladakis & Iacovidou, 2019).

This study proposed a digital-based management system to simplify storing plastic waste collection data and commission a system for waste collectors to optimize the plastic recycling process. By focusing on these critical areas, the paper seeks to provide a thorough understanding of the challenges and opportunities in digitizing plastic waste recycling in developing nations, particularly Indonesia. Ultimately, the goal is to enhance waste management systems and mitigate environmental pollution.

2. LITERATURE REVIEW

Several concepts are involved in the CE definition, and there needs to be more clarity regarding how they relate. Some are basic, classic, and fundamental principles, and others are complex, built on the basic ones. Circular economy (CE) is a new economic model that focuses on maximizing the reuse and recycling of materials to minimize waste generation. It aims to revolutionize the production, consumption, distribution, and recovery process based on a cradle-to-cradle vision (Ghisellini et al., 2018). The Circular Economy is an economic system aiming for zero waste and pollution by reusing materials and using clean, renewable energy sources (Nobre & Tavares, 2021). As definitions evolve, they encompass various aspects of the Circular Economy, including the design of new products, the emergence of new legislation, and adoption by industry (Arruda et al., 2021). Expanding on the criticisms discussed earlier, achieving genuine circularity would require a practical circular economy that should address specific issues, be specific about its goals, consider trade-offs, encompass energy, individuals, and waste globally, and be open and accountable for its economic, social, and environmental impacts (Corvellec et al., 2022).

Digital technology in waste recycling is a significant advancement that complements traditional mechanical recycling methods. This technology, which is continuously evolving, plays a crucial role in managing waste by providing real-time information on the location, status, and quantity of non-biodegradable trash. It enhances traceability and makes products and services more accessible, keeping our audience informed about the latest advancements in the field (Kurniawan et al., 2023; Mangold & von Vacano, 2022). Digital tools enable individuals to make environmentally

conscious choices and assist organizations in offering the best sustainable solutions. The leading technologies of Industry 4.0 included sensors, IoT, blockchain, big data analytics, and AI.
Furthermore, much of the research concentrated on municipal waste management, waste collection procedures, and recycling methods (Kannan et al., 2024). Internet of Things devices can efficiently simulate, monitor, and verify products within the supply chain (Sarkis et al., 2021). Dealing with environmental effects and methods for using data, improving energy usage, and reducing digital waste and carbon footprint.

The best way to deal with plastic is by transforming plastic waste into valuable products like tiles, paver blocks, concrete, sanitizers, perfumes, graphene, electrode materials, carbon nanotubes, etc. This addresses the environmental issue and presents a significant economic opportunity. Responsible waste management is a crucial step towards a sustainable future, underscoring the importance of our work and inspiring our audience to continue their efforts (Maitlo et al., 2022). It offers an opportunity to generate economic value. Establishing responsible supplier-buyer relationships requires economic incentives, trust-building efforts, and a willingness to learn and adapt. By having waste pickers sort materials and then using industrial-scale sorting and washing, the resulting recyclables were similar in quality to recyclables from advanced formal recycling systems in high-income countries (Gall et al., 2020)

3. METHOD

The study employed a thorough qualitative approach to obtain contextual findings, utilising a comprehensive mixed method. The research designed a systematic application named BijakBerplastik to record the collection and processing of plastic bottle waste from bottled drinking water used by the Recycling Business Unit (RBU). Komodo Water develops the application in collaboration with Danone Indonesia.

Waterfall software development methodology

The application development is based on the standard software development cycle, while each phase will be executed in a single cycle known as The Waterfall Model (Aroral, 2021; Pargaonkar, 2023). The Waterfall Model is known as a linear sequential life cycle model. The earliest process model is straightforward to comprehend and apply. Each phase must be finished before the next one can commence, and there is no overlap between phases. The model depicts the software development process in a linear sequential flow. As a result, it is also called a linear-sequential life cycle model, which implies that any phase in the development process begins only when the preceding phase is finished. In the waterfall model, the five phases do not overlap. This model is widely utilized in software engineering to ensure project success. In "The Waterfall" approach, the entire software development process is divided into distinct phases, and typically, the output of one phase serves as the input for the subsequent phase sequentially. Each cycle consists of 5 stages: planning and requirements, design, implementation, verification, and maintenance. The application was developed for six months, followed by training for three months.

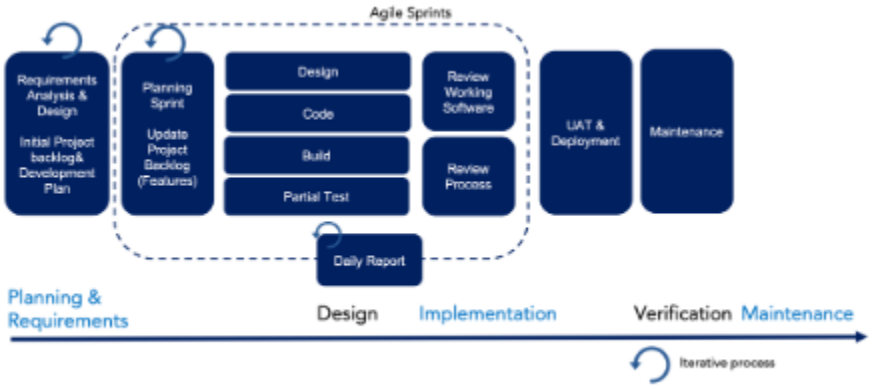

Figure 1. The waterfall model for BijakBerplastik application development

Planning and requirements

In the initial phase of the Design Sprint, a series of crucial activities are undertaken in close collaboration with the client. This ensures that the project meets the client's requirements and expectations. High-level requirements are identified based on the initial client needs, and any further data or information necessary to ensure clarity and accuracy is gathered. Subsequently, a prototype is developed based on the client's input, which is then presented for approval, ensuring that the layout and navigation flow meet their expectations.

Feedback from the client is also solicited, and an 'Unclear Issues' document is provided to address any questions or areas requiring further clarification. This document ensures that all client concerns are addressed and resolved. The feedback is meticulously documented and is a reference for subsequent project stages. Once the client validates the requirements, a flow diagram and high-fidelity designs are created, and each item in the backlog is defined with scenarios and behaviour-driven development specifications. Additionally, a simple Functional Specification Document (FSD) is produced as the final deliverable of the Design Sprint process, accompanied by comprehensive project documentation.

Following the insights gained from the Design Sprint, the Project Manager devises the plan for the subsequent Development Sprint stage. The Design Sprint process is iterative, each lasting five working days and limited to two revisions per iteration to maintain project momentum. Preparedness for any requirements or application flow changes during development is emphasized, and these changes are re-analyzed and may necessitate timeline adjustments. Requests outside the initial scope may result in a Change Request (CR), but the process is adaptable to accommodate such changes.

Design and implementation

The Design and the Implementation phase ensures the system is developed and refined through an iterative approach. The process begins with the continuation of the Design Sprint, which is carried out in tandem with development activities. If the remaining requirements are to be addressed, these are further analyzed during this stage. The design sprint outcomes are then applied in the development sprint scheduled for the following week. Notably, the first sprint of application development cannot commence until at least one design sprint has been completed to ensure a clear and well-validated starting point.

During the Development Sprint, the system is built incrementally, with each cycle focusing on smaller, manageable portions of the application. New features and functionalities are added progressively, allowing the system to evolve with each iteration. The development team remains flexible, accommodating feature adjustments during the development process as long as they stay within the original scope. However, any significant changes to the flow or requirements may affect the project timeline and, if beyond the initial agreement, could result in additional costs.

Verification and maintenance

The Testing phase is essential for ensuring that the system functions as intended. Several types of testing are conducted during this phase. Unit Testing verifies the functionality of individual components, ensuring they meet the specified requirements. Following this, System Integration Testing (SIT) is carried out jointly by Komodo Water and Danone to ensure the smooth integration of the new system with existing ones. Positive and negative test scenarios are explored during SIT to ensure robust system performance. Once integration testing is complete, the end users conduct User Acceptance Testing (UAT) to validate that the solution meets their needs. Any errors or defects identified during testing are addressed through bug fixes. The final deliverables from this phase include the UAT document and deployment approval. The Deployment stage marks the system’s transition to live operation. Once deployed, a 6-month warranty period help to fix any necessary bug.

Training

To ensure a smooth rollout of the system, comprehensive training and mentoring will be provided to all on-the-ground staff, including both application users and administrators. This training will cover all necessary aspects of the system's operation, enabling staff to utilize and manage the application effectively. The mentoring component aims to provide ongoing support to address any challenges during the initial implementation phase, ensuring that staff are fully equipped to operate the system efficiently.

Loyalty program

To increase participation in waste collection, RBU has introduced a loyalty program. Participants will earn points by collecting a certain amount of waste. These points can then be exchanged for rice or cooking oil. Participants will earn 1 point for every 100 kg of plastic waste collected. Five points can be exchanged for 2 liters of cooking oil, and 10 points for 5 kg of rice. The program runs throughout the year, allowing waste collectors to accumulate points as long as they meet the required volume.

Evaluation

Following the maintenance phase, the research also included evaluating the pilot implementation in the field. Data was collected through the distribution of questionnaires, structured focus group discussions (FGDs), and in-depth interviews. The evaluation study was conducted in August-September 2025, with questionnaires distributed to 100 respondents who used the application out of 345 users from RBU South Tangerang.

4. RESULT AND DISCUSSION

BijakBerplastik is a pilot digital waste traceability program for rPET supply chains in Indonesia. The system empowers all stakeholders by providing traceability of the plastic recycling process supply chain. It consists of a mobile application for waste-pickers and a web-based back office application for aggregators and bottled water companies, like Danone, enabling them to manage and report data. The primary goals are to increase the scope and granularity of information monitored, establish a transparent and traceable chain of custody, and control pricing and incentives to respond quickly to market changes. One of the key features is real-time reporting, which ensures that all stakeholders can operate efficiently and respond promptly to any market changes.

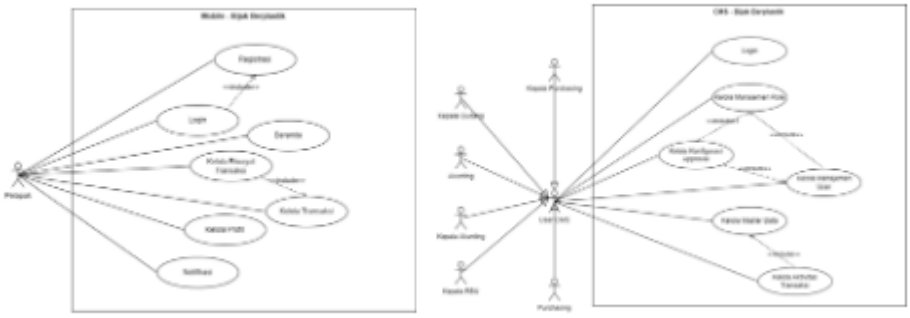

Figure 2. Use case mobile and CMS phase 1

Additionally, it offers cloud-based access to an information dashboard that is not reliant on physical infrastructure, with tiered access depending on the user's role in the supply chain. To operate BijakBerplastik optimally, users must have hardware with specific minimum specifications, including a smartphone, a processor with a minimum capacity of 1.5 GHz, memory/RAM with a minimum capacity of 2 GB, and storage media/hard drive with at least 10 GB of available capacity. The software operating system must be Android with a minimum version of 5.0 or iOS with a

minimum version of 12, and the application requires an internet network connection. Users are expected to understand how to use and operate a smartphone device.

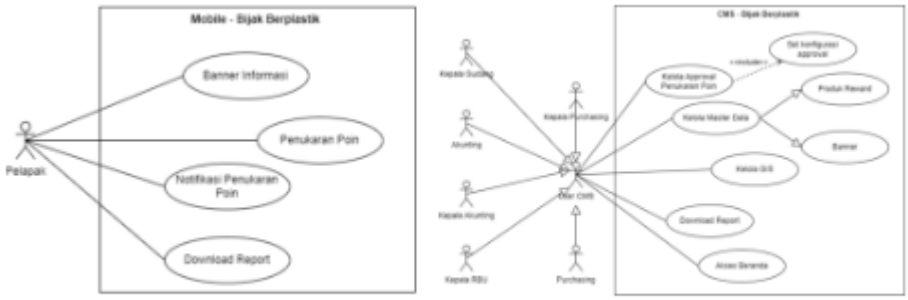

Figure 3. Use case mobile and CMS phase 2

10-month digitalisation journey has yielded promising results, with a 169% increase in users. This surge is attributed to user interest in digitalisation, the practical education provided by the RBU officers, and the incentivisation system in place. The initial three months were the most challenging, with user education being the linchpin. The RBU officers played a pivotal role in enlightening the users about the significance of digitalisation and providing a manual guide to instil confidence in the digital process.

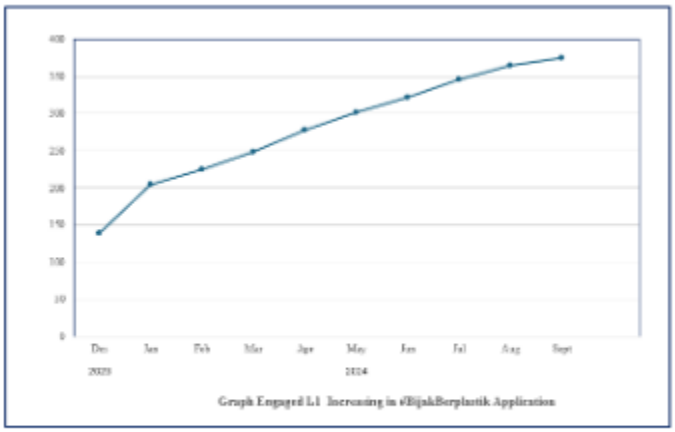

Figure 4. Increasing user number of BijakBerplastik application

The loyalty program trial, conducted in January, has been a resounding success in attracting traders and scavengers to the application system. This is evident from the graph, which shows a consistent increase in participation since January. The point exchange feature has emerged as the most popular among users. However, the quantity of waste collected fluctuates based on its availability in the field, a factor that underscores the program's reliance on external factors and the need for a steady supply of waste. The variation in waste collection is not dependent on the number of users using the application, but rather on the supply of raw materials for plastic bottle waste in the field. This is influenced by the price offered, the number of players, and the competitors in the field who absorb raw materials.

Up to this point, 20 users have availed themselves of the point exchange, a clear indication of the program's popularity. This figure signifies that 20 individuals have collectively redeemed 20 sets of 5 points, totaling 500 kg, or 20 sets of 10 points, equivalent to 1,000 kg, resulting in a total of 10,000 kg and 20,000 kg, respectively. This not only demonstrates the program's success but also the significant economic value it generates. Assuming the selling price of plastic waste is IDR 7,300.00/kg, it is estimated that transactions involving 500-1,000 kg carry an economic value

of IDR 36,500,000.00-73,000,000.00. When juxtaposed with the capital costs of purchasing rice or cooking oil, the expenses incurred by RBU for this endeavor amount to only IDR 3,500,000.00 -7,000,000.00, constituting a mere 5% of the total sales value.

The results indicate that digitalization did not increase the volume collected. This can be attributed to various factors, primarily driven by competition. Price competition, buying mechanisms, and social relations all affected this outcome. However, it is essential to note that digitalization has other significant benefits, as discussed in the following paragraphs. We acknowledge the challenges faced in the digitalization process and are committed to addressing them for future improvements.

Figure 5. Collected plastic waste by BijakBerplastik application

The digitalization journey has significantly improved RBU's productivity, simplifying supplier data management by 20%. Previously, RBU relied on spreadsheets for data collection and analysis. However, with digitalization, RBU can now make decisions based on graphical representations of the data, leading to a more efficient and productive process.

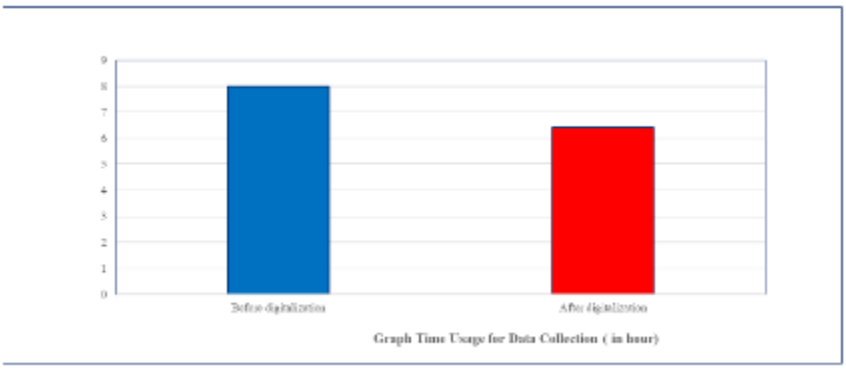

Figure 6. Time usage for data collection

Digitalization has also led to a decrease in material costs, primarily due to the implementation of an incentivization system. By reducing the buying price and managing market price fluctuations through incentivization, RBU has navigated the middle ground in price wars. The more volume a supplier sells to RBU, the more incentive they receive, providing a strong motivation for increased sales.

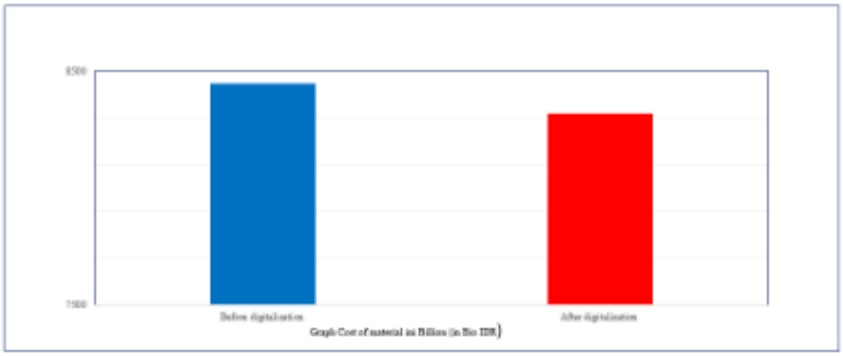

Figure 7. Cost of material in billion IDR

5. CONCLUSION

Digitalization has the potential to significantly improve the effectiveness of the circular economy, particularly in waste management and recycling, through applications and platforms. By leveraging incentivization systems, digital platforms can enhance recycling collection rates while reducing material costs. The cornerstone of this system's success is user education—ensuring that consumers, waste traders, scavengers, and waste banks understand and utilize the technology effectively. However, education alone is insufficient. Ongoing training and consistent assistance are critical to building trust and fostering a culture of collaboration between Recycling Business Units (RBU), waste traders, scavengers, and other stakeholders in the waste ecosystem. These elements support smooth operations and help embed digitalization into daily waste management practices. A personal approach is necessary to handle waste collection's diverse and challenging nature, where each stakeholder has unique needs and circumstances. Furthermore, digital applications have the transformative power to revolutionize waste management. These platforms can integrate creative approaches like gamification and community gatherings to cultivate enthusiasm. For instance, a point redemption system or competitive challenges among users can engage traders and scavengers, motivating them to deposit more waste. This dynamic engagement fosters a sense of ownership and participation, thereby strengthening the circular economy. In essence, digital applications can metamorphose the traditional waste management model into a collaborative, incentivized, and efficient system, driving sustainability and reducing environmental impact. Digitalization improves the recycling collection rate and reduces the cost of materials through an incentivization system. The critical success factor of digitalization is the education of the users. Training and consistent assistance are not just tasks, but crucial elements that need to be done to build the trust and culture between RBU and the waste trader, scavanger and waste bank. However, the nature of waste collection and management is challenging and requires a personal approach to manage. Providing creative approach like community gathering or gamification through point redemption system will help build dynamic enthusiasm among the users, encouraging the traders and scavengers to deposit more waste.

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Life Cycle Assessment (LCA) of the Grease Gone System

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Abstract: The increasing concerns over environmental pollution and the inefficiencies of traditional grease traps in wastewater management necessitate innovative solutions. Traditional grease traps capture grease but contribute to environmental damage through improper disposal, delaying the inevitable release of grease into the earth's ecosystems. This paper presents a Life Cycle Assessment (LCA) of the Grease Gone system, an eco-friendly alternative to conventional grease traps. By utilizing human hair combined with Nomex, Grease Gone offers a sustainable solution for residential and commercial settings. The LCA evaluates the system across its entire lifecycle, from raw material extraction to disposal, focusing on key metrics such as Global Warming Potential (GWP), energy consumption, water usage, and waste generation. Results show that Grease Gone significantly reduces the carbon footprint and water pollution by diverting grease from wastewater treatment plants, while its use of biodegradable and recyclable materials minimizes environmental impact at the end of its life. Although energy use in production presents a trade-off, the overall environmental benefits of Grease Gone outweigh those of traditional systems.

Keywords: Life Cycle Assessment, Sustainable Waste Management, Grease Trap Innovation.

1. INTRODUCTION

The improper disposal of grease in wastewater systems presents a significant environmental challenge. Grease, which originates primarily from commercial kitchens, food processing plants, and residential sinks, is a major contributor to blockages in sewer systems and pollution in water bodies (Jaruwan Wongthanate, 2014). Grease traps capture grease but are often inefficient at preventing the long-term release of grease into the environment, leading to significant environmental challenges in wastewater management (B E Davidson, 2016). Improper grease disposal can lead to significant damage in wastewater systems and environmental pollution (X Wang, 2018).

The sticky nature of oil and grease causes them to accumulate in drainpipes and sewer lines, creating odor problems and leading to corrosion under anaerobic conditions. When large quantities of these substances reach municipal wastewater treatment plants, they float on the water surface, adhere to pipes and walls, and block strainers and filters, disrupting the treatment operations. Since oil and grease are resistant to degradation during the treatment process, they ultimately end up in the final sludge. Traditional grease traps are designed to capture grease before it enters the sewer system; however, they do little to address the long-term environmental effects of improper grease disposal.

Many research proved that human hair has a good oil absorption properties. The study presented in "Mitigation of oil spills from synthetic seawater using human hair – Experimentation, modeling and optimization" (N K Jilagam, 2023) focuses on the effectiveness of human hair as an adsorbent for cleaning up oil spills in synthetic seawater. The research investigates the impact of factors like adsorbent weight, initial oil concentration, and contact time on oil removal efficiency, potentially offering a sustainable and cost-effective method for oil spill mitigation. The research in (M L Phillips, 2018) focuses on the effectiveness of human hair as an oil spill sorbent, comparing its performance to commercial alternatives.

The study on using human hair as oil-absorbing properties has demonstrated its effectiveness in capturing and solidifying grease, making it a promising component for the Grease Gone system. Human hair is a natural, renewable, and biodegradable material that can effectively absorb and trap grease, preventing it from entering wastewater systems and the environment. By combining human hair with Nomex, a durable and heat-resistant synthetic fiber, the Grease Gone system aims to provide a comprehensive solution for efficient grease capture and sustainable disposal. The system is designed for both residential and commercial applications, where grease disposal is a recurring challenge.

In addition to preventing grease from entering wastewater treatment facilities, Grease Gone minimizes the harmful effects of releasing grease into the environment by utilizing biodegradable and recyclable materials.
The Grease Gone system offers a more sustainable solution by utilizing a combination of human hair and Nomex, a heat-resistant synthetic fiber, to absorb and solidify grease. Unlike conventional grease traps, Grease Gone prevents grease from entering the wastewater stream, effectively reducing the burden on sewage treatment plants and minimizing the risk of environmental contamination. Most systems merely trap grease, delaying its release into the environment rather than preventing it. This has raised concerns about the sustainability of these systems, especially as society places increasing emphasis on eco-friendly and zero-waste practices.

By studying the comprehensive Life Cycle Assessment of the Grease Gone system, researchers can evaluate its environmental performance across the entire lifecycle, from raw material extraction to end-of-life disposal. (C. Choe, 2023) focuses on Life Cycle Sustainability Assessment as a tool for analyzing the sustainability of products, services, or processes, particularly within the context of a sustainable energy future. The authors review the LCSA methodology and its application in supporting decision-making throughout a product's life cycle, contributing to sustainable development.

This paper conducts a Life Cycle Assessment (LCA) of the Grease Gone system to evaluate its environmental impact throughout its entire lifecycle, from the sourcing of raw materials to manufacturing, usage, and disposal. The LCA framework assesses the environmental impacts in terms of Global Warming Potential (GWP), energy consumption, water usage, and waste generation. By comparing these metrics to traditional grease trap systems, this study aims to provide a comprehensive understanding of how Grease Gone contributes to sustainable waste management practices. The purpose of this LCA is not only to quantify the environmental benefits of Grease Gone but also to identify areas for potential improvement, ensuring that the system can continue to align with the principles of zero-waste and eco-friendliness. This analysis will help position Grease Gone as a viable solution for businesses and households looking to adopt more sustainable practices in their operations. Furthermore, the findings of this study offer valuable insights into the future optimization of the system, supporting the ongoing transition toward environmentally responsible technologies in wastewater management.

2. LITERATURE REVIEW

Life Cycle Assessment (LCA) is an established methodology used to assess the environmental impacts associated with all stages of a product's life, from raw material extraction, processing, and manufacturing to distribution, use, and disposal. According to ISO 14040 (International Organization for Standardization, 2016), LCA provides a structured framework for evaluating the potential environmental effects of a product, service, or system by considering various impact categories such as global warming potential, resource depletion, and human health effects. The holistic nature of LCA helps stakeholders identify opportunities for improving environmental performance at each stage of a product's life cycle.

Studying the life cycle impacts of waste management systems similar to grease traps can provide valuable insights into the potential environmental impacts of Grease Gone. For instance, LCA studies on wastewater treatment systems like septic tanks and filters reveal that the use phase is often the most environmentally impactful, particularly due to maintenance and waste disposal (A P Machado, 2017). The energy and resources required to maintain these systems, as well as the handling of captured waste, contribute significantly to their overall environmental footprint.

3. METHOD

This study uses Life Cycle Assessment (LCA) to evaluate the environmental impact of the Grease Gone system, examining its entire life cycle, including raw material extraction, manufacturing, transportation, usage, and disposal. The system’s primary materials, human hair and Nomex were selected for their environmental and technical properties. Data was collected through experimental testing of the filter's performance and from existing LCA studies for comparable materials.

The Life Cycle Inventory (LCI) collected data on the energy required for manufacturing and material extraction, as well as waste generation at each stage. The use phase involved laboratory testing to assess grease capture efficiency

and water consumption. Lastly, the end-of-life phase evaluated disposal options, focusing on biodegradability and recycling potential.

The Life Cycle Impact Assessment quantified the environmental impacts of the Grease Gone system using the following impact categories: Global Warming Potential, energy consumption, water usage, and waste generation. This analysis allows for a comprehensive understanding of the environmental performance of the Grease Gone system in comparison to conventional grease trapping technologies.

The impact assessment measured environmental factors like Global Warming Potential (GWP), energy consumption, and water usage using established LCA metrics. Data from previous studies on traditional grease traps was compared with the results for the Grease Gone system, highlighting its reduced environmental footprint.

4. RESULTS AND DISCUSSION

1. Grease Capture Efficiency

   The Grease Gone system demonstrated significant improvements in grease capture compared to traditional grease traps. In experimental trials, the system filtered up to 95% of the grease content containing suspended solid (SS), fat oil and grease (FOG), and biochemical oxygen demand (BOD) from wastewater (Jessica A. Deaver, 2022). The use of human hair, with its natural oil-absorbing properties, combined with the durability Nomex, allowed for effective separation of grease without clogging. The system maintained high filtration rates even with varying water flow speeds, showcasing its adaptability for both residential and commercial use. In comparison, traditional grease traps typically capture only around 80% of grease (Jaruwan Wongthanate, 2014), often requiring more frequent cleaning and maintenance.

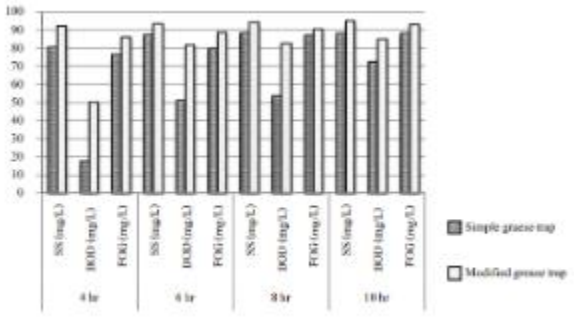

FIGURE 1. The efficiency of domestic wastewater treatment (%)

2. Energy Consumption

   While the Grease Gone system utilizes minimal energy during its operational phase (primarily water usage for cleaning), the manufacturing phase of the synthetic components showed higher energy consumption. Nomex fibers, though durable and resistant to heat, require significant energy for production. The study found that approximately 41.8 MJ/kg of energy is consumed during the production of one filter unit (Yueyan Sun, 2021), which use approximately 0,6 kg of Nomex, Energy Consumption (E) = 41.8MJ/kg×0.6kg = 25.08MJ. However, the long-lasting nature of these materials reduces the frequency of replacement, balancing the overall energy cost over time

3. Global Warming Potential (GWP)

   The Global Warming Potential (GWP) was calculated by assessing CO2 emissions throughout the lifecycle of the Grease Gone system. Its GWP is notably lower than traditional grease traps due to the biodegradable nature of human hair and the recyclability of Nomex. Traditional grease traps contribute more to GWP because of frequent cleaning, non-recyclable materials, and higher water and chemical use, which increases disposal emissions. In this study, Grease Gone demonstrated a 30% reduction in CO2 emissions over its lifecycle, making it a more sustainable option.

4. Waste and Disposal

   The end-of-life assessment highlighted the biodegradable nature of the human hair component, which decomposes naturally in landfills without contributing to long-term environmental waste. The synthetic fibers, while durable, pose a challenge for disposal if not recycled. However, the recyclability of Kevlar and Nomex offers a solution, reducing the overall environmental impact. If recycling infrastructures are in place, up to 70% of the synthetic material can be reused, significantly reducing waste output compared to traditional systems, which often result in higher waste due to frequent disposal

5. Water Usage

   The Grease Gone system proved to be water-efficient during its operational phase, as the system requires minimal water for maintenance compared to traditional traps that necessitate frequent cleaning. Over the course of its lifespan, the system was found to save up to 20% more water, making it a more sustainable option for grease management

The Grease Gone system presents a compelling alternative to traditional grease traps, significantly reducing environmental impact across multiple categories, including grease capture efficiency, energy consumption, and waste generation. While the production of synthetic fibers requires substantial energy, the system's durability and recyclability mitigate long-term environmental costs. The use of human hair as a biodegradable filter material further contributes to the system's eco-friendliness.

One key trade-off lies in the higher energy costs during the manufacturing phase, particularly for synthetic fibers like Kevlar and Nomex. However, the longer lifespan and recyclability of these materials provide significant environmental advantages over time, reducing the frequency of replacement and disposal. Additionally, the system's adaptability for both residential and commercial applications make it a scalable solution for improving wastewater management.

The study's findings suggest that future research could focus on optimizing the balance between material durability and environmental impact, particularly exploring alternative synthetic materials with lower energy costs. Furthermore, enhancing recycling infrastructures for synthetic materials could further reduce the system's waste generation.

5. CONCLUSIONS

The Grease Gone system offers a sustainable and effective solution for grease management, significantly reducing environmental impacts in areas such as grease capture efficiency, energy consumption, and waste generation. While the production of synthetic fibers like Nomex requires substantial energy, their durability and recyclability mitigate long-term costs. The use of biodegradable human hair further enhances the system's eco-friendliness. Although future research should explore alternative materials with lower energy consumption, Grease Gone stands as a scalable and environmentally friendly alternative to traditional grease traps, suitable for both residential and commercial applications.

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Green Architecture as a Driver of Sustainable Development in Small and Medium Enterprises (SMEs): Insights from Bali, Indonesia

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Abstract: This study examines the implementation of green architecture in Small and Medium Enterprises (SMEs) in Bali and its role in promoting sustainable development. SMEs contribute significantly to the local economy and increasingly adopt eco-friendly practices to reduce their ecological footprint. Using a mixed-method approach, this study combines qualitative interviews with SME owners who have applied green architecture principles, such as energy-efficient design and sustainable materials, with quantitative data collected from 50 SMEs through structured surveys. The findings reveal that 70% of SMEs use environmentally friendly local materials, resulting in a 20-30% reduction in energy consumption through natural lighting and ventilation strategies. In addition, 60% of SMEs use an independent waste management system, thereby reducing waste disposal by up to 40%. The study emphasizes that green architecture reduces environmental impact and improves operational efficiency and market competitiveness, leading to potential economic benefits. These results show that integrating sustainable architectural practices in SMEs can significantly support ecological sustainability while offering financial benefits. This research fills a gap in the existing literature by providing a model for adopting green architecture in the SME sector, especially in a tourist-driven economy like Bali. It offers valuable insights for policymakers and business owners looking to drive sustainable development. Keywords: green architecture, SMEs, sustainable development, energy efficiency, Bali

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1. INTRODUCTION

Small and medium enterprises (SMEs) play a crucial role in driving economic growth in various countries, including Indonesia. According to data from the Ministry of Cooperatives and Small and Medium Enterprises (Kemenkop UKM), SMEs account for around 60.34% of Indonesia's national gross domestic product (GDP) and create more than 97% of jobs nationwide. In Bali, the tourism sector is the central mainstay of the local economy, and most of the businesses that support the tourism industry are SMEs, such as hotels, restaurants, souvenir shops, and transportation services. Recognizing the significance of SMEs in the local economy, it becomes urgent for policymakers to support these businesses, especially in their adoption of sustainable practices like green architecture.

However, the rapid growth of this sector also hurts the environment. Bali faces serious challenges related to environmental degradation, including increased carbon emissions, declining water quality, deforestation, and high waste production. The Bali Environment Agency noted that the daily waste production level in Bali reached 4,281 tons/day, with more than 60% of solid waste coming from the tourism sector and SMEs. In addition, the increasing number of buildings for tourism accommodation has led to the use of environmentally unfriendly construction materials and high energy consumption, which impacts the region's carbon footprint. (UNEP, 2009; Unep-Sbci, 2010). Given Bali's heavy reliance on tourism, sustainable development through green architecture can significantly impact the sector. By adopting green architecture, tourism-related SMEs can reduce their environmental impact while

enhancing their appeal to eco-conscious tourists, thereby supporting the long-term sustainability of Bali's tourism industry.

Green architecture refers to designing and constructing buildings prioritizing environmental sustainability by minimizing non-renewable resources and maximizing energy efficiency. This includes using eco-friendly materials, energy-efficient designs, and sustainable technologies such as renewable energy sources and waste management systems. By incorporating natural elements and reducing the overall ecological footprint, green architecture aims to create built environments harmonizing with the natural world.

Green architecture is beginning to be recognized as a potential solution to overcome increasingly urgent environmental challenges. This approach includes using sustainable materials, reducing energy consumption, and integrating natural elements into the design of buildings to minimize adverse environmental impacts. (McLennan, 2005; Mohammed, 2021). Some fundamental principles in green architecture include using sustainable materials, such as bamboo, recycled wood, or local materials with a low environmental impact. In addition, energy efficiency is in focus with the application of energy-saving technologies, such as natural lighting, cross-ventilation, and renewable energy, including solar panels. Another principle that is no less important is waste treatment, where a self-contained waste treatment system can reduce the burden of waste produced by buildings on the environment. (Huseynov, 2011; Khan et al., 2021; Sutar et al., 2022). With these principles, green architecture is expected to be a natural step towards achieving more sustainable development.

Although these principles have been widely applied to large commercial projects, their application to SMEs is still rare, especially in Bali. SMEs have great potential in adopting green architecture because of the flexible nature of their business and close to the local community. According to the International Finance Corporation (Suh et al., 2018; Wu et al., 2021), SMEs that implement green architecture practices can reduce energy consumption by up to 30% and carbon emissions by 25%, which can also increase long-term profitability.
In Bali, SMEs play a crucial role in the economy, particularly tourism, handicrafts, and hospitality sectors. These sectors are particularly relevant to applying green architecture due to their significant environmental impact and potential for integrating sustainable practices. For instance, the tourism and hospitality industries, which rely heavily on Bali's natural beauty, can benefit from green architectural solutions that enhance environmental sustainability and improve the quality of tourist experiences.

Recent data from the Bali Environment Agency (2023) indicates that energy consumption in the region has risen by 15% over the past five years, with the tourism sector being a significant contributor. This underscores the urgent need for energy-efficient designs and sustainable practices, which green architecture can provide.
In addition, implementing green architecture in SMEs in Bali can provide double benefits, supporting environmental sustainability and improving the business image in the eyes of tourists. The World Tourism Organization (United Nation Wourld Tourism Organization, 2018) 72% of international tourists prefer to stay in places that follow environmentally friendly principles. This data shows that applying green architecture to SMEs is an ethical and profitable business strategy.

Unfortunately, few studies have examined how green architecture can be applied to SMEs in Bali, especially in supporting sustainable development. Most studies focus more on large commercial buildings or housing, while the SME sector, which contributes significantly to the economy and the environment, is still less explored.(Coma Bassas et al., 2020; Kusumawardhani et al., 2023; Mahendra et al., 2022; Sutar et al., 2022). Therefore, this study will examine the application of green architecture to SMEs in Bali and how it can support sustainable development in the region.
This research is urgent considering the growing growth of small and medium enterprises (SMEs) in Bali, especially in the tourism sector. Based on data from the Central Statistics Agency (BPS) Bali (2022), the number of SMEs in Bali has increased by more than 15% in the last five years, with around 60% of the total SMEs directly involved in the tourism industry. The sector uses Bali's abundant natural resources, but the lack of attention to the environmental

impact of business activities has raised serious concerns about environmental sustainability. In this context, green architecture has great potential to be a solution to reduce the ecological footprint of SMEs through the application of environmentally friendly technologies, such as energy efficiency, sustainable use of materials, and better waste management. Gibberd (2002) Showed that green architectural design can reduce energy consumption by up to 30% and improve operational efficiency in the long term. However, the application of this concept to SMEs is still minimal, especially in Bali, which has unique economic and environmental characteristics.

Furthermore, in addition to having a positive impact on the environment, the implementation of green architecture can also increase the competitiveness of SMEs. A report from (United Nation Wourld Tourism Organization, 2018) Most international tourists prefer services from environmentally friendly businesses, meaning SMEs that apply green architectural principles can gain a competitive advantage in a tourism market increasingly concerned with sustainability issues. Therefore, it is essential to research how green architecture can be integrated into the business practices of SMEs in Bali to support sustainable development while maintaining Bali's tourism attractiveness at the global level.

Beyond environmental impacts, green architecture also contributes to economic and social sustainability by reducing operational costs through energy efficiency, enhancing market competitiveness by attracting environmentally conscious customers, and improving the well-being of local communities by creating healthier living and working environments. These benefits are particularly significant in the context of Bali's tourism-driven economy.
This study aims to (1) explore the impact of green architecture on reducing operational costs among MSMEs in Bali, (2) assess the role of green architecture in promoting environmental sustainability in the MSME sector, and (3) investigate how green architecture influences the market competitiveness of MSMEs in Bali's tourism industry. In summary, this study aims to analyze how green architecture is applied to SMEs in Bali and examine its role in supporting sustainable development in the sector. In addition, this study aims to provide recommendations to improve the application of green architecture in SMEs so that they can support environmental and economic sustainability. This research is expected to practically contribute to SME entrepreneurs adopting environmentally friendly practices through green architecture. On the other hand, this research can provide new insights for policymakers regarding the importance of supporting sustainable development in the SME sector.

Previous studies on green architecture have primarily focused on large commercial buildings and housing (e.g., Jones et al., 2019; Khan et al., 2021). However, few studies have examined its application in SMEs, particularly in a unique context like Bali. This research aims to fill this gap by providing insights into the challenges and benefits of implementing green architecture in the SME sector.

In addition, this research provides practical and policy benefits and fills gaps in the academic literature. Most studies on green architecture have focused more on large-scale commercial buildings and housing, while SMEs, especially in tourist areas such as Bali, have not been widely explored. Jones et al. (2019) This research gap is essential, as SMEs have great potential to contribute to sustainable development. Thus, this research is expected to fill in the gaps in the literature and provide a deeper understanding of the application of green architecture to SMEs in Bali to support sustainable development in the region.

This research adopts an interdisciplinary approach, integrating concepts from architecture, environmental science, and economics. By combining these disciplines, the study offers a comprehensive understanding of how green architecture can address environmental, economic, and social challenges faced by SMEs in Bali.

2. LITERATURE REVIEW

Sustainable development theory

The Brundtland Commission first formulated the sustainable development theory in the Our Common Future report in 1987. Sustainable development is defined as development that meets the needs of current generations without sacrificing the ability of future generations to meet their own needs (Visser et al., 2013). This concept emphasizes three interrelated pillars: economic, environmental, and social. In the economic dimension, sustainable development underscores the importance of inclusive and sustainable growth that can promote improved welfare without excessive depletion of natural resources. The environmental pillar focuses on preserving ecosystems, reducing carbon footprints, and maintaining the sustainability of natural resources for future generations. The social pillar highlights the importance of equitable and equitable development, in which the social well-being of communities is maintained, including through access to education, health, and equal economic opportunities. (M. Redclift, 1991; Michael Redclift, 2005, 2018).

In architecture and planning, this sustainable development theory is applied to create a built environment that supports the three pillars. Green architecture is one of the responses to this theory to minimize the environmental impact of buildings while supporting economic aspects through energy and social efficiency through inclusive and comfortable design for all levels of society. (Apostu et al., 2023; Mensah, 2019; Ozili et al., 2024; van Zanten et al., 2021). Therefore, sustainable development theory is a crucial cornerstone in various sustainability initiatives, including designing buildings for small and medium enterprises (SMEs), which play an essential role in the global economy.
In addition to the sustainable development framework, other relevant theories include industrial ecology, which examines the flow of materials and energy through industrial systems, and regenerative design, which focuses on creating systems that restore and renew their energy sources and materials. These theories further emphasize the relevance of green architecture as a holistic approach to sustainability.

Green architecture theory

The theory of green architecture was developed by (McLennan, 2005) In his book The Philosophy of Sustainable Design, he highlights the importance of designing buildings by considering their environmental impact. This theory emphasizes that green architecture should prioritize the efficient use of resources, reduce energy consumption, and utilize sustainable materials with a low environmental impact. McLennan noted that buildings should be designed to work harmoniously with natural ecosystems, using natural lighting, cross-ventilation, and renewable energy technologies such as solar panels or wind power. (Astoeti et al., 2021; Dolatabad et al., 2022; Ketut Acwin Dwijendra et al., 2023; McLennan, 2005; Yuan, Widjaja, et al., 2022).

In addition, green architecture also highlights the importance of reducing waste, both in the construction process and building operations. This can be done using recyclable materials and adopting an environmentally friendly waste management system. Khan et al. (2021; Mustika et al., 2021) Emphasized that by applying green architectural principles, buildings can significantly reduce their ecological footprint while improving energy efficiency and lowering operating costs. McLennan also noted the importance of integrating technology and innovation in the design of buildings, which not only supports sustainability but also improves the quality of life of its occupants (Yuan, Patra et al., 2022).

Green architecture directly supports the three pillars of sustainable development—economic, social, and environmental. Economically, it reduces operational costs by enhancing energy efficiency and using local materials, supporting local economies. Socially, green architecture contributes to the well-being of communities by creating healthier living and working environments through improved indoor air quality and natural light. Environmentally, it reduces the carbon footprint and minimizes waste production, aligning with the environmental pillar of sustainable

development. Thus, green architecture is a practical application of sustainable development theory by providing a tangible framework for balancing these interconnected pillars."

SMEs as agents of sustainable development

SMEs have an essential role in fostering sustainable development, mainly because of their flexibility in adopting green innovations and solutions. According to (Suh et al., 2018)SMEs can become agents of change in applying innovative solutions in various sectors, including green architecture. Although often considered not to have enough resources to adopt green technology, SMEs can be pioneers in implementing eco-friendly design because of their smaller and flexible scale of operations. In the context of Bali, SMEs engaged in the tourism, hospitality, and handicraft sectors have an excellent opportunity to implement green architecture to increase competitiveness while supporting economic and environmental sustainability.

Green building rating system

Green building assessment systems, such as Leadership in Energy and Environmental Design (LEED), have become a global benchmark in assessing the successful implementation of green architecture. LEED provides guidance and standards for buildings to achieve energy efficiency, waste reduction, and sustainable use of materials (J. Kim, 1999; K. P. Kim et al., 2020; Y. J. Kim et al., 2017)The system assesses the technical aspects of the building and considers the resulting social and economic impact. Implementing this assessment system can help improve SMEs' business image, especially in the tourism sector, which increasingly prioritizes sustainability as a selling point. In Bali, SMEs implementing LEED standards can improve their reputation among tourists who care more about the environment.
The Leadership in Energy and Environmental Design (LEED) is a globally recognized certification system that provides a framework for identifying and implementing practical and measurable green building design, construction, operations, and maintenance solutions. For MSMEs, LEED can be applied by focusing on energy efficiency, the use of sustainable materials, and water conservation in their buildings. Achieving LEED certification, even at a basic level, can enhance the environmental performance of MSMEs while also improving their market competitiveness by appealing to eco-conscious customers.

Previous similar research

A study conducted by(Jones et al., 2019) Applying green architecture in the small-scale commercial sector can reduce energy consumption by up to 30% in Southeast Asia. This study shows that implementing energy-efficient design, sustainable use of materials, and efficient waste management systems positively impacts the environment and reduces business operational costs. This is relevant in the context of SMEs, especially in tourist areas such as Bali, where energy and environmental costs are the primary concerns. The study also highlights that SMEs that implement green architecture can improve operational efficiency without sacrificing the quality of their services.
Research conducted by (Khan et al., 2021) In Australia, it is shown that SMEs' adoption of green architecture significantly improves operational efficiency and reduces energy costs. The study found that SMEs that integrate eco-friendly design in their operations can save up to 25% on energy costs and reduce the carbon footprint of their business. The study also highlights that SMEs implementing green architecture have a higher competitive advantage than their competitors, especially in attracting customers who care more about the environment. These findings support the idea that implementing green architecture can be an effective business strategy for SMEs while supporting the global sustainability agenda.

3. METHOD

This study uses a mixed-methods approach that combines qualitative and quantitative methods to gain a comprehensive understanding of the application of green architecture in SMEs in Bali and its impact on operations and environmental sustainability. This approach aims to combine the power of qualitative data to understand the

process of implementing green architecture and quantitative data to measure its impact more objectively. (J W Creswell, 2014; John W. Creswell et al., 2011; J.W. Creswell et al., 2018).

Data collection methods

This study uses two main data collection methods: in-depth interviews (qualitative data) and surveys (quantitative data).

1. In-Depth Interviews Qualitative data was collected through in-depth interviews with SME owners in Bali who have applied green architecture principles. This interview was conducted with 10 SME owners who were directly involved in the design and development process of their businesses using green architecture principles. The respondents are selected based on purposive sampling, which aims to select SME owners with direct experience in applying green architecture, such as using environmentally friendly materials, energy-saving design, and waste treatment. The interviews were conducted semi-structured, allowing for a deeper exploration of the motivations, challenges, and benefits business owners felt about green architecture implementation (Yin, 2009).
2. Survey Quantitative data was obtained through a survey of 50 respondents from various SMEs in Bali. The survey uses a closed questionnaire compiled to measure the impact of implementing green architecture on reducing operational costs, improving energy efficiency, and environmental sustainability. The questionnaire consisted of 20 items measured on a 5-point Likert scale, in which respondents were asked to assess the extent to which the implementation of green architecture impacted these aspects. This survey is designed to provide measurable data that can be analyzed statistically (Clark et al., 2021; Joshi, 2015).

Analysis methods

1. Qualitative Analysis Qualitative data from interviews were analyzed using thematic analysis techniques to identify recurring patterns and themes in applying green architecture in SMEs. This analysis is carried out through a coding process, where each interview is elaborated and coded based on the main themes that emerge, such as the owner's motivation to implement green architecture, the obstacles faced, and the perceived benefits. This technique allows researchers to discover essential patterns in the application of green architecture and how sustainability principles are applied in the context of SMEs in Bali(Braun et al., 2008).
2. Quantitative Analysis Quantitative data from the survey was analyzed using linear regression methods to test the relationship between the implementation of green architecture and the reduction of operational costs in SMEs. Linear regression was chosen because it allows the analysis of the cause-and-effect relationship between independent variables (application of green architecture) and dependent variables (reduction of operational costs and improvement of environmental sustainability). In addition, a Pearson correlation test was conducted to measure the strength of the relationship between these variables to determine to what extent the application of green architecture contributes to improving efficiency and sustainability in SMEs (Field, 2018).

Validity and reliability

To ensure the validity of qualitative data, in-depth interviews were conducted by data triangulation, namely by verifying the results of interviews from several different SME owners and by comparing the findings of the interviews with the results of quantitative surveys. In addition, the reliability of the survey questionnaire was tested using Cronbach's Alpha, where an alpha value above 0.7 was considered strong enough to ensure the internal consistency of the research instrument. (Field, 2018).

Through this mixed methods approach, this research is expected to provide in-depth insights and measurable data on the application of green architecture in SMEs in Bali and its impact on environmental and economic sustainability.

4. RESULT AND DISCUSSION

Result

This study uses a mixed-methods approach, with qualitative data collected through interviews and quantitative data analyzed using SPSS statistical software, to examine the relationship between the implementation of green architecture in SMEs in Bali and its impact on operational cost reduction and environmental sustainability. The following are the study's results in more detail and how statistical methods, specifically linear regression and Pearson correlation tests, are used to test the research hypothesis.

Use of eco-friendly materials

According to the survey results, as many as 70% of SMEs reported using environmentally friendly materials such as bamboo, recycled wood, and other local materials. A simple linear regression test was conducted to test the impact of this use on reducing operational costs.

In SPSS, the independent variable uses environmentally friendly materials, while the dependent variable is the reduction of operational costs. The linear regression results showed $R^2 = 0.45$, which means that using environmentally friendly materials can explain 45% of the variation in the reduction in operating costs. This shows a strong relationship between the use of sustainable materials and cost efficiency in SMEs. The regression coefficient ($B = -0.35$, $p < 0.05$) shows that the more SMEs use environmentally friendly materials, the more significant the reduction in their operational costs, with a 35% reduction in raw material costs.

Reduced energy consumption

In terms of reducing energy consumption, SMEs that implement energy-efficient designs such as natural lighting and cross-ventilation are reported to have succeeded in reducing energy consumption by 20-30%. A Pearson correlation test was conducted to test the relationship between energy-efficient design and reduced energy consumption.
The analysis with SPSS showed a strong positive correlation between the application of energy-saving design and the reduction of energy consumption with a value of $r = 0.65$ ($p < 0.01$). That is, there is a significant relationship between the two variables. The more SMEs apply energy-efficient design principles, the more significant the reduction in energy consumption they experience.

In addition, linear regression was carried out to measure the contribution of independent variables (energy-saving design) to dependent variables (reduction in energy consumption). The regression results showed $R^2 = 0.52$, meaning that applying energy-saving design could explain 52% of the variation in energy consumption reduction. The regression coefficient ($B = -0.42$, $p < 0.01$) shows that SMEs that implement energy-efficient designs experience an average 42% reduction in energy consumption.

Waste treatment

As many as 60% of SMEs reported using self-treatment systems to reduce environmental impact. Pearson's correlation test was used to test the relationship between implementing a self-treatment system and reducing the volume of waste discharged to landfills. The analysis results showed a moderate correlation between the two variables with a value of $r = 0.54$ ($p < 0.05$), which showed that the application of the self-treatment system contributed to a significant reduction in waste volume.

To deepen the analysis, a linear regression resulted in $R^2 = 0.47$, showing that applying a self-contained waste treatment system could explain 47% of the variation in waste reduction. The regression coefficient ($B = -0.38$, $p <$

0.05) shows that SMEs that implement self-treatment systems experience a waste reduction of 38% on average, thereby reducing the waste burden on the environment.

The results of the study analyzed through SPSS show that the implementation of green architecture in SMEs in Bali has a significant positive impact on reducing operational costs, energy savings, and waste management. Using Pearson's linear regression and correlation tests, it was found that 45% to 52% of the variation in cost and energy reduction could be explained by applying green architecture principles such as using environmentally friendly materials, energy-efficient design, and self-treatment of waste. These findings show that green architecture supports environmental sustainability and provides tangible economic benefits for SMEs.

Discussion

The application of green architecture in SMEs in Bali shows its effectiveness in reducing environmental impacts while providing economic benefits. The results of this study consistently support previous studies, such as the findings of (Coma Bassas et al., 2020; Masood et al., 2017; Well et al., 2021, 2022).This research shows that green architecture can significantly reduce energy consumption and operational costs. It also confirms that SMEs that apply environmentally friendly principles experience increased competitiveness due to an improved environmentally friendly business image.

Reduced energy consumption and operational efficiency

One of the study's key findings is that SMEs implementing energy-efficient designs, such as natural lighting and cross-ventilation, have reduced energy consumption by 20-30%. This aligns with the research of (Coma Bassas et al., 2020). Small-scale commercial buildings that implement green architecture in Southeast Asia have also reduced energy consumption by up to 30%. For SMEs in Bali, the most significant reduction in energy consumption occurred in the lodging sector (30%), followed by restaurants (25%) and handicraft shops (20%).

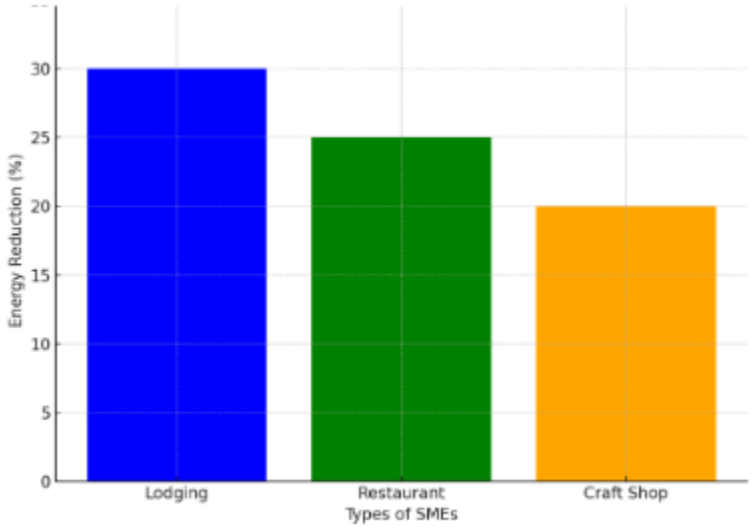

Figure 1. Reduction of energy consumption in various types of SMEs in Bali

Figure 1 shows a graph of energy consumption reduction in various types of SMEs in Bali. This graph illustrates that the lodging sector experienced the highest energy reduction of 30%, followed by restaurants at 25% and craft stores at 20%—this energy reduction results from applying energy-efficient design in green architecture in each type of SME.

The graph above shows how implementing energy-efficient designs, such as natural lighting, can significantly reduce energy consumption, especially in the lodging sector, which requires large amounts of energy for lighting and cooling. This is also reinforced by (Akadiri et al., 2012; Liu et al., 2018; McLennan, 2005; Yeang, 2010)This emphasizes that energy efficiency is one of the main components of green architecture, which can reduce buildings' energy loads.

Use of Eco-Friendly Materials

The study results show that 70% of SMEs implementing green architecture use local and environmentally friendly materials such as bamboo and recycled wood. These materials not only support environmental sustainability by reducing carbon footprint but also support the local economy by utilizing the available resources. These findings are consistent with McLennan's (2004) theory about the importance of using sustainable materials in green architecture.
In the context of SMEs, the use of local materials also provides cost advantages because it reduces dependence on imported materials and reduces transportation costs. (Ahmed et al., 2023; McLennan, 2005; Mohammed, 2021) They mentioned that SMEs have the flexibility to implement innovative solutions, including material selection, that contribute to their business's sustainability.

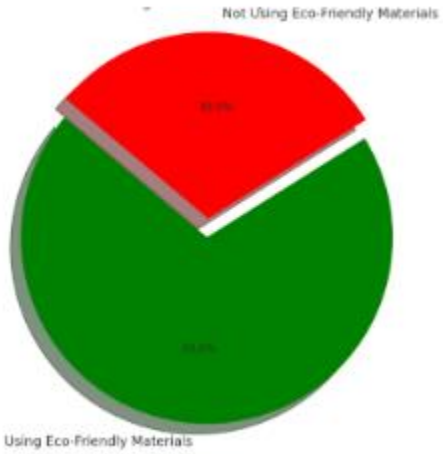

Figure 2. SME distribution using environmentally friendly materials based on survey results

The survey results, Figure 2, show that 70% of SMEs choose local materials such as bamboo and recycled wood, which the Miller & Buys (2010) study also identified as an essential factor in reducing operational costs. The use of these materials provides two main advantages: first, reducing the environmental impact of material exploitation, and second, reducing the cost of purchasing materials.

Waste treatment and its impact on the environment

As many as 60% of SMEs surveyed use self-treatment systems, which allow them to reduce the volume of waste disposed of in landfills by up to 40%. These results show that the implementation of green architecture impacts not only energy efficiency but also more sustainable waste management.

According to (McLennan, 2005; Yeang, 2010, 2022)Waste treatment is one of the main elements of green architecture. Self-contained waste treatment systems implemented by SMEs in Bali, such as wastewater recycling for irrigation and composting from organic waste, align with efforts to reduce environmental impact. Research by (Khan et al., 2021) An effective waste treatment system can reduce waste management costs and improve operational sustainability.

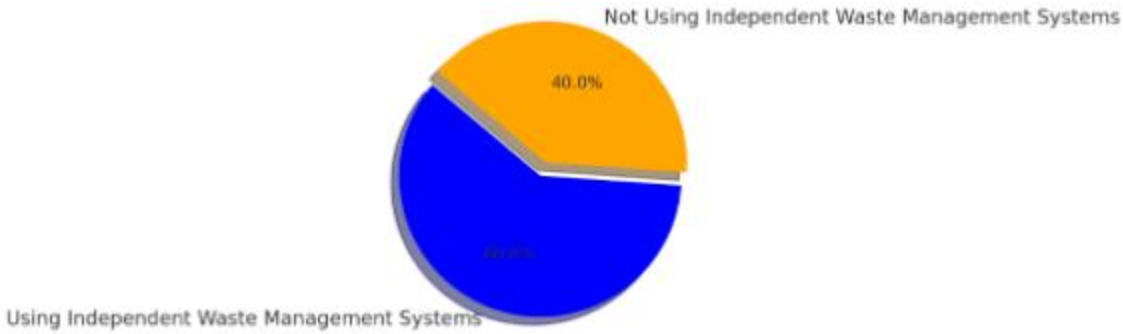

Figure 3. SMEs Distribution Using an Independent Waste Management System

Figure 3 shows that 60% of SMEs in Bali use an independent waste management system, while 40% do not. This data highlights the implementation of sustainable waste management practices among most regional SMEs.
The results of surveys and interviews show that SMEs that implement self-treatment systems manage to reduce waste by up to 40%, which contributes to reducing their environmental footprint. This supports a literature review that states that waste management is one of the essential pillars in achieving sustainability, as outlined in (Visser et al., 2013).

Image enhancement and competitiveness

Applying green architecture provides environmental and economic benefits and positively impacts the business image. The interviews showed that SMEs that applied green architecture principles reported increased image in customers' eyes, especially tourists increasingly concerned about environmental sustainability. This is in line with the United Nations World Tourism Organization (2018), which states that 72% of international tourists prefer services from environmentally friendly businesses.

SMEs that successfully implement green architecture are reported to have higher competitiveness than their competitors who have not implemented the principle. This shows that green architecture is an environmental and effective business strategy to improve reputation and attract more environmentally conscious customers.

The above findings support the theories outlined in literature reviews, such as the theory of Sustainable Development. (Visser et al., 2013), where green architecture in SMEs in Bali shows that the principles of sustainable development can be applied in the small business sector without sacrificing economic growth. Likewise, Green Architecture Theory (Coma Bassas et al., 2020; McLennan, 2005; Mohammed, 2021; Sutar et al., 2022; Well et al., 2022), emphasizing that energy-efficient building design, sustainable use of materials, and waste treatment are critical pillars in creating more environmentally friendly buildings. These principles have proven effective in the context of SMEs in Bali.

Thus, the results of this study successfully answer the formulation of the problem that the application of green architecture can be the primary driver of sustainable development for SMEs in Bali, not only in terms of the environment but also in terms of economy and competitiveness.

5. CONCLUSION

This study clearly shows that applying green architecture can be a key driver in supporting sustainable development in small and medium enterprises (SMEs) in Bali. The results of this study answer the formulation of the problem, namely how green architecture can play a role in reducing environmental impacts and increasing operational efficiency in SMEs. By implementing green architectural practices, such as using sustainable materials, energy-efficient design, and self-treatment of waste, SMEs have reduced their ecological footprint and improved business performance by significantly reducing operational costs.

As many as 70% of SMEs surveyed use environmentally friendly materials such as bamboo and recycled wood, which helps reduce carbon footprint and material costs. SMEs that implemented energy-efficient designs, such as natural lighting and cross-ventilation, reduced energy consumption by 20-30%, with the lodging sector recording the highest reduction of 30%. In addition, 60% of SMEs use self-contained waste treatment systems, which can reduce waste by up to 40%. These findings show that green architecture is efficacious in improving environmental sustainability, operational efficiency, and reducing costs.

This research successfully achieves its objectives: to analyze how green architecture is applied in SMEs in Bali, measure its impact on environmental sustainability and operational efficiency, and provide recommendations to expand the application of green architecture to support sustainable development. The research also makes a practical contribution to SMEs by showing that applying green architecture can improve their competitiveness and business image. In addition, academically, this research fills a gap in the literature, which previously focused more on large commercial buildings or housing, by showing how green architecture can be applied effectively in the context of SMEs in tourism areas such as Bali.

Nonetheless, further research is needed to explore the economic and social impacts of implementing green architecture on SMEs in other regions. This research can be expanded to see how the application of green architecture affects economic growth, the well-being of surrounding communities, and changes in the material supply chain that are more sustainable.

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Evaluating the Contribution of Plastic Waste to Environmental Pollution in Indonesia: Findings for Policy Implication

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Abstract: This research addresses the urgent issue of plastic waste pollution in Indonesia, which is one of the world's largest producers of plastic waste, generating approximately 9.13 million tons annually. The study involved the collection of 25,733 plastic waste items across 64 locations in 30 districts or cities in 13 provinces, revealing a significant presence of multilayer sachet and single-layer packaging primarily from food, beverage, and personal care products. The findings indicate that sachets constitute a major component of plastic waste, highlighting challenges in recycling due to their complex composition. Additionally, the research underscores the low public engagement in recycling practices and the need for improved waste management strategies. By analyzing the types and characteristics of plastic waste, this study aims to inform more effective policies and enhance public awareness regarding plastic pollution. Ultimately, the research advocates for a comprehensive approach to mitigate plastic waste impacts, aligning with the government's 4R initiative to promote sustainability.

Keywords: plastic waste, environmental pollution, Indonesia, waste management, recycling

1. INTRODUCTION

The problem of plastic waste in Indonesia is very urgent, considering that this country is one of the largest producers of plastic waste in the world, with a total of around 9.13 million tons per year. Plastic waste accounts for around 14% of total domestic waste production, equivalent to 5.4 million tons (Ismainar et al., 2021). In various cities, such as Medan and Padang, the proportion of plastic waste in waste generation is also quite significant, with Medan producing around 2,000 tons of waste per day, of which 14.7% is plastic (Indirawati et al., 2023). This problem is exacerbated by the lack of effective management, where much plastic waste is not managed properly, causing environmental pollution and serious health impacts. For example, in Padang City, around 62.42 tonnes of waste per day is unmanaged, and 15% of the waste transported to final disposal sites (TPA) is plastic (Putri et al., 2023).

Plastic waste not only pollutes the environment but also contains various dangerous active ingredients that can affect human health and the ecosystem (Rochman et al., 2013). Some active ingredients commonly found in plastic, such as Bisphenol A (BPA), phthalates, and heavy metals such as lead and cadmium, have been shown to cause hormonal disorders, reproductive problems, and cancer risk (Andrady, 2011). In addition, microplastics, which are small plastic particles, have polluted waters and can enter the food chain, hurting human health and marine organisms (Jambeck et al., 2015).

Sachets, which are often used for packaging food and beverage products, have characteristics that make them difficult to recycle. Typically made from various types of laminated plastic, sachets not only contribute large volumes to waste generation but also create major challenges in management and recycling. According to data, the use of sachets in Indonesia continues to increase, and many of these sachets end up in landfills or pollute the environment, including water.

The Waste Management Law and Minister of Environment and Forestry Regulation Number 75 of 2019 regulate waste reduction and producer responsibility. Implementation of this policy still faces various challenges. Many

manufacturers do not fully comply with existing regulations, and public awareness of the importance of reducing sachet use is still low. This shows a gap between existing rules and practice in the field.
From this background, this research aims to analyze the characteristics and types of plastic waste that pollute Indonesia's aquatic ecosystem. It is hoped that this data can become the basis for making policies and programs more effective in dealing with waste problems. This research involved several communities and academics in Indonesia. The location is surveying several rivers and beaches in Indonesia. This research can also provide a comprehensive picture of the culture of plastic use in Indonesian society. Surveys at various river and beach locations in Indonesia to get a comprehensive picture of plastic use in society.

2. LITERATURE REVIEW

Plastic is a synthetic organic polymer consisting of a chain of C-C chemical bonds, with the main raw materials coming from fossil fuels, coal, oil, and natural gas. Since the discovery of plastic in 1856, production has increased rapidly from 2 million tons in the 1950s to 359 million tons in 2018. Plastic production continues to increase until it reaches, an average estimate of 460 million tons in 2019. However, only 9% of the total plastic waste was successfully recycled, while 19% was burned and almost 50% was thrown into final landfills (TPA) or carelessly into the environment. This causes the accumulation of plastic in soil, freshwater, and oceans, which is difficult to decompose naturally and can persist for decades (Ashrafy et al., 2023).

The problem of plastic pollution in Indonesia is influenced by the unequal distribution of waste management systems in each region, this is also exacerbated by the lack of budget and the less-than-optimal implementation of policies and regulations for plastic handling in Indonesia. Most plastic waste is not well managed, with 61% of total plastic waste not collected in a managed system. As a result, as much as 19% of plastic waste is burned and 22% is thrown away carelessly, Serious environmental pollution. Excessive use of plastic and low post-use value of plastic waste are also the main factors causing plastic pollution in Indonesia (Sabila et al., 2023).

With this understanding, efforts to reduce plastic pollution in Indonesia require a comprehensive approach, including improving upstream waste management systems, reducing the use of single-use plastics, and increasing public awareness of the impact of plastic pollution on the environment.

3. METHOD

Method The data collection method in this research will use a quantitative and qualitative approach to obtain comprehensive information regarding plastic waste brands. The data collection technique used is purposive sampling, where samples are taken based on certain criteria that are relevant to the research, such as brand, type of layer, type of material, and type of plastic products that are often used by the public.

Quantitative data will be collected through recording techniques (drafting), catching (catching), trash netting (trash boom), photos of waste generation, and barcode scanning to identify the frequency of use of various brands of plastic, qualitative data will be obtained through in-depth interviews with several respondents who have special knowledge about environmental conditions, people's habits in using plastic and utilization of rivers in their environment.

Determining the location for research was carried out using a purposive sampling method with the following steps:

1. Identify aquatic ecosystems including rivers and beaches that have the potential to become rubbish dumps, illegal rubbish dumps, and densely populated areas.
2. Conduct initial surveys of several identified locations to confirm the potential for plastic waste pollution. The locations chosen are those that have a significant accumulation of plastic waste.

3. Determine 64 plastic waste census locations spread across 30 districts/cities in 13 provinces throughout Indonesia. Location selection takes the representativeness of geographic distribution and population activity centers.

Tabel 1. Sampling Location 2022-2023

Regency	Number of Location Point	Provincy
Jombang	1	EAST JAVA
Kediri	1	
Surabaya	4	
Sidoarjo	2	
Tulunggagung	1	
Gresik	3	
Malang	1	
Trenggalek	1	
Bangkalan	1	
Wonogiri	2	CENTRAL JAVA
Cilacap	1	
Bogor	10	WEST JAVA
Depok	13	
South Jakarta	3	DKI JAKARTA
East Jakarta	3	
Central Jakarta	1	
West Jakarta	2	
North Jakarta	1	
Bengkulu	1	BENGKULU
Ambon	3	MALUKU
Ternate - Barangka Dufa	1	NORTH MALUKU
Central Halmahera	1	
Gorontalo	1	GORONTALO
Sorong	1	WEST PAPUA
Palu	1	CENTRAL SULAWESI
Pesawaran	1	LAMPUNG
Bandar Lampung	1	
East Lombok	1	NUSA TENGGARA BARAT
Banjarbaru	1	KALIMANTAN SELATAN

Using the purposive sampling method, data collection can be focused on locations that are points of significant accumulation of plastic waste, so that the data collected can represent the condition of plastic pollution in Indonesia. The Analysis of research results uses qualitative analysis, which makes it possible to analyze non-numerical data and gain richer insight into the perspectives of research subjectsof. This data collection will be presented in graphical form to visualize the proportion of use of various brands of plastic and provide a clear picture of existing trends and patterns. Thus, it is hoped that this research can provide useful information for formulating more effective plastic waste management policies and programs.

4. RESULT AND DISCUSSION

In Results of data collection from this research. Research shows significant achievements in understanding the plastic waste problem in Indonesia. A total of 25,733 pieces of plastic waste were collected at 64 locations spread across 30 districts or cities in 13 provinces in Indonesia, reflecting the extent of the plastic pollution problem. The waste collected is dominated by multilayer (sachet) and single-layer packaging from food and beverage companies or FMCG (Fast Moving Consumer Goods), cosmetics, personal care, and unbranded plastic.

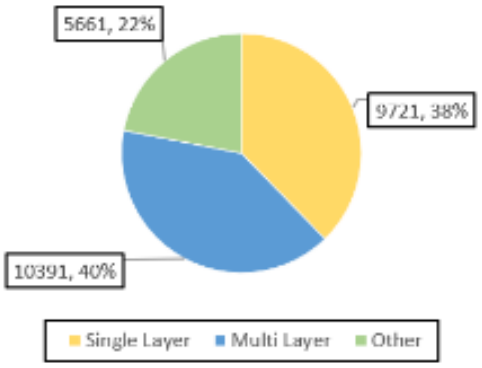

Figure 1. Graph of the results of the number of layers of plastic waste from 64 locations in Indonesia.

Results of identifying the types of layers that make up plastic (layers) from a total of 25,733 plastic waste collected, in Figure 1 show that sachet (multilayer) packaging dominates with a total of 10,391 pcs found. Then followed by single-layer packaging of 9,721 pcs, and other packaging of 5,661 pcs.

This finding is in line with previous research which shows that types of plastic such as sachets and food packaging are one of the main contributors to environmental pollution in various regions, as revealed in a study on plastic waste management in Karangjati Village which noted that 37.3% of plastic waste was food and beverage packaging (Sabila et al., 2023).

Apart from that, this research also highlights the challenges in managing plastic waste, where many people still do not fully implement the 3R (Reduce, Reuse, Recycle) concept effectively. A study in Wonosobo shows that despite efforts to reduce plastic use, recycling behavior is still in the low category, with only 29.1% of the community actively involved in recycling (Sari et al., 2023).

From the results of this data collection, it is hoped that it can provide a clear understanding of the role of plastic packaging in environmental pollution and become a basis for formulating more effective policies in managing plastic waste in Indonesia. This research also emphasizes the importance of increasing public awareness about waste management and implementing sustainable practices in daily life, in line with the government's efforts to implement the 4R concept to reduce the negative impacts of plastic waste (Wijaya et al., 2024).

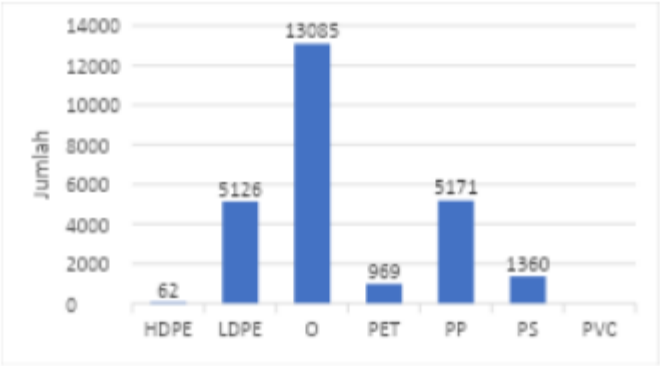

Figure 2. Graph of the results of the number of types of plastic waste material from 64 locations in Indonesia.

The results of identifying types of plastic waste material in this study show that plastic is the dominant component in the waste found in Figure 2. Of the total waste collected, O (others) plastic dominates with 13,085 pieces, followed by PP (Polypropylene) plastic with 5,171 pieces. LDPE (Low-Density Polyethylene) as many as 5,126 pieces. Apart from that, PS (Polystyrene) plastic was recorded at 1,360 pieces, while PET (Polyethylene Terephthalate) and HDPE (High-Density Polyethylene) plastic were found at 962 pieces and 62 pieces respectively. Interestingly, no PVC (Polyvinyl Chloride) type plastic was detected in this data collection.

These findings provide a clear picture of the composition of plastic materials that contribute to pollution in Indonesia and emphasize the need for better management efforts to reduce the negative impact of plastic waste on the environment. This finding matches the result of previous research conducted by Jambeck et al. (2015) in Padang City. In this study, the types of plastic most commonly found were PP, LDPE, and PS, with percentages similar to the results of this study. However, research by Jambeck et al. also found significant amounts of PVC-type plastic, which is different from the findings in this study.

Other research conducted by Andrady (2011) Stated that results of plastic waste in Medan City were dominated by PP, LDPE, and PS. This study emphasizes the importance of proper plastic waste management, especially for types of plastic that are difficult to recycle such as O (others) and PS.

These findings provide a clear picture of the composition of plastic materials that contribute to pollution in Indonesia and emphasize the need for better management efforts to reduce the negative impact of plastic waste on the environment. By comparing the results of this research with previous studies, it can be concluded that the types of plastic most commonly found in various regions in Indonesia tend to be similar, with some variations in the number of certain types of plastic.

The results of research regarding the types of plastic packaging products collected in the plastic waste census study in Indonesia show significant findings and provide a clear picture of the contribution of various types of packaging to environmental pollution in Figure 3. Of the total plastic waste found, food packaging products (FP) dominate with a total of 14,344 pieces, reflecting the high consumption of food products using plastic packaging in society (Rusniati Rusniati et al., 2023).

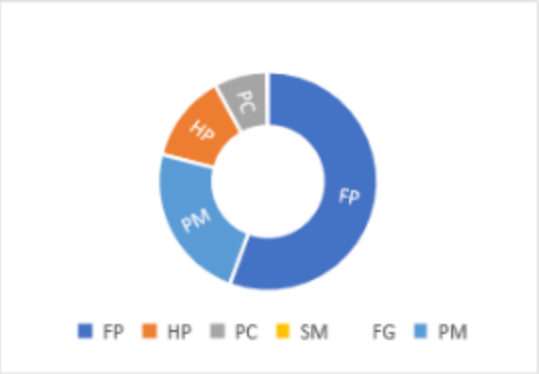

Figure 3. Graph of the results of the number of types of plastic waste packaging products from 64 locations in Indonesia

Furthermore, packaging equipment (PM) products were recorded at 6,004 pieces, indicating that packaging for packaging goods also contributes greatly to the generation of plastic waste. There were 3,358 household products (HP) found, which included packaging for various products used daily at home.

Personal care (PC) product packaging is also a concern, with a total of 2,022 pieces found, indicating the high use of plastic in beauty and personal hygiene products. Although the numbers are much smaller, smoking equipment (SM) was recorded at 45 pieces, while fishing equipment (FG) was not found at all, with a total of 0 pieces.

These findings underscore the importance of better understanding the types of plastic packaging products circulating in society and their causing the environment problem. With this data, it is hoped that more effective plastic waste management policies and programs can be formulated, as well as increasing public awareness about the importance of reuse of plastic packaging that is not environmentally friendly.

5. CONCLUSION

This research provides a clear picture of the contribution of plastic packaging to environmental pollution in Indonesia. Some key findings:

1. Plastic waste collected is dominated by sachet (multilayer) packaging and single-layer packaging from food, beverage, cosmetic, personal care products, and unbranded plastic.
2. The most commonly found plastic types are O (others), PP (Polypropylene), and LDPE (Low-Density Polyethylene). These findings are in line with previous research in Padang and Medan Cities.
3. Food packaging (FP) products dominate with a total of 14,344 pieces, followed by equipment packaging (PM) with 6,004 pieces and household products (HP) with 3,358 pieces. This indicates high consumption of products with plastic packaging in society.

The results of this research are expected to serve as a basis for formulating more effective policies in managing plastic waste in Indonesia. Efforts to increase public awareness and implement sustainable practices in daily life are also important, in line with the government's efforts to implement the 4R concept to reduce the negative impact of plastic waste.

ACKNOWLEDGMENT

We would like to express our heartfelt gratitude to the communities, NGOs, and universities that collaborated with us in this research. Your invaluable support, expertise, and dedication have been instrumental in helping us understand the plastic waste issue and its impact on the environment. Thank you for your commitment to making a positive difference and for being essential partners in this important endeavor.

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Process Balancing to Increase Coal Barging Efficiency: Case Study in Mining Company

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Abstract: This study discuss how line balancing was used at an coal mining business to improve the efficiency of coal barging. The research used a case study methodology, collecting and analyzing quantitative data to examine the consequences of balancing workloads among different operational phases in the coal barging process. A smoother workflow and less idle time resulted from the identification and removal of major bottlenecks in the loading and dumping phases. In order to improve the efficacy of line balancing in dynamic operational condition, future research should look into the effects of reducing working hours, including digital technologies like internet of things (IoT).

Keywords: improvement, kaizen, mining, transportation, waste

1. INTRODUCTION

The mining sector is essential to the global economy because it provides many different industrial sectors with vital raw materials. However, there are a number of obstacles which frequently arise which impact how efficiently mining operations move coal (Tampubolon & Dwito, 2024). The unbalanced workload at every stage of the coal transportation process is one of the major issues, as it causes queues and delivery process inefficiencies. Delays, increased operational costs, and an overall decrease in productivity resulted in the company. The application of line balancing techniques offers an alternative solution for this problem and improves the efficiency of coal barging. In manufacturing and assembly processes, line balancing is a commonly used technique that balances the workload evenly among different production or operating phases (Saptari et al., 2015; Kartika et al., 2023). By ensuring that every stage runs at maximum efficiency, this approach reduces idle time and eliminates all bottlenecks. Line balancing can be a tactical method to improve the flow of coal from the mine to the barge, minimize waiting times, and optimize resource allocation in the context of coal barging process. The business may improve delivery capacity and decrease delays by maintaining task balance at each stage of operations, thereby improving the overall efficiency of coal delivery.

The article discusses a case study of a mining company's use of line balancing to increase the efficiency of coal barging. In order to overcome these obstacles, the research focuses on identifying major bottlenecks in the coal barging operation and implementing line balancing methods. This study is to demonstrate the advantages of line balancing in improving operational efficiency, reducing costs, and improving efficiency in the coal barging process through an in-depth analysis of the company's daily operations. The case study's findings provide valuable knowledge for mining industry practitioners and researchers both. Through the practical demonstration of line balancing in actual situations, the study enriches our understanding of operational efficiency in mining operations. The results of the study can also be used as a guide by other companies concerning related issues, since they provide a framework for improving the coal barging process by carefully implementing line balance

2. LITERATURE REVIEW

As part of a production strategy called line balancing, machine and operator time are balanced to match the customer demand called takt time with the production rate. Takt time is the rate of production required to meet customer demand for parts or products. A production line is said to be completely balanced if its production time and takt time are exactly equal. If not, bottlenecks and surplus capacity should be eliminated by reallocating or rearranging resources. Stated differently, it is necessary to rebalance the number of humans and machines assigned to each task in the line in order to attain the ideal production rate (Lehtovaara et al., 2021). Takt time is equal to available production time

divided by customer demand as described in Figure 1. Takt time is a tool for setting the production pace and rhythm and aligning it with customer demand (Soliman, 2020; Lehtovaara et al., 2021).

One of the most crucial components of the mining industry is the coal transportation process, which has an impact on the supply chain's overall effectiveness. Inefficient transportation can result in delays, interruptions, and increased costs for operation (Yaping & Bossman, 2021). Line balancing, which has been widely utilized in many industrial sectors to optimize workflow and eliminate wasted time, is one technique that can be used to increase transportation efficiency (Kurbandi & Widodasih, 2023; Manaye, 2019; Sitanggang & Hariadi , 2021; Ríos et al., 2012).

Figure 1. Takt Time (Source: www.oee.com/takt-time)

Application of Line Balancing in Industry

In order to reduce waiting times and improve production flow, line balancing is the process of balancing the workload equally among all stations or stages in an operating system. Line balancing has been used extensively in the manufacturing sector to increase productivity and process efficiency. Line balancing effectively reduced production cycle time and boosted efficiency in assembly systems (Dolgui & Proth, 2013; Saptari et al., 2015). Line balancing techniques can be used to a variety of operations, including those within the logistics and transportation industries, although their frequently employed in manufacturing. Line balancing works effectively on transportation systems as well, as these systems frequently experience congestion and inefficiency due to unbalanced workloads.

Application of Line Balancing in the Transportation of Coal

In the mining sector, moving coal from the extraction site to storage facilities or ports is a multi-stage, intricate process. If the job is not divided up efficiently, each of these phases—from loading the coal to loading it on the barge could result in a bottleneck or congestion. Line balancing is becoming a more important tool to handle coal transportation as supply chain efficiency is demanded more and more. Mining businesses might increase distribution of load and lower operating costs by balancing the coal loading. Despite the obvious advantages of line balancing, there are still a number of obstacles that must be solved before this technique can be used in the mining industry. One of the biggest obstacles is the distance fluctuations, environmental condition which frequently cause difficulties with line balance. The inadequacy of certain mines' infrastructure and equipment also presents challenges to the efficient application of this method. These challenges can be solved, however, with the development of automation technologies and data analysis. mining businesses can monitor and control transportation flows more effectively by utilizing real-time data analysis and Internet of Things (IoT) technologies, which would ultimately increase operational efficiency.

3. METHOD

This study uses a case study methodology to investigate how line balancing can be applied to increase a mining company's coal barging efficiency. This approach was used in order to acquire a comprehensive understanding of the actual situation in the industry and the practical steps the company has taken to eliminate inefficiencies. These are the steps that make up the method. A case study was carried out at an Indonesian coal mining firm which operates in Kalimantan. Logistics division, operational managers, field supervisors, and transportation operators are among the

research subjects in this site, which focuses on the transfer of coal from the mine to the shipping port. This company was selected in part because of problems with workload imbalance and inefficiencies in the coal barging process that were found. Direct observation was used to collect data. To make it more practical, the barging process divided into four processes: loading coal into the truck (loading), hauling coal from stockpile to hopper (hauling), dumping coal to hopper (dumping) and transfer coal to barge by conveyor system (conveyor) as described in Figure 2. At different operating stations, observations were conducted on the coal barging activities, ranging from the coal loading procedure at the stockpile to the truck transportation and final transfer to barge loading conveyor (BLC) at the port as described in Figure 1. Every stage's cycle time will be recorded in order to identify any workload imbalances or bottlenecks. The method will be explained as below steps:

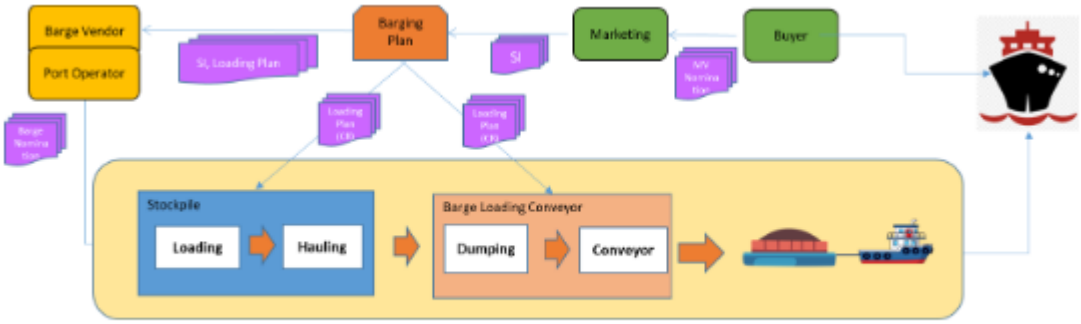

Figure 2. Coal Barging Material & Information Flow Chart

Identify Work Load: This step utilizing time study. The aim of time study is to calculate and identify the workload of every stage of coal barging, starting with the first data collection from loading process, hauling, dumping and loading conveyor.

Determine Bottleneck: This step determines the process which has highest cycle time and which process could not meet the takt time. The process stages that are causing the congestion will be identified based on preliminary observations and data analysis. There may be a bottleneck when the coal is being loaded, being transported by truck, or getting transferred in to the barges.

Workload Distribution: To ensure that each stage has a balanced cycle time, the workload will be redistributed after the bottleneck has been identified using kaizen techniques. This stage might involve re-arrangement of equipment, work sequence, reducing the number of trucks or allocating additional resources.

Kaizen: To improve the bottleneck, in this case the cycle time which are above takt time become the priority. Kaizen techniques has been used to reduce cycle time. Kaizen focuses on optimizing processes, increasing efficiency, and minimizing waste. At this research kaizen step used plan, do, check, action steps. For example, the highest cycle time was in loading process. Plan: the team find out the root cause and the team found that this was happened because the working space is too narrow for equipment to maneuvers, which lead to high cycle time. At that time, there were two fleets of loading equipment working in one stockpile slot. Do: the improvement team doing equipment arrangement by split the fleet working into two slots instead of single slot to enable equipment have enough space for maneuverings freely. The next kaizen will be described in Section 4, result and discussion. Check: the team check the result after re-arrange the equipment. Act: the improvement continuous to the next process bottleneck.

Evaluation and Analysis After Implementation: Following the application of line balancing, operational efficiency will be evaluated once again in order to compare the results with before implementation data. Cycle time, throughput (the volume of coal transported) are among the metrics that are analyzed.

4. RESULT AND DISCUSSION

To make sure that BLC system could meet the demand, takt time must be calculate and compare with cycle time of each station. Takt time is an important yet frequently tool for aligning production with demand and establishing flow in process. It is impacting capacity planning, process design, production scheduling, and plant floor operations. Takt Time is equal to available production time divided by customer demand. Table 1 show the calculation of takt time which is 166 second. This result come from customer demand for barge 270 feet size with 5200 MT normal capacity. Truck volume 24 MT, and the capacity will be fulfilled by 217 truck cycle (217 ritages). The company allocate time for 270 feet barges was 10 hours, means available time for one barge 270 ft was 10 hours. Using equation in figure 1 resulted in takt time 166 second.

Table 1
Takt Time Calculator

Demand	Quantity	Metric
Barge Quantity 270 Ft	5200	Metric Ton
Volume DT (MT)	24	Metric Ton
Truck Ritage	217	Ritage (rit)
Available time		
Hour/Day	12	Hour/Day
Effective Hour per shift	10	Hour
Available time per day	36,000	Second
Takt Time	166	Second/ritage

With takt time 166 second means that this is the pace of customer demand, thus all the process stage should meet the customer demand. After collecting the actual data from the field and it is shown in Figure 3. Thera are two processes exceed the takt time: loading process (231 second) and dumping process (170 second). Therefore, the improvement should be focus on loading process, because it will be a system bottleneck. Takt Time will help to see the flow throughout process and reduce waste by balancing the line (so each step moves at the same pace). A bottleneck is a point of congestion in a production system that severely slows the system. The inefficiencies brought about by the bottleneck often create delays and higher production costs.

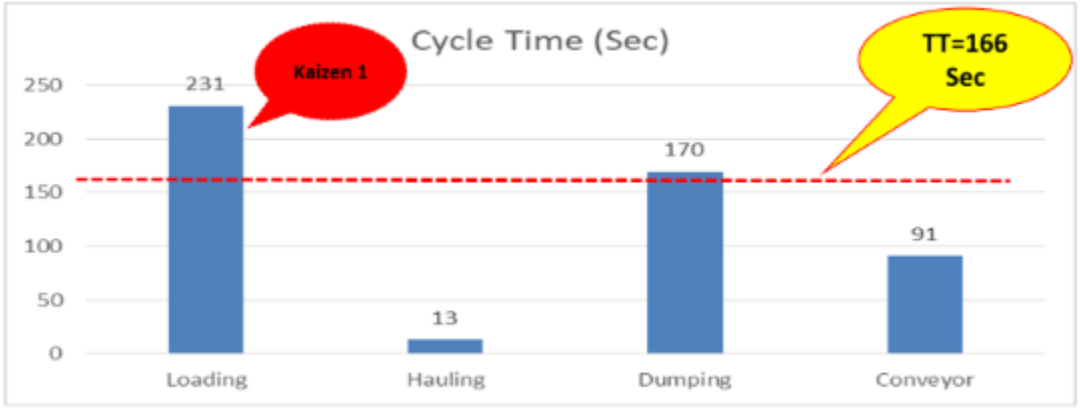

Figure 3. Cycle Time Analysis (Before)

The analysis has been made, the team find out the root of the problem and found that the slot of stockpile was too narrow. There were two-wheel loader and four trucks have been assigning to serve the barging process with hauling distance approximately 200 meters. The coal source assigned from one slot, but it was too narrow, there are no enough space for truck to make maneuver. So, some of the truck will stand far away when another truck doing loading process, and this situation increase cycle time of loading process. The solution for this problem was two split the equipment into two slots. One stockpile slot consists of one wheel loader and two trucks, so there will be enough space for trucks maneuvering. The kaizen result has reduced loading cycle time from 231 seconds to 116 seconds as described in Figure 4.

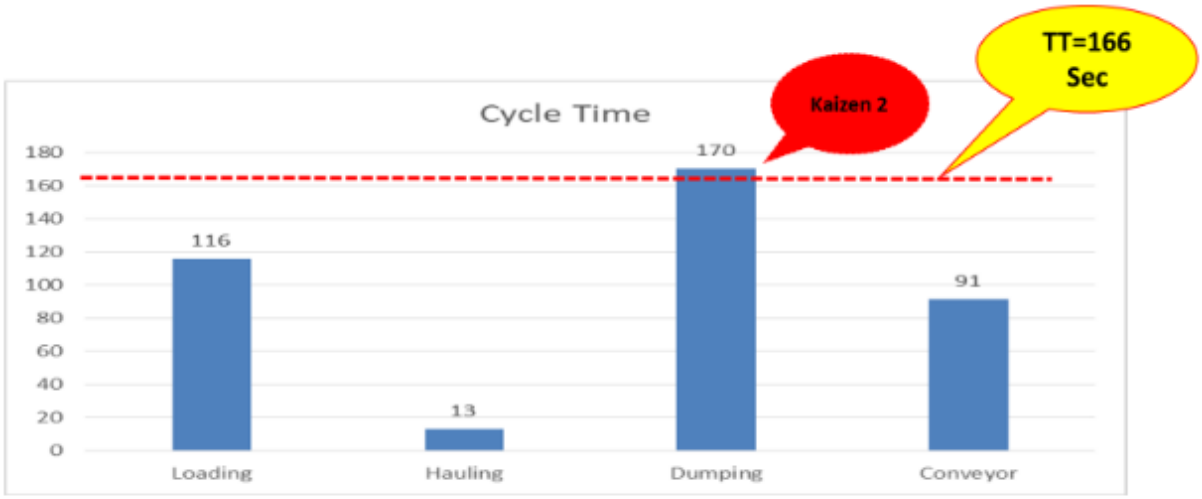

Figure 4. Cycle Time Analysis (After Kaizen 1)

Analysis has been carried out after Kaizen 1, the dumping process cycle time still above takt time, there for the team find out the root cause. The problem was the size of coal has clogged the hopper. Since the wide of the hopper gate was 50 centimeter maximum, therefore coal with bigger size will stop the coal flow to conveyor. To rectify this problem, the team doing resizing process especially for big coal. This happened because the type of the coal was manual crushed coal. After second kaizen has been made, the data was collected and the result the dumping process cycle time has reduce from 170 second to 140 second as described in Figure 5.

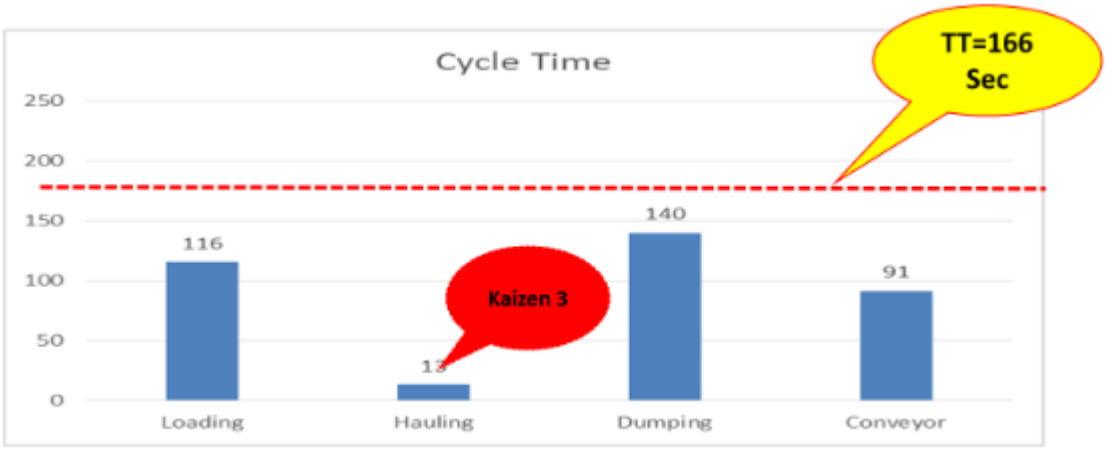

Figure 5. Cycle Time Analysis (After Kaizen 2)

After second kaizen has been executed, the dumping cycle time now below the takt time. The process able to meet customer demand. However, the system still unbalances, because the hauling system cycle time was to fast, compare to its next process. The actual situation in the field showed that some truck queuing in front of dumping area. Because hopper capacity unable to absorb the capacity of hauling which is bigger than hopper capacity. This situation will create waste on process, waste of waiting and waste of fuel. Therefore, third kaizen should be made. There are two option to overcome this problem. The team propose those two. The first was to reduce number of trucks, so the total cycle time of the hauling will increase. The second option was to arrange di hauling distance. Since there are two fleet of loading equipment, therefore distance combination will be made. One fleet hauling from slot with 200-meter distance and one fleet from another slot with 300–400-meter distance. This combination expected will increase the hauling system cycle time. The team expected the cycle time of hauling match with the cycle time of loading equipment as described in Figure 5. For this purpose, trial in the field should be made.

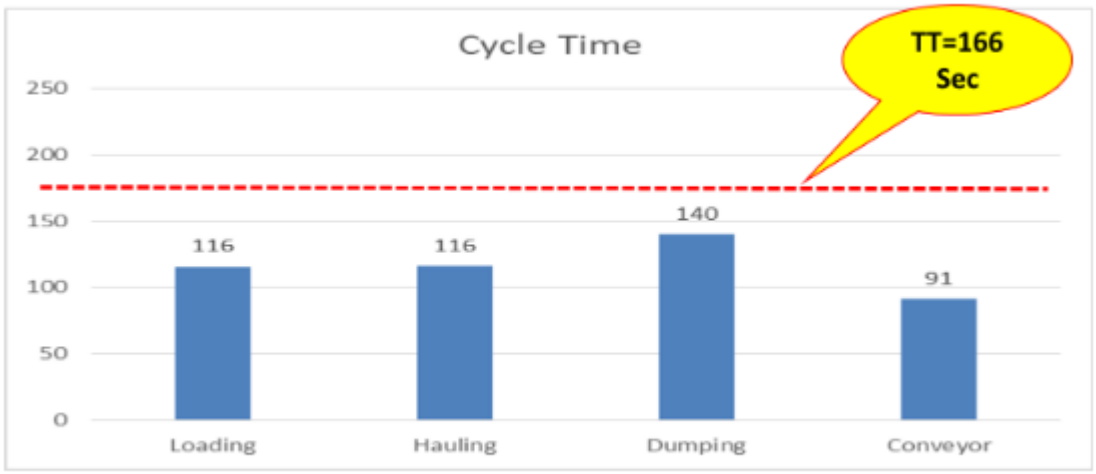

Figure 5. Expected Cycle Time of Hauling (After Kaizen 3)

5. CONCLUSION

The application of line balancing has been successful in increasing the mining company's coal transportation efficiency, as indicated by the data and analysis above. The company significantly decreased cycle time of loading process, decrease dumping cycle time and reduce waste of truck waiting, thus decreased operating expenses with a more balanced job distribution. Notwithstanding a number of obstacles, mostly associated with output volatility and infrastructural constraints, this study's findings show that line balancing is a dependable technique for raising system efficiency for coal transportation. Even though line balancing has been successfully applied, this study also notes a number of implementation-related difficulties. The environment condition creates significant problem, causing variations in the effort at every level. Even if the workload has been reduced, imbalances might still happen on days due to environment impact like rainy condition that force loading must stop due to slippery and safety concern.

Even though this study has shown that line balancing may effectively increase the efficiency of coal transportation, there are still a number of significant topics that need be thoroughly investigated in future study projects. Here are a few recommendations for further research: Reduce working hour from 10 hour to 8 hour for example, this will reduce the takt time. This will lead to potential solution to address this efficiency and productivity improvement. The time to complete one barge 270 feet will reduce. The second is real-time load balancing this will create rapid and real time data for improvement and fast decision making. To create more complex workload optimization models, future research could also make use of algorithm-based optimization techniques. Using this technique, simulation scenarios that can foresee different production situations and react to changes more rapidly can be created.

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Resilience Supply Chain Food and Beverage During the Pandemic in the Hospitality Industry

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Abstract: Three years ago, the COVID-19 pandemic caused the hotel industry to decline in visitors and revenue. Therefore, this article describes a preliminary study proposing an AR (Agile, Resilience) index to assess the agility and resilience of companies and their respective supply chains. A resilience index that discusses how supply chains can handle unexpected disruptions. The results obtained from the weight calculation show that all proposed practices are relevant to improving agile and supply chain resilience. The combined implementation value in the reference index AR is 3,548. The results of risk analysis using the House of Risk (HOR) method can be that the House of Risk (HOR) phase 1 model is to determine the priority of risk agents as the cause of risk in order to take preventive measures to cause the highest risk in the food & beverage business process, namely raw material stocks are still available with an ARP value of 648. The House of Risk (HoR) phase 2 model prioritizes proactive measures that effectively reduce the occurrence of risks based on financial capabilities and other resources. PA4 action with mitigation measures in the form of raw material orders reduced during COVID-19 with a Tech value of 10530.

Keywords: Resillience supply chain, AR Index, House of Risk (HOR), Agile

1. INTRODUCTION

The world is being hit by the COVID-19 outbreak, which initially came from Wuhan, Hubei province, China, in December 2019 and was designated by WHO as a world pandemic on March 11, 2020. The first COVID-19 case in Indonesia was detected on March 2, 2020. The COVID-19 pandemic is felt not only by Indonesia but also by all countries in the world. COVID-19 has affected business performance due to inconsistent material supply and organizations that have provided crucial needs to affect traditional procurement strategies. It has motivated practitioners and researchers to explore how companies generate the art of management to cope with the consequences of the COVID-19 pandemic and the unexpected effects of events on supply chain resilience (Shivajee et al., 2022). During the COVID-19 pandemic, several measures were taken to prevent the spread of the virus and protect public health. In the presence of lockdown during the COVID-19 pandemic, several industries, such as the aviation industry and the tourism and hospitality industry, were closed. After the gradual relaxation, these companies must adjust to new remote and capacity guidelines, operating curfews, declining revenues, job losses, and widespread insecurity expected to continue (Ntounis et al., 2022). Annoyance supply chain It comes in all forms and usually results in consequences ranging from mild to severe, starting from financial losses, increased cost needs, reduced market share, and customer turnover. In general, supply chain resilience is the basis for every company facing a crisis due to the unexpected (Harrington & Chain, 2014). Supply chain resilience is his ability to prepare food security in the face of

various changes and disruptions. The COVID-19 pandemic has put tremendous pressure on the supply chain. Through disruption, it tested its resilience in several areas, including the hospitality industry, on its part food and beverage (Dou et al., 2021). Supply chain resilience The hotel should be built in a unique position. Resilience at different scales at each stage of the food chain. To build resilience and achieve truly sustainable results, companies in the food and beverage industry should implement strategies that identify vulnerabilities and drive adaptive action at all stages of their supply chains. As investors pay more attention to environmental, social, and governance principles, the company food and beverage should be encouraged to report their level of protection (Bezares et al., 2021).

2. LITERATURE REVIEW

Paradigm resillience, which relates to supply chains' ability to cope with unexpected disruptions. Today, the focus of supply chain design should be on resilience, although in the past the top priority was service optimization or reducing costs. Paradigm resillience will contribute to supply chain are more competitive in time, quality and 2 customer service, increasing market share and strengthening leadership. Index resillience will affect performance and competitiveness supply chain (H. Carvalho et al., 2013) . In reducing these risks, methods are used House of Risk (HOR). Method House of Risk (HOR) is used to determine risk and Risk Agent Causes of risk and proposed strategies to mitigate Risk Agent. The HOR method is carried out in two phases, namely: House of Risk (HOR) phase 1 and House of Risk (HOR) phase 2. Method House of Risk (HOR) phase 1 conducts risk identification based on a business process framework using practice indicators Agile and resillience. Then the method House of Risk (HOR) phase 2 as a risk strategy determination (F. Chaisani., 2021). The following table 1 shows past research.

Table 1 Previous Research

No	Citations	Method	Object	Result	Contribution Journals in Research
1	(V. Shivajee et al., 2022)	*Procurement System*	*Supply chain resillience* of business performance in COVID-19	Procurement *systems* can identify new strategies and practices	The *procurement* function has made a significant contribution in creating supply chain resilience during the COVID-19 pandemic
2	(N. Ntounis et al., 2022)	*Design approach* and *Business Resillience Composite Score* (BRCS)	Tourism-dependent businesses in the English city	The application of BRCS relative to some other sectors such as professional services, tourism-dependent businesses are more vulnerable to the pandemic.	Providing policymakers' relevant insights can include indications of the relative priorities of initiatives across industry sectors to improve the impact of tourism based on its relative resilience
3	(B. L. Harrington et al., 2014)	Traditional approach	*DHL Resillience*	DHL has developed *resillience* 360 for risk analysis that maps the company's supply chain risks.	Provide an understanding of *traditional* approaches to responding to supply chain risks following predictable patterns
4	(Z. Dou et al., 2020)	*Convenience-snowball sampling*	Food system resilience during pandemics across national China and the United States	Household food security worsened during pandemic	Provide an understanding of food system resilience across a range of functional indicators
5	(N. Bezares et al., 2021)	The qualitative descriptive method is SWOT analysis	*Food and Beverage* at Cavinton hotel Yogyakarta	Due to COVID-19, public awareness of cleanliness, health, safety and environmental sustainability is very large	Provide understanding related to innovation and strategies in order to survive the COVID-19 pandemic
6	(L. Hendriyati et al., 2021)	Triangulation test method	Hospitality industry	Strategies that have been successfully carried out in the hospitality industry to make businesses bounce back after the pandemic	Provide an understanding of suggested strategies to build supply chain resilience
7	(P. L. Rini et al., 2022)	*House of Risk* (HOR) based on the SCOR model	Fish supply chain amid COVID-19 pandemic	HOR identified 31 risk events and 46 risk agents	Provide an understanding of risks and design mitigation strategies
8	(C. Solisa et al., 2022)	*House of Risk* (HOR)	Construction projects at CV.Asri Tehnika	Risks that occur in CV.Asri Tehnika	Understand the understanding and purpose of using the HOR method to help overcome problems with supply chain activities

No	Citations	Method	Object	Result	Contribution Journals in Research
9	(E. W. Abryandoko., 2020)	Agile *index* and *resillience*	*Agile* automotive companies	Using *agile* indices to assess the *agile* of automotive companies with *appropriate supply chains*	Understand agile indices and *resillience* with *supply chains*
10.	(H. Carvalho et al., 2013)	Triangulation test method	Hospitality industry	Strategies that have been successfully carried out in the hospitality industry to make businesses bounce back after the pandemic	Provide an understanding of suggested strategies to build supply chain resilience
11.	(F. Chaisani., 2021)	*House of Risk* (HOR)	Construction projects at CV.Asri Tehnika	Risks that occur in CV.Asri Tehnika	Understand the understanding and purpose of using the HOR method to help overcome problems with supply chain activities

3. METHOD

Research methodology describes the stages carried out to obtain and process the data used. There are four stages of the resillience model, namely:

3.1 Stage 1 (react) model resillience

3.1.1 Determination of the Resillience Indicator

At this stage, the research aims to determine resillience indicators that are in accordance with XYZ hotels engaged in the hotel industry. These indicators will then be adjusted to the current condition of the company. The following table 2 is the determination of resillience indicators adjusted to previous research.

Table 2 Agility and Resillience Practices of Previous Research

Agile practices	References					Resilient practices	References			
	a	b	c	d	e		a	b	c	d
First-tier supplier ==> Focal firm				✓	✓	**First-tier supplier ==> Focal Firm**				
To use IT to coordinate/integrate activities in design and development					✓	To use sourcing strategies to allow switching of suppliers	✓			
To use IT to coordinate/integrate activities in procurement					✓	Committing to contracts for material supply (buying capacity whether it is used or not)	✓			
Ability to change delivery times of supplier's order					✓	To make use of flexible supply base/flexible sourcing			✓	
To reduce the development cycle time					✓	To develop visibility to a clear view of upstream inventories and supply conditions		✓		
Focal Firm					✓	**Focal Firm**				
To use IT to coordinate/integrate activities in manufacturing			✓	✓	✓	Designing production systems that can accommodate multiple products and real-time changes	✓			
To integrate supply chain/value stream/virtual corporation	✓					To use a multi-skilled workforce	✓			
To use centralised and collaborative planning				✓		Exceed capacity requirements	✓			
To reconfigure the production process rapidly	✓					Postponement			✓	
To produce in large or small batches		✓				To minimise batch sizes		✓		
To accommodate changes in production mix					✓	To constitute strategic stock		✓	✓	✓
To reduce manufacturing throughput times to satisfy customer delivery					✓	To employ make-and-buy trade-off			✓	

Agile practices	References				
	a	b	c	d	e
To reduce development cycle times					✓
To minimise setup times and product changeovers		✓			
To organise along functional lines			✓		
To facilitate rapid decision making			✓		
Focal Firm ==> First-tier customer					
To use IT to coordinate/integrate activities in ligostics and distribution					✓
To increase frequency of new product introduction			✓	✓	✓
To speed up adjustments in delivery capability					✓
To speed up improvements in customer service				✓	✓
To speed up response to changin market needs					✓
To capture demand information immediately			✓		
To retain and grow customer relationship			✓		
To develop prodicts with added value for customers			✓		

Source:
a : Naylor et al. (1999) c : Lin et al. (2006) e : Swafford et al. (2008)
b : Goldsby et al. (2006) d : Agarwal et al. (2007)

Resilient practices	References			
	a	b	c	d
To plan strategic disposition of additional capacity and/or inventory at potential 'pinch points'		✓		
To develop visibility to a clear view production and purchasing schedules		✓		
To create total supply chain visibility				✓
To reduce lead time		✓	✓	
To ensure process and knowledge back-up				✓
To employ a supply chain risk management culture		✓		
To develop collaborative working across supply chains to help mitigate risk		✓		

Source:
a : Rice and Caniato (2003) c : Tang (2006)
b : Christopher and Peck (2004) d : Iakovou et al. (2007)

3.1.2 Resillience Indicator Assessment

At this stage, an in-depth analysis of each indicator of resillience from the company is carried out based on the data that has been collected. This in-depth analysis of each resillience indicator serves to describe how the company's condition in each of these resillience indicators . Each indicator also serves as an initial calculation of the recillience index value. This agile and resillience paradigm will help supply chains become more competitive in terms of time, quality and customer service, increase market share and improve leadership. The selection of indicators is adjusted to the company through a questionnaire given to the Head Office Department (HOD) of the hotel. The following table 3 shows the analysis of each indicator.

Table 3 Agile and Resillience Practices in Companies

Agile practices	Company	
	Exist	None
First-tier supplier ==> Focal firm		
Using IT to coordinate / integrate activities in design and development	✓	
Using IT to coordinate / integrate activities in procurement	✓	
Ability to change the delivery time of supplier orders	✓	
To reduce development cycle time	✓	
Focal Firm		
Using IT to coordinate / integrate manufacturing activities	✓	
To integrate supply chains/value streams/virtual enterprises	✓	

Resilient practices	Company	
	Exist	None
First-tier supplier ==> Focal Firm		
Use procurement strategies to enable supplier turnover	✓	
Commit to a supply material contract (purchase capacity whether it is used or not)	✓	
To utilize a flexible supply base / flexible resources	✓	
To develop visibility into a clearer view of upstream inventory and supply conditions	✓	
Focal Firm		
Design production systems that can accommodate multiple products and changes in real time	✓	
To use a workforce that has a lot of expertise		

Agile practices	Company		Resilient practices	Company	
	Exist	None		Exist	None
To use a centralized, collaborative plan	✓		Exceeded capacity requirements		✓
To quickly reconfigure production processes	✓		Procrastination		
To produce in large or small batches	✓		To minimize batch size	✓	
To accommodate changes in the production mix	✓		To consolidate strategic stocks	✓	
To reduce production time to speed up delivery to customers	✓		To make a make-and-buy trade-off	✓	
To reduce development cycle time	✓		To plan a disposition strategy of additional capacity and/or inventory on potential 'pinch points'	✓	
To minimize setup and product replacement time	✓		To develop visibility into a clearer view of production and production schedules	✓	
To organize by functional flow	✓		To create total supply chain visibility	✓	
To facilitate quick decision making	✓		To parse the timeout	✓	
Focal Firm ==> First-tier customer			To ensure process and knowledge return	✓	
Using IT to coordinate / integrate logistics and distribution activities	✓		To implement a culture of supply chain risk management	✓	
To increase the frequency of the latest product introductions	✓		To develop collaborative work across the supply chain to help mitigate risk	✓	
To speed up customization in delivery capabilities	✓				
To accelerate improvements in customer service	✓				
To accelerate response to changing market needs	✓				
To meet information needs quickly	✓				
To maintain and develop relationships with customers	✓				
To develop value-added products for customers	✓				

3.2 Stage 2 (anticipate) model resillience

3.2.1 Calculation of Resillience Index Value

In the last stage of processing this data, the measurement of values on each dimension of resillience and the calculation of the overall correlation value for the company. The corresponding one is used to calculate each indicator of the company.

3.2.1.1 Weighted Practices

The assessment of the total weight of each corresponding sub-indicator is used to calculate each indicator of the company. The above equation shows that, in relation to each paradigm, corporate behavior is influenced by the degree of implementation of the practice and the corresponding weight. The following formula in the agile and resillience paradigm is:

$(B_A)j = \sum_{i=1}^{y} w_{Ai} \times (P_{Ai})j$ ..... (1)
$(B_R)j = \sum_{i=1}^{y} w_{Ri} \times (P_{Ri})j$ ..... (2)
Information:
- (PAi)j and (PRi)j respectively for companies is j and the level of practice application is i from the agile and resillience paradigms. The level of implementation of each practice is assessed on a 5-point Likert scale, namely:
1 : practice not applied
2: practice applied but not all departments
3 : Practice applied
4: Practice applied by almost all departments
5 : Practice applied to all departments

In this assessment, it is carried out with Head Office Department (HOD) of five departments namely, Operational HOD, HOD Accounting and HOD Engineering, HOD HRD and HOD Sales & Marketing. The following data is obtained from HOD Hotel XYZ.

3.2.1.2 Supply Chain AR Index Construction

The next step is to describe the correlation matrix for the practice under consideration. According to the correlation matrix, the variable is not highly correlated with others at a significance level of 5%. Most of them are not significantly related to each other at all. After weights accounted for and verified practice correlation, next is for the AR index (Agile, Resillience) to assess the level Agile and Resilient supply chain hotel with the following formula equation:

$AR_j = 0.5 \times (B_A)_j + 0.5 \times (B_R)_j$ .....(3)
Information:
$(BA)_j$ and $(BR)_j$ = corporate behavior j in accordance with agile and resillience paradigms respectively. If you want the supply chain to be more flexible, then the practice must be implemented (implementation). To determine the value of implementation, use a 5-point Likert scale, namely:
1 : practice not applied
2: practice applied but not all departments
3 : Practice applied
4: Practice applied by almost all departments
5 : Practice applied to all departments

3.3 Stage 3 (collaborate) model resillience

3.3.1 Risk Identification

The process of identifying risks to risk events in activities that occur at XYZ hotels is carried out by means of discussions and interviews with employees for assessment related to risk events. Determining the severity level provides an overview of the impact of risk events that disrupt business processes. Severity evaluation uses criteria on a scale of 1 – 10. Risk events can be found in identified risk events (risk agents), which are also identified by evaluating the level of potential sources of risk. Each cause of risk has opportunities that must be minimized to prevent risk events. The value of risk events and risk agents is carried out by discussions and interviews with XYZ hotel employees. Evaluation of occurance using criteria scale 1 – 10. Then give a correlation value to the risks that have been identified. Risk correlation is assessed by conducting interviews that discuss the relationship between risk events and risk causes. The scales used are 0,1,3 and 9. The severity and occurance assessment by XYZ hotel employees is processed in step 1 of the House of Risk (HoR) method to generate ARP (Aggregate Risk Potential) value.

3.3.2. House of Risk (HOR) phase 1

After knowing the value of the relationship between the risk event and the risk agent, the ARP (Aggregate Risk Potential) value is found using the formula.

$$ARPj = Oj\sum SiRij \quad (4)$$

Information:
ARP = Aggregate Risk Priority.
Oj = To measure the value of the probability of occurrence of a risk factor
Si = Measure the impact of risk.
Rij = Measurement of the correlation value of risk events.

3.4 Stage 4 (orchestrate) model resillience

3.4.1 House of Risk (HOR) phase 2

After phase 1 of the House of Risk is completed, the next step is carried out by the House of Risk phase 2, which includes planning a risk management strategy to reduce the influence of risk factors and as a prevention of the occurrence of risks. The House of Risk phase 2 uses tables to determine the precautions to take. The calculation in House of Risk phase 2 involves total effectiveness of action (Tek), degree of difficulty performing action (Dk) and Effectiveness of difficulty ratio (ETDk) with the highest value, namely ETDk which will be prioritized for risk management actions. Total effectiveness is used to determine the level of efficiency of each risk management strategy. The calculation of total effectiveness and the results of the degree of difficulty assessment are determined by multiplying the correlation values between risk factors and preventive measures by the ARP value to the nth value.

4. RESULT AND DISCUSSION

4.1. Results of Weighted Practices

The results obtained from the weight calculation show that all proposed practices are relevant to improving agile and supply chain resillience. Unimportant practice with an average score of 3.6 on the 5-point Likert scale. Other practices with ratings equal to or greater than 3.6 indicate that all practices in the calculation are relevant for the AR supply chain index. Here is table 4 of the results of calculating agile weight and resillience.

Table 4 Results of Calculating Agile Weight and Company Resillience

Agile variables	Mean Rating	Rank	Weighting	*Resillience variables*	Mean Rating	Rank	Weighting
PA1 = Company uses technology for ordering	3.6	19	0.03974	PR1 = The company uses procurement strategies to find the best and cheapest	4.4	2	0.06285
PA2 = The company uses technology to calculate the raw materials to be ordered to suppliers	4	7	0.04415	PR2 = The company has a commitment to the raw material supply contract	3.8	7	0.054285
PA3 = The company can change the delivery time of raw materials from suppliers	4	7	0.04415	PR3 = Company utilizes flexible supply	3.8	7	0.054285
PA4 = The company purchases raw materials that have run out in the kitchen	3.6	19	0.03974	PR4 = Company increases visibility by having the right budget	3.8	7	0.054285
PA5 = The company uses technology in carrying out service activities in the company	3.8	11	0.04194	PR5 = The company designs food processing from existing materials so that the processing time does not take much time	3.8	7	0.054285
PA6 = The company purchases with an integrated kitchen through Odoo to facilitate PR (Purchase Request) and SR (Store Request)	3.8	11	0.04194	PR6 = Company has a multitasking workforce	4	4	0.057142
PA7 = Company uses Odoo app for food orders between front office and kitchen	3.6	19	0.03974	PR7 = Company can suspend activities	3.6	8	0.051428
PA8 = Company prepares raw materials to be used before cooking	4	7	0.04415	PR8 = Company minimizes food production capacity	3.6	8	0.051428
PA9 = Company produces large or small scale through room system	3.8	11	0.04194	PR9 = Company consolidates existing stock of raw materials	3.8	6	0.054285
PA10 = Company rotates food at breakfast	4.2	4	0.04636	PR10 = The company manufactures and purchases goods	3.8	6	0.054285
PA11 = The company prepares raw materials to reduce customer waiting time	3.6	19	0.03974	PR11 = Company adds capacity	4.6	1	0.065714
PA12 = The company provides a monthly rotation of promo menus for food and beverages that have been prepared	3.8	11	0.04194	PR12 = The company ensures that the required raw materials are available on time	3.6	5	0.051428
PA13 = The company rotates the breakfast menu to prepare for the next day	4.2	4	0.04636	PR13 = Company develops real-time visibility on aspects of the supply chain	4.4	1	0.062857

PA14 = The company has a department with socialized duties and responsibilities	4	7	0.04415	PR14 = Company reduces customer waiting time	3.6	4	0.051428
PA15 = Department of Food & Baverage makes decision to provide food looking at room occupancy	4.4	2	0.04857	PR15 = The company knows the menu to be made and ensures raw materials are available	4	2	0.057142
PA16 = The company uses the application for the distribution of goods	3.8	11	0.04194	PR16 = Company implements supply chain risk management	4.4	1	0.062857
PA17 = Company makes large quantities of food and beverages for new menus	3.6	19	0.03974	PR17 = Companies can develop collaborative work across the supply chain	4	1	0.057142
PA18 = Company prepares raw materials to reduce customer waiting time	3.8	11	0.04194				
PA19 = Company prepares raw materials to be used before cooking	3.8	11	0.04194				
PA20 = The company can serve customer needs	4.8	1	0.05298				
PA21 = Food &; Baverage Department can perform services according to customer wishes	4.4	2	0.04857				
PA22 = The company conducts promotions to maintain relationships with customers	3.8	11	0.04194				
PA23 = Company can provide customer food requests	4.2	4	0.04636				

4.2 Supply Chain AR Index Construction Results

Table 4 illustrates the correlation matrix for the practice under consideration. According to the correlation matrix, the variable is not highly correlated with others at a significance level of 5%. Most of them are not significantly related to each other at all. The following table 5 is the correlation of weighted supply chain practices.

Table 5 Weighted Correlation of Companies

Correlation Matrix		PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	PA11	PA12
Agile Practices	PA1	1.000	-0.133	-0.801	-0.308	0.534	0.308	0.142	-0.142	0.378	0.134	-0.309	0.267
	PA2	0.133	1.000	0.000	0.000	-0.250	0.866	0.267	-0.668	-0.530	0.250	0.000	0.875
	PA3	-0.801	0.000	1.000	0.000	-0.875	0.000	-0.267	0.000	-0.530	-0.250	0.000	-0.250
	PA4	-0.308	0.000	0.000	1.000	0.289	-0.167	0.000	0.617	-0.408	0.722	1.000**	-0.144
	PA5	0.534	-0.250	-0.875	0.289	1.000	-0.289	0.267	0.267	0.530	0.375	0.289	0.000
	PA6	0.308	0.866	0.000	-0.167	-0.289	1.000	0.000	-0.617	-0.612	0.289	-0.167	0.722
	PA7	0.142	0.267	-0.267	0.000	0.267	0.000	1.000	-0.429	0.378	-0.267	0.000	0.535
	PA8	-0.142	-0.668	0.000	0.617	0.267	-0.617	-0.429	1.000	0.000	0.401	0.617	-0.802
	PA9	0.377	-0.530	-0.530	-0.408	0.530	-0.612	0.378	0.000	1.000	-0.530	-0.408	-0.177
	PA10	0.133	0.250	-0.250	0.722	0.375	0.289	-0.267	0.401	-0.530	1.000	0.722	0.000
	PA11	-0.308	0.000	0.000	1.000**	0.289	-0.167	0.000	0.617	-0.408	0.722	1.000	-0.144
	PA12	0.267	0.875	-0.250	-0.144	0.000	0.722	0.535	-0.802	-0.177	0.000	-0.144	1.000
	PA13	-0.801	0.125	0.500	0.722	-0.250	-0.144	0.000	0.267	-0.530	0.250	0.722	0.000
	PA14	-0.429	0.668	0.668	0.000	-0.802	0.617	0.000	-0.429	-0.756	0.000	0.000	0.401
	PA15	0.000	-0.866	0.000	-0.167	0.144	-0.667	-0.617	0.617	0.408	-0.144	-0.167	-0.866
	PA16	-0.802	0.250	0.875	0.289	-0.750	0.144	-0.134	0.000	-0.707	0.000	0.289	0.000
	PA17	0.143	0.802	0.134	0.000	-0.401	0.926	-0.143	-0.429	-0.756	0.401	0.000	0.535
	PA18	0.309	0.433	-0.433	-0.167	0.289	0.167	0.926	-0.617	0.408	-0.289	-0.167	0.722
	PA19	0.535	-0.250	-0.875	0.289	1.000**	-0.289	0.267	0.267	0.530	0.375	0.289	0.000
	PA20	-0.756	-0.530	0.530	0.612	-0.177	-0.612	-0.378	0.756	-0.250	0.177	0.612	-0.707
	PA21	0.143	0.802	-0.134	0.309	0.000	0.617	0.571	-0.429	-0.378	0.267	0.309	0.802
	PA22	0.535	-0.250	-0.875	0.289	1.000**	-0.289	0.267	0.267	0.530	0.375	0.289	0.000
	PA23	0.756	0.530	-0.530	-0.612	0.177	0.612	0.378	-0.756	0.250	-0.177	-0.612	0.707

After obtaining the value of weight and correlation, behavioral calculations are carried out. The following table 6 shows the results of the calculation of company behavior.

Table 6 Agile and Resillience Behavior of Companies

Agile Practices	Implementation Degree (PA)j	Agile Practices	Implementation Degree (PA)j
PA1	4	PA13	3.8
PA2	2.6	PA14	3.6
PA3	4.2	PA15	3.2
PA4	3.8	PA16	3
PA5	3.4	PA17	4.2
PA6	3.4	PA18	3
PA7	4.6	PA19	4
PA8	4	PA20	3
PA9	3.2	PA21	3.2
PA10	3.8	PA22	3.6
PA11	3.4	PA23	4
PA12	4.2		
Agile behaviour reference value = 3.603 $(B_A)j = \sum_{i=1}^{y} w_{Ai}\ x\ (P_{Ai})j$			

ResillliencePractices	Implementation Degree (PR)j	ResillliencePractices	Implementation Degree (PR)j
PR1	3.6	PR10	4.4
PR2	3.2	PR11	3.6
PR3	3.4	PR12	2.8
PR4	4.2	PR13	3.8
PR5	4	PR14	4
PR6	3.4	PR15	2.8
PR7	4.2	PR16	4.4
PR8	3.8	PR17	3.6
PR9	2.8		
Resillience behaviour reference value = 3.493 $(B_R)j = \sum_{i=1}^{y} w_{Ri}\ x\ (P_{Ri})j$			
AR index reference value = 3.548 $AR_j = 0.5\ x\ (B_A)_j + 0.5\ x (B_R)_j$			

The combined implementation value in the reference index AR is 3,548. This value shows that in the current situation, XYZ hotel has sufficiently implemented agile and resillience practices. Therefore, supply chains need to be more flexible and durable to become more competitive.

4.3 House of Risk (HOR) phase 1

ARP (Aggregate Risk Potential) calculation is carried out to determine the risk that receives the solution based on the ARP (Aggregate Risk Potential) value received. The following table 7 and figure 1 show the cumulative ARP.

Table 7 Cumulative ARP Figure 1 Pareto Diagram

Kode	Risk Agent	ARP	Kumulatif	%Kum	%Kum	Rank
A2	Stock of raw materials is still available	1827	1827	12.63%	12.63%	1
Al2	There is a PSBB in the supplier area	1548	3375	10.70%	23.32%	2
A4	Not much budget	1410	4785	9.74%	33.07%	3
A9	Employees do not comply with SOP	1105	5890	7.64%	40.70%	4
A7	Late in preparing materials	990	6880	6.84%	47.55%	5
A10	Employees are not careful in counting stock	975	7855	6.74%	54.28%	6
A16	There was an error in delivering the customer's order in F&B	925	8780	6.39%	60.68%	7
A6	Human error	860	9640	5.94%	66.62%	8
A11	Employees who are careless in inputting production and sales databases	852	10492	5.89%	72.51%	9
A5	Food waste	768	11260	5.31%	77.82%	10
A15	The quality of raw materials does not match the hotel's requirements	676	11936	4.67%	82.49%	11
Al4	Changes to customer orders	618	12554	4.27%	86.76%	12
A17	An error occurred in the packing process	581	13135	4.02%	90.77%	13
Al	Error in calculating the amount of raw materials	495	13630	3.42%	94.19%	14
A8	Planning calculation error	412	14042	2.85%	97.04%	15
A3	Waiting for F&B Manager approval	276	14318	1.91%	98.95%	16
A13	The cooking tools used are limited	152	14470	1.05%	100.00&	17

Based on table 6, the result of the ARP value that has the highest value is A2, namely the stock of raw materials in the company is still available with a value of 1827. The ARP rating in the Pareto chart whose value reaches the highest reaches 80% is the cause of risk with codes: A2, A12, A4, A9, A7, A10, A16, A6, A11, A5 and A15 accounting for 82.49% of the total ARP value.

4.4 House of Risk (HOR) phase 2

The calculation in House of Risk (HOR) phase 2 involves total effectiveness of action (Tek), degree of difficulty performing action (Dk) and Effectiveness of difficulty ratio (ETDk) with the highest value, namely ETDk which will be prioritized for risk management actions. The outcome of House of Risk (HOR) phase 2 is the proposed strategy or preventive action contained in HOR 1. The following table 8 shows the proposed strategy in House of Risk (HOR) phase 2:

Table 8 Strategy Proposals

Kode	Risk Event	Kode	Risk Agent	Kode	Tindakan pencegahan	Dk
E2	The number of raw material orders to suppliers decreased due to COVID-19	A2	Stock of raw materials is still available	PAI	Raw material orders reduced during COVID-19	3
E12	Supplier late in sending raw materials	Al2	There is a PSBB in the supplier area	PA2	Looking for new suppliers that suit the hotel	4
E4	The price of raw materials is relatively high	A4	Not much budget	PA3	Processing menus with available raw materials	3
E9	An error occurred in the cooking process	A9	Employees do not comply with SOP	PA4	Employee training every month	3
E7	Delay the production process (cooking)	A7	Late in preparing materials	PA5	Prepare raw materials before opening the hotel	2
E10	The stock of raw materials in the data does not match the existing stock (physical)	A10	Employees are not careful in counting stock	PA6	Implementing computer technology	2
E16	Customer orders do not match the availability of raw materials	A16	There was an error in delivering the customer's order in F&B	PA7	Carry out raw material calculations before opening a hotel	2
E6	There was an error in recording the customer's room number.	A6	Human error	PA8	Conduct cross checks between employees and customers when placing orders	2
E11	An error occurred while checking the receiving incoming material process.	A11	Employees who are careless in inputting production and sales databases.			
E5	There is a buildup of ready-made food	A5	Food waste	PA9	Reduce the number of menu batches	3

The strategy proposal that has been calculated in House of Risk (HOR) 2, obtained the result of the PA1 value, namely raw material orders reduced during COVID-19 which was the highest at 30681.

5. CONCLUSION

1. Based on the data processing and analysis that has been done, the conclusion obtained is The combined implementation value in the reference index AR is 3,548. This value shows that in the current situation, XYZ hotel has sufficiently implemented agile and resillience practices. Therefore, supply chains need to be more flexible and durable to become more competitive.
2. Based on the results of the analysis of the House of Risk method, it can be concluded as follows: A. This HOR 1 model to determine the priority of risk agents as the cause of risk in order to take preventive measures to cause the highest risk in the project is A2 "Stock of raw materials is still available" with a value of ARP 1827. B. The HOR 2 model prioritizes proactive measures that effectively reduce the occurrence of risks based on PA1 capabilities. PA1 actions with mitigation measures in the form of raw material orders were reduced during a pandemic, such as COVID-19 with an ETDk value of 10227.

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Life Cycle Assessment (LCA) for Preparation of Environmental Impact Reduction Proposal on Cheddar Cheese Production Process

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Abstract: While beneficial for businesses, the increasing number of food industries each year also poses environmental challenges such as global warming and ozone depletion. One such developing industry is Jogja Cheese House (KEJUGJA), which produces various types of cheese. The energy consumption in each production process adversely affects the environment, and improper disposal of whey waste, a by-product of cheese production, adds to the problem. This study aims to assess the environmental performance of the production process and propose improvement strategies. The research focuses on cheddar cheese production. The method used is Life Cycle Assessment (LCA), which involves four main stages: goal and scope definition, inventory analysis, impact assessment, and interpretation. The goal and scope define the research objectives, focusing on energy, water, and fuel use in cheddar cheese production. Inventory analysis is conducted using the gate-to-gate method to measure mass and energy use. Impact assessment identifies emissions and their environmental contributions. Based on LCA results, a fishbone diagram is used to identify problems from six aspects: people, methods, machines, materials, environment, and leadership. The proposed improvements from the fishbone diagram include conducting training sessions by environmental agencies and NGOs, establishing long-term contracts with milk suppliers to ensure quality standards, using Material Requirement Planning (MRP) to manage raw material demand fluctuations, considering High-Temperature ShortTime (HTST) pasteurization, and processing whey waste into value-added products like whey protein, whey-based drinks, and whey crackers, or using it as an additive in cow feed.

Keywords: Life Cycle Assessment, cheddar cheese, environmental impact, waste management

1. INTRODUCTION

Public interest in cheese has significantly increased the demand for cheese products in Indonesia. In 2022, national cheese demand rose by 12.5%, and this percentage is expected to grow annually, given cheese's vital role as a food ingredient in today's culinary world. The rising demand for cheese has encouraged the expansion of the cheese processing industry, from micro to macro-scale enterprises, which have become increasingly prevalent in society. One such enterprise is UMKM Rumah Keju Jogja (KEJUGJA), a micro, small, and medium enterprise (MSME) located in Sleman Regency, Special Region of Yogyakarta. KEJUGJA specializes in processing fresh cow's milk into various types of natural cheese, including cheddar cheese. KEJUGJA processes 110 liters of cow's milk daily to produce cheddar cheese. The cheese production process generates a by-product known as whey, a liquid waste with relatively high nutritional content. Cheese whey comprises 95.1% water, 0.85% protein, 0.27% fat, and 4.7% lactose. Despite its potential for reuse, whey that is not managed correctly can lead to environmental pollution. At KEJUGJA, the current practice involves disposing of whey waste into nearby infiltration sources. This practice has resulted in environmental pollution, particularly during the dry season, causing a foul odor and the darkening of water bodies. Additionally, KEJUGJA's production process involves the excessive use of electrical energy, contributing to carbon emissions. For example, a 2200 W cheese vat is used for cheese pasteurization to separate the whey for 8 hours. In addition to this, two 1 PK air conditioners (AC), two 196 W ice boxes, two 115 W refrigerators, and one 190 W showcase unit are used continuously for 24 hours to maintain cheese refrigeration, further increasing energy consumption and environmental impact. Given these issues, this study addresses the problem of proposing improvements to the cheese production process at KEJUGJA UMKM to mitigate the most significant negative environmental impacts. This research aims to develop strategies that optimize the cheese production process at

KEJUGJA, focusing on reducing whey waste pollution and excessive energy consumption, thereby promoting a more sustainable and environmentally friendly production approach.

2. LITERATURE REVIEW

Widyastuti (2010) defines cheese as a processed milk product made from cow, goat, sheep, or other mammal milk. It involves removing water through rennet and fermentation, resulting in a nutritious product commonly used in various processed foods. Hilman & Kristiningrum (2008) stated that the International Organization for Standardization, commonly called ISO, established by the International Organization for Standardization in 1947, focuses on creating international standards for environmental management. It benefits organizations by improving environmental practices across different sectors, including goods, services, and government. According to Irawati & Andrian (2018), Life Cycle Assessment (LCA) is is a method for evaluating the environmental impacts of a product throughout its entire life cycle, from material extraction to disposal. LCA helps improve process efficiency, reduce costs, and support green marketing. According to Santoso & Ronald (2012), OpenLCA developed by GreenDelta2 in 2006, is software that facilitates LCA and sustainability assessments. It simplifies the analysis of environmental impacts using various databases. According to Mustafa (2015), mass balance is based on the conservation of mass principle, which states that the mass entering a system equals the mass leaving it. It is used to evaluate material flow and composition within a system. According to Agustina (2021), the energy is grounded in the law of energy conservation, which asserts that energy cannot be created or destroyed. It provides insights into energy production, transformation, and usage within a system. According to the Big Indonesian Dictionary (KBBI), energy consumption refers to the use of energy for various processes. Electrical energy, in particular, is derived from mechanical or chemical interactions and is used to power human activities through various forms such as motion and light. The fishbone diagram, as described by Gaspersz (2001), is a key quality tool used to identify the causes of a problem by emphasizing cause-and-effect relationships. It helps teams identify and address the root causes of issues, aiding in problem-solving, generating ideas, and formulating actions for improvement. Previous studies on ecological impact using Life Cycle Assessment (LCA) typically focus on different aspects depending on the approach. This study will employ LCA methods, including ReCiPe Endpoint (H) V1.13 and CML 2 Baseline 2000 V2.05, to assess the environmental impacts of cheese production at UMKM Rumah Keju Jogja (KEJUGJA) using a gate-to-gate system. Following the LCA analysis, a fishbone diagram will be created to address the identified impacts and manage whey waste, based on methods outlined by Khasanah, Faishal, and Suharyanto (2021).

3. METHOD

Data processing in this study involves handling primary and secondary data to address the identified issues. The inventory analysis phase includes data collection on all stages of the cheese production process, such as pasteurization, acidification, coagulation, curd cutting, cheese heat treatment, whey separation, cheese salting, molding, packaging, and energy use. Mass and energy balances are calculated, including electrical energy usage for refrigeration and cheese VAT operations and fuel calculations for LPG. The goal and scope of the Life Cycle Assessment (LCA) are defined to analyze the environmental impact of cheddar cheese production at UMKM KEJUGJA using a gate-to-gate approach. Life Cycle Inventory (LCI) quantifies inputs and outputs in the production process using primary and secondary data from KEJUGJA and literature. Data collection involves direct observation, interviews, and process flow diagram creation to show input needs and emissions. Life Cycle Impact Assessment (LCIA) evaluates environmental impacts using CML IA Baseline and Recipe Endpoint methods, focusing on categories such as human health, ecosystems, and resources. This includes characterization, normalization, weighting, and single-score calculations to compare processes. Interpretation combines LCI and LCIA results using OpenLCA software to identify significant environmental impacts and determine the least impactful improvement options. A fishbone diagram is developed based on LCA results to identify root causes of significant environmental impacts, categorized using the 4M+1L framework (methods, machines, materials, people, environment), which helps formulate

proposals for improvements to the cheddar cheese production process. The data processing process for this study can be seen in Figure 1.

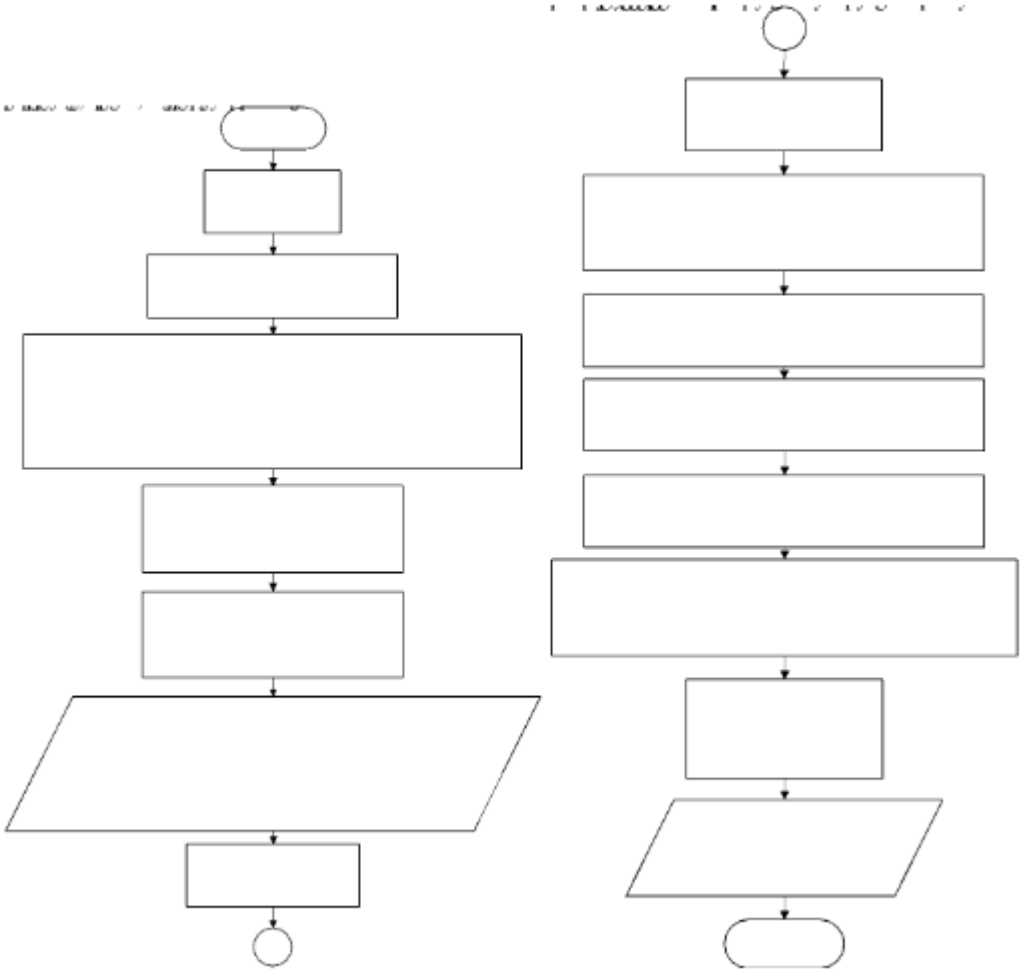

Figure 1. Data processing

4. RESULT AND DISCUSSION

At the impact assessment stage, the environmental impacts were determined from the Life Cycle Inventory (LCI) stage using the CML IA Baseline method. At the characterization stage, it was found that the milk pasteurization process contributed the most significant impact with a total value of 3968.62 for the milk pasteurization process, with the three most significant environmental impacts being marine aquatic ecotoxicity with a value of 3212.08 kg 1.4DB-eq, abiotic depletion (fossil fuels) with a value of 635.28 MJ, and global warming (GWP100a) with a value of 117.27 kg CO2-eq. The following is a graph of the characterization analysis of the cheese production process, which can be seen in Figure 2. The characterization analysis value can be seen in Figure 3.

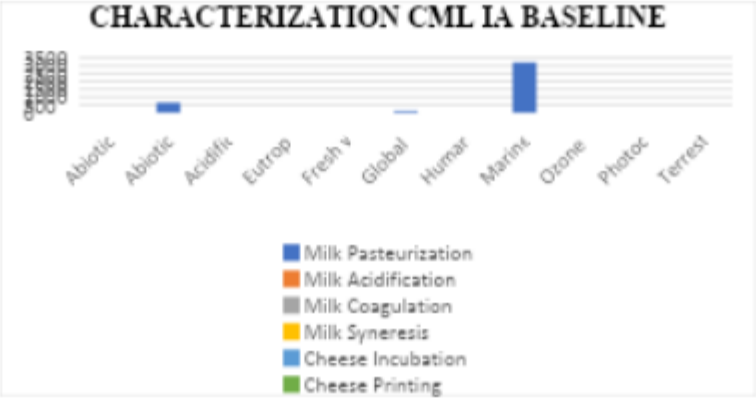

Figure 2. Analysis graph of the characterization of the cheese production process using the CML IA Baseline method

Impact Indicators	Milk Pasteurization	Milk Acidification	Milk Coagulation	Milk Syneresis	Cheese Incubation	Cheese Printing	Cheese Packaging
Abiotic depletion	3,01858E-06	0	0	0	0	0	0
Abiotic depletion (fossil fuels)	635,2807404	0	0	0	0	0	0
Acidification	0,768093379	0	0	0	0	0	0
Eutrophication	0,165865483	0	0	0	0	0	0
Fresh water aquatic ecotox.	0,928943881	0	0	0	0	0	0
Global warming (GWP100a)	117,2678776	0,000610214	0,000254243	0,000533287	5,7175E-05	0,001245896	1,29943E-05
Human toxicity	2,094059526	0	0	0	0	0	0
Marine aquatic ecotoxicity	3212,079842	0	0	0	0	0	0
Ozone layer depletion (ODP)	8,34319E-06	0	0	0	0	0	0
Photochemical oxidation	0,02674663	0	0	0	0	0	0
Terrestrial ecotoxicity	0,012187853	0	0	0	0	0	0

Figure 3 Characterization analysis values using the CML IA Baseline method

Then, at the normalization stage, through normalization analysis, it was found that the pasteurization process has the most significant impact with a total value of 0.0000000000273097, with the three most significant environmental impacts being marine aquatic ecotoxicity with a value of 0.0000000000165743 kg 1.4DB-eq. There is acidification with a value of 0.00000000000321831 kg So2 eq and global warming (GWP100a) with a value of 0.0000000000028027 kg CO2-eq. The following is a graph of the normalization analysis of the cheese production process, which can be seen in Figure 4. The normalization analysis value can be seen in Figure 5.

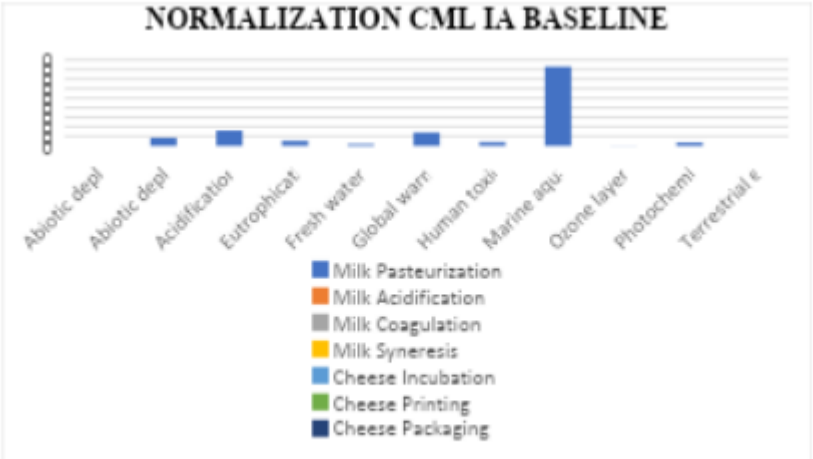

Figure 4. Analysis graph of the normalization of the cheese production process using the CML IA Baseline method

Impact Indicators	Milk Pasteurization	Milk Acidification	Milk Coagulation	Milk Syneresis	Cheese Incubation	Cheese Printing	Cheese Packaging
Abiotic depletion	1,44288E-14	0	0	0	0	0	0
Abiotic depletion (fossil fuels)	1,67079E-12	0	0	0	0	0	0
Acidification	3,21831E-12	0	0	0	0	0	0
Eutrophication	1,04827E-12	0	0	0	0	0	0
Fresh water aquatic ecotox.	3,92943E-13	0	0	0	0	0	0
Global warming (GWP100a)	2,8027E-12	1,45841E-17	6,07641E-18	1,27456E-17	1,36648E-18	2,97769E-17	3,10564E-19
Human toxicity	8,12495E-13	0	0	0	0	0	0
Marine aquatic ecotoxicity	1,65743E-11	0	0	0	0	0	0
Ozone layer depletion (ODP)	3,67935E-14	0	0	0	0	0	0
Photochemical oxidation	7,27508E-13	0	0	0	0	0	0
Terrestrial ecotoxicity	1,11519E-14	0	0	0	0	0	0

Figure 5. Normalization analysis values using the CML IA Baseline method

At the impact assessment stage, the environmental impact obtained from the Life Cycle Inventory (LCI) stage was determined using the Recipe 2016 Endpoint (H) method. It began with the characterization stage. Based on the results of the characterization that had been carried out, it was found that the milk pasteurization process contributed the most significant impact, with a total value of $ 6.68, with the most significant environmental impact being the scarcity of fossil resources. The following is a graph of the characterization analysis of the cheese production process, which can be seen in Figure 6. The characterization analysis value can be seen in Figure 7.

Figure 6. Analysis graph of the characterization of the cheese production process using the Recipe 2016 Endpoint method

Impact Indicators	Milk Pasteurization	Milk Acidification	Milk Coagulation	Milk Syneresis	Cheese Incubation	Cheese Printing	Cheese Packaging
Fine particulate matter formation	7,85084E-05	0	0	0	0	0	0
Fossil resource scarcity	6,67576866	0	0	0	0	0	0
Freshwater ecotoxicity	4,2787E-11	0	0	0	0	0	0
Freshwater eutrophication	5,98571E-10	0	0	0	0	0	0
Global warming, Freshwater ecosystems	1,07457E-11	5,19331E-17	2,16588E-17	4,53861E-17	4,86596E-18	1,06034E-16	1,1059E-18
Global warming, Human health	0,000130587	6,2839E-10	2,621E-10	5,49172E-10	5,88781E-11	1,28301E-09	1,33814E-11
Global warming, Terrestrial ecosystems	3,93442E-07	1,89556E-12	7,90584E-13	1,65603E-12	1,77608E-13	3,87023E-12	4,03654E-14
Human carcinogenic toxicity	4,41878E-07	0	1,5524E-17	0	0	0	0
Human non-carcinogenic toxicity	5,96766E-07	0	1,30291E-18	0	0	0	0
Ionizing radiation	5,13671E-09	0	0	0	0	0	0
Land use	5,09026E-10	0	0	0	0	0	0
Marine ecotoxicity	1,1403E-11	0	0	0	0	0	0
Marine eutrophication	4,00148E-13	0	0	0	0	0	0
Mineral resource scarcity	0,002455402	0	0	0	0	0	0
Ozone formation, Human health	2,3974TE-08	0	0	0	0	0	0
Ozone formation, Terrestrial ecosystems	5,58966E-09	0	0	0	0	0	0
Stratospheric ozone depletion	1,13366E-07	0	0	0	0	0	0
Terrestrial acidification	1,93212E-07	0	0	0	0	0	0
Terrestrial ecotoxicity	1,08458E-10	0	0	0	0	0	0
Water consumption, Aquatic ecosystems	4,43428E-14	0	0	0	0	0	0
Water consumption, Human health	1,57508E-07	0	0	0	0	0	0
Water consumption, Terrestrial ecosystem	9,71686E-10	0	0	0	0	0	0

Figure 7. Characterization analysis values using the Recipe 2016 Endpoint method

At the normalization stage, the scarcity of fossil resources had the most significant impact on the cheese pasteurization process, with a value of $187009.072. The following is a graph of the normalization analysis of the cheese production process, which can be seen in Figure 8. The normalization analysis value can be seen in Figure 9.

Figure 8. Analysis graph of the normalization of the cheese production process using the Recipe 2016 Endpoint method

Impact Indicators	Milk Pasteurization	Milk Acidification	Milk Coagulation	Milk Syneresis	Cheese Incubation	Cheese Printing	Cheese Packaging
Fine particulate matter formation	1,89243E-06	0	0	0	0	0	0
Fossil resource scarcity	180940,293	0	0	0	0	0	0
Freshwater ecotoxicity	3,06497E-14	0	0	0	0	0	0
Freshwater eutrophication	4,29402E-13	0	0	0	0	0	0
Global warming, Freshwater ecosystems	7,69752E-15	3,72013E-20	1,55149E-20	3,25116E-20	3,48934E-21	7,59554E-20	7,92192E-22
Global warming, Human health	3,10184E-06	1,49261E-11	6,22568E-12	1,30445E-11	1,39853E-12	3,04752E-11	3,17848E-13
Global warming, Terrestrial ecosystems	2,81835E-10	1,35785E-15	5,65321E-16	1,18667E-15	1,27226E-16	2,77237E-15	2,8915E-17
Human carcinogenic toxicity	1,04959E-08	0	3,68741E-19	0	0	0	0
Human non-carcinogenic toxicity	1,4175E-08	0	3,03473E-20	0	0	0	0
Ionizing radiation	1,22012E-10	0	0	0	0	0	0
Land use	3,62483E-13	0	0	0	0	0	0
Marine ecotoxicity	8,16857E-15	0	0	0	0	0	0
Marine eutrophication	2,86638E-16	0	0	0	0	0	0
Mineral resource scarcity	68,77876536	0	0	0	0	0	0
Ozone formation, Human health	5,69471E-10	0	0	0	0	0	0
Ozone formation, Terrestrial ecosystems	2,57159E-12	0	0	0	0	0	0
Stratospheric ozone depletion	2,68278E-09	0	0	0	0	0	0
Terrestrial acidification	1,38408E-10	0	0	0	0	0	0
Terrestrial ecotoxicity	7,76922E-14	0	0	0	0	0	0
Water consumption, Aquatic ecosystems	3,17642E-17	0	0	0	0	0	0
Water consumption, Human health	3,74128E-09	0	0	0	0	0	0
Water consumption, Terrestrial ecosystem	6,08098E-13	0	0	0	0	0	0

Figure 9. Normalization analysis values using the Recipe 2016 Endpoint method

At the stage of weighting and single score analysis, it was found that the pasteurization process was the largest source of impact with a value of 508,656,000,000 pt, with the most dominant environmental impact being resources. The following is a graph of the weighting and single-score analysis of the cheese production process, which can be seen in Figure 10. The value of the weighting and single score analysis can be seen in Figure 11.

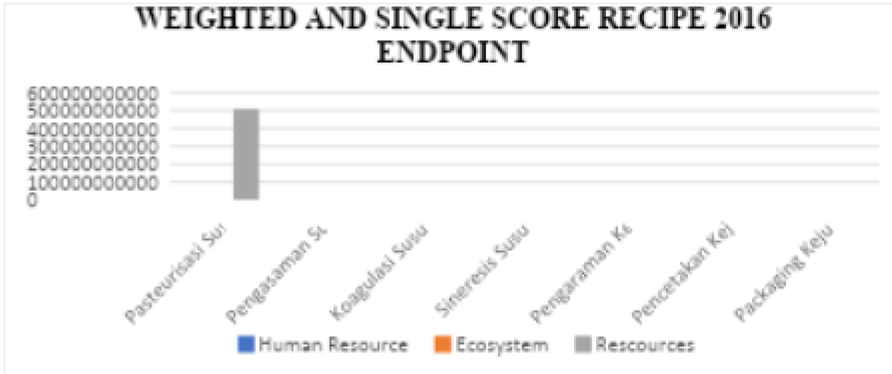

Figure 10. Analysis graph of the weighted and single score of the cheese production process using the Recipe 2016 Endpoint method

Indikator Dampak	Pasteurisasi Susu	Pengasaman Susu	Koagulasi Susu	Sineresis Susu	Pengaraman Keju	Pencetakan Keju	Packaging Keju	Total
Human Resource	0,001888637	5,97015E-08	2,41602E-08	3,21774E-08	5,38417E-10	1,71801E-08	1,77138E-10	0,001888453
Ecosystem	1,65798E-09	5,43154E-13	2,26534E-13	4,74882E-13	5,88316E-14	1,30808E-12	1,15883E-14	1,65772E-07
Rescources	5,08656E+11	0	0	0	0	0	0	5,08656E+11

Figure 11. Weighted and single score analysis values using the Recipe 2016 Endpoint method

The Life Cycle Assessment (LCA) results using the CML IA Baseline method reveal three significant environmental impacts in the pasteurization process: marine aquatic ecotoxicity (0.0000000000165743 DB-eq), acidification (0.00000000000321831 kg SO2-eq), and global warming potential (0.0000000000028027 kg CO2-eq). In contrast, the Recipe 2016 Endpoint (H) method identifies "resources" as the most significant impact category with a value of 508,656,000,000 pt. Key factors contributing to these impacts at UMKM KEJUGJA include raw material use and energy consumption in cheddar cheese production. The milk syneresis process generates 80 kg of whey waste daily, a primary concern. A fishbone diagram was developed through a literature review and discussions with UMKM KEJUGJA to address these issues, suggesting alternative strategies to reduce environmental impacts and optimize energy use in the production process. The proposed alternative used in the cheddar cheese production process is obtained from making a fishbone diagram. This fishbone diagram is based on the results of the Life Cycle Assessment (LCA) carried out and the mitigation of whey waste management, which is the main problem in UMKM KEJUGJA. In overcoming the problem of environmental impacts generated through the Life Cycle Assessment (LCA) process and the main problem of UMKM Rumah Keju Jogja (KEJUGJA), namely whey waste, the two problems are integrated into the main problem for in-depth analysis. Fishbone diagrams are used as valuable tools for analyzing these problems. This is based on the advantages of the fishbone diagram tool, namely, being able to formulate more focused and strategic solutions. The following are the results of the fishbone diagram, which can be seen in Figure 12.

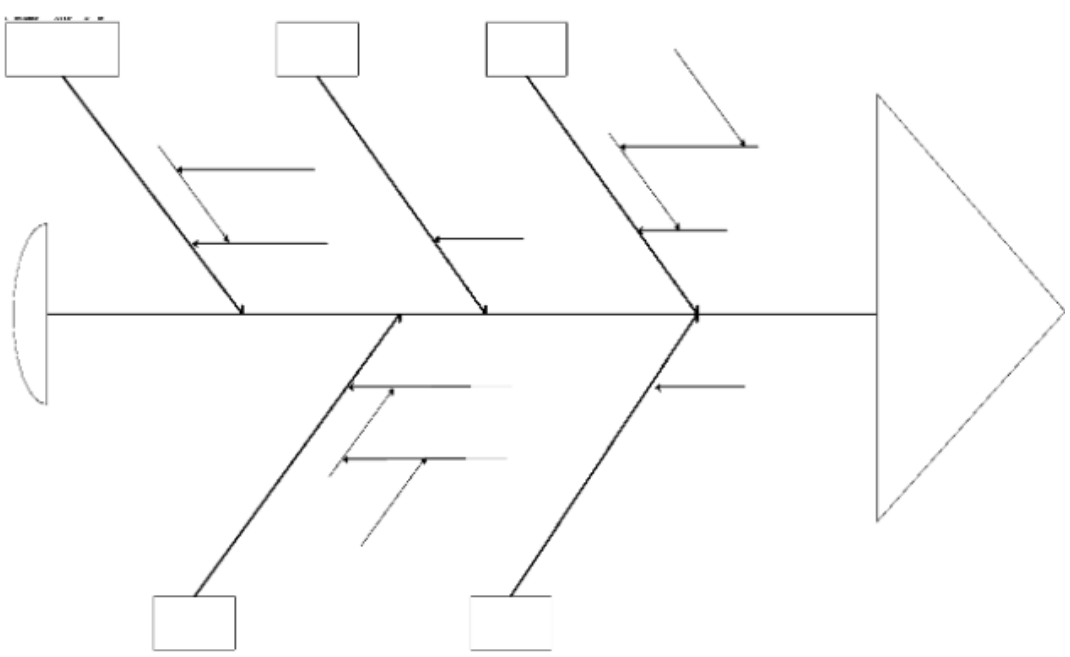

Figure 12. Fishbone diagram analysis

Through a fishbone diagram formed based on the results of interviews with UMKM KEJUGJA and literature studies that have been conducted, the proposals that UMKM KEJUGJA can provide are to provide training for workers regarding the utilization of added value from whey waste, increase cooperation with suppliers through long-term contracts, plan raw material needs using the MRP (Material et al.) method, consider using the high-temperature pasteurization method in a short time (HTST), modify the heating system on cheese VAT with more energy efficient technology, such as induction heating or heat recuperation systems, process whey waste into value-added products such as whey protein, whey-based drinks, and whey crackers, and become a supplier of whey waste as an additive in cow feed for cow's milk suppliers.

5. CONCLUSION

Based on the results of the research that has been conducted, this research produces information regarding the most significant environmental impact produced by KEJUGJA UMKM in the cheddar cheese production process. Information was obtained that the pasteurization process has the most significant environmental impact through the Life Cycle Assessment (LCA) method. Then, the information is used as input to produce alternative proposals for improvements to the pasteurization process that have the most significant environmental impact, whey waste problems, and operational problems experienced by KEJUGJA UMKM. Based on the results obtained through the fishbone diagram analysis with the 4M + 1L method (human, material, machine, method, and environment), the proposals that UMKM can give KEJUGJA to overcome the problems caused by the most significant impact through Life Cycle Assessment (LCA) in the form of the pasteurization process and whey waste that is still disposed of in the surrounding infiltration sources, namely by providing training for workers regarding the utilization of added value from whey waste, increasing cooperation with suppliers through long-term contracts, planning raw material needs using the MRP (Material Requirement Planning) method, considering using the high-temperature pasteurization method in a short time (HTST), modifying the heating system on cheese VAT with more energy efficient technology, such as induction heating or heat recuperation systems, processing whey waste into value-added products such as whey protein, whey-based drinks, and whey crackers, and becoming a supplier of whey waste as an additive in cow feed for cow's milk suppliers.

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Extended Producer Responsibility (EPR) as Corporate Social Responsibility: a Bibliometric Analysis

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Abstract: This activity results in waste from plastic materials increasing every year. This condition requires the government to make a policy that can control the amount of unmanaged plastic waste. One of them is with extended producer responsibility (EPR). This article aims to analyze the publication trend of scientific research results related to EPR. The results in network visualization, the most commonly found keyword is extended producer responsibility. This can be seen that the keyword extended producer responsibility has a larger circle size than other keywords. The larger the size of the circle, the more widely used the keyword has been. In the visualization of the latest overlay regarding a research topic, it is shown in brighter colors. Bright yellow colors are review, cooperation, and plastic waste. Meanwhile, keywords with darker circles are problem, government, and corporate social responsibility. This illustrates that the topic has been discussed for quite some time. The results of the visualization showed that the keywords legal framework, problem, solution, cooperation, and corporate social responsibility looked dimmer than other keywords. This shows that these keywords are still few and not diverse in research and so there is an opportunity to be used as research in the future.

Keywords: producer, social, responsibility

1. INTRODUCTION

One of the problems that is being faced by modern society today is waste. The increasing population, the accelerating level of industrialization and the shift in people's consumption patterns will result in the volume, type and variety of waste characteristics which are increasingly uncontrollable. Moreover, the problem of waste with a population of approximately 260 million people is a scary thing for countries, especially like Indonesia. Waste that is not handled properly will have an impact on polluting the environment and disrupting environmental sustainability (Kusuma et al., 2014). Waste is the remains of human daily activities and/or natural processes in solid form. Waste managed according to the law consists of household waste, household-like waste, and specific waste. Household waste is waste that comes from daily activities in a household, except for feces and specific waste. Household-like waste is waste that comes from commercial areas, industrial areas, special areas, social facilities, public facilities, and/or other facilities. Plastic waste is one of the problems experienced by various countries in the world (Fauzi et al., 2024). Plastic is one of the human inventions that has properties like a double-edged sword on the one hand, plastic helps humans in their daily activities, but the uncontrolled existence of plastic also affects the environment which will ultimately have a negative impact on humans (Syahroni & Sholehuddin, 2022). This can happen because waste has properties that are difficult to decompose. Knowing its properties that are difficult to decompose does not reduce the amount of waste, what is happening now is an increase in waste accumulation every year. Various industries in the world use plastic to package their products. In the long term, plastic waste pollution causes damage to human health, ecosystems, and the climate. Meanwhile, plastic production has always increased from year to year. This increase is mainly due to the increasing demand or need for plastic packaging. Plastic production has increased 20-fold since 1964. In 2014, production reached 311 million tons, and will double in the next 20 years and quadruple by 2050. Although plastic is a useful product, around 50 percent is only used once and thrown away (Alfitri et al., 2024). The instant food and beverage industry, for example, chooses aluminum foil-coated plastic or multilayer plastic as packaging because it is considered safe and can keep the product fit for consumption. In addition, this packaging material does not increase production costs. Manufacturers can still sell retail products at affordable prices. The same thing is done by manufacturers of shampoo, candy, milk and medicines. Aluminum foil-coated plastic packaging replaces glass, cans and paper as packaging materials. So at the same time, without realizing it, industrial products are abundant, human needs become complex, people continue to shop and need bags to carry their goods. With the presence of plastic, it

then becomes the answer to current needs because plastic has characteristics that are cheap, strong, light, rust-free, thermoplastic, can be labeled with various creations, can always be made attractive and can be an effective branding tool (Malihah & Nazairin, 2023). Plastic can finally be found with certain business brands in supermarkets, bookstores, boutiques, electronics stores to baby supply stores (Hosien, 2022). Before plastic bags appeared, humans used bags made from natural materials such as knitted rattan roots, leaves and cloth. Currently, even though they have brought quite large bags, many people still ask for plastic bags when shopping because currently plastic has become part of the human lifestyle from remote areas to cities.

2. LITERATURE REVIEW

Indonesia is the second largest contributor of plastic waste leaking into the ocean after China. According to the Ministry of Environment and Forestry, the waste produced by Indonesian citizens reaches 0.8 kg per person per day with a composition of 15% plastic waste which accumulates as much as 189 thousand tons of waste per day. Therefore, the high amount of waste production must be comparable to the percentage of waste that is processed while the rest is not managed and can cause environmental pollution (Maskun et al., 2023). Indonesia already has special regulations related to the waste problem, namely Law No. 18 of 2008 concerning Waste Management. The existence of the Waste Management Law still leaves legal uncertainty which causes ineffectiveness in overcoming various waste problems that are growing rapidly along with the increasing population and increasing public consumption (Wibowo et al., 2023). The existence of the polluter pays principle has been widely recognized in the environmental legal regime. However, the normative power of this principle is still vague in a special mechanism to facilitate and urge business actors or producers to be responsible for the products/packaging they produce until they eventually become waste. Although based on Article 15 of the Waste Management Law, it is stated that producers are required to manage packaging and/or goods they produce that cannot or are difficult to decompose by natural processes. In the development of environmental law, this is referred to as the principle of Extended Producer Responsibility (EPR) which can simply be interpreted as the principle of extended producer responsibility (Verawati, 2018). Extended Producer Responsibility (EPR) is a responsibility that must be carried out by producers to be able to collect the plastic waste they produce or by changing the design of their products to be more environmentally friendly or easy to recycle (Saefudin, 2020). EPR aims to shift the responsibility for environmental management from the community to producers (Malinda & Maharani, 2024). EPR encourages producers to design their products to be more durable, recyclable, or easy to recycle. This reduces the amount of waste that goes into landfills. EPR supports the recycling industry and promotes the reuse and recovery of products, which helps reduce pressure on natural resources. Many countries and regions have implemented regulations on EPR efforts that require producers to be responsible for the management of their product waste, thereby maintaining compliance with the regulations.

Waste is still a problem that has not been fully resolved in Indonesia. (Muhardono et al., 2023), Usually the last way to destroy plastic is by burning it, namely to eliminate the unsightly view that can disappear from sight in an instant, so it is known that community involvement in reducing the use and recycling of plastic is still very minimal. This can be seen that the waste that we have so far just thrown away can actually be reprocessed, including in the form of crafts with economic value, artistic and unique taste and the potential to manage plastic waste by utilizing plastic into creative products can provide added value and livelihood. Therefore, waste must be processed or recycled properly so as not to pollute the environment and interfere with human health (Nurmalasari et al., 2024). However, the responsibility of producers to manage waste from the packaging they produce is not impossible to implement in Indonesia. Of course this is not easy, because it instinctively contradicts the basic principles of the company to obtain maximum profit, by increasing production costs. But this must be done for sustainable efforts, to ensure that the carrying capacity and environmental capacity still allow for future human activities. So that all possible efforts need to be tried to maximize efforts to overcome the problem of plastic waste which has become a global problem today. Therefore, the focus of this study is to determine the research trend regarding Extended Producer Responsibility (EPR) as a corporate social responsibility. With the bibliometric analysis method in seeing the development of trends that are developing in research and it is hoped that it can be used as a reference for researchers who are interested in taking up the topic of

discussion about Extended Producer Responsibility (EPR). Given that this topic has the potential to continue to develop because recently the topic of EPR has developed rapidly in the realm of international environmental law. By using Vosviewer software which is used as a tool to help bibliometric analysis to see trends, patterns, and areas that are right on target for use in future research.

3. METHOD

This research is a descriptive quantitative research with a bibliometric approach. Bibliometrics is a method used, namely several articles with a certain topic that are summarized into one (Susanti et al., 2022). This type of research focuses on observing the development of research publication trends obtained from database applications on a topic. The search for research articles was carried out using the Harzing's Publish or Perish application. Then mapping and grouping were carried out through bibliometric visualization assisted by Vosviewer software and analysis was carried out which then conclusions were drawn from the results of the analysis (Amaliyah et al., 2023). Data collection by searching for scientific literature using keywords identified using a bibliometric database, one of which is Google Scholar (Paujiyah, 2023). The data obtained came from the Google Scholar database based on the Open Journal System (OJS) which discusses Extended Producer Responsibility (EPR) for the period 2000-2023. Google Scholar is used as a data source in this study because Google Scholar is the largest database compared to other data sources and also access to published articles is greater and is accessed for free compared to Scopus or Web of Science. The development of research related to Extended Producer Responsibility (EPR) resulted in a search of 100 documents that were downloaded and then saved in RIS format. The results of data export in RIS format were then processed and analyzed using Vosviewer software. The results of the analysis display three visualizations, namely network visualization, overlay visualization, and density visualization. Through this scientific writing, it is hoped that it can provide references for further research to use discussion topics that are still rarely used.

4. RESULT AND DISCUSSION

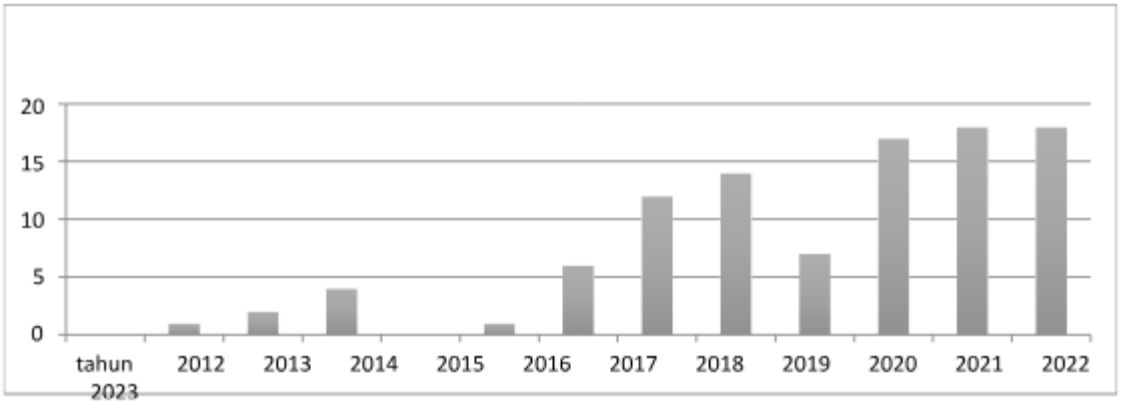
Table 1.
Research Development on Extended Producer Responsibility (EPR) in Indonesia 2000-2022

Years of Publications	Number	Percentage
2000	0	0%
2001	0	0%
2002	0	0%
2003	0	0%
2004	0	0%
2005	0	0%
2006	0	0%
2007	0	0%
2008	0	0%
2009	0	0%
2010	0	0%
2011	0	0%
2012	1	1%
2013	2	2%
2014	4	4%
2015	0	0%
2016	1	1%
2017	6	6%
2018	12	12%
2019	14	14%
2020	7	7%
2021	17	17%
2022	18	18%
2023	18	18%
Amount	**100**	**100%**

Source: Processed by the author, (2024)

Table 2.

Research Development Graph on Extended Producer Responsibility (EPR) in Indonesia 2000-2022



Based on the table and graph above, it is known that publications related to EPR only existed in 2012, where in that year there was only one publication with the theme of EPR. Then in 2013- 2014 it began to increase by 2 to 4 publications with the theme of EPR. However, in 2015-2016 there was a decline, there was only 1 publication in 2016 while in 2015 there were no publications researching the theme of EPR. Research with the theme of EPR increased again in 2017-2019 by 6 to 14 publications. It decreased again with only 7 publications in 2020. Furthermore, in 2021-2022 it increased by 17 to 18 publications, while in 2023 there was no increase, there were only 18 publications the same as in 2022. Thus, the development of research with the theme of EPR has fluctuated from year to year. The bibliometric analysis in this study uses the Vosviewer application. There are 100 scientific works on Extended Producer Responsibility (EPR) obtained from 2000-2023 published on Google Scholar which are downloaded in RIS format via the Publish or Perish application which will later be processed in Vosviewer. Then the researcher carries out the process of filtering the intensity of keywords displayed in the visualization to form 7 clusters or mapping groups. From the data processing using Vosviewer, three visualizations are produced, namely network visualization, overlay, and density.

Table and figure are centered in the position. The table title must be written over the table, and the figure title must be under the figure. Both are written in Times New Roman, 10 point. The font used in the table is Times New Roman 10 point and 1 space. Tables should be illustrated as simply as possible to avoid misprints. The Table and Figure must be referred in the paper. The Table and Figure are inserted as close as possible to the description that refers them for the first time. The numbering of the Table and Figure is arranged from the number 1 onwards. The example of table can be seen in the Table 1. Fonts for the information of the Figure should be bigger and more visible, so it can be read easily.

1. Research Mapping on Extended Producer Responsibility (EPR) in Indonesia

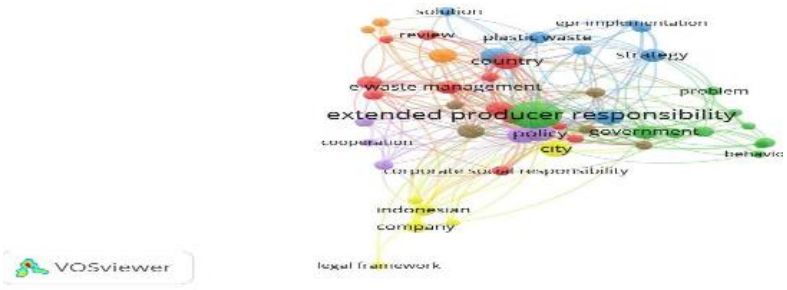


Figure 1. Network Visualization About Extended Producer Responsibility (EPR) in Indonesia 2000-2022

Network Visualization or network visualization illustrates the relationship between keywords in one scientific work and another. In this visualization, items are indicated by the size of the circle. The larger the circle size, the higher the intensity of research containing the words in the item (Amaliyah et al., 2023). Based on the image of the results of the publication network visualization with the EPR theme from 2012-2023, there are 49 items or keywords related to EPR, 7 clusters or keyword groups, and a total of 453 lines (links). The first keyword in red consists of Conceptual framework, corporate social responsibility, country, e-waste management, epr concept, industry, producers responsibility, product, review, role, state, and waste bank implementation. The second keyword in green is Behavior, community participation, comparative study, electronic waste, electronic waste management, extended producer responsibility, government, obligation, problem, and waste bank. The third keyword in blue consists of Challenge, circular economy, epr implementation, plastic waste, solution, strategy, waste management, and waste management policy. The fourth keyword in yellow is City, company, electronic waste recycling, Indonesian, legal framework, and waste concept. Then the fifth keyword in purple consists of Cooperation, Indonesian government, policy, program, and recycling. Furthermore, the sixth keyword in brown is Case study, electronic product, environment, manufacturer, and recovery. Finally, the seventh keyword in orange consists of Conceptual model, e-waste management system, and regulation. Of all the keywords, the most frequently found keyword based on network visualization is the keyword extended producer responsibility. This can be seen that the keyword extended producer responsibility has a larger circle size than the other keywords. The larger the circle size, the more the keyword has been used in relation to research with the EPR theme.

2. Overlay Visualization

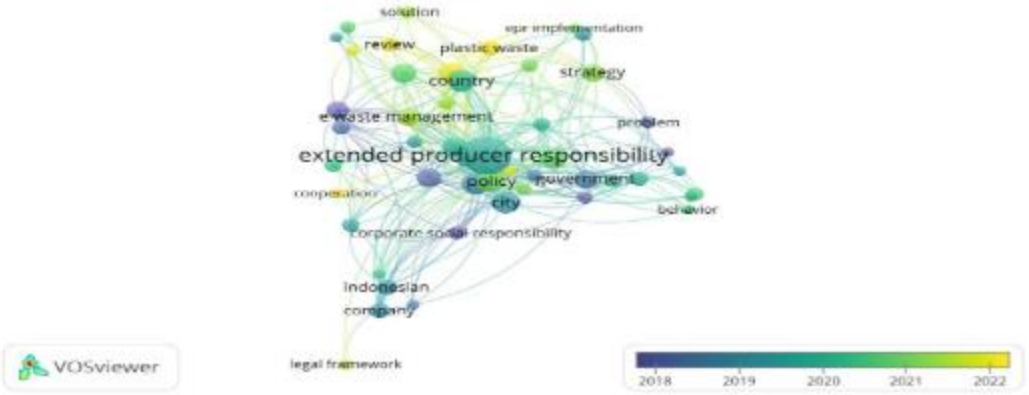


Figure 2. Overlay Visualization About Extended Producer Responsibility (EPR) in Indonesia 2000-2022

Overlay visualization shows several keywords related to extended producer responsibility (EPR) based on the year of publication. It can be seen in the image that the time span in the visualization is from 2018 and below, waste 2022 and above. Through this visualization, the novelty of the topic related to EPR can be seen. The color shown is the more yellow the connecting line color, the younger the year of the research and the topic has been discussed in recent years but with not too many studies (Ardiansyahroni et al., 2023). If the color of the circle is darker, this indicates that the topic has been discussed for a long time. With this visualization, the novelty related to the research can be seen and gaps can be found through the keywords displayed. In the overlay visualization, the novelty of a research topic is shown in a brighter color. Based on image 2, keywords in bright yellow, namely review, cooperation, and plastic waste, were widely published in 2022. These keywords indicate the novelty of the EPR topic in Indonesia. While the keywords with darker colored circles are problem, government, and corporate social responsibility. This shows that the topic related to the keyword has been discussed for quite some time.

3. Density Visualization

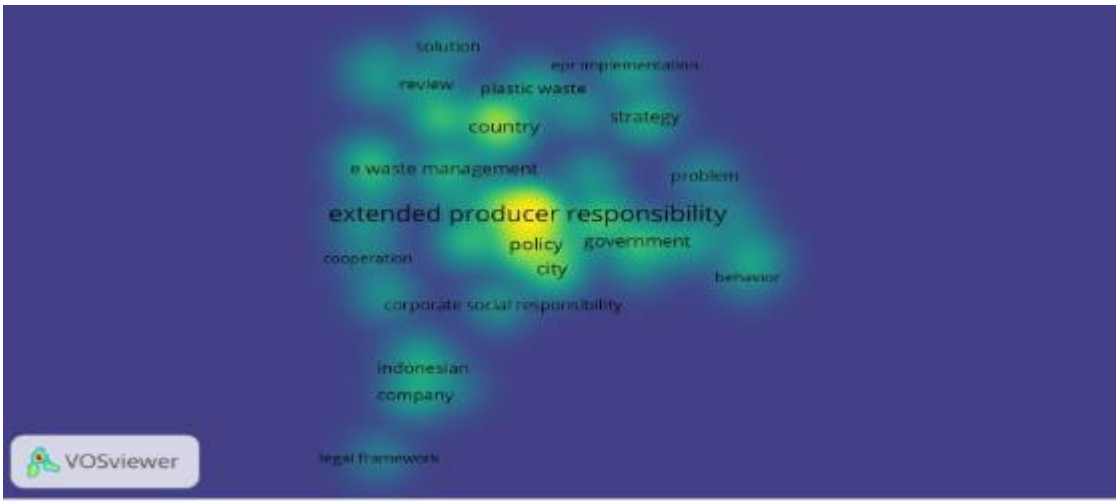


Figure 3. Density Visualization About Extended Producer Responsibility (EPR) in Indonesia 2000-2022

In the visualization of area density with lower light intensity indicates topics that appear less frequently or are less related to the analysis (Judijanto et al., 2023). In the visualization above, it is shown with a color that tends to be dimmer. The brighter the color that appears in this visualization related to a topic means that the topic is often studied by researchers and the dimmer the color in the visualization, the less the topic is studied.

Based on the results of the density visualization, it can be seen that the keywords legal framework, problem, solution, cooperation, and corporate social responsibility related to the EPR topic appear dimmer than other keywords. This shows that research containing these keywords is still limited and there are not many studies that examine and have the opportunity to be used as research in the future.

In reality, unmanaged and unutilized waste will be a factor causing pollution and environmental damage, this is in line with Sumartini et al., (2021) which states that waste if utilized and managed properly will bring economic opportunities. A firm framework and policy are needed regarding waste management so that it can reduce the impact of environmental damage (Septianingrum et al., 2023). Producers and consumers are subjects of environmental pollution, especially in river flows, the government as a policy maker has the authority to regulate waste management, one of which is through EPR (Sani, 2022). Awareness and active role of the community are very much needed to overcome the impact of environmental damage (Malihah, 2022). Social and cultural factors of the community also play an important role in environmental improvement efforts (Tristiana, 2018).

5. CONCLUSION

Publications related to EPR in Indonesia have only been around since 2012 and increased in 2023. In the network visualization, the most frequently found keyword is extended producer responsibility. This can be seen from the keyword extended producer responsibility having a larger circle size than other keywords. The larger the circle size, the more widely the keyword has been used. In the visualization of the expanse of the novelty regarding a research topic, it is shown in a brighter color. Keywords with bright yellow colors are review, cooperation, and plastic waste. While keywords with darker colored circles are problem, government, and corporate social responsibility. This illustrates that the topic has been discussed for quite a long time. The results of the visualization of the density show that the keywords legal framework, problem, solution, cooperation, and corporate social responsibility look dimmer

than other keywords. This shows that these keywords are still few and not diverse in research and therefore have the potential to be used as research in the future.

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Developing the Local Economy of New Rivermoon Klaten Ecotourism: Community Participation, Zero Waste, and SDGs Achievement

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Abstract: New Rivermoon Ecotourism is an environmentally-based tourist attraction in Klaten Regency, Central Java. New Rivermoon Ecotourism is a sustainable tourist attraction carried out collaboratively with the surrounding community. This study aims to identify the role of New Rivermoon Ecotourism in conservation efforts and economic development for local communities by implementing the principle of zero waste that contributes to achieving SDGs. This study uses a qualitative approach with data collection techniques through in-depth interviews. Data analysis is carried out through the process of data collection, data reduction, data presentation, conclusion, and verification. The results of the study show that New Rivermoon Ecotourism has a positive impact on river conservation through various river flow cleaning efforts carried out collaboratively with the community. In addition, economically, ecotourism has an impact on improving the economy of local communities by opening new jobs. The implementation of zero waste contributes to the realization of a circular economy through the management of organic and inorganic waste. The efforts made by New Rivermoon Ecotourism help achieve Sustainable Development Goals No. 8, 12, 15, and 16.

Keywords: ecotourism, SDGs, zero waste, economic growth, conservation.

1. INTRODUCTION

Ecotourism is a concept of sustainable tourism that can combine economic and environmental values. Ecotourism is a solution offered to open up economic opportunities for the community but at the same time carry out environmental conservation. Ecotourism is a form of tourism that is responsible for the preservation of natural areas, provides economic benefits, and maintains the integrity of culture for the local community (Fandeli & Mukhlison, 2000). In various regions, ecotourism has been proven to have a positive impact on the economy, society, and environment (Hunt et al., 2015; Sangpikul, 2017). Amid the triple planetary crisis, efforts to develop ecotourism are the right choice. This effort also contributes to environmental sustainability by maintaining the existence of biodiversity (Brandt & Buckley, 2018; Kiper, 2013), preventing pollution by managing resources harmoniously (Meng, 2021), while contributing to reducing the effects of global warming through conservation efforts (Brandt & Buckley, 2018; Dushani et al., 2023). However, there is still doubt that ecotourism can maintain its existence towards environmental sustainability (Hunt et al., 2015).

Environmental sustainability reflected in the form of aesthetics is one of the attributes inherent in ecotourism destinations (Liu & Huang, 2017; Saputra et al., 2023). Ecotourism sells environmental values whose presence can be enjoyed by tourists. Therefore, ecotourism managers need to maintain the condition of their natural environment from various destructions due to human activities (Amare, 2015; Fajar & Rini, 2020; Fandeli & Mukhlison, 2000). Klaten Regency is one of the areas with high natural potential in the form of water resources to be used for ecotourism. Klaten is known as the 1001 Springs district (Anggraheny et al., 2020) in addition to being famous for its river resources which are used as tourist locations. These water resources are mostly managed by the community to improve the local

economy (El Anshori et al., 2024; Rahajeng & Suprapto, 2019). The management of this tourism is based on community participation and is under the auspices of the BumDes institution or other forms of business. Many residents are empowered in tourism management so it becomes a job opportunity for them. In addition, the increase in the community's economy also grew from the emergence of various MSMEs around tourist (Nusyirwan et al., 2024; Runtunuwu & Rajasekera, 2023).

One of the ecotourism destinations in Klaten that is a favorite destination for tourists is New Rivermoon. This tour utilizes the potential of the Pusur River resources by making it a vehicle for water recreation in the form of tubing. In addition to making efforts to conserve river resources, New Rivermoon ecotourism also carries out zero waste-based management of those generated from visitor activities. This is an interesting study in addition to the positive impacts generated from ecotourism activities at New Rivermoon. As is currently a fact, the problem of waste in Indonesia is still unresolved, so it takes seriousness for various parties to become problem solvers in terms of waste. In addition, tourism is one sector that has the potential to produce large amounts of waste with a large number of tourist visits (Hilman et al., 2023; Mateu-Sbert et al., 2013). The independence of waste management by ecotourism managers is a solution to the problems that arise at tourist locations. In addition to being a solution, waste management can be part of the educational element that is a characteristic of ecotourism. Integrated efforts of community participation-based ecotourism by implementing zero waste management are also part of the realization of the Sustainable Development Goal for a sustainable future of the earth.

Research on community empowerment-based ecotourism has indeed been widely conducted in various regions. In Klaten, studies on ecotourism were conducted in various water tourism locations, both springs and river tourism. Various studies on ecotourism that have been conducted examine various aspects such as analysis of the willingness to pay for environmental services (Deristani & Hidayat, 2022), ecotourism development strategies and their impacts (Kusumaningrum et al., 2023), implementation of the CBT concept in ecotourism development (Putri & Gustaman, 2024), innovation in ecotourism development (El Anshori et al., 2024), and the potential and challenges in ecotourism development (Widyaningtyas, 2023). Research on Rivermoon ecotourism has indeed been conducted but more on the study of tourism potential analysis (Kurniawan, 2023). In this research, the study focused on integrated ecotourism efforts with the principle of zero waste and the impact of the presence of this ecotourism on local communities and its relationship with Sustainable Development Goals.

2. LITERATURE REVIEW

Ecotourism is a form of tourism that combines social, economic, and environmental aspects. In ecotourism activities there is conservation and sustainable development, opening new job opportunities for local communities, as well as providing environmental education for tourists (Butarbutar, 2021). Ecotourism can also be an alternative source of livelihood for people living in rural areas (Kim et al., 2019). Four components characterize tourist locations, namely Attractions, Amenities, Accessibility, and Ancillary (Andrianto & Sugiama, 2016; Harianto et al., 2021). The main principles that characterize ecotourism include conservation, education, tourism, economy, and community participation (Fandeli & Mukhlison, 2000; Kusumaningrum et al., 2023).

Ecotourism has an impact on the community's economy by increasing the economic level and reducing the percentage of low-income people (Arsad et al., 2021). The majority of people admit that ecotourism has a positive impact from an environmental, social, and economic perspective (Kim et al., 2019). The development of ecotourism has a positive impact on the surrounding community through several aspects, namely opening up opportunities for local MSMEs, developing village infrastructure and supporting tourist attractions as well as creating environmental conservation, felling trees, and maintaining cleanliness from plastic waste (Muhammad & Widarjono, 2024)
The success of ecotourism based on local community participation can have a positive impact on the development of tourist attractions, marked by the development of tourism destination attributes over time(Putri & Gustaman, 2024). In developing ecology-based tourism, nature conservation, and community empowerment are still considered

(Wahyuni et al., 2023). In Klaten, ecotourism development is carried out by implementing cooperative, participatory, and emancipatory principles, which means that all components involved in BUMDes have established good cooperation for the development and continuity of the business as a tourist village(El Anshori et al., 2024). In efforts to develop ecotourism, several aspects need to be prioritized, such as maintaining and improving the ecosystem, improving service quality, and optimizing spatial planning (Widyaningtyas, 2023).

In Indonesia, the implementation of the zero waste principle has been carried out in several tourist locations, one of which is in Kunjir Village, South Lampung (Metalia & Sembiring, 2022). The implementation of the zero waste concept is carried out through various strategies such as improving the quality of human resources through information technology and entrepreneurship, marketing environmentally friendly tourism, developing environmentally friendly tourism products, synergistic and independent waste management, and developing tourism infrastructure and facilities based on environmentally friendly tourism. At the Lombok halal tourism location, the zero waste principle is also implemented through the provision of supporting infrastructure and facilities, the existence of a waste bank, the provision of environmentally friendly equipment, simple waste sorting activities, and maintaining environmental cleanliness (Rojabi et al., 2020).

3. METHOD

This research is qualitative. The research location is the New Rivermoon tourist attraction. The research was conducted in June-September 2024. The data collection method was through observation and in-depth interviews. Informants consisted of New Rivermoon ecotourism managers, local communities as employees at tourist attractions, as well as MSMEs who sell around tourist attractions. Data analysis is carried out through the process of data collection, data reduction, data presentation, as well as drawing conclusions and verification.

Figure 1. The Maps of New Rivermoon Ecotourism

4. RESULT AND DISCUSSION

History and Description of New Rivermoon Ecotourism

Ecotourism development has become an increasingly recognized approach to improving the sustainability and economic prosperity of a region. One of the ecotourism developed in Klaten is New Rivermoon. This ecotourism utilizes the resources of the Pusur River by combining natural adventure with environmentally friendly recreational activities. New Rivermoon is located in Pusur Hamlet, Karanglo Village, Polanharjo District, Klaten Regency, Central Java. Ecotourism is outdoor tourism that utilizes the surrounding environment such as open land, rice fields, and rivers. There is a river tubing activity offered to visitors with two choices of tubing distance, namely 500 m and 2 km. Safety facilities to support tubing activities are available in the form of life jackets, helmets, and tires, and accompanied by an instructor. New Rivermoon also offers natural outbound activities for visitors. Apart from that, some restaurants provide various dishes, ranging from Indonesian, and oriental, to Western dishes.

This ecotourism was founded in 2016 where initially it was agricultural land that was unproductive because the yield was low or the land was less fertile. In the 1970s, in this area a large dam collapsed and was destroyed, resulting in a lot of material covering the area below New Rivermoon, such as river rocks. This material enters the rice fields below so that the land cannot be reused. New Rivermoon Ecotourism is a tourism business owned by individuals but empowering local communities as employees. There are 140 residents recruited to manage this ecotourism, starting from parking guards, waiters, river tubing guides, ticket counter officers, and others.

Community Involvement in Conservation Efforts and Ecotourism Management

One of the important elements in ecotourism is nature conservation efforts to maintain the continuity of ecosystem functions within it; biodiversity, flood control, water quality, and carbon sequestration (Boley & Green, 2016). Nature conservation at New Rivermoon Ecotourism has an important role in preserving the resources of the Pusur River so that its existence can continue to be enjoyed as a source of life for biota, drinking water, agricultural irrigation, fisheries, recreation, and others. Community involvement in ecotourism conservation is an important element in sustainability. At New Rivermoon Ecotourism, conservation efforts are carried out by both employees and the local community. This is because rivers are not only a resource for recreation, but also for the sustainability of people's lives. Employees at New Rivermoon routinely carry out river crossing activities to maintain cleanliness and environmental sustainability. This activity is carried out every Saturday and Sunday morning with the main aim of cleaning up plastic waste, dry leaves, and other rubbish that can pollute the water ecosystem, especially in river areas which are often used as waste dumping points.

The involvement of local communities in cleaning the river is carried out once a month. This activity aims to educate residents to be more concerned about environmental cleanliness and sustainability, especially river ecosystems. Keeping rivers clean will have a positive impact on the surrounding flora and fauna, help maintain water quality and maintain ecosystem balance. River conservation efforts based on community participation in sustainable ecotourism are also carried out in other places such as the Mayangsari River, Semarang (Fajar & Rini, 2020). Various regulations and activities to preserve rivers are carried out, such as making regulations and sanctions not to pollute rivers, providing rubbish bins in every house, providing free toilet assistance to households that do not have latrines, cutting down banana trees around rivers which can cause the soil to erode easily, carry out cooperation in cleaning rivers, and educate the public about preserving the river environment.

Apart from river conservation efforts, New Rivermoon ecotourism management also pays attention to the principle of zero waste. Both organic and inorganic waste are managed through separate management sites for organic and non-organic waste. At this location, there is also an independent Waste Water Treatment Plant (IPAL) which has been tested by the Environmental Service and is declared capable of processing waste safely. This installation includes waste management from canteens, toilets, and restaurants. Apart from that, the eco enzyme is added to preserve the

environment. Eco enzyme is used to process organic waste, such as skin and fruit or vegetable dregs, into a useful liquid. Eco enzyme is a recycling method to overcome environmental pollution from organic waste. Plastic or inorganic waste in New Rivermoon is stored in its well-managed waste storage area. The waste is sorted independently, then released, and collaborates with community waste banks, such as the Sami Ikhlas Waste Bank in Polanharjo, as well as other waste collectors. Ecotourism also encourages reducing the amount of waste produced, recycling and reusing materials, as well as reducing the environmental impact of products and production processes. This helps maintain environmental cleanliness and avoid river pollution. Despite the many benefits obtained, New Rivermoon faces challenges, such as a lack of public awareness about waste management and a mindset that still relies on burning waste.

Economic Impact of the New Rivermoon Ecotourism

Economic growth is one of the indicators of successful development in an economy (Ma'ruf & Wihastuti, 2008). Economic growth can be seen from indicators in the form of increased production of goods and services in the economic activities of the community (Regina, 2022). The existence of New Rivermoon ecotourism encourages economic growth in the Pusur Village community. This is evidenced by the availability of jobs for the surrounding community in the tourism sector. In addition, New Rivermoon ecotourism also provides benefits for MSMEs around the New Rivermoon Ecotourism environment.

"90% of employees at New Rivermoon Ecotourism come from the surrounding community. Increasing (-economic conditions-), 140 local community employees and can support their families. " (Ecotourism Manager, P01, 24 years old). The existence of New Rivermoon ecotourism has an impact on improving the quality of life for the local community. "My life has improved a lot. I used to not have a motorbike, now I have a motorbike. My house used to be ugly, now it's pretty good. Can send children to college" (Parking Employee, Y02, 53 years old) Almost all employees working at New Rivermoon Ecotourism have experienced an increase in income. "I think all employees here, almost all of them can be said Alhamdulillah have increased. Especially in River Tubing. Previously there were no school children who could work, so the children could lighten the burden of their parents because Saturday and Sunday they could work here", (Tubing employee, A03, 26 years old). New Rivermoon Ecotourism also participates in the development of business activities in the surrounding community. There is an increase in purchasing power in MSME activities such as souvenirs and street vendor around the New Rivermoon Ecotourism environment. "With the presence of Rivermoon MSME souvenirs are selling well because there is a market or place, increased purchasing power, street vendor stalls can sell around," (Ecotourism Manager, P01, 24 years old). "The presence of New Rivermoon Ecotourism helps improve his economy. I used to sell around. However, now I only sell around the New Rivermoon Ecotourism area from morning until the closing time of the New Rivermoon Ecotourism," (UMKM actor, S04, 70 years old)

A similar thing also happened in Kalitalang Ecotourism, Balerante Village, Kemalang District, and Klaten Regency. In a similar study conducted by Muhammad and Agus Widarjono, the study stated that the existence of Kalitalang Ecotourism helped increase the economic activities of the surrounding community. In the study, it was explained that Kalitalang Ecotourism absorbed at least 130 people in tourism operations. In addition, the study also explained that the existence of Kalitalang Ecotourism also helped in increasing the increase of MSMEs (Muhammad & Widarjono, 2024). The presence of ecotourism does have a positive impact on the economic aspects of the community. Various previous studies have shown that the presence of ecotourism can increase the economic level of the community (Arsad et al., 2021; Runtunuwu & Rajasekera, 2023). In addition, ecotourism is also a means to create business opportunities for the surrounding community (Nusyirwan et al., 2024).

The Relationship Between New Rivermoon Ecotourism and Sustainable Development Goals (SDGs)

SDGs or Sustainable Development Goals (TPB) are a series of goals set by the United Nations (UN) to achieve sustainable development at the global level. SDGs are a continuation of the Millennium Development Goals (MDGs) program initiated in 2000 which still focuses on socio-economics. SDGs add an environmental proportion to the development planning carried out (Elder & Olsen, 2019). SDGs cover various aspects of development, including economic, social, and environmental. New Rivermoon strives to apply the principles of sustainable development. The steps taken at New Rivermoon contribute to achieving the SDG's goals namely responsible production and consumption (SDG 12), decent work and economic growth (SDG 8), life on land (SDG 15), and peace, justice, and institutions the strong one.

One measure of the success of ecotourism is by setting Sustainable Development Goals (SDGs) or sustainable development goals (Muqsith et al., 2023). New Rivermoon Ecotourism has attempted to conserve river resources through various efforts involving the community. The management also educates visitors not to throw rubbish in the river. Apart from that, waste management efforts are carried out in an integrated manner to implement the zero-waste principle. All of this is part of ecotourism management that supports sustainable development goals, especially SDG 12 and SDG 15

The existence of New Rivermoon also has a significant positive impact on society in the economic aspect, thus contributing to the achievement of SDG 8. A clean tourist environment and increased tourist visits encourage the growth of MSMEs and increase sales of souvenirs. Apart from that, the availability of job opportunities provides opportunities for local communities to earn income. The implementation of zero waste also has an economic impact, especially as part of circular economic activities. The resulting waste is reprocessed and used, such as organic waste which is converted into maggots for catfish feed and fertilizer applied to agricultural land. Inorganic waste is also deposited in waste banks and provides economic value to society.

New Rivermoon also contributes to cultural preservation by providing sponsorship funding for cultural carnivals. An exclusive and peaceful cultural parade can promote peace and harmony in society by respecting diversity. In addition, cultural carnivals are used as an educational tool to increase awareness and understanding of local and global culture and support learning about history and traditions. This is part of the realization of SDG 16.

5. CONCLUSION

New Rivermoon Ecotourism is one of the tourist attractions that utilizes water resources by making conservation efforts to create economic opportunities for local communities. The existence of this ecotourism has an impact on the realization of river sustainability as a source of livelihood for the community while being able to improve the economy with the existence of jobs and the growth of MSMEs. The implementation of the zero-waste principle is carried out at the ecotourism location by managing organic and inorganic waste that has economic value. New Rivermoon Ecotourism also contributes to the creation of sustainable development goals through the creation of decent jobs, the implementation of responsible production and consumption patterns, protecting, restoring, and encouraging the use of sustainable terrestrial ecosystems, and strengthening inclusive, peaceful communities, realizing justice and building strong institutions.

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Optimizing Rattan Waste Processing in Furniture Production with a Green Supply Chain Model Approach

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Abstract: This research examines the application of a green supply chain to support the implementation of zero waste in the rattan handicraft industry. In general, the production process of rattan handicrafts uses raw materials with a length of 3 to 5 meters to produce products such as chairs, tables, and baskets. However, there is a significant problem in the form of residual rattan waste measuring 15 to 30 cm that is often discarded by craftsmen, thus triggering waste of raw materials. To overcome this, the concept of green supply chain is applied with the aim of optimally utilizing all available raw materials, including recycling the remaining materials into by-products of economic value, such as key chains, bracelets, and other accessories. A mathematical model is used to formulate an optimization strategy that considers the costs of raw materials, transportation, energy, and waste management. The objective function of the model is to minimize the total cost and maximize the value of the by-products, without applying a closed-loop approach. This research shows that implementing a green supply chain can significantly reduce waste, lower production costs, and improve resource efficiency, without compromising product aesthetics. In addition, the concept supports economic sustainability by utilizing waste as an additional resource, while reducing the environmental impact of the rattan handicraft industry. The implementation of a green supply chain is proven to improve the competitiveness and sustainability of this industry.

Keywords: Green Supply Chain, Zero Waste, Waste, Linerar Programming, Life Cycle Assessment.

1. INTRODUCTION

The rattan handicraft industry is one sector that has great potential for export, especially in countries rich in natural resources like Indonesia. Craft products made from rattan have high aesthetic value and increasing demand in the global market. However, this industry also faces several challenges, one of which is logistics efficiency and waste management. During the production process, rattan waste is often neglected or discarded, even though it has the potential to be processed into value-added products. Additionally, another common issue is the suboptimal utilization of space and weight in cargo, which leads to higher transportation costs and inefficiencies in product distribution. Efficiency in cargo utilization becomes crucial in the context of globalization and increasingly tight competition, where logistics costs can affect product competitiveness in the international market.

In this situation, the concept of cargo maximization through the utilization of rattan waste as additional products emerges as a potential solution. By implementing a green supply chain model, where waste is repurposed as raw materials for new products, the handicraft industry can not only improve resource usage efficiency but also optimize cargo capacity. This will reduce transportation costs per unit of product, enhance operational sustainability, and strengthen the competitive position of handicraft products in the global market.

Cargo maximization aims to utilize every inch of space and every gram of weight available in shipments. By producing additional crafts from rattan waste, the industry can fill empty spaces in cargo containers, which would typically be wasted. This not only reduces the cost per unit of shipment but also allows for more products to be shipped in a single shipment, thereby improving overall logistics efficiency. Reducing empty space and fully utilizing cargo capacity

means fewer shipments are needed for the same volume of products. This directly lowers transportation costs, which is a key component in the selling price of products in the export market. With lower logistics costs, rattan handicraft products can be sold at more competitive prices, or companies can increase their profit margins.

Using waste as raw materials for additional products supports sustainable business practices and a green supply chain. This aligns with global trends increasingly prioritizing environmentally friendly products and socially responsible production processes. Industries that can demonstrate a commitment to sustainability are likely to be favored in international markets, especially in countries with strict environmental regulations. Products made from waste not only add variety to the product portfolio offered by companies but also provide added value. These products can be marketed as part of the company's sustainability initiatives, attracting environmentally conscious consumers. Furthermore, by maximizing cargo, companies can sell more products with relatively the same shipping costs, meaning total export value also increases.

In the context of supply and demand, utilizing waste for additional products allows the industry to be more flexible in adjusting to demand fluctuations. If there is higher demand for certain products, the waste generated from primary production can quickly be transformed into products that meet market demands, without needing to start from scratch. Cargo maximization through the utilization of rattan waste is not just a technical solution for improving logistics efficiency but also a business strategy that can provide a competitive edge in the export industry. By integrating the green supply chain concept, the rattan handicraft industry can reduce costs, enhance sustainability, and add value to the products they offer to international markets. This makes the cargo maximization model relevant and important for adoption by companies that wish to remain competitive in the ever-evolving global market.

2. LITERATURE REVIEW

Supply Chain Management

Supply Chain Management is an approach that is applied to form suppliers, entrepreneurs, warehouses, and storage places in an efficient unit so as to produce products and distribution with the right quality, location, and time to get the minimum cost by satisfying consumer needs [1]. Supply Chain Management is management that is carried out continuously in order to obtain highly competitive business partners without ignoring consumer needs that focus on developing innovative solutions and synchronizing the flow of products, services and information to form unique consumer assessments [2].

Processing activities in the form of obtaining raw materials, transforming these raw materials into goods in process and finished goods, and delivering these goods to consumers through a distribution system with an integrative approach in managing the flow of products, information, and money by involving parties from upstream to downstream consisting of suppliers, factories, distribution networks and logistics services [3][4].

Supply Chain Management has the main components of upstream, internal and downstream. Upstream of the supply chain includes the activities of a manufacturing company with its suppliers (which can be manufacturers, assemblers, or both) and their connections to their suppliers (second-tier suppliers). Supplier relationships can extend to multiple strata, all the way from material origin. In the downstream part of the supply chain, the main activity is procurement. The internal part of the supply chain includes all the in-house processes used in transforming inputs from suppliers into the organization's outputs. It extends from the time inputs enter the organization. Within the internal supply chain, the main concerns are production management, manufacturing, and inventory control. The downstream part of the supply chain includes all activities that involve delivering products to end customers. In the downstream supply chain, more attention is directed to distribution, warehousing, transportation, and after-sales service [5].

Green Supply Chain Management

The implementation of GSCM in the company turns out to have great benefits, especially in improving the environmental and business performance of the company's GSCM aspects by building long- term buyer-supplier relationships. This is supported by collaborative relationships between customers and suppliers can lead to improved environmental performance and better product/service quality. One reason for this improvement is that consumers are now more knowledgeable about business environmental violations. Companies and all their partners in the supply chain will achieve sustainable business if products and services that have a negative impact on the environment are abandoned in favor of environmental principles [6][7][8]. There is a kind of symbiotic mutualism that exists between companies and suppliers if the supply chain also pays attention to environmental aspects.

On the other hand, according to Turnip (2009), the implementation of GSCM in the company will provide the following benefits:

1. GSCM encourages companies to mitigate risks and innovate.
2. The analytical process in GSCM will lead to continuous process innovation which in turn increases the adaptability of the company to changes in its environment.
3. Negotiations with customers and suppliers carried out in GSCM will improve the alignment of strategies and business processes between the company, customers and suppliers.
4. Potential for production cost savings through efficiency in the use of natural resources and energy.
5. The company's reputation as a company that cares about the environment will increase the attractiveness of the company in the eyes of customers.
6. More careful management of the natural resources used by the company will also provide assurance of supply for the company in the future.

Components of Green Supply Chain Management

Green Supply Chain Management (GSCM) is an approach that integrates the principles of environmental sustainability into the entire supply chain, from start to finish. The goal is to minimize environmental impacts at every stage of the supply chain process. GSCM not only focuses on production, but also includes waste management, recycling, and efficient use of resources. The following are the components of the methodology in Green Supply Chain:

1. Green Procurement

   Companies should consider the environmental impact of the raw materials they purchase, including using materials that are recyclable, renewable or produced from environmentally friendly processes. This also includes selecting suppliers that implement environmentally friendly practices. This can be implemented by purchasing materials from suppliers that have environmental certifications such as ISO 14001.

2. Green Manufacturing

   Reduce the negative impact of production processes on the environment by using clean technology, reducing energy use, minimizing waste, and improving process efficiency by using more energy- efficient production processes.

3. Green Distribution

   Reduce the carbon footprint of the distribution process by optimizing delivery routes, arrangement of goods, and form of packaging.

4. Green Packaging

   Design environmentally friendly packaging, such as using recyclable materials, reducing the size and weight of packaging, and ensuring that packaging can be recycled or reused.

5. Reverse Logistics

It involves managing products after consumer use for recycling, repair or safe disposal. Reverse logistics plays a role in reducing waste and increasing recycling, as well as maximizing the use rattan raw materials by creating by-products from leftover furniture materials.

6. Green Transportation

Optimizing energy use during delivery of goods through eco-friendly or fuel-efficient vehicles, and planning optimal delivery routes to reduce greenhouse gas emissions.

7. Waste Management

Involves reducing waste generated from production, distribution and post-consumption processes. The company strives to reduce hazardous waste and manage recycling.

8. Design for Environment (DfE)

Incorporate environmental considerations in the product design stage to minimize negative impacts on the environment. DfE aims to design products that are easier to recycle and have a longer life cycle.

9. Lifecycle Assessment (LCA)

Calculates the environmental impact of a product or process over its entire life cycle, from raw material procurement to final disposal. The goal of LCA is to understand where the greatest environmental impacts occur and take steps to reduce them [9].

Zero Waste

The concept of zero waste comes from a philosophy that seeks to redesign the life cycle of resources, so that all products are reused, recycled, or processed into new materials without anything ending up as waste. Zero waste is an attempt to change the way waste is viewed, not just as something to be disposed of, but as a valuable resource. Zero waste focuses on preventing the creation of waste upstream, different from conventional waste management methods that focus more on downstream management. Zero waste is part of a broader strategy to create a sustainable society that balances environmental and economic needs. There are several key principles in the concept of zero waste including reducing the amount of waste generated in the first place, maximizing the reuse of existing materials and products, as well as facilitating material recycling, designing products and production processes in such a way that they produce the minimum amount of waste possible, and using materials that can be recycled or biodegraded, the application of zero waste also emphasizes the importance of community participation in promoting sustainability practices at the local level [10].

Many sectors have started to implement the zero-waste approach, especially in the manufacturing, construction, and food industries. Many manufacturing companies, especially in the furniture sector, have started to adopt zero waste practices by redesigning products to make them more recyclable and reusing production waste.

Zero waste can reduce a company's operational costs through reduced waste management costs and the purchase of new raw materials. By recycling and reusing materials, companies can reduce dependence on limited resources, which ultimately results in cost efficiency [11].

3. METHOD

List of Notations

K : Profit
M : Manufacturer
R : Retailer
X : Quantity of products from manufacturer
Z : Quantity purchased by retailer
D : Market demand
d : Market basic demand
v : Product volume
w : Product weight
V : Container volume limit
W : Container mass limit
P : Manufacturer selling price
C : Production cost
P_M : Selling price of the product from the manufacturer
P_R : Selling price of the product from the retailer
C_M : Production cost of the product from the manufacturer
T_M : Tax per item shipped
F_C : Fixed shipping cost
C_W : Waste processing cost per kilogram
α : Price elasticity
β : Coefficient of waste product (kilogram/product), $0 < \beta < 1$
γ : Persentage of waste that can be processed
y : Recycled waste product purchased by the retailer
C_D : Production cost of recycled products
P_D : Selling price of recycled product by manufacturer
D_S : Secondary demand for recycled product
P_S : Secondary price of recycled product
d_S : Basic secondary demand

Supply Chain Model Without Waste Processing

Supply chain modeling involves the use of mathematical models and algorithms to analyze and design supply chain systems. These models can be used to optimize various aspects of the supply chain, such as costs, time, and efficiency. The following are some steps and components in supply chain modeling:

$$K_M = ZP_M - XC_M - \beta X C_W$$
$$K_R = DP_R - ZP_M - ZT_M - F_C$$
$$D = d - \alpha P_R$$

Constraints

1. $X \geq Z \geq D$
2. $Z.v \leq V$
3. $Z.w \leq W$
4. $Z.P_M > XC_M + \beta XC_W$
5. $\left(d - \alpha P_R\right).P_R > ZP_M + ZT_M + F_C$
6. $0 < \beta < 1$
7. $0 < \alpha < \frac{d}{P_R}$

Modified Supply Chain Model

$$K_M = ZP_M + y.P_D - XC_M - \gamma\beta XC_D - (1 - \gamma)\beta C_W$$
$$K_R = DP_R + D_S P_S - ZP_M - yP_D - (Z + y)T_M - F_C$$

Constraints

1. $X \geq Z \geq D$
2. $Z.v + yV_S \leq V$
3. $Z.w + yw_S \leq W$
4. $Z.P_M > XC_M + \beta XC_W$
5. $\left(d - \alpha P_R\right).P_R > ZP_M + ZT_M + F_C$
6. $0 < \beta < 1$
7. $0 < \alpha < \frac{d}{P_R}$
8. $\gamma\beta X \geq y \geq D_S$
9. $0 < \gamma < 1$
10. $0 < \alpha_S < \frac{d_s}{P_s}$
11. $P_D > \frac{\gamma\beta X}{y}(C_D - C_W)$
12. $D_S P_S > yT_M$

4. RESULT AND DISCUSSION

The integration of supply chain models and cargo optimization offers an innovative approach to enhance operational efficiency and sustainability in the rattan craft industry. Traditional supply chains, which focus on the flow of goods from raw material sources to end consumers, often face challenges such as high operational costs, suboptimal container capacity, and inefficient waste management. By integrating the principles of green supply chain management, companies can reduce their environmental impact through the utilization of production waste and optimization of shipping capacity.

Table 1 Comparison of Supply Chain Models Before and After Modification for Manufacturers

	Before Waste Processed	After Waste Processed
Product	X	$X\gamma\beta X$
Production Cost	$X.C_M$	$X.C_M + \gamma\beta XC_D$
Waste	βX	$(1-\gamma)\beta X$
Waste Processing Cost	βXC_W	$(1-\gamma)\beta XC_W$
Sales	Z	Zy
Income	ZP_M	$ZP_M + yP_D$

Table 2 Comparison of Supply Chain Models Before and After Modification for Distributors

	Before Waste Processed	After Waste Processed
Purchase	Z	Zy
Shipping Cost	$Z.T_M + F_C$	$Z.T_M + yT_M + F_C$
Sales	D	DD_S
Income	DP_R	$DP_R + D_SP_S$

Cargo optimization is a crucial component of the green supply chain, with its primary goal being to reduce the number of inefficient shipments by maximizing container capacity usage. This not only lowers transportation costs but also reduces carbon emissions, which is one of the main objectives of the green supply chain. Rattan waste, which typically pose a challenge in traditional supply chains, can be transformed into by-products such as accessories or decorative items, helping to fill empty space in containers and decreasing the need for new raw materials.

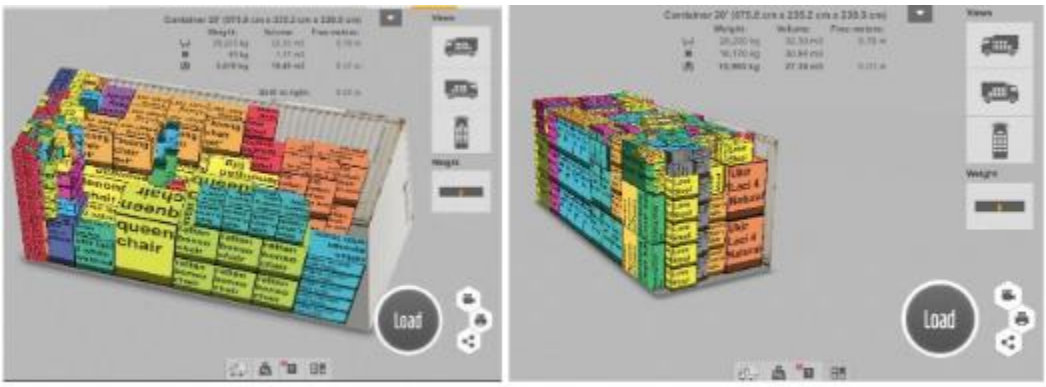

Figure 1 Before and After Cargo Optimization

With this strategy, container usage can be optimized to achieve maximum efficiency in cargo shipping. The mathematical model used to integrate cargo optimization with the green supply chain aims to maximize container utilization while minimizing costs and emissions. In this model, products generated from waste are prioritized to fill empty spaces, allowing companies to reduce waste and enhance shipping efficiency. The impact of this integration is evident not only in terms of reduced operational costs and increased profitability but also in the reduction of the company's carbon footprint, which is becoming increasingly important for meeting global environmental regulations. Furthermore, the adoption of a green supply chain provides a competitive advantage for companies in a global market that increasingly prioritizes sustainability.

Although challenges in implementation, such as operational complexity and the need for eco-friendly raw materials, still exist, the benefits gained from this integration are far more significant. By combining cargo optimization and the green supply chain, companies can not only achieve higher operational efficiency but also play a crucial role in

maintaining environmental sustainability, ultimately enhancing their reputation and competitiveness in the international market.

Figure 2 Export Product of Rattan Craft

Figure 1 Export Product from Rattan Waste

5. CONCLUSION

By adding high-density items and reorganizing the arrangement of goods, cargo dimensions can be maximized by reducing empty space and approaching the allowable weight limits of the container. This strategy not only enhances shipping efficiency but also contributes to reducing logistics costs and environmental impact. Thus, a systematic approach to utilizing space and weight will bring significant benefits to the success of the logistics process, maximizing profits for both producers and distributors.

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Environmental, Social, and Governance (ESG) in Indonesia: Insights from Bibliometric Analysis

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Abstract: The implementation of Environmental, Social, and Governance (ESG) criteria is gaining momentum worldwide and in Indonesia. Unlike green financing, which focuses on environmental projects, or climate terminology that often pertains to carbon emissions and climate change mitigation, ESG encompasses a broader spectrum, including social equity and corporate governance issues for a holistic sustainability strategy. This research analyzes the classification, trends, and potential future directions of ESG (Environmental, Social, and Governance) studies in Indonesia. Utilizing the robust and reliable Scopus database, combined with tools such as Publish or Perish, Mendeley, and VOSviewer, this paper examines the keyword "ESG" and "Indonesia" from 2018 to 2024. The findings indicate that research related to this keyword can be categorized into three main clusters: the role of ESG, country-based ESG comparisons, and ESG during the pandemic. Currently, trending topics include the role of ESG, strategy, government policies, and financial performance. However, there is a limited amount of literature on specific topics that present opportunities for future research, such as ESG factors, investment decisions, corporate social responsibility, climate change, and competitive advantage. Additionally, there are research gaps that could be explored further, such as the relationship between ESG activities and investment decisions, or climate change and sustainable development.

Keywords: bibliometric analysis, Publish or Perish, VOSviewer, ESG

1. INTRODUCTION

Globally, societies are currently confronting similar conditions and an array of challenges. These issues include global warming and climate change, environmental degradation, and increasingly complex social problems. These are some of the negative impacts stemming from development and economic growth. This shared global experience underscores the urgent need for collaborative efforts to mitigate these detrimental effects and foster sustainable development practices. Efforts to advance the economy are implemented through the enhancement of industrial activities and energy utilization, which negatively impact the environment and result in health issues, as evidenced by Turner et al. (1994), Margono et al. (2014), WHO (2016), and Tietenberg and Lewis (2016). Furthermore, economic development also leads to various new social problems within society, highlighted by Stiglitz (2012) and Piketty (2014). This dual consequence underscores the complex interplay between economic progress and sustainable development, necessitating a balanced approach that promotes economic vitality while mitigating environmental degradation and social upheaval. The challenge lies in devising strategies that harmonize industrial growth with ecological preservation and social welfare, ensuring a holistic advancement for future generations. In light of the issues mentioned earlier, various movements and ideas have emerged to address these challenges. One such effort is the adoption of Environmental, Social, and Governance (ESG) principles in corporate activities. This term gained popularity after the UN Global Compact Initiative's "Who Cares Wins" report introduced the concept. Unlike the "green" concept or terms related to "climate change" that focus mainly on environmental aspects, ESG also highlights social responsibility and good governance. These are essential components of sustainable development, alongside environmental and economic factors (UNDP, 2023) as can be seen on Figure 1.

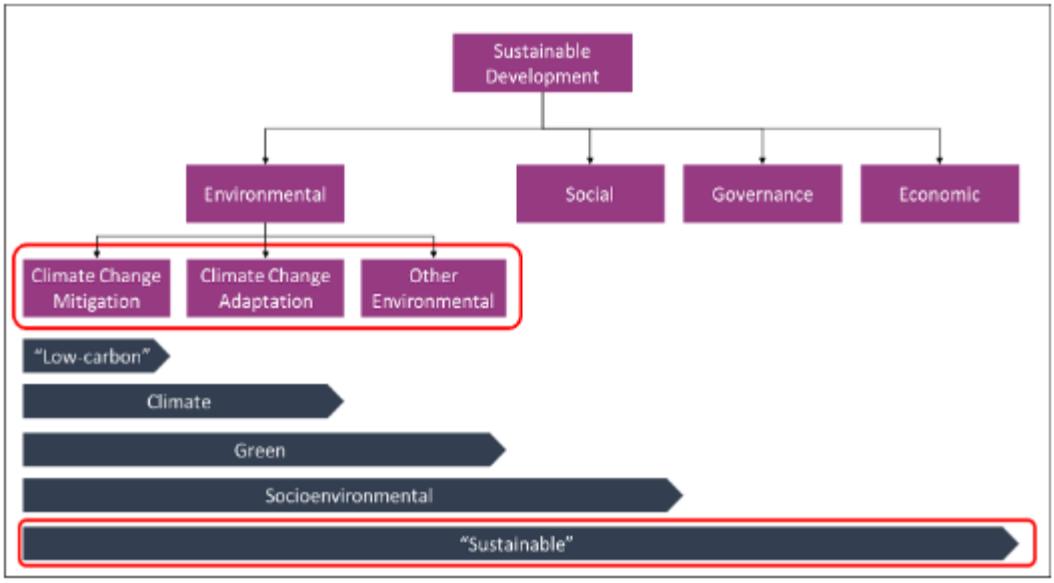

Figure 1. Role of ESG in Sustainable Development

There is now a substantial body of literature addressing the implementation of Environmental, Social, and Governance (ESG) principles from the perspectives of investors, governments, and corporations. Furthermore, discussions on ESG have been extensively conducted both globally and within specific sectors. To effectively analyze the application of ESG, it is imperative to undertake a comprehensive and systematic literature review. One valuable method for this purpose is bibliometric analysis, which assesses the impact and influence of scientific publications based on citation data. This analysis identifies new trends in how articles and journals are performing, understand collaboration patterns and key research contributors, and explore the intellectual framework of a specific field within the existing literature (Donthu, et.al., 2021). Thus, bibliometric analysis can help identify research trends, collaboration patterns, scientific networks, and knowledge gaps. Generally, bibliometric analyses that have been published are more often related to the global implementation of ESG such as Khurshid and Islam (2024) who discuss the ESG literature mapping. However, to the best of our knowledge, there is no literature which discuss bibliometric analysis on ESG application in Indonesia. Therefore, this research fills that gap by conducting a bibliometric analysis of articles related to ESG in Indonesia, with the aim of classifying, identifying trends, and analyzing potential research topics on ESG in Indonesia for the future.

2. LITERATURE REVIEW

This research employs the methodology of bibliometric analysis, which is an integral part of a comprehensive literature review. Bibliometric analysis involves examining the relationships between various reported physical units, bibliographic units, and their substitutes (Broadus, 1987). This methodological approach can reveal the accuracy and relevance of aspects related to scientific publications, such as authors, recurring keywords, and citations (Rusly, et al., 2019). By transforming qualitative informative data into quantitative data, bibliometric analysis allows for a detailed assessment of the strength and impact of research studies and their topics (Baraibar-Diez et al., 2020). Bibliometric analysis is particularly useful for analyzing journal articles, books, and other written scientific documents (Heersmink et al., 2010). It provides a systematic way to measure and evaluate the influence of these publications within the scientific community. This method can uncover patterns and trends in research, helping to identify key areas of focus and emerging topics within a specific field.

This bibliometric analysis encompasses two main aspects: performance analysis and science mapping analysis. Performance analysis is based on bibliometric indicators that measure the productivity and impact of individual

researchers, institutions, countries, and journals. It evaluates the number of publications and citations to determine the influence and reach of these entities within the scientific community. This aspect of bibliometric analysis helps to highlight the most prolific and impactful contributors to a particular field of study. Science mapping analysis, on the other hand, represents the topological and chronological arrangement of cognitive and social structures within a specific research discipline (Cobo et al., 2012). This type of analysis provides a visual representation of the relationships and connections between different research topics, authors, and institutions. It helps to identify the intellectual structure of a field, showing how various concepts and ideas are interconnected. Science mapping can also reveal the evolution of research trends over time, highlighting shifts in focus and emerging areas of interest. The objective of bibliometric analysis is to summarize bibliographic data to present the latest developments in the structure of knowledge and research trends on specific topics (Donthu et al., 2021). By providing a comprehensive overview of the existing literature, bibliometric analysis can identify gaps in knowledge and suggest potential directions for future research. This method is invaluable for researchers, policymakers, and practitioners who seek to understand the current state of research in a particular field and to make informed decisions based on this understanding.

3. METHOD

Fahimnia et al. (2015) proposed a comprehensive framework for bibliometric analysis, delineating five critical stages:

1. initial search;
2. presentation of initial search results,
3. refinement of search results,
4. presentation of statistical descriptions of the final search results, and
5. data analysis.

This research adheres to these stages meticulously, employing the “Publish or Perish” application in conjunction with the Scopus database. The “Publish or Perish” application is a sophisticated tool designed to retrieve and analyze academic citations. It leverages multiple data sources to gather raw citation data, which it then processes to present a variety of citation metrics, including the number of papers, total citations, and the h-index (Harzing, 2023).

In this study, we utilized data from Scopus, a comprehensive abstract and citation database introduced by Elsevier in 2004 (Baas et al., 2020). Scopus is renowned for its extensive content coverage, encompassing a wide range of disciplines and providing detailed information on authors and their affiliations. Its user-friendly interface, robust impact indicators, and resistance to data manipulation make it an ideal choice for bibliometric analysis (Pranckute, 2021). The selection of Scopus as the primary data source is aligned with the stringent requirements of bibliometric analysis, which demands high-quality information and reliable citation data (Bosi et al., 2022).

The initial search phase involves identifying relevant literature using specific keywords and search criteria. This is followed by the presentation of initial search results, where the retrieved data is organized and displayed for preliminary review. The refinement stage entails narrowing down the search results to exclude irrelevant or redundant entries, ensuring that the final dataset is both comprehensive and focused.

Subsequently, the presentation of statistical descriptions of the final search results provides a quantitative overview of the dataset. This includes metrics such as publication counts, citation frequencies, and the distribution of research outputs across different journals and institutions. Finally, the data analysis phase involves a detailed examination of the refined dataset to uncover patterns, trends, and insights related to the research topic.
By following these stages, this research aims to provide a thorough and systematic bibliometric analysis of ESG-related literature in Indonesia. The insights gained from this analysis will help identify key research trends, collaboration patterns, and knowledge gaps, thereby contributing to the advancement of ESG research in the region.

4. RESULT AND DISCUSSION

When conducting a Scopus search using the "Publish or Perish" application, we utilized the keyword "ESG" and "Indonesia" to identify relevant literature concerning the implementation of ESG principles in Indonesia. In the initial stage, no limitations were applied regarding the year of publication. Consequently, the results encompass all literature related to the implementation of ESG in Indonesia or any relevant studies on ESG in Indonesia, without any time constraints. The initial search yielded 98 papers that met the criteria as listed in Table 1.

Table 1. Result of Initial Search

Type of Document	*Number of Document*
Journal Articles	63
Book Chapters	6
Conference Papers	24
Review Articles	5

However, it is important to note that the acronym ESG can also refer to other technical terms such as Environmental Safe Guard and Ecological Species Group. Therefore, we excluded any literature where ESG did not pertain to Environmental, Social, and Governance.

In the third stage, after filtering out irrelevant literature, we were left with 83 papers that specifically addressed ESG topics in Indonesia as shown in Table 2.

Table 2. Result of Refinement Search

Type of Document	*Number of Document*
Journal Articles	56
Book Chapters	5
Conference Papers	18
Review Articles	4

A list of the 10 most cited papers among the 83 relevant documents on ESG in Indonesia as shown on Table 3.

Table 3. List of the 10 Most Cited Papers

Authors	*Title*	*Years of Publication*	*Cites*
Qoyum, A., Sakti, M.R.P., Thaker, H.M.T., & AlHashfi, R.U.	Does the islamic label indicate good environmental, social, and governance (ESG) performance? Evidence from sharia-compliant firms in Indonesia and Malaysia	2022	41
Chairani, C. & Siregar, S.V.	The effect of enterprise risk management on financial performance and firm value: the role of environmental, social and governance performance	2021	30
Gunawan, J., Permatasari, P., Sharma, U.	Exploring sustainability and green banking disclosures: a study of banking sector	2022	29
Singhania, M., Saini, N.	Quantification of ESG Regulations: A Cross-Country Benchmarking Analysis	2022	28
Khalil, M.A., Khalil, R., Khalil, M.K.	Environmental, social and governance (ESG) - augmented investments in innovation and firms' value: a fixed-effects panel regression of Asian economies	2024	26
Harymawan, I., Nasih, M., Agustia, D., Putra, F.K.G., Djajadikerta, H.G.	Investment efficiency and environmental, social, and governance reporting: Perspective from corporate integration management	2022	25
Harymawan, I., Putra, F.K.G., Fianto, B.A., Wan Ismail, W.A.	Financially distressed firms: Environmental, social, and governance reporting in indonesia	2021	25
Adeneye, Y.B., Kammoun, I., Ab Wahab, S.N.A.	Capital structure and speed of adjustment: the impact of environmental, social and governance (ESG) performance	2023	20
Fuadah, L.L., Mukhtaruddin, M., Andriana, I., Arisman, A.	The Ownership Structure, and the Environmental, Social, and Governance (ESG) Disclosure, Firm Value and Firm Performance: The Audit Committee as Moderating Variable	2022	17
Qoyum, A., Al Hashfi, R.U., Zusryn, A.S., Kusuma, H., Qizam, I.	Does an Islamic-SRI portfolio really matter? Empirical application of valuation models in Indonesia	2021	17

The next step involves presenting the statistical data from the final selection. The final search results using the keywords “ESG” and “Indonesia” with the Publish or Perish application from the Scopus database for publications from 2018 to 2024 yielded a total of 83 articles, as shown in Figure 2. From this figure, we can also observe that research on ESG is becoming increasingly popular, as evidenced by the significant rise in the number of papers on the topic.

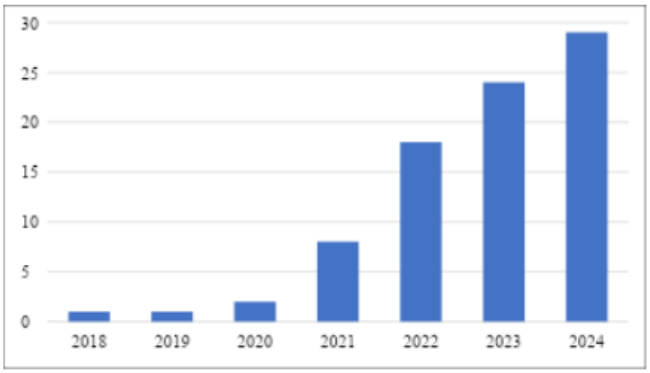

Figure 2. Number of Publication per Year

The subsequent analysis employs the VOSviewer application, a sophisticated tool for classifying scientific publications and analyzing clustering results (van Eck & Waltman, 2017). The initial step involves extracting data from the titles and abstracts of 83 articles using VOSviewer. During the data extraction process, a minimum occurrence threshold of 5 was set, meaning that a word must be mentioned in at least 5 articles to be considered. Out of the 2235 terms identified in the titles and abstracts of 83 papers, 71 terms met this threshold. From these 71 terms, only the top 60% of the most relevant terms were selected, resulting in 43 terms being deemed relevant for the bibliometric analysis of ESG.

The bibliometric analysis conducted with VOSviewer generates three types of visualizations: network visualization, overlay visualization, and density visualization. The primary objective of this research, which is to analyze the classification of studies on ESG in Indonesia, is illustrated through the network visualization results. Figure 3 presents the network visualization mapping. Interrelated keywords are depicted in three distinct colors, each representing a different cluster. VOSviewer automatically maps the visualization of 83 research articles into three clusters or classifications.

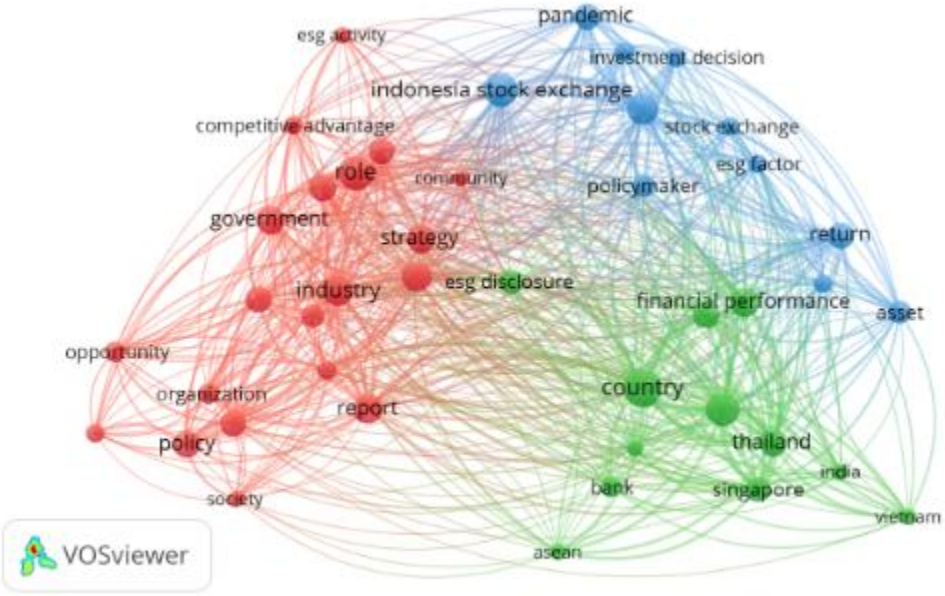

Figure 3. Result of Network Visualization Analysis

Twenty keywords form the first cluster (red): business, climate change, community, competitive advantage, corporate social responsibility, development, ESG activity, firm value, framework, government, industry, management, opportunity, organization, policy, report, role, society, strategy, and sustainability report. The keyword "role" has the highest occurrence in this cluster, appearing 22 times. This indicates that the topic "role" is the most researched within the red cluster. Research on ESG in this cluster is heavily related to the role of ESG in various contexts, such as its impact on business practices, community engagement, and corporate strategies. The frequent occurrence of "role" suggests a significant focus on understanding how ESG principles are integrated and operationalized within organizations.

In the second cluster (green), there are 12 keywords: ASEAN, bank, country, ESG disclosure, ESG score, financial performance, India, Malaysia, Singapore, sustainability development, Thailand, and Vietnam. The keyword with the highest occurrence is "country," appearing 25 times. This cluster highlights the comparative studies of ESG implementation across different countries, particularly within the ASEAN region. The focus on "country" indicates a strong interest in examining how different national contexts influence ESG practices and outcomes. Research in this cluster often explores the variations in ESG disclosure, scoring, and financial performance among countries like India, Malaysia, Singapore, Thailand, and Vietnam, providing valuable insights into regional differences and best practices. In the third cluster (blue), 11 keywords appear: asset, COVID, ESG factor, ESG practice, Indonesia Stock Exchange, investment decision, pandemic, policymaker, return, stock exchange, and sustainability performance. The keywords with the highest frequency are "pandemic" and "COVID," with a total frequency of 30 times. This cluster is particularly relevant in the context of the recent global health crisis. The high occurrence of "pandemic" and "COVID" reflects the increased attention to how ESG factors and practices have been impacted by and responded to the pandemic. Research in this cluster examines the role of ESG in mitigating the effects of the pandemic on financial markets, investment decisions, and corporate sustainability performance. It also explores the responses of policymakers and the implications for the Indonesia Stock Exchange and other stock exchanges.

In the network visualization, the thickness of the lines indicates the intensity of the relationship between keywords. Thicker lines mean that the keywords appear together more frequently in the same research. For example, "role" and "government" are connected by a thick line, indicating that these two topics are often used together in research. This suggests a strong linkage between the role of ESG and government policies, highlighting the importance of regulatory frameworks in shaping ESG practices. Next, in the second part of the study aimed at identifying research trends related to ESG, the researchers conducted an overlay visualization analysis, as shown in Figure 4. This figure shows that the keywords in yellow (brighter) are more popular in recent research. Based on Figure 4, the most popular current topics are related to the pandemic and COVID. This trend underscores the growing interest in understanding the intersection of ESG and global health crises, and how companies and governments are adapting their ESG strategies in response to such unprecedented challenges.

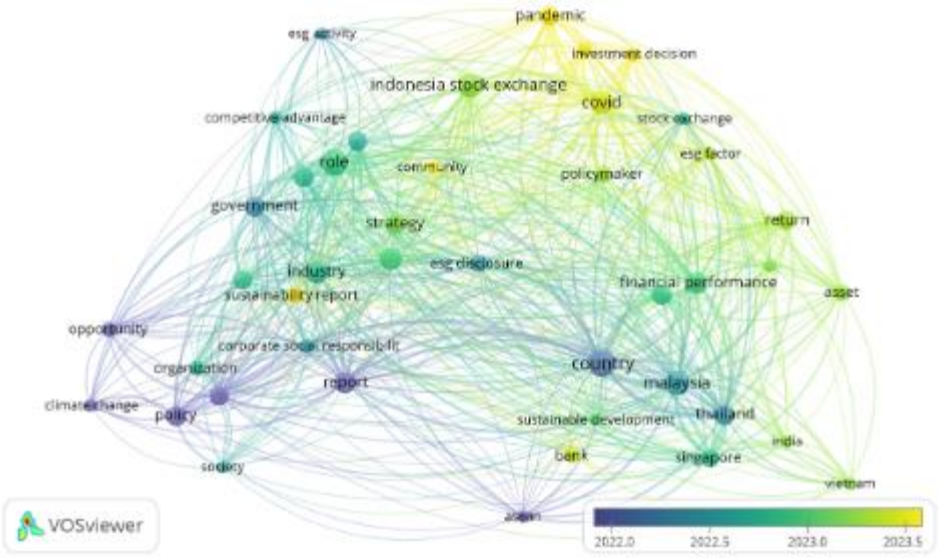

Figure 4. Result of Overlay Visualization Analysis

The third research objective, as depicted in Figure 5, illustrates the results of a density visualization analysis aimed at identifying both popular and less-researched topics within the field. The visualization uses the size and brightness of keywords to indicate their popularity among researchers.

Large and bright keyword visualizations signify that a topic is widely studied and holds significant interest in the research community. For instance, the keyword ‘role’ stands out with the largest and brightest visualization, indicating its prominence. Other keywords that also appear quite large and bright include “financial performance,” “strategy,” “industry,” and “country.” These topics have been extensively explored and are well-established in the literature, reflecting their importance and the substantial amount of research dedicated to them.

On the other hand, small and dim keyword visualizations suggest that a topic has garnered less attention from researchers. For example, keywords like “climate change,” “ESG factor,” and “asset” are depicted with the smallest and dimmest visualizations. This indicates that these topics are not as widely studied and may represent emerging areas of interest or gaps in the current research landscape. Despite their current lower visibility, these topics hold significant potential for future research and development. Researchers might find valuable opportunities in exploring these less conventional choices, contributing to the advancement of knowledge in these areas.

In summary, the density visualization analysis provides a clear picture of the research landscape, highlighting both widely used and underexplored topics. This can guide researchers in identifying areas that are ripe for further investigation and those that are already well-covered, helping to balance the research efforts across different topics.

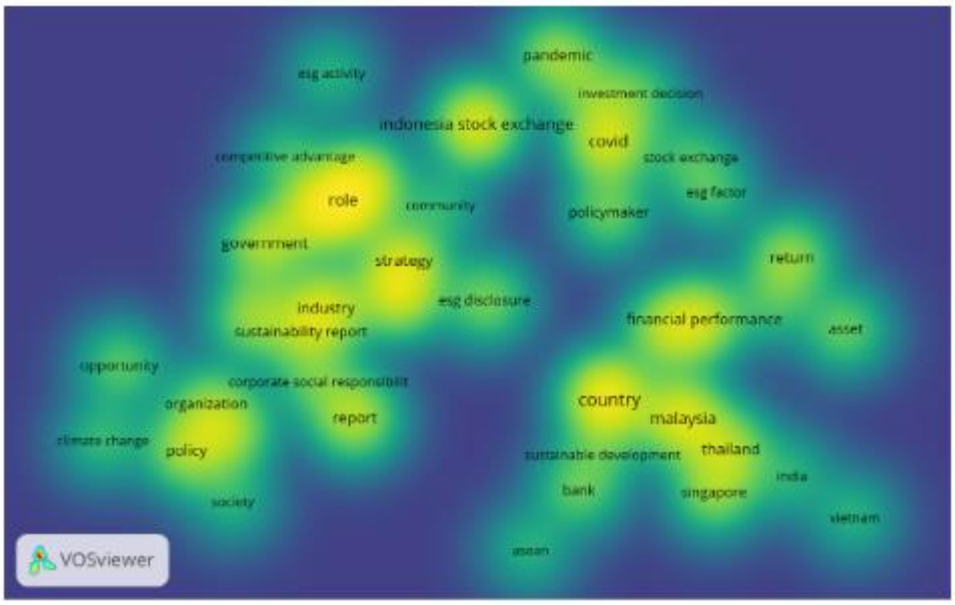

Figure 5. Result of Density Visualization Analysis

One way to explore research topic opportunities is by using network visualization, as shown in Figure 3. This method allows us to see the relationships between keywords used in previous research. If two keywords are connected by a thin line, it means that the relationship between these topics has been rarely studied. If there is no line connecting two keywords, it means that no research has combined these topics. For example, in Figure 3, we can see that "ESG activities" and "investment decision" are not connected by a line. This explicitly indicates that there has been no research studying the relationship between ESG activities and investment decision. Similarly, the lack of connection between "climate change" and "sustainable development" suggests that there has been no research examining the relationship between these two topics.

This analysis also reveals that current research on ESG practices predominantly focuses on their implementation within larger companies. This trend is evident in Figure 5, where the term "Indonesia Stock Exchange" appears relatively brighter. This trend indicates that the unique challenges and opportunities associated with ESG in small and medium enterprises (SMEs) are often overlooked.

5. CONCLUSION

The results of the bibliometric analysis on research regarding ESG in Indonesia from 2018 to 2023 can generally be classified into three main clusters. The first cluster includes research related to the role of ESG, which examines how ESG factors influence various aspects of business and investment decisions. The second cluster focuses on country-based ESG comparisons, analyzing how different countries approach and implement ESG practices and policies. The third cluster looks at ESG during the pandemic, exploring how the COVID-19 pandemic has impacted ESG considerations and practices. Currently, the most widely researched topics in ESG include the role of ESG in business, industry-specific ESG strategies, the impact of ESG on financial performance, and country-specific ESG practices. These topics are crucial as they help understand the broader implications of ESG on global business and investment landscapes.

However, several areas within ESG remain underexplored. These include the impact of climate change on ESG factors, the development of ESG frameworks and standards, the role of ESG in asset management, and the specific factors that constitute ESG. Additionally, there is a notable trend highlighting the need to address the unique challenges and

opportunities associated with ESG in small and medium enterprises (SMEs), which are often overlooked. Recognizing the potential benefits of extending ESG practices to SMEs could lead to more comprehensive and inclusive sustainability efforts. Therefore, it is imperative that future research explores ESG implementation in SMEs to fully understand its impact and to develop tailored strategies that support these smaller businesses in their sustainability journeys. These under-researched areas present valuable opportunities for future studies to contribute to the growing body of knowledge on ESG.

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Development Monitoring Laundry Management System Based on Ios Core Data

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Abstract: Laundry is an alternative service that can help people wash their clothes. Nowadays, there are a lot of laundry users, from teenagers to adults. It's no wonder that we often carry out and encounter this business because it is indeed a great business opportunity and can be developed. Even so, there are still problems that often occur in using laundry services. These problems include laundry service users who forget their own laundry clothes, clothes that are lost or lacking during washing, and forget to take laundry clothes. Therefore, the writing team discusses how the Apparel Management Application for Laundry Users Using iOS-Based Core Data can help solve many people's laundry problems. Based on our survey with questions, most users are onboarding in the DiLaundry application. With the results obtained, 96.8% of respondents answered yes, 1 respondent (3.2%) answered no, and all the respondents agreed 100% that they could properly manage and check their laundry clothes through the DiLaundry application. Based on our research, we wish this monitoring laundry application could continue with more utility and facility in serving the laundry client.

Keywords: laundry, mobile application, management, Core Data, iOS

1. INTRODUCTION

People these days also have lifestyle changes in terms of clothing due to the influence of the internet and social media. The number of clothes has become an important part of life today. The emergence of new trends that continue to be the thing that makes human dressing styles also change. For example, from usually only wearing 1 t-shirt, now the t-shirt is layered again with other clothes, which means that the clothes worn by a person are getting more and more. So, the clothes owned by humans today are quite a lot. Clothes must also be washed regularly, while most people today want everything to be practical. That is why this causes problems for many people. From the two things above, namely a lot of activities and clothing matters, many people today use the help of laundry to overcome it. Laundry is an alternative that can be used easily and has the opportunity to be developed. Laundry is a practical and fast laundry service that only takes about 1-3 days. All groups are currently using this service, from students to parents. This service is also still very profitable, so this service is easily found everywhere. The high public interest in using laundry services is partly due to the large number of people who currently live in rental or boarding houses.

However, there are some shortcomings that laundry currently has. The current laundry system, which is still manual, makes some people difficult and less helpful. Difficulties are experienced, such as a manual counting system for clothes, so it is possible that there are incidents of missing or lack of clothes. Then the management system is long, and sometimes people forget the estimated time or time to pick up the clothes that have been completed. Therefore, the solution that can be done must provide more convenience for laundry users. The solution that will be done is to create an application that is able to record the clothes to be laundered, based on the type of clothing. After that, the application is also able to provide reminder notifications for users to notify laundry pickup schedules. This notification works after the user enters the pickup date according to the information from the laundry place. With the appearance

of this application, problems regarding laundry that may occur will be minimized, and then users will become more helpful and feel confident when going to use laundry services anywhere.

2. LITERATURE REVIEW

Laundry has a definition, namely the process of cleaning an object by removing unwanted particles or impurities from the object so that the original state of the difference is obtained [1]. To help solve laundry-related problems in today's society, a practical and appropriate solution is needed. One of them is through mobile applications. Mobile application is software that can only be obtained and run on mobile devices [2]. Why use a mobile application? Because many people today like mobile applications because they are cheap, flexible, and portable. In that case, the laundry application that will be created is iOS-based. In making applications, of course, we use programming languages. A programming language is a language that is a tool for programmers to use in the process of making software [3]. The programming language used in this application is Swift programming language. Swift Programming Language is a hybrid programming language that has a functional object orientation. Swift is a fast and secure programming language. Swift is currently used to develop apps and systems for iOS, watchOS, and tvOS [4]. Furthermore, Xcode, which is software and part of Apple's development tools, helps in coding [5]. The application will be core data-based, as core data serves as the framework used to manage the model layer objects in the application [6].

In creating this application, the design pattern used is MVVM (Model-View-ViewModel). This MVVM concept is a design pattern with 3 layers, which involves a new concept of ViewModel and is a companion object for ViewController on iOS [7]. To call and facilitate communication with other applications, an API is needed in the application [8]. After that, the Rest API is needed, which is a protocol that utilizes HTTP (Hypertext Transfer Protocol) [9]. If the API is to communicate with other applications, then the Rest API is the architectural design of the API. This API was built and documented using software called Postman. [10]. For the framework, Laravel Middleware is used. Laravel is a PHP website-based backend and has an MVC (Model-View-Controller) pattern [11]. Some of the advantages of using the Laravel framework are the lightweight template, support for MVC, many object-oriented libraries, artisan tools available, and individual and independent modules [12]. The process of modeling and implementing the system in the application will be done through UML (Unified Modeling Language). UML aims to make developers have a reference, and users also have a reference for how to use the application. [13]. After the model of the system has been formed, it is also necessary to model the form of the application itself. Therefore, a prototype is needed. A prototype is a product model that already includes some of the main features of the product before proceeding to the final phase [14].

After the application is ready to be given to the user, testing will be carried out. Testing is done in several ways, one of which is the black box testing method. This method is done by testing a person or group of people who do not know anything about the system of the application and how the application works [15].
Here are some of the features loaded in this app:

- Users can have data on their clothes that are being laundered.
- Users can view and know the laundry time in progress.
- Users can get an automatic reminder if the laundry process has been completed.
- Laundry users become more helpful to check laundry clothes.

3. METHOD

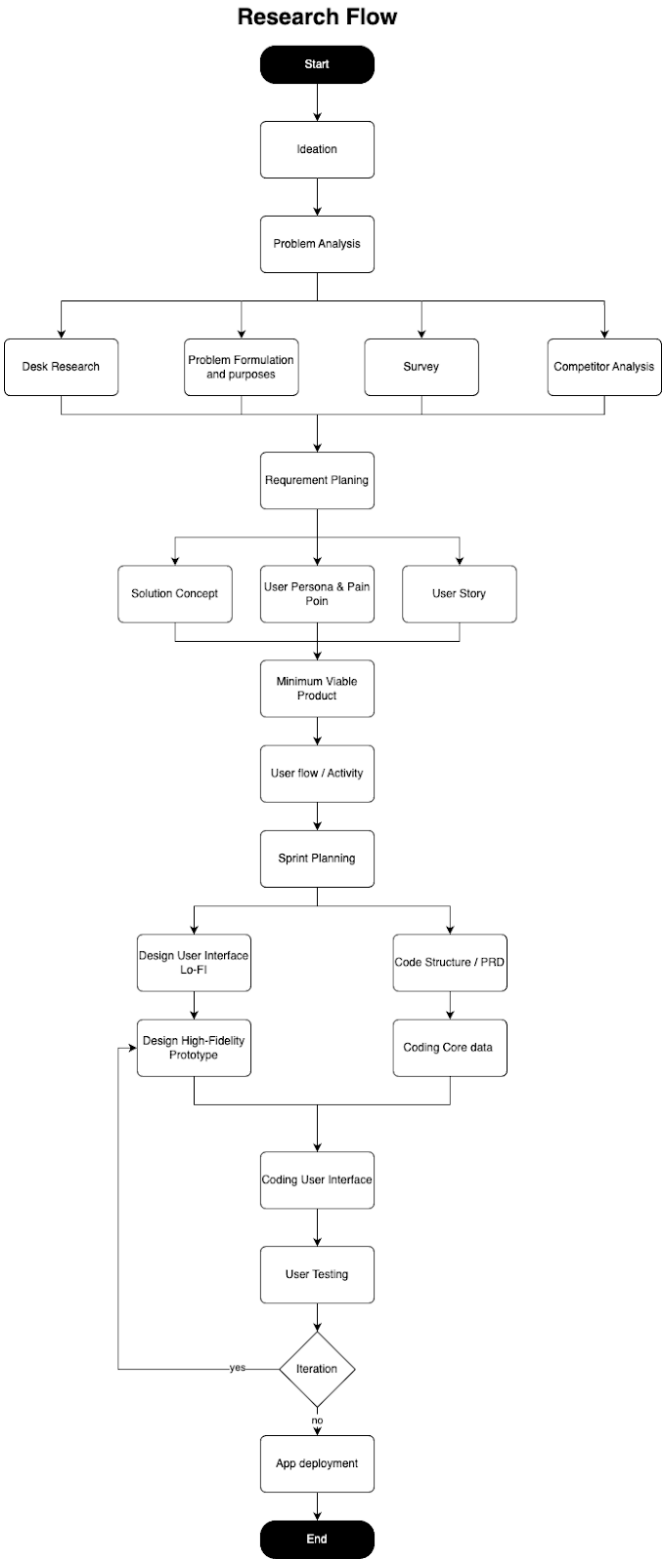


Figure 1. Application Development Process

The author sets the name for the application to be made with the name DiLaundry. There are several stages of the research method carried out by the author in making this DiLaundry application. First, the author develops the idea of what application will be made. The application that the author thinks of is one that does not currently exist but is needed by the community. The author has several ideas at this early stage. Finally, the author chose to make this laundry application. This is because there are not many laundry applications that exist and are known by the public. Then, the author analyzes the problems of the laundry-related community. Several problems were found that could be overcome by the author through the application to be developed. In the next stage, the author conducts searches related to books, journals, and information from various sources that contain laundry, goods, and data management systems, as well as about the application base that will be made, namely iOS. Next, the author formulates the problem and purpose of this application. The author then conducts a survey of the community, ranging from teenagers to adults. This is useful so that the targets and objectives of this application can and are appropriate. After the survey data is collected, the author also collects data from surveys of applications that are similar to what the author wants to develop. The author found several applications that refer to laundry purposes. From all these data, the author can finally formulate the needs of the community to be included in the application. In the next stage, the author compiles a series of good solutions so that later they can be used by the community. Therefore, the author must create user personas, pain points, and user stories. Next, the author creates an MVP (minimum viable product) to get appropriate results by reducing things that can mess up the final result of the application. After that, the author creates an activity diagram related to the process of working the application. Followed by sprint planning to discuss the next work steps. The next series of work is to create a Lo-FI User Interface Design, which is then followed by a High Fidelity Prototype Design. At the same time, the author also created a code structure/PPRD and created the core data. After that, the author did the coding for the application interface. Because this application is for the community later, the next step is testing with the user. This testing aims to examine how the user experiences the interface and the workings of the application. If there are shortcomings, then iteration of prototyping is carried out. The author must ensure that this application is working properly. And finally, the author can deploy the application that has been developed.

4. RESULT AND DISCUSSION

In designing DiLaundry, it really requires needs analysis which is very supportive in the design and development of this application.

A. Requirement defination

The following are the supporting needs in the development of this application:

1) Create a system that can record the amount by categorizing the user's clothes when they want to do laundry.
2) Help laundry users to record how long the laundry process takes from the estimate given by the service provider.
3) Provide reminders in the form of notifications for picking up laundry clothes for users after the laundry process is complete.
4) Creating a useful system so that laundry users can confirm the clothes they receive.

B. Software and Design System

After all the requirements are carried out by users, start by designing the system using use cases and UML.

1) System Design

At the beginning, we planned by making a Use Case Diagram which can be seen in figure 2.

- Use Case Diagram

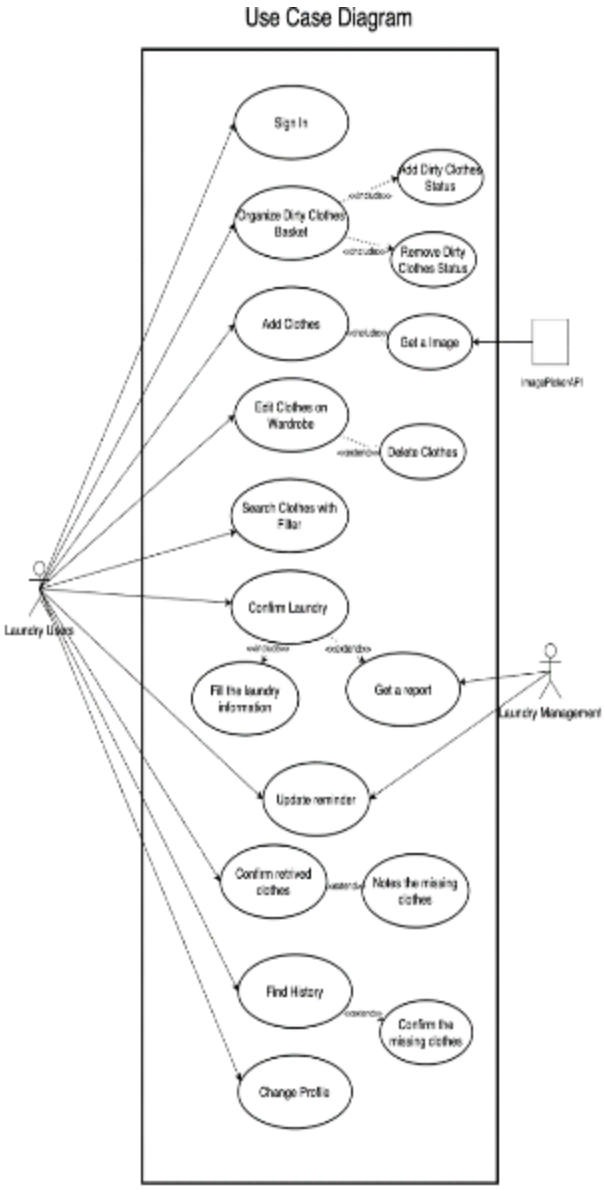


Figure 2. Use Case Diagram DiLaundry

Figure 2 explains the use case diagram of DiLaundry. In this use case, there are 3 actors: laundry users, laundry management, and the image picker API. The use case diagram explains activities that can be carried out by actors in using the application.

- Activity Diagram

Figure 3. Activity Diagram

In figure 3 describes the activity diagram for adding clothes features within our DiLaundry application. From this figures there will be interaction between the users and system.

- Class Diagram

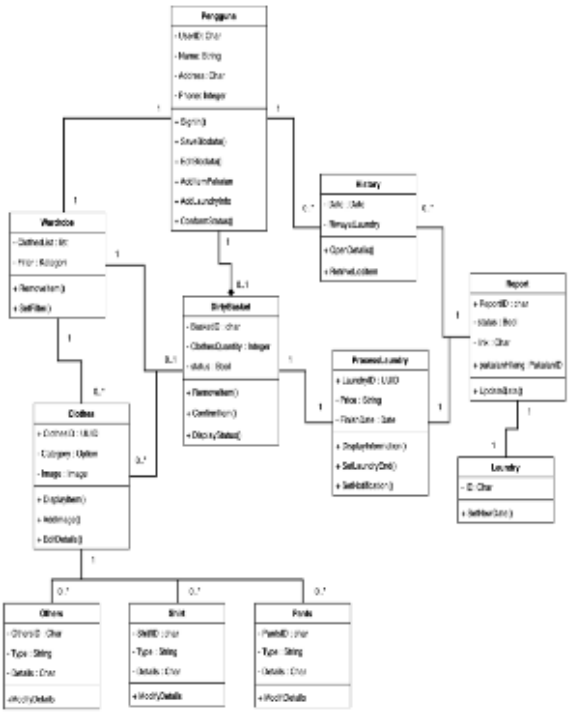


Figure 4. Class Diagram

In figure 4 describes the class diagrams that have been created for the DiLaundry application.

2) User Interface Design

Figure 5. User Interface of Home Page

In figure 5 is a view of the home page of the DiLaundry app. In this application inform some menu to support the system.

C. Application Development

After completing the application development design with diagrams and prototypes, we started to create projects according to their needs, including the main thing is to creating Core Data as an essential backend in our application so that it can accommodate data and make your application work.

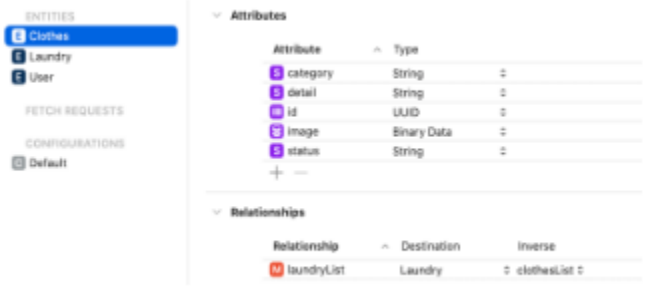


Figure 6. Core Data Laundry

In the figure above is a Core Data figure that is accommodated based on the entities that have been designed in the Entity Relation Diagram, including users, clothes, and laundry. Each entity has its own attributes and is related to recording the data involved. This core data creation only adds entities to the core data model, then adds their functions to each model.

```
import CoreData
class ClothesModel{
   private var context: NSManagedObjectContext
   init() {
      self.context = PersistenceController.shared.container.viewContext
   }
   init(context: NSManagedObjectContext) {
      self.context = context
   }
```

The source code of the SwiftUI Model is a coded part of the Clothes Model. Core Data can transform entities as a data model; you no longer need to create structs to insert data. Therefore, we must import Core Data at the top of the file. Use this import on every file that will deal with core data. Core Data runs in the background task so it doesn't interfere with the main thread. Make this context variable a global variable so you don't have to create this variable repeatedly.

```
func saveClothes(image: Data, category: String, status: String = "clean") -> Bool {
      let clothes = Clothes(context: context)
      clothes.id = UUID()
      clothes.image = image
      clothes.category = category
      clothes.status = status
      clothes.detail = ""
```

Then, we will create a function to save the core data. The creation of this method is optional, but since we will use it repeatedly Without using this method, the existing data model will be a regular structure. The data contained in it will not be saved into Core Data.

```
import SwiftUI
struct ImagePicker: UIViewControllerRepresentable {
   @Binding var image: UIImage?
   @Binding var isShown: Bool
   var sourceType: UIImagePickerController.SourceType = .photoLibrary
```

Then in the next source code is corelated with API. The use of the ImagePicker API is embedded in our application for image capture needs in the clothing addition feature. This function in it will call the camera to take a picture.

D. Testing

After developing the DiLaundry application, testing is carried out to confirm whether the application created is suitable in terms of system and functionality. Testing was carried out using the Black Box Testing method. In this test, all functions contained in the DiLaundry application were tested to ensure whether the functions, flows, and appearance of the application were running as needed. The DiLaundry application was tested with a total of 22 test cases. The results of the tests are that 22 test cases were declared passed.

E. Questionnaires

To get evaluation data from users of the DiLaundry application, questionnaires are needed for that. The questionnaires are meant to find out whether users are interested or not in the DiLaundry application. Then, get information about things that are lacking from the DiLaundry application. The following are some of the questions contained in the DiLaundry application questionnaires:

1) Did you see the On Boarding screen when you find opened the DiLaundry application?\

Figure 7 User see the boarding room

In Figure 7, the conclusion of the question is that of the 31 respondents, most saw OnBoarding in the DiLaundry application. With the results obtained, 30 respondents (96.8%) answered yes, and 1 respondent (3.2%) answered no.

2) Can you add your dirty clothes in the DiLaundry application?

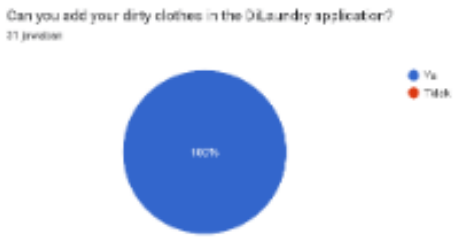


Figure 8 User can add their dirty clothes

In figure 8, the conclusion of this question is that of the 31 respondents, all respondents 100% agreed that the DiLaundry application could add their dirty clothes.

3) Can you manage and check your laundry clothes properly through the DiLaundry application?

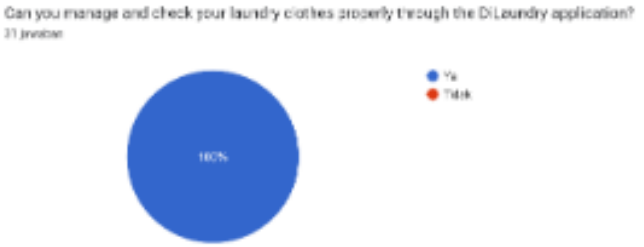


Figure 9. User can manage and check their laundry

In figure 9, inform the conclusion of the questionnaire question that all the respondents agreed that they could properly manage and check their laundry clothes through the DiLaundry application.

4) Can you send a report on your laundry clothes to the laundry manager in the DiLaundry application?

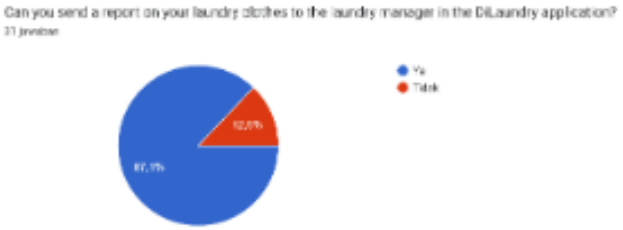
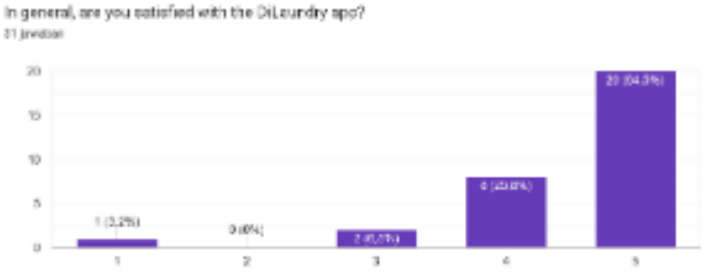


Figure 10. User can send a report their laundry

In figure 10, the conclusion of the questionnaire question is that, from 31 respondents, most of the respondents were able to send their laundry report to the laundry manager. With the results obtained, 27 respondents (87.1%) answered yes, and 4 respondents (12.9%) answered no.

5) In general, are you satisfied with the DiLaundry app?



In figure 11, inform the conclusion that of the 31 respondents, most agreed that they were satisfied with the DiLaundry application. With the acquisition of results, 20 respondents (64.5%) gave a value of 5, 8 respondents (25.8%) gave a value of 4, 2 respondents (6.5%) gave a value of 3, 1 respondent (3.2%) gave a value of 1.

5. CONCLUSION

1) Based on the DiLaundry application that has been developed using the Swift programming language with the main database using core data, the survey results from user evaluations that have been carried out show that most users feel helped by the features presented in the DiLaundry application. Then it can be concluded that the flow of using the DiLaundry application is easy to understand and makes it easier for most respondents to manage their dirty clothes. Not only that, the laundry manager also feels helped by the link report, which is presented by the DiLaundry application to see a summary of the clothes of their laundry service users while at the same time being able to change the date of collection of the laundry.
2) DiLaundry application development is built from database management system theory, which is in line with changeable and flexible management theory. Users will find it easier to categorize clothes, organize their dirty clothes, set reminders for picking up laundry clothes, and be assisted in checking laundry collection to minimize errors/lost clothes in the return process. Of course, these features are presented to help laundry users and managers so that the laundry process can run smoothly.
3) From a comparison of other similar applications related to laundry, there is no application that has functions like the DiLaundry application. This is what makes the DiLaundry application a new invention that can solve the main problems of laundry users.

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Integrating Sustainability in Active Street Frontage: Strategic Planning for Ubud's Tourism Development

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Abstract: Active Street Frontage (ASF) in Ubud, Bali, poses a critical role and challenge due to the tourism destination development. ASF strongly linked with environmental conservation, social-culture, and economic activity. This paper explores strategic planning for integrating sustainability into ASF to support high-quality tourism destination in Ubud. Utilizing a case study approach, the research focuses on examining basic formulation and identifying strategic measures to ensure the quality of Ubud street frontage. This research found the importance of integrating sustainability aspects within ASF to create a socially-dynamic, attractive, vital, and ecological-friendly destination. Very important to maintain the quality of the place (aesthetic form, meaning, and activity) along with environmentally friendly, social stability, and economic vitality in Ubud. The findings indicate that a holistic, community-based approach significantly enhances collaboration in ASF development, ensuring alignment with local cultural values and environmental preservation. The study emphasizes the pivotal role of local eco-friendly materials, such as bamboo and natural stone and the importance of green space that also create uniqueness identity of ASF Ubud. These local materials not only reduce environmental impact but also foster a sense of pride and connection to our cultural heritage. Recommendations are provided for stakeholders to foster sustainable urban planning and incentives for fostering the sustainable ASF.

Keywords: Active Street Frontage, eco-friendly, sustainability, strategic-planning, tourism, Ubud, Bali

1. INTRODUCTION

The Ubud area, Bali, is one of the leading tourist destinations offering a unique combination of local culture and international tourism (Bappeda, 2021; Krista, 2023). As tourism grows, the need to preserve the environment is increasingly urgent. Active Street Frontage (ASF) has essential contribution in creating attractive and environmentally friendly public and shared spaces (J. Jacobs, 1992). Still, the development of an ASF that does not pay attention to sustainability principles can disrupt the environmental, economic and social balance. Therefore, the sustainable oriented planning of ASF is not just important, but urgent in planning the Ubud tourism area. This article aims to identify planning strategies that can integrate sustainability aspects into ASF design in the Ubud area.

Ubud, located in the middle of the island of Bali in Gianyar regency, has long been known as a tourist destination that combines the richness of local culture with natural beauty. Ubud become Bali's first international tourist destination because its well-known beauty of landscape, art, and ritual (MacRae, 1997). According to the Bali Provincial Tourism Office (BPS Provinsi Bali, 2022), Ubud attracts more than 15% of foreign tourists visiting Bali, making it one of the most significant tourist areas on the island. Tourism in Ubud is booming, but this growth also presents new challenges related to environmental impacts, land use, and pressure on local infrastructure. In other side, Ubud's highest attractor for tourist are physical and cultural motivation (Putri & Abdillah, 2019; Sari & Zuraida, 2019). Integrating

sustainability concept on ASF is one way to make more optimal use of existing shared spaces along street that provide a better tourism experience while supporting environmental and cultural sustainability.
ASF refers to a livable quality of street frontage that emphasizes the interaction between public and commercial spaces along the street, thus creating dynamic and sustainable social activities and vibrant place (Fyfe, 2006; Gehl, 2011; Moughtin, 2003; Yoojin & Chong, 2017; Ziad et al., 2019) . However, ASF development that does not pay attention to sustainability can lead to environmental and place identity degradation, lack of sense of place, deterioration of air quality, and triggered congestion, especially in tourism hubs such as Ubud, which are crowded with tourists activities and commercial activities.

Based on data from the Bali Central Statistics Agency (BPS Provinsi Bali, 2022), Ubud has experienced an increase in the number of tourists by up to 7.8% every year. This growth has impacted the need for public facilities that can accommodate tourists while maintaining the balance of the local environment and culture, which is the main attraction of Ubud. This shows the urgency of integrating sustainability principles in public space planning, especially ASF, to support sustainable tourism development. The urgency of this research is based on three main factors: 1) overtourism tendency that lead place quality degradation, 2) environmental degradation, and 3) socio-cultural imbalance effected from imported culture from tourist. Ubud experiences an uncontrollable increase in tourism. Ubud has experienced a surge in tourist visits in the last decade. However, adequate infrastructure has not matched this increase, especially in public space management and transportation systems (Dewi & Nawastara, 2015; Nyoman Trisna Kurniawan, 2022; Widyantara, 2015)

The massive development of tourism support facilities and accommodation in Ubud has led to significant landscape changes, increased carbon footprint, and damage to natural resources and local ecosystems. According to reports (Budhiana, 2024; Suarjana, 2023) around 30% of green land in Bali, including Ubud, is reduced due to massive development. This development tends to be uncontrolled, with unplanned macro impacts on regional areas. Sustainability is related to the environment, economic as well as social and cultural aspects (Strezov et al., 2017). The development of an ASF character as a public space strongly linked with community's place (Hauge, 2007; Muktiwibowo & Laskara, 2018; Qazimi, 2014; Wang & Chen, 2015). ASF that does not pay attention to this aspect can erode local identity and cause social conflicts in the people of Ubud. The loss of identity and character on ASF erodes the sense of community and ownership of collective memory.

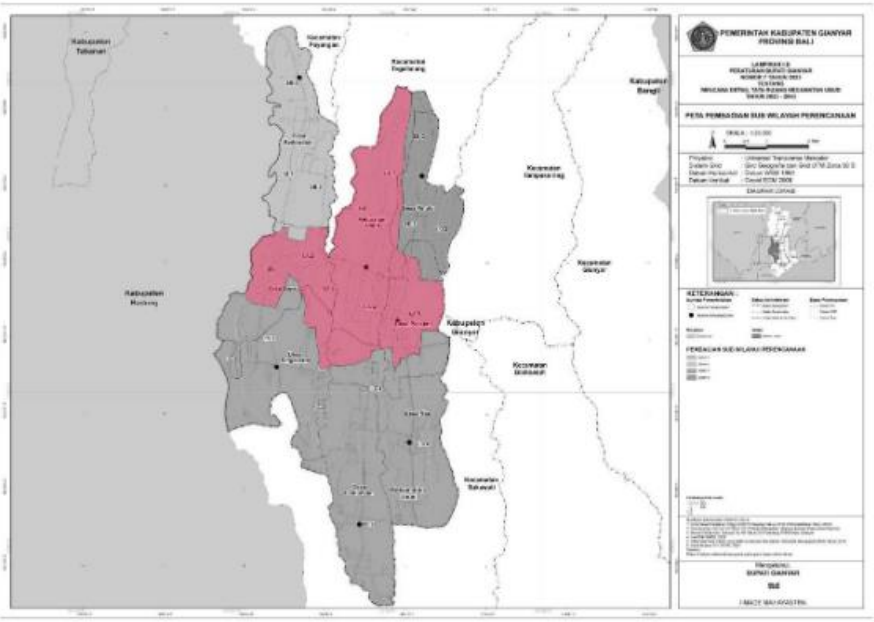


Figure 1. Ubud Tourism Area
Source : RDTR Kecamatan Ubud Tahun 2023-2043 (Gianyar, 2023)

Based on the background and urgency described, this study focuses on formulating the following problems: How can the concept of sustainability be integrated into the planning of ASF in the Ubud tourism area? What are the critical challenges in implementing strategic planning for sustainable ASF in Ubud? How can sustainable ASF development support sustainable tourism in Ubud?

This study aims to:

1) Identify sustainable design elements that can be integrated into the development of ASF in Ubud.
2) Analyze the challenges and opportunities in strategic planning that support sustainability in ASF in Ubud.
3) Provide strategic recommendations for stakeholders in the sustainable development of ASF as part of efforts to support sustainable tourism.

This paper strength provides a basic approach needed to integrating sustainability in ASF design and planning, particularly in the context of Ubud, Bali, which is a significant contribution due to the region's unique cultural and environmental characteristics. The study effectively utilizes a case study approach, which allows for a detailed examination of the interaction between strategic planning and public space design. Furthermore, the paper emphasizes the use of local and eco-friendly materials, which not only supports environmental sustainability but also aligns with the local cultural values of Bali. The research provides actionable recommendations for stakeholders, making it highly practical and relevant for architects, urban planners and policymakers.

While many studies have explored sustainable tourism planning in Bali, there is still a gap in the literature regarding the specific application of sustainability in ASF planning in Ubud. Some research examines ASF as a livable shared space that encourage walkability and sustainability in order developing vibrant place along main roads in urban areas (Ewing et al., 2015; McAllister, 2021; Simpson et al., 2019; Zordan et al., 2019). Still, no study has focused on tourist areas such as Ubud, which have very different cultural and environmental characteristics.

This paper contributes significantly to sustainable urban planning and vibrant street by providing a novel approach to integrating sustainability within ASF in a culturally rich context like Ubud. The study fills a gap in the literature by addressing the specific application of sustainability principles in ASF, particularly in tourism-driven economies. Doing so offers valuable insights that can be applied to other regions facing similar challenges. This research offering an approach that focuses on the local context, primarily cultural and ecological influences, in the integrating sustainability principles on ASF in the Ubud tourism area.

2. LITERATURE REVIEW

Active Street Frontage as an Important Component of Livable and Sustainable Development

Active Street Frontage (ASF) theory was first introduced by (Gehl, 2011) in his book Life Between Buildings. Gehl argues that well-designed public spaces, especially in street areas, can increase social interaction, improve people's quality of life, and encourage economic activity. ASF is a design approach that places buildings with an open orientation towards the street, enabling visual and physical connectivity between indoor and outdoor spaces (Dumbaugh & Gattis, 2005). The main goal is to create vibrant and interactive pedestrian-friendly environment that is visually appealing and supports sustainable commercial activities. A livable and a success place will create sense of place for people that contains visually attracted physical form, vibrant activity, and meaning attachment and its perception (Montgomery, 1998)

ASF also plays a vital role in creating high walkability (Hermawan & Laskara, 2022; McAllister, 2019; Moughtin, 2003), which, according to (Gehl, 2011), can increase social activity by up to 60%. In addition, this design can encourage sustainability by walkability oriented planning that reducing the use of private vehicles, reducing carbon

footprints, and supporting biodiversity and green mobility in tourism areas (Rafiemanzelat et al., 2017; Ujang & Muslim, 2015; Zainol et al., 2011). This concept suitable for cultural tourism area such as Ubud.
ASF is an essential component of success urban design that can integrates sustainable development in various aspects, including economic, environmental, and social dimensions that support city sustainability (Rafiemanzelat et al., 2017). This concept aims to create a dynamic and interactive shared space that improves the quality of life while encouraging sustainable development that has direct impacts on economic, environmental, and social aspects (Heffernan et al., 2014; Kickert, 2019).

From an economic perspective, ASF significantly contributes to the economic vitality of urban areas by fostering a dynamic and attractive environment that encourages pedestrian activity and local business engagement. Transparent storefronts, operable entrances, and outdoor dining areas enhance aesthetic appeal and increase the desire to pay for better street facilities (McAllister, 2021; Yoojin & Chong, 2017)

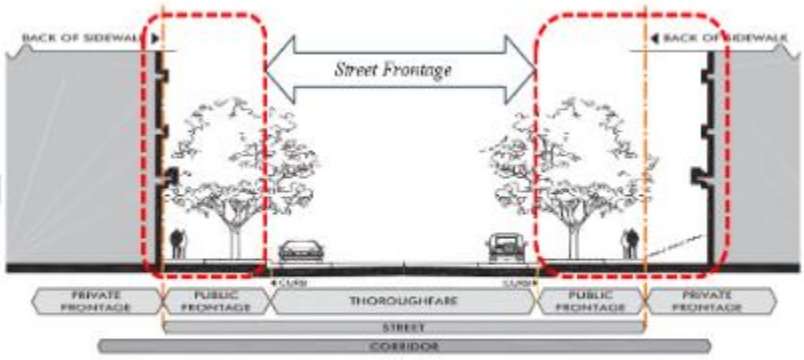


Figure 2. Street frontage elements
Source : Adaptation (Gehl, 2011)

Studies have shown that improving pedestrian routes can significantly increase economic benefits. For example, a 2020 study by the Transport Agency New Zealand found that trees or plants on the road can increase the desire to pay by 20%, while sheltered pedestrian routes can improve it by 28%. Similarly, the Ashburton City Centre streetscape renewal project in New Zealand saw an increase of 40% or more in pedestrian willingness to pay due to better landscaping and broader pedestrian walkways (Corbett-Davies & Abley, 2024).

In the environmental aspect, ASF also plays a vital role in achieving ecological sustainability. By incorporating natural landscape, green infrastructure and promoting pedestrian-friendly spaces, these facades can reduce ecological issues such as noise pollution, rainwater runoff, and the heat island effect (Abdulmawla et al., 2022; Moughtin, 2003). Beautiful and shady pedestrian ways, a unique and aesthetic diversity of vegetation that is vital element for ASF on tropical climate. Various vegetation, colors, and aromatic flowers along the road and pedestrian paths and drainage system creates a vibrant atmosphere. This approach beautifies urban landscapes and provides many environmental benefits, including rainwater management and carbon emission reduction. For example, the design of green roads in Medan involves planting between 20% to 30% of the street space, improving the urban-ecological complex, and reducing urban ecological damage (Fachrudin et al., 2023).

In the social aspect, ASF is very important for social sustainability because it facilitates interaction between pedestrians and places and increases a sense of community and security (Dover & Massengale, 2013; A. B. Jacobs, 1993). The presence of ASF increases natural surveillance, reduces the fear of crime, and enhances safety measures in the surrounding environment. Local community participation in designing their urban communities is essential for social sustainability. ASF encourages community engagement by providing spaces for social interaction, such as cafes and open-air exhibition activities. This integration helps create a neighborhood that meets local needs and allows

residents to adapt and manage their built environment according to their changing needs (Loper et al., 2022; Shekfa & Ahmed, 2022).

According to the (UNWTO, 2005), sustainable tourism is "managing all resources in such a way that economic, social, and aesthetic needs can be met while maintaining biodiversity, essential ecological processes, life support systems, and cultural heritage." This concept underlies the importance of balancing tourism development and preserving the local environment and culture.

Sustainable tourism, especially in cultural tourism destinations, is a multifaceted approach that integrates economic vitality, social stability, and environmental sustainability. The concept aims to preserve local cultural heritage while promoting sustainable development, ensuring that tourism activities benefit local communities and protect the environment (Angelevska-Najdeska & Rakicevik, 2012; N K A Dwijendra et al., 2020). Sustainable tourism in cultural destinations prioritizes the integration of three dimensions: economic growth, social justice, and environmental protection. This holistic approach ensures that tourism activities generate positive economic benefits for local communities while respecting social and cultural norms and minimizing ecological impacts (Hall, 2000; Jing & Loang, 2024; Syafi'i & Suwandono, 2015; Wijaya, 2014).

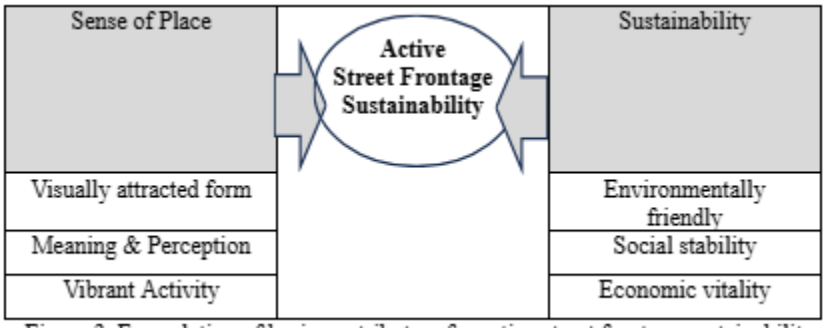


Figure 3. Formulation of basic contributors for active street frontage sustainability

Sustainable principles in the context of ASF planning involves various criteria, such as 1) using environmentally friendly materials, 2) energy efficiency; and 3) contextual green space. Sustainable ASF design must use local and renewable materials that easily found around the site. This material will have a low carbon footprint, and also durable with the site climate (Ngakan Ketut Acwin Dwijendra, 2019). Energy efficiency, buildings, and infrastructure along the ASF must be designed and construct efficiently to minimize energy consumption and carbon footprint. Energy efficiency can be achieved by applying environmentally based design and energy-saving technologies, such as energy-saving lighting or natural ventilation systems (Toh, 2022). Green space in ASF can function as a heat trap, improve air quality, filter noise, and create a more attractive visual experience for tourists and local communities (Anak Agung Ngurah Aritama, Gede Windu Laskara, 2022; Femy et al., 2017). In Ubud, this concept has become very relevant, considering that the area relies on unique cultural and natural attractions. Ubud street frontage applied local green space concept called Telajakan, that creates many local identity and environmental benefit for sustainable ASF (Adhika & Putra, 2020; Kato et al., 2017, 2019). Therefore, implementing designs that are in harmony with the local environment and culture is essential to maintain the sustainability of tourism in this region.

ASF principles are essential in maintaining and enhancing sustainable cultural tourism, those principles creating dynamic public spaces encouraging walkability, visually attracted places, community engagement, collaboration and artistic preservation (Asriana, 2021; Laskara et al., 2023). ASFs with transparent storefronts, frequent openings, windows and attractive signage contribute to a dynamic and interactive environment that enhances visitors' creative experience. This transparency encourages "eyes on the street" encouraging pedestrian activity and social interaction, which is essential for a rich cultural experience (A. B. Jacobs, 1993; Laskara et al., 2020; Law et al., 2020)

ASF also facilitates community engagement by providing space for social interaction. For example, incorporating façade design can give a sense of unity and diversity, encouraging community participation in cultural activities and events. By preserving traditional architectural elements and integrating them into modern design, ASF can help preserve cultural heritage. For example, restoring old gathering places for locals and tourists can preserve cultural facilities and redesign existing functional spaces to form cultural areas, the significance of cultural tourism innovation in enhancing tourist experiences and promoting authenticity (Jing & Loang, 2024).

Figure 4. Ubud Street Frontage
Source : (Sun, 2023)

Studies on the application of Active Street Frontage in sustainable tourism are still limited. Still, some studies show that proper strategic planning can reduce negative environmental impacts while maintaining the attractiveness of tourist areas. In his research, (Jones, 2019) entitled Sustainable Tourism and Active Street Frontage Design: Challenges and Opportunities in Tourist-Driven Economies, highlights the importance of strategic planning focusing on sustainable design. Jones found that integrating renewable energy and using recycled materials can reduce the carbon footprint of tourist areas by up to 25%. In addition, green spaces incorporated into ASF can increase the comfort of tourists while improving air quality in urban areas. The study also emphasizes the need for a more holistic approach to ASF planning, where the involvement of local communities and industry players is critical to successful implementation.

Another study by (Beatley, 2011) in his book Biophilic Cities: Integrating Nature into Urban Design and Planning shows that integrating ecology in urban spatial planning can improve people's welfare. According to Beatley, environmentally friendly ASF design contributes to environmental preservation and the community's quality of life by creating a healthier, beautiful, and functional environment. This approach is particularly relevant for the Ubud region, where residents and tourists highly value the harmony between the natural environment and local culture. Successful implementation of ASF in tourist areas such as Ubud requires a holistic approach. This means that every element, from economic booster to social and ecological integration, must be considered to create an environment that functions well and is in harmony with the local nature and culture. Research by (Newman & Kenworthy, 1999) in Sustainability and Cities: Overcoming Automobile Dependence shows that reducing dependence on motor vehicles

through strategic planning of public spaces can reduce greenhouse gas emissions by up to 30%. In the context of Ubud, implementing pedestrian-first ASF can contribute to reducing pollution and congestion and supporting greener mobility. Overall, this literature review highlights the importance of implementing sustainable design to develop Active Street Frontage in tourist areas. Previous researches by showed that integrating the concept of sustainability into the design of public spaces not only provides ecological but also economic and social benefits. In the context of Ubud, applying these concepts will support sustainable tourism development, maintain the attractiveness of local culture, and ensure environmental sustainability.

3. METHOD

This research uses a case study approach chosen because of its relevance in analyzing specific phenomena in an accurate and in-depth context (Yin, 2018). The case study is considered appropriate for exploring how sustainability can be integrated into the design of Active Street Frontage (ASF) in the Ubud tourism area. Through this approach, the research can explore in detail the interaction between strategic planning and public space design and challenges and opportunities in applying sustainability in the region. Case studies also provide flexibility in combining various data collection methods to obtain a comprehensive understanding, including interviews, observations, and document analysis (Craswell, 2014). The Ubud area was chosen because of the challenges in maintaining a balance between tourism development, environmental preservation, and local culture. This study uses qualitative methods, which involve several data collection techniques to obtain in-depth and contextual information about the sustainable implementation of ASF in Ubud. The following are the data collection methods used:

Semi-structured interviews were chosen because of their flexibility in digging into in-depth information while allowing respondents to explain their views (Kvale & Brinkmann, 2015)

1. Interviews were conducted with registered architects and city planner to understand the technical and aesthetic aspects of the ASF design, and also to obtain information on policies and regulations related to the development of ASF in Ubud. Interviews also to Tourism industry players to understand the needs and expectations from an economic point of view and how they manage their building façade that can increase tourist attraction. The questions focused on the challenges, opportunities, and experiences in designing and implementing sustainable aspect on their property on the street frontage.
2. Field observations were conducted to observe firsthand how ASF appearance in Ubud. Researchers observe building façade and its design, which is how buildings along the street interact with public spaces. Use of green spaces: How natural elements such as trees, parks, or green open spaces are integrated into the design—social and economic activities: Tourists and locals utilize street spaces that function as ASF. Non-participant observation is used, in which the researcher is not involved in the observed activity but notes the phenomenon that occurs (Spradley, 1980).
3. The document's analysis was used to review policies related to ASF's spatial planning and development in Ubud. The records analyzed included local government regulations related to the management of public spaces and sustainable tourism in Ubud, spatial studies, and environmental reports published by local agencies. The study of this document serves to obtain information related to regulations and policies that affect ASF's planning and development in the Ubud tourist area.

After the data was collected, this study used thematic analysis to identify the main patterns in the qualitative data. Thematic analysis is a technique used to organize and interpret data by finding recurring themes or patterns in interviews, observations, and documents (Braun & Clarke, 2006). The stages of analysis include:

1. Data obtained from interviews and observations are encoded using an open coding method, where each relevant piece of data is assigned a specific label or category (Strauss & Corbin, 1998). These codes represent critical themes related to sustainability in ASF design, such as using place theory and sustainable theory that linked to ASF. Also found that environmentally friendly materials, green spaces, and energy efficiency are critical aspect.

2. Identify themes after coding, the next step is to group the codes into broader themes. These themes reflect critical issues faced in implementing sustainable ASF in Ubud, such as regulatory challenges, local community engagement, and design innovation.
3. Interpretation is carried out by connecting the themes found with the theoretical framework and concept of sustainability discussed in the literature review. Triangulation is carried out by comparing the results of interviews, observations, and documents to ensure the validity of the data (Denzin & Lincoln, 2011).

To ensure the validity and reliability of the research, several steps are taken:

1. Triangulation method: This study combines interviews, observations, and document analysis to ensure that the data comes from various sources, providing a richer and more in-depth perspective (Patton, 2002).
2. Member checking: After the interview, the results and interpretation will be reconfirmed with the respondent to ensure that the researcher's interpretation is based on the respondent's original views (Craswell, 2014).

Although the case study approach provides in-depth insights, this study's results are limited to the context of the Ubud tourism area. They may not be broadly generalized to other regions in Bali or Indonesia. In addition, obstacles to collecting field data, such as weather and access to certain areas, need to be anticipated.

4. RESULT AND DISCUSSION

Based on the comprehensive analysis of the data collected from observations and interviews, strategic planning were obtained that integrate sustainability in the ASF in tourism area of Ubud through the matrix description below. The strategic planning emphasizing eco-friendly local material, green space, energy efficiency that creates physical ambience for sustainability on ASF in Ubud.

Table 1. The matrix of strategic planning on integrating sustainability principles in Ubud's ASF

	Visually attracted form	Meaning & Perception	Vibrant Activity
Environmentally friendly	Using unique and eco-friendly local materials that represent Ubud and its nature landscapes	Emphasizing Ubud's green space *telajakan*, the diversity of natural landscape as a tourist experience at ASF	Eco-vibrant that implement smart system technology to promote energy efficiency, and green infrastructure
Social stability	Local culture and its architecture identity as basic guidelines for the design of building façade and frontage	Maintaining local culture, social and traditional spaces as a top priority above tourism activities.	Cultural activities that carried out at ASF area engage tourist's contributions and community collaboration
Economic vitality	Innovative and creative design with flexibility, durability and easy maintenance as main aspect	Socio-cultural activities that attract tourism must provide benefits and profit to the local community	The diversity of commercials and attractive retails activities that supporting walkability, that prioritized local enterprise

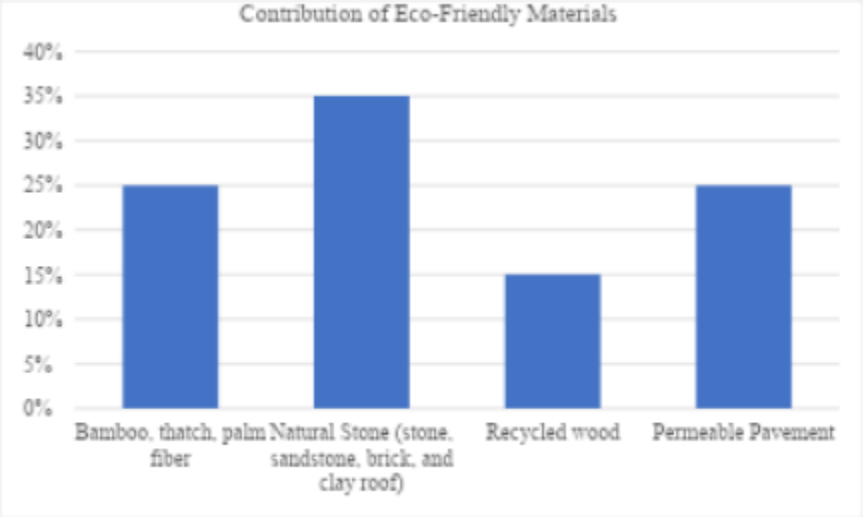
Further studies, based on interviews with 25 (twenty-five) architects and planners in Ubud, it was found that one of the essential components in creating sustainable and also unique ASF in Ubud is the use of locally-produced and environmentally friendly materials, such as bamboo, thatch, palm fibers (ijuk), various natural stone, and also recycled materials. Their decision also considered Bali's building design regulation for building appearances materials and style, and also imagining the presence of space experiences (shades of Ubud) in the design of tourist accommodation ASF through the architect's knowledge of the nuances of Ubud (Primadewi et al., 2021). This situation supports environmental sustainability and aligns with Bali's local cultural values, which consider nature part of spirituality and daily life in Ubud.

The following are the observation data related to the materials used in the application of ASF in Ubud:

Table 2. Local and Environmentally Friendly Materials in ASF in Ubud

Material	Usage (%)	Environmental Benefits
Bamboo, Thatch, Palm Fibers *(Ijuk)*	25%	Local vegetation, fast-growing, and renewable materials
Natural Stone - Stone, Sandstone, Brick, Clay Tile and Roof	35%	Local production and reduces carbon emissions because no need for long delivery
Recycled wood	15%	Reducing waste, bring a specific ambient, and sustainable resource utilization
Permeable pavement	25%	Improves water absorption and reduces rainwater runoff

In addition, creating traditional green spaces (telajakan) along the ASF is essential in improving air quality, reducing overheating, and providing a refreshing atmosphere for tourists and residents. It's found about 30% of the building façade on the main road frontage area has been equipped with green space. And it's about 40% of the building façade on the secondary road frontage has been equipped with green space. This green space such as of telajakan, small gardens, shade trees, and hanging or removeable vegetation, these all which also serve as microclimate controllers. Here is a graphic showing the contribution of materials and green elements in ASF design in Ubud:



Graph 1. Contribution of Eco-Friendly Materials on ASF in Ubud

In addition to planning with environmentally friendly materials, the use of technology has also been carried out. Energy-saving technologies such as energy-saving LEDs and solar panel technology are used for garden lighting in the terrace area. The ASF area has adopted rainwater management through permeable paving and bioswale/biopharma. This model reduces energy consumption, improves water efficiency, and repels potential local flooding. Water management is heritage aspect of Bali, while traditional irrigation system and drainage called subak inspires water management, such as gutter system below the pedestrian way on ASF (Geria et al., 2023).

Table 3. Efficiency of the Use of Environmentally Friendly Technology in ASF in Ubud

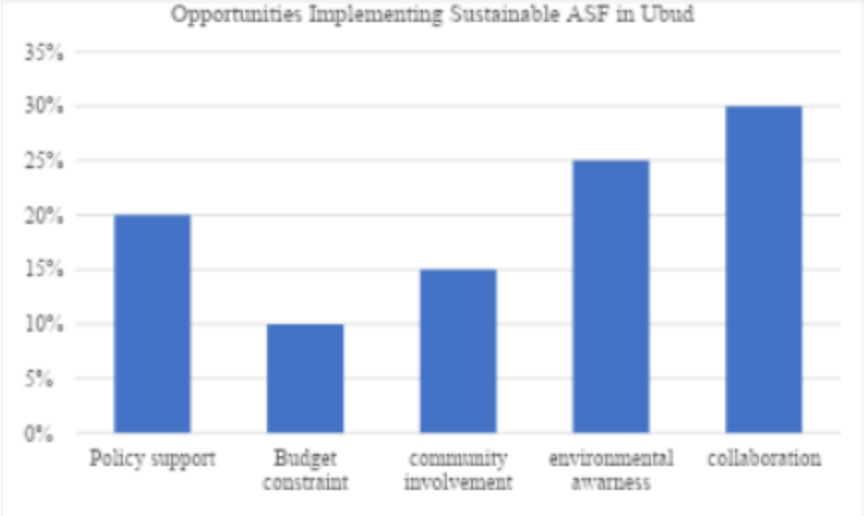
Technology	Environmental Benefits	Implementation
Electricity Energy-Saving	Reduce energy consumption	LED Lighting, Solar panel lighting on the signage media and green space
Rainwater Management System	Improves water absorption and reduces runoff	Absorbability pavement surface and biophory box
Protect Natural Contour & Vegetation	Reduces landscape changes and carbon emission	Keep natural contour and existing trees

The results of interviews with tourism industry stakeholders and local peoples in Ubud show that the active participation of local communities in the ASF planning process has proven to be very effective. Most respondents emphasized that involving indigenous peoples in design decisions ensures that ASF projects align with local cultural values and do not disrupt social balance.

Challenges and Opportunities of Sustainable ASF Planning in Ubud Tourism

According to the results of interviews with tourists, using local and natural materials in designing ASF in Ubud, Bali, significantly improves the design character and sense of identity for international tourism. These materials reflect Bali's identity and cultural heritage and contribute to environmental sustainability. Balinese architecture is famous for using natural materials such as bamboo, wood, and stone. These materials are not only pleasing to the eye but also sustainable. For example, bamboo buildings in Bali have been around for centuries and are now innovatively integrated into modern design to preserve cultural traditions while adapting to contemporary needs.

Incorporating local materials such as bamboo and wood in ASF in Ubud gives tourists in Bali, especially Ubud, a sense of identity and a sense of place. In addition, the use of local materials reduces dependence on non-renewable resources and minimizes environmental impact. This approach is in line with the principles of sustainable development, which emphasize the importance of preserving the natural environment and cultural heritage. Although the potential for implementing sustainable design in ASF is significant, several challenges exist. One of the main challenges is the lack of incentives support from public policy from relevant stakeholders. Some tourism industry stakeholder stated that policies related to incentives or a reward for environmentally friendly projects are still limited. Meanwhile, the cost of adopting green technologies such as energy-efficient lighting and technological rainwater management systems is still relatively high.



Graph 2. Opportunities in the Implementation of Sustainable ASF in Ubud

Graph 2 shows the challenges and opportunities in implementing sustainable Active Street Frontage (ASF) in the environmental aspects of Ubud. This graph showcases factors such as policy support, budget constraints, community engagement, environmental awareness, and collaboration and their contribution to the successful implementation of sustainable ASF in the region. The graph above shows that collaboration between the government, local peoples, and the tourism industry is the most incredible opportunity to overcome the existing challenges. In addition, increasing environmental awareness among global tourists is also a driver for the development of a more environmentally friendly ASF. The following features a sustainable Active Street Frontage (ASF) design in Ubud, using natural eco-friendly material that create sustainability also uniqueness to ASF Ubud. This image shows the integration of eco-friendly materials in architecture with green spaces to create an environment that supports sustainability.

Figure 5. ASF Ubud that applied eco-friendly material and green spaces creates ASF uniqueness and sustainability

Figure 5 shows how using materials such as bamboo and natural stone has succeeded in creating a visually accessed space that is not only aesthetically pleasing but also environmentally friendly while providing an atmosphere that is in line with the character of Balinese culture. Integrating local and natural materials and green technology in designing

ASF in Ubud, Bali, significantly increases the sense of place for tourists. Although there are challenges related to cultural sensitivity to the application of new technologies and environmental impacts on the excessive exploration of natural materials, these challenges can be overcome through collaborative actions and innovative solutions based on local principles and contexts. By respecting local customs while adapting to modern needs, urban architects and designers can create a sustainable environment in the ASF area that attracts tourists while preserving Bali's cultural heritage.

While the study presents a strong case for sustainable ASF strategic planning in Ubud, some limitations must be acknowledged. Firstly, the research primarily relies on qualitative methods, which may not capture the full scope of the quantitative impacts of ASF design. Secondly, the case study approach, while in-depth, limits the generalizability of the findings to other regions outside Ubud or similar cultural contexts. Moreover, there is a need for a more detailed analysis of the cost implications of the proposed sustainable practices, which could affect their feasibility and adoption.

5. CONCLUSION

ASF is a multifaceted concept that integrates sustainable development in all economic, environmental, and social dimensions. Various aspects of ASF design in Ubud support these principles by encouraging pedestrian activities, improving environmental quality, and encouraging community participation. These highlight the importance of integrating sustainability aspects within ASF to create a dynamic, attractive, vital, and sustainable destination. The strategic planning sustainability ASF matrix (Table 1) showed that its is very important to maintain the place quality (aesthetic form, meaning, and activity) in line with three main aspect of sustainability (environmental friendly, social stability, and economic vitality) on Ubud tourism area.

ASF makes a significant contribution to the overall sustainability of tourism destination areas. The use of local materials and eco-friendly technology is the key to the success of sustainable design in Ubud. Implementing these aspects requires collaborative support to achieve sustainable ASF success in the Ubud tourist area. This research successfully answered the formulation of problems related to the integration of sustainability in the design of Active Street Frontage (ASF) in Ubud, Bali. Based on the results and discussion, the conclusions that can be drawn are as follows:

1. Use of eco-friendly materials: Local materials such as bamboo, thatch, palm fibers, and various natural stones have proven effective in creating sustainable ASF designs. This material not only supports environmental sustainability but is also in harmony with the local cultural character of Bali, answering the formulation of problems related to sustainability in the context of Ubud tourism. Using recycled materials and permeable technology in ASF reduces carbon footprint and improves energy efficiency.
2. Creation of green spaces and traditional garden: The study results show that the green spaces integrated in ASF, such as gardens and shade trees, contribute significantly to Ubud's environmental quality. This helps reduce overheating, improve air quality, and create more comfortable public spaces for tourists and local communities. This garden strengthens the concept of Balinese traditional gardens in the street frontage area known as the telajakan. In addition, the types of trees in Ubud give a characteristic tourist destination in a tropical climate. This gives a specific impression of the atmosphere of Ubud for tourists who come from non-tropical climate countries.
3. The role of local community participation: The active participation of traditional leaders (puri), indigenous communities, and local communities in ASF planning is crucial for successfully implementing sustainable development. The role of indigenous leaders and communities ensures that the concept of ASF in Ubud can be passed on to the next generation using traditional instruments and customary rules. This participation helps to preserve Balinese cultural values and ensures that tourism development does not disrupt the social and artistic balance. It also provides solutions to the challenges faced in the ASF strategic planning process.
4. Application of green and energy-saving technology: Using environmentally friendly technologies such as energy-saving LED lighting systems and rainwater management through permeable paving has been proven

to improve energy efficiency and environmental management in public spaces, especially in the road surface area in Ubud. This shows that sustainable technological innovation can be effectively integrated into ASF design.

5. Challenges and opportunities: The main challenges in implementing sustainable design in ASF in Ubud are strong policy support and high budgets to adopt green technologies. However, significant opportunities are seen in collaboration between the government, indigenous leaders/communities, and tourism industry players, which can encourage the creation of sustainable ASF design. This answers questions related to the obstacles faced in implementing sustainable ASF.

Based on the conclusions of the study, several suggestions can be given to stakeholders to support the sustainable development of ASF in Ubud, namely:

1. Policies that support sustainable principles and have Ubud's natural and cultural identity. Local governments need to strengthen policies supporting sustainable design implementation in developing ASF design guidelines in Ubud. This guideline must emphasize the importance of Ubud's sense of place such as material, landscape, innovative and creative design that suitable socio-cultural aspects. This includes incentivizing developers to use environmentally friendly materials and energy-efficient technologies. Regulatory enforcement is essential to ensure that the control of the development and preservation of the local environment and culture is maintained and represented in the ASF in Ubud.
2. Increased awareness and collaboration: Tourism industry stakeholders, urban planners, and local communities must be more aware of implementing sustainable design in ASF. Collaboration between these parties is essential to ensure the successful implementation of environmentally friendly ASF aligned with social, cultural, and economic needs. The government must also play an active role in facilitating this collaboration through discussion forums and training programs.
3. Priority use of green and natural technology: Green and environmentally friendly technology should be a priority in any ASF development project. Green technology refers to the technology and management system of natural resource developed from locally-handed technology, to enhance tourist experience as Ubud known as cultural tourism destination. Prioritizing the role of nature and local community contribution in providing comfort for tourism. Governments and developers should invest in smart system and green technologies like green building concept, biophilic concept, smart lighting, green mobility, and efficient water management systems like subak system in innovative way. This technology has been proven to reduce environmental impact, small amount of waste and carbon emissions toward smart cities and tourism (Casini, 2017), and most importantly improve the quality of public experience in Ubud.

Furthermore, a study on community participation in ASF planning in Ubud is needed. Research on how local community participation can be more deeply integrated with the ASF planning process in Ubud and other tourism areas, primarily related to increased Indigenous people's involvement in public space design and management decisions, is needed. Future research could benefit from incorporating quantitative methods to complement the qualitative findings, providing a more holistic understanding of the impacts of sustainable ASF planning. Additionally, expanding the study to include comparative analysis with other regions would enhance the generalizability of the results. Exploring the economic feasibility of sustainable practices in ASF design in more depth would also be beneficial, as it would address one of the critical challenges identified in this study. Lastly, further engagement with policymakers could help translate the study's recommendations into actionable policies.

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Improving the Quality of Book Printing Products through Six Sigma Approach that integrated with Experimental Design

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Abstract: This research applies the Six Sigma (DMAIC) approach which is integrated with experimental design at the process improvement stage. The research was conducted at a book printing company. Three dominant defects were found in the book printing process, namely uneven cutting results (44.29%), uneven colors (32.8%) and torn books (23.82%). The sigma value measured at initial conditions is 2.172. The research was carried out by following the Six Sigma DMAIC stages, and in stage I (improvement) experiments were carried out by changing the cutting speed process parameters. The experimental design uses a completely randomized design with the engine speeds to be tested in the experiment being 50 RPM, 60 RPM and 70 RPM. The number of replications in the experiment was 10 times at each level. The number of levels is 3, so the total number of trials is 30 experiments. The treatment stage selected based on the Student Newmann Keuls Test was a level 2 experiment with an independent variable of 60 RPM. The sigma value obtained in the post improvement condition was 2.58 σ, an increase in sigma of 0.408 compared to the initial condition. The percentage of post-improvement production defects is 4.62%.

Keywords: six sigma, experimental design, cutting speed, completely randomized design.

1. INTRODUCTION

Six Sigma method has been proven to be able to identify and eliminate defects, errors or failures in business processes or systems by focusing on process performance characteristics that are very important to customers (Snee, 2004). Six sigma method has been successfully applied in many large companies, but its application in smaller organizations is still less well documented (Jiju et.all, 2005). Various studies examining the application of six sigma in small and medium companies include Scheller et al, (2017), Kandil and Aziz (2017), and Swarnakar, Tiwari and Singh, (2020). Kandil and Aziz's (2017) research focuses on problems related to supply chains in small and medium enterprises in Egypt. The six sigma method is used to explore areas that need improvement and assess the impact of technology in improving company performance. Scheller et.al (2017) shows that Lean and Six Sigma are implemented separately in two different programs. Several aspects required to improve the integration of both approaches have been identified while considering each phase of DMAIC and the actual approach implemented by the company. Although some positive results have been achieved, there are many critical factors and failures that can affect the implementation of both approaches, such as employee training and changes in the organizational environment. Swarnakar, Tiwari and Singh (2020) conducted research with the aim of identifying, evaluating and developing a structured model that measures the interrelationship between critical failure factors (CFF) that influence the sustainable implementation of Lean Six sigma in manufacturing organizations. Six sigma research that uses experimental design at the Improve stage is still very limited. The research conducted examined the company's performance in reducing defective products through a series of DMAIC stages, and specifically carried out process improvements in stage I (improvement) by designing experiments. The research was conducted at PT X, a company engaged in the school textbook printing industry in the city of Bandung. Problems faced by book printing companies include overproduction caused by the unavailability of accurate information about the percentage of defective products in the post-print process. To anticipate the occurrence of defective products, PT X uses a policy of providing production tolerances higher than the demand in the employment contract with consumers. For example, in a particular contract the amount of consumer demand is 3 149 100 copies of books, but produced 3 486 680 copies of books. The disability rate is 7%, or about 244 067 copies of books. Although consumer demand can be met according to the contract, but defective products that are not sold are very high. The sigma value calculated by the six sigma method is still 2.17.

2. METHOD

The research was conducted in the school textbook printing industry using the Six Sigma approach, Pyzdek & Keller (2010), which includes the stages of define, measure, analyze, improve, and control. At the define stage , observation of the production process, analysis of production data and identification of types of defects that may occur in book printing products are carried out. The measure stage measures the number of defective products and the achievement of sigma values in conditions when research is carried out. The analyze phase identifies the root cause of the problem using pareto diagram tools, fishbone diagrams and failure mode effect analysis. At the improve stage, process improvement is carried out by conducting experiments through determining parameter settings on the cutting machine. The study used two types of data, namely primary data and secondary data. Primary data were obtained from interviews and observations of the Company's stakeholders, which include president directors, production directors, production supervisors and production operators. Observation is carried out by active observation where this research is carried out based on field conditions and researchers participate in the production process. The experimental design used to improve the cutting process is an experimental design with the Complete Randomized Design (RAL) method. Experiments were conducted to obtain an optimal parameter set up in reducing product defects in the 3-sided cutting section (treemar) in the TSK Binding Inline Machine.

3. RESULT AND DISCUSSION

3.1 Define

Define is the initial stage carried out in the DMAIC approach. At this stage, define and select the problems to be solved. Figure 1 is the process flow that occurs at PT. X, starting from the supplier to the hands of consumers using the SIPOC diagram (*supplier, input, process, output, customer*).

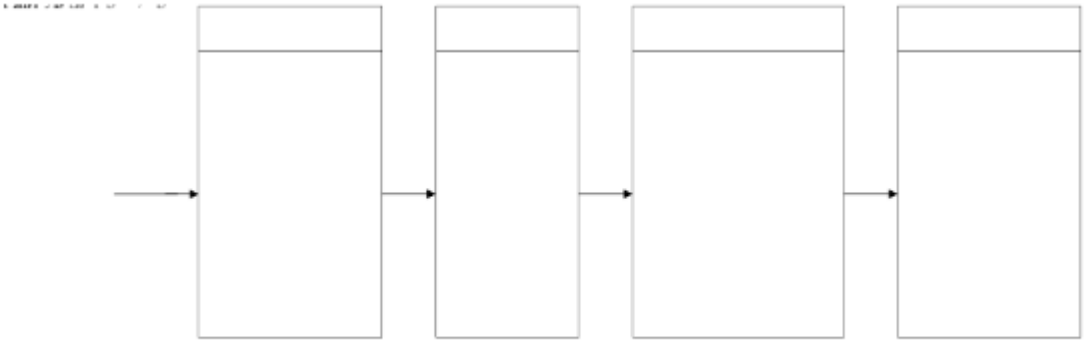

Figure 1. Diagram Supplier–Input– Process–Output-Control

PT. X has approximately 83 suppliers, ranging from suppliers of paper rolls, paper sheets, ink and others. At this stage explain the symptoms of problems observed at PT. X by using a cause effect diagram. The cause effect diagram can be seen in figure 2.

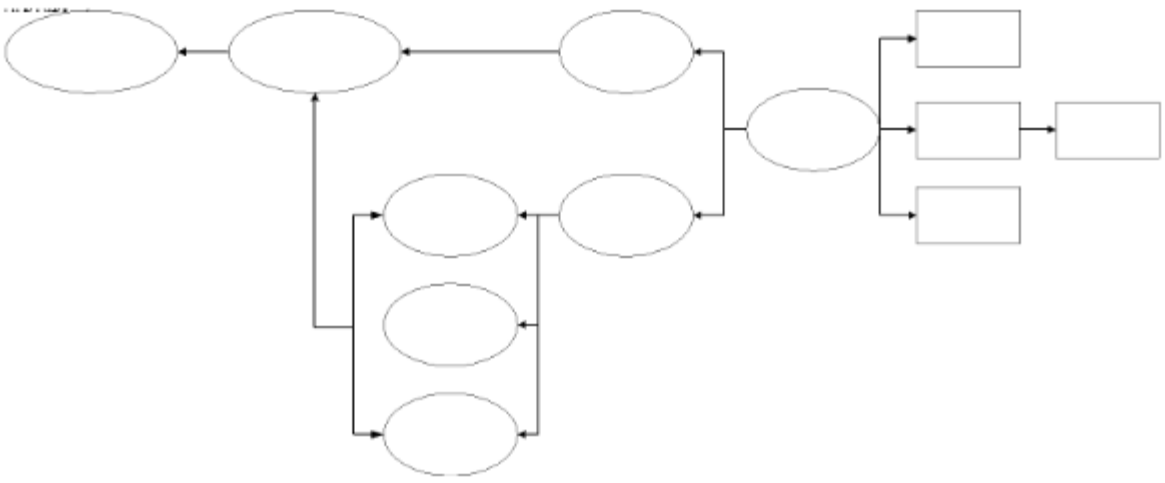

Figure 2. *Cause effect diagram*

3.2 Measure

Measure is the stage of measurement of problems that have been defined to be solved. At this stage, various data are measured, measuring process characteristics and capabilities. The data are presented in Table 1 to Table 5.

Table 1. Type and Quantity of Production

No.	Level	Class Level	Book Title	Oplagh Quantity (Units)
1	SD	1	Tema 1 - 8	423000
2	SD	2	Tema 1 – 8	420000
3	SD	3	Tema 1 – 8	642100
4	SD	4	Tema 1 – 8	548000
5	SD	5	Tema 1 – 8	471000
6	SD	6	Tema 1 – 8	645000
Total				3149100

PT. X initially experienced the phenomenon of overproduction, one of which was caused by the post-print process. The following are the production results for thematic books at the elementary school (SD) level for a certain year period.

Table 2. Thematic Book Production Results

No.	Level	Class Level	Book Title	Oplagh
				Quantity (Units)
1	SD	1	Tema 1-8	484912
2	SD	2	Tema 1-8	474872
3	SD	3	Tema 1-8	697596
4	SD	4	Tema 1-8	596387
5	SD	5	Tema 1-8	531266
6	SD	6	Tema 1-8	701649
Total				3486680

Table 3. Production-demand deviation

Level	Class Level	Book Title	Oplagh
			Quantity (Production Yield - Demand)
SD	1	Tema 1-8	61912
SD	2	Tema 1-8	54872
SD	3	Tema 1-8	55496
SD	4	Tema 1-8	48387
SD	5	Tema 1-8	60266
SD	6	Tema 1-8	55647
Total			337580

The difference in products is inventory produced by the company which will be stored in the warehouse and then sold at retail. The company suffered losses caused by the inventory. Estimated losses due to overproduction can be seen in table 4.

Table 4. Estimated Company Loss

Level	Class Level	Book Title	Difference (Eksemplar)	HET/Product	Total (Rupiah)
				ZONA 1	
SD	1	TEMA1- TEMA 8	61912	Rp 12,400.00	Rp 767,708,800.00
SD	2	TEMA1- TEMA 8	54872	Rp12,400.00	Rp 680,412,800.00
SD	3	TEMA1- TEMA 8	55496	Rp12,400.00	Rp 688,150,500.00
SD	4	TEMA1- TEMA 8	48387	Rp 12,400.00	Rp 599,998,800.00
SD	5	TEMA1- TEMA 8	60266	Rp 12,400.00	Rp 747,298,400.00
SD	6	TEMA1- TEMA 8	55647	Rp 12,400.00	Rp 692,502,800.00
Total					Rp 4,176,072,000.00

Besides inventory, there is a major problem experienced by the Inline *TSK Binding Machine* , namely production defects. Table 5 describes the number of defective products of thematic book production for the Primary School (SD) level in Theme 1 – Theme 8 in the TSK *Inline Binding Machine*.

Table 5. Number of defective products

No.	SD	Class Level	Book Title	Defective Products
				Total Amount
1	SD	1	TEMA 1 - TEMA 8	49,261
2	SD	2	TEMA 1 - TEMA 8	52,129
3	SD	3	TEMA 1 - TEMA 8	47,862
4	SD	4	TEMA 1 - TEMA 8	48,271
5	SD	5	TEMA 1 - TEMA 8	43,411
6	SD	6	TEMA 1 - TEMA 8	50,377
Total				291,311

Defective products are products produced in the production process with specifications that are not in accordance with the quality standards set by the company. The Company experiences losses caused by product defects so that if calculated losses based on defective products can be seen in table 6.

Tabel 6. Estimasi Kerugian Karena Produk Cacat

No.	Tingkat	Jenjang Kelas	Judul Buku	Produksi Cacat	HET/Produk	Total (Rupiah)
					ZONA 1	
1	SD	1	TEMA1- TEMA 8	49261	Rp 12,400.00	Rp 610,836,400.00
2	SD	2	TEMA1- TEMA 8	52129	Rp 12,400.00	Rp 646,399,600.00
3	SD	3	TEMA1- TEMA 8	47862	Rp 12,400.00	Rp 593,488,800.00
4	SD	4	TEMA1- TEMA 8	48271	Rp 12,400.00	Rp 598,560,400.00
5	SD	5	TEMA1- TEMA 8	43411	Rp 12,400.00	Rp 538,296,400.00
6	SD	6	TEMA1- TEMA 8	50377	Rp 12,400.00	Rp 624,674,800.00
Total						Rp 3,612,256,400.00

3.3 Analyze

The analysis stage is the stage to find a solution that can solve the problem based on the root cause that has been identified. The different types of manufacturing defects in PT X are described in Figure 3.

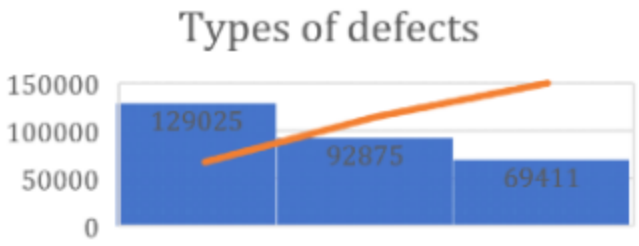

Figure 3. Different Types of Production Defects

Each type of defect is caused by various factors, which include human factors, *inline tsk binding machine* factors, 3-sided cutting method factors and environmental factors. The data stating the cause of the occurrence of manufacturing defects when sorted from the largest percentage of product defects is shown in Figure 3.

The deduction does not correspond to the percentage of disability of 44.291%

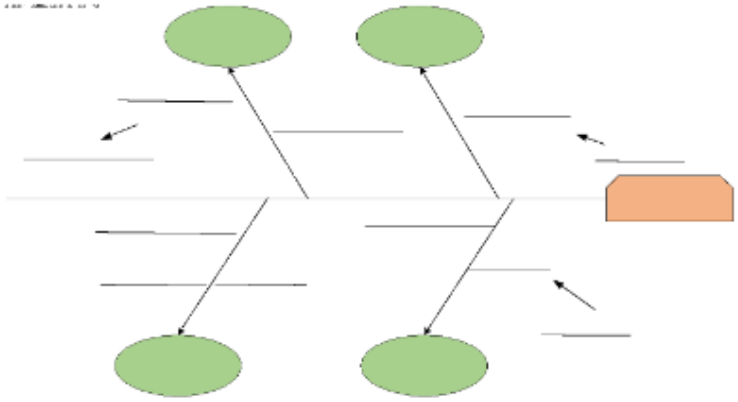

Figure 4. Product defects due to inappropriate cutting size

Inappropriate colors or uneven colors with a defect percentage of 31.884%

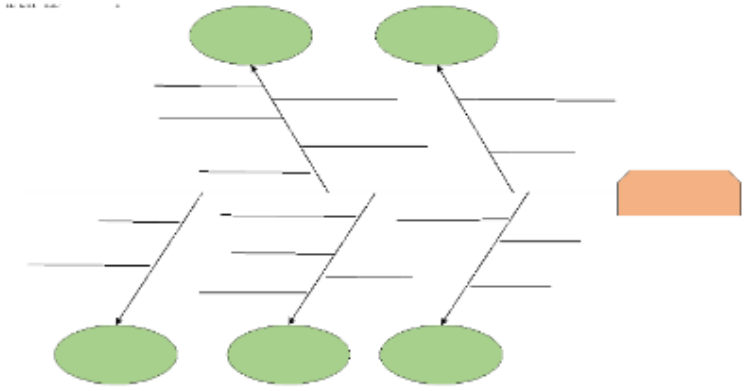

Figure 5. Product defects due to uneven color

Tearing with a manufacturing defect percentage of 23.827%

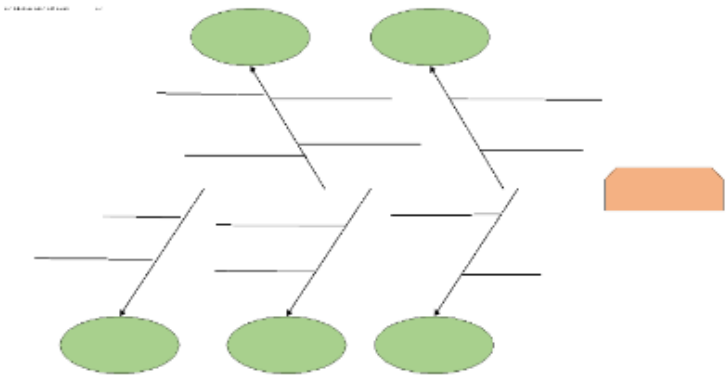

Figure 6. Product defects due to tearing

The measurement results show that the most dominant product defects are caused by *the Inline TSK Binding* Machine on the *treemar* (3-sided cutting). The dominant defect is thought to be caused by the engine speed (RPM) used is not optimal. The alleged cause of the dominant factor of disability is supported by the FMEA (*Failure Mode Effect Analysis*) diagram which shows this.

3.4 Improve

The *improvement* stage was carried out by designing experiments using the Complete Random Design (RAL) method on the *TSK Inline Binding* Machine of *the treemar* section (3-sided cutting). Factors to consider are engine speed (RPM) and the stack of books to be cut to minimize defective products. Settings to determine cutting parameters are obtained through primary data, both from the manual *book*, operator experience and policies from PT. X. In the *existing* state, the company uses three measures of engine speed (RPM), namely 55 RPM, 60 RPM, and 65 RPM. The stack of books will be cut in a *setting of* 4 – 7 books, depending on the thickness of the book. The small or large number of stacks of books is done based on the stack capacity required by the *inline binding TSK* Machine, which is 70 mm – 75 mm high. In this study, experiments were carried out by *setting a stack of* 5 books. Observations inform that the high speed of the machine will cause disruption to the *gathering* process for book filling, so that the book filling will be folded and when cut on 3 sides will experience product defects. The engine speed (RPM) is too slow will result in disruption of the queue when the cutting process is carried out on 3 sides of the *treemar*. The phenomenon that occurs in a low RPM state is the friction between 1 book and another book which causes the stack of books to become misaligned (experience a shift in books), so that the 3-sided cutting process becomes asymmetrical. Therefore, it is necessary to choose the right speed to minimize product defects. The engine speeds to be tested in the experiment are 50 RPM, 60 RPM and 70 RPM. The number of replications in an experiment is 10 experiments at each level. The number of levels is 3, so the total number of trials is 30 trials. The experimental results are shown in Table 7.

Table 7. Experimental data

Operating Parameters	Speed		
	Level 1	Level 2	Level 3
	50 RPM	60 RPM	70 RPM
Production Defects (in book copies)	1177	933	1284
	1199	1047	1259
	1303	1004	1357
	1259	1068	1308
	1314	1045	1368
	1259	938	1307
	1154	937	1526
	1307	936	1088
	1264	981	1303
	1283	1173	1324
Sum	12519	10062	13124
Many Observations	10	10	10
Average	1251.09.00	1006.02.00	1312.04.00

3.5 Control

The purpose of the control stage is to standardize, control and maintain the improved process. The control stage is carried out by compiling standard operating procedures / SOPs with a machine speed of 60 RPM.

4. CONCLUSION

1. Based on research conducted on the post-print process at PT. X, The independent variable in the form of engine speed (RPM) used at the time of the experiment consisted of 3 levels, namely 50 RPM, 60 RPM and 70 RPM with a stack of 5 copies of books.
2. The treatment stage selected based on the Newmann Keuls Student Test is a level 2 experiment with a free variable of 60 RPM.
3. The sigma value obtained in post-improvisation conditions is 2.58 σ, there is an increase in sigma of 0.408 compared to the initial state.
4. The percentage of post-improvement production defects is 4.62%.

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Increasing Electric Vehicle Acceptance, an Insights into Reducing Range Anxiety

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Abstract: Given the increasing worldwide focus on sustainability, electric vehicles (EVs) have become important in the efforts to decrease carbon emissions and address climate change. Nevertheless, the broad acceptance of electric vehicles (EVs), especially in Indonesia, encounters substantial barriers, with range anxiety being one of the main issues. This article explores the complex nature of range anxiety, specifically examining its technological aspects and the important function of customer support in reducing the effects. This study uses Structural Equation Modeling (SEM) with a Partial Least Squares (PLS) approach to analyze the relationships among Charging Infrastructure, Customer Support, Perceived Technological Sophistication, and Range Anxiety. The data collected from 146 individuals aware regarding EV technology is analyzed. The findings suggest that customer service and perceived technological sophistication have a substantial effect on lowering range anxiety. However, the presence of charging infrastructure does not have a statistically significant influence on alleviating range anxiety. This discrepancy indicates a requirement for focused approaches that tackle both physical and psychological obstacles to electric vehicle (EV) adoption.

Keywords: Electric Vehicles (EVs), Charging Infrastructure, Perceived Technological Sophistication, Range Anxiety, Customer Support.

1. INTRODUCTION

Electric vehicle (EVs) are leading the way in reducing carbon emissions and tackling climate change, offering a possible replacement to traditional gasoline-powered vehicles [1]. EVs provide numerous environmental and operational advantages, such as reduced operating expenses and no emissions from the exhaust pipe. Still, their acceptance, especially in Indonesia, has been limited by range anxiety, a major concern about the driving distance EVs can cover and the availability of charging stations. This research investigates the complex nature of range anxiety, analyzing not only the technology side but also the customer support. This study suggests a comprehensive method to reducing range anxiety, which is crucial to accelerating the adoption of electric vehicles (EVs), by incorporating these factors. The Indonesia Electric Vehicle Outlook 2023 reveals a notable surge of 60% in worldwide electric vehicle sales, reaching an all-time high 10.6 million units in 2022. This surge is a result of Indonesia's initiatives to reduce carbon emissions in its transportation sector and fulfill its commitments under the Paris Agreement's Nationally Determined Contributions (NDC) targets. The nation's ambitious strategy involves raising the number of electric motorcycles and cars by 2025 and 2030, respectively. The increase in the adoption of electric vehicles (EVs) has been additionally stimulated by a cut in value-added tax (VAT) from 11% to 1% for electric cars that have a minimum of 40% locally sourced components. This has resulted in a substantial rise in sales for models such as Hyundai's IONIQ 5 and Wuling's Air EV, thanks to tax incentives offered by the government [2], [3]. While there has been a significant increase in the sales of electric vehicles (EVs), as indicated by the Indonesia Electric Vehicle Outlook 2023, the rate at which EVs are being adopted has not yet reached its full potential, primarily because of concerns about the limited driving range of these vehicles, often known as range anxiety. Range anxiety, which refers to the concern that an electric vehicle (EV) may not have enough charge to reach its destination, continues to be an important challenge. This fear eclipses the advantages of reduced carbon emissions and is in line with worldwide environmental goals. This concern restricts the wider acceptance of consumers and decelerates the shift towards a transportation system that is more sustainable and free from fossil fuels, despite the implementation of substantial tax incentives and government regulations intended to accelerate the adoption of electric vehicles.

Range anxiety has a substantial impact on users of battery electric vehicles (BEVs), acting as a psychological barrier to their general acceptance. This anxiety stems from anxieties about the battery running out of power before reaching a destination or a place to charge, and also includes worries about the amount of time it takes to charge. These concerns impact users' charging habits and travel plans, taking consideration the availability and duration of charging at infrastructure points. The combination of worries connected to distance and time not only affects the decisions made about everyday vehicle usage, but also discourages potential purchasers who compare the convenience of traditional vehicles with the limitations of electric mobility [4]. A number of important factors affect consumer willingness to buy battery electric vehicles. One of the many issues that arises is range anxiety, which is caused by the battery's limited driving range. [5]. The adoption of electric vehicle (EV) technology leads to a substantial decrease in emissions and reduces dependency on fossil fuels, representing a pivotal advancement towards achieving environmental sustainability and ensuring energy security. Nevertheless, the restricted distance that electric cars (EVs) can go in comparison to conventional gasoline vehicles is a significant factor in causing users to experience range anxiety. The worry about the possibility of not having enough battery power to reach a destination or a place to charge the electric vehicle is still a significant obstacle to the widespread acceptance of EVs, despite the advantages of this technology in reducing pollution and promoting a transition away from non-renewable energy sources. [6].

The adoption of electric vehicles (EVs) is an essential and unavoidable step in the pursuit of sustainable transportation, motivated by the pressing requirement to decrease carbon emissions and address climate change. Nevertheless, the fear of running out of battery power, known as range anxiety, poses a significant barrier to the widespread adoption of electric vehicles. Despite the environmental and economic advantages, it impedes customer confidence and readiness to adopt EV technology. Conquering this barrier is crucial for expediting the acceptance of electric automobiles. [7]. The primary obstacle to the widespread adoption of electric vehicles (EVs) in Indonesia is mostly due to range anxiety experienced by users, which is caused by the limited availability of charging or battery swapping infrastructure. Furthermore, there is a continuous discussion regarding the supremacy of charging stations compared to battery swap stations, which requires a thorough examination that takes into account demographic, geographic, cultural, and socio-economic viewpoints. [8]. Range anxiety is a significant obstacle that is preventing the broad acceptance of battery electric vehicles (BEVs). Range anxiety, caused by the dread of running out of battery power before reaching a destination or charging point, has a substantial impact on both daily car usage and the consumer market's desire to adopt electric mobility. The restricted range of electric vehicles, in comparison to conventional gasoline-powered vehicles, worsens these problems, impacting customers' charging routines and travel arrangements. Although EV technology provides significant environmental and economic benefits, including as huge reductions in emissions and reduced dependence on fossil fuels, the fear of running out of battery power, known as range anxiety, continues to be a significant obstacle. This barrier not only impacts individual choices but also presents a difficulty to the overall market expansion of electric vehicles (EVs).

In order to successfully alleviate concerns about limited driving range among individuals considering or already using electric vehicles (EVs), a comprehensive strategy is required. This strategy should primarily prioritize the advancement of technological complexity, namely in the field of battery technology. Cutting-edge battery technologies that provide extended driving ranges, accelerated charging times, and enhanced durability are essential for effectively tackling the root cause of range anxiety. This technological advancement holds the potential to increase the range of electric cars (EVs) on a single charge, so making them more convenient to use and comparable to traditional vehicles. Nevertheless, technological progress alone is unable to completely solve the problem of range anxiety. The development of charging infrastructure is equally crucial. Increasing the number of charging stations, particularly those that offer fast-charging capabilities, in various locations such as cities, rural areas, and important transportation routes, guarantees drivers a dependable and uninterrupted access to charging facilities. This network development alleviates concerns about depleting battery power at a significant distance from a charging station, hence improving the convenience of using electric vehicles for both long trips and regular commuting.

In addition to technical and infrastructural progress, support systems such as customer support are crucial. Superior customer service that offers expert advice, knowledge, and support for electric vehicle (EV) consumers. Customized customer assistance that specifically answers the concerns and inquiries of electric vehicle (EV) consumers has the potential to clarify the technology, hence enhancing its accessibility and reducing its perceived complexity. This kind of assistance not only alleviates concerns about the limited distance an electric vehicle can travel without recharging, but also promotes a favorable overall experience with electric transportation. Therefore, this article goes beyond solely analyzing the technological aspects of electric vehicle (EV) adoption. It explores the equally important function of customer service. The report emphasizes the importance of considering and solving both the physical and psychological obstacles to electric vehicle (EV) adoption by incorporating several comprehensive strategies. Given the complex strategy for reducing concerns about limited driving range in the deployment of electric vehicles (EVs), we put up the following hypothesis:

- Technological sophistication, significantly decreases range anxiety among potential and current EV users.
- The expansion and strategic distribution of EV charging infrastructure significantly decreases range anxiety among potential and current EV users.
- Enhanced customer support for EV users significantly decreases range anxiety among potential and current EV users.

2. LITERATURE REVIEW

Range anxiety is a psychological condition that affects both consumers and vehicle operators. It is caused by worries about the restricted distance that electric cars (EVs) can go without needing to be recharged. It includes the concern felt by consumers regarding the ability of electric vehicles (EVs) to go the necessary distances without depleting their energy supply, as well as the operator's anxiety about the vehicle running out of power during a voyage. The anxiety surrounding the vehicle's durability and the accessibility of charging infrastructure is recognized as a crucial barrier to the broader acceptance and adoption of electric mobility. This emphasizes the need of comprehending customer behavior towards electric vehicles. [9], [10], [11]. Perceived Technological Sophistication in this study refers to the degree to which persons see electric cars (EVs) as progressive, inventive, and modern products within the automobile industry. This construct incorporates the perception of electric vehicles (EVs) as symbols of advanced technology, showcasing modernity through their form and functionality, and symbolizing the most recent technological progress in the industry. This survey measures the opinions of the participants regarding the level of sophistication and innovation present in electric vehicles. It evaluates their perspectives on the technological advancements that electric vehicles represent in the automotive industry. [12], [13], [14], [15]. Previous study indicates that perceived ease of use in technology can accelerate the adoption rate of new technology in society [16], [17] and technology also one of competitive advantages for businesses to keep inline with the environment [18].

Technological advancement is essential in overcoming range anxiety, a major obstacle to the general acceptance of electric cars (EVs). Electric vehicle (EV) owners frequently misunderstand how well the battery capacities of available EVs align with their transportation requirements, which results in a desire for extended battery ranges and a hesitancy to embrace EVs. In order to reduce concerns about the limited range of electric vehicles, several solutions have been suggested. These include creating efficient charging management systems for EVs that can be charged while driving, incorporating intelligent human-machine interfaces (HMIs) that offer accurate strategies for dealing with range limitations, and addressing both user perception and actual factors that impact the range of EVs. These technological developments have the objective of enhancing the assurance of electric vehicle (EV) consumers, mitigating concerns about limited driving range, and fostering the acceptance and implementation of EV technology. [6], [19], [20], [21]. The exploration of technology solutions aimed at decreasing range anxiety reveals a notable relationship between technological sophistication and range anxiety. A charging station is a facility designed to supply electric power for charging electric vehicles (EVs) [22]. Charging stations play a crucial role in promoting the widespread use of electric vehicles (EVs) and the transition to a sustainable transportation system. The presence and ease of use of charging

infrastructure play a crucial role in motivating potential customers to switch from conventional to electric vehicles, thereby eliminating a major obstacle to the widespread adoption of EVs.

The density of charging stations is directly correlated with the level of range anxiety experienced by individuals when considering the adoption of electric vehicles. (EVs) [23], [24]. Increasing the number of charging stations might mitigate range anxiety, which is the apprehension of running out of battery power while traveling. [25]. The presence of charging stations offers reassurance to electric vehicle (EV) customers, ensuring that they can conveniently locate a charging port when necessary, so alleviating worries about depleting their battery charge. [26]. Consequently, this can enhance the inclination to embrace electric vehicles (EVs) by tackling one of the primary obstacles to their extensive use. [27]. Moreover, the effectiveness of charging stations is influenced by their proximity to densely populated regions and the presence of existing charging stations. In general, the existence and ease of access to charging stations are extremely important in reducing concerns about the limited range of electric vehicles and encouraging their widespread use. Customer support represents the communication and assistance provided by a corporation to customers following their purchase of a product. The role include responding to customer inquiries, resolving technical issues, diagnosing and rectifying product defects, and delivering comprehensive assistance to improve the client's satisfaction. [28]. Customer support is necessary for guaranteeing consumer satisfaction and cultivating lasting relationships with customers. The initial interaction with customers is frequently the primary point of contact and has the potential to greatly influence their image of the firm. [29], [30].

This study aims to explore the correlation between customer support and range anxiety by analyzing the overall connection between customer support and customer anxiety in general. Due to the lack of extensive research on the direct impact of customer support on range anxiety in the electric vehicle (EV) industry, this technique enables us to deduce the possible effect of customer support in reducing range anxiety. Recent study in different fields highlights the crucial importance of customer support and services in reducing consumer anxiety. This research reveals a complex connection that covers multiple aspects such as Web 2.0, omnichannel platforms, social anxiety, and e-commerce environments. Research indicates that increased customer involvement and support through Web 2.0 can enhance the quality of e-services. Additionally, studies on omnichannel customer experiences reveal that anxiety plays a role in moderating the relationship between consumer psychology factors and loyalty. This suggests that implementing effective customer service strategies can help alleviate anxiety in these circumstances. Moreover, those who experience social anxiety have a preference for particular online customer care channels. This highlights the importance of adapting customer support to meet the various demands of consumers. Relational marketing strategies that focus on mental benefits, trust, and hedonic value can help alleviate anxiety in e-commerce transactions. This highlights the importance of customer support in reducing consumer anxiety and promoting a positive relationship between the business and its customers. [31], [32], [32], [33].
Thus, Based on the above literature review, the hypothesis for this study is as follows:

- Hypothesis 1 (H1): Higher perceived technological sophistication among consumers is inversely related to the intensity of range anxiety.
- Hypothesis 2 (H2): The density and strategic location of charging stations are directly related to the alleviation of range anxiety
- Hypothesis 3 (H3): customer support plays a critical role in reducing range anxiety in the context of electric vehicle (EV).

3. METHOD

The purpose of empirical testing is to assess the correlation between perceived technological sophistication, charging station density, customer assistance, and range anxiety in the context of electric vehicle (EV) adoption. This study especially targets respondents in Indonesia who possess expertise in electric vehicles (EVs), so ensuring that the data collected accurately represents the perspectives of individuals who are

already well-versed in EV technology. The minimum sample size needed to obtain a confidence level of 95% and a margin of error of 10% has been determined to be 97 respondents. The study will utilize a non-probability sampling technique, namely convenience sampling, to collect data. The survey will be disseminated in Bandung to individuals who have exhibited expertise in electric vehicles, with the objective of gathering a diverse array of perspectives and experiences pertaining to EV utilization.

Before distributing the survey, the variables will be operationalized to match the defined concepts in the study context. The operationalization process entails defining indicators for each variable to ensure that the survey items effectively capture the core aspects of perceived technological sophistication, charging station density, customer support, and their impact on range anxiety among potential and current electric vehicle (EV) users.

Table 1. Variables Operationalization

Variables	Indicators
Range Anxiety (RA)	Concern about the mileage of electric vehicles (EVs)
	Mileage concerns on decision-making regarding electric vehicles.
Perception of Technological Sophistication (PTS)	Electric vehicles as highly sophisticated and innovative products.
	The technology behind electric vehicles conveys modernity.
Customer Support (CS)	Satisfaction with customer support for electric vehicle owners
Charging Infrastructure (CI)	The availability and convenience of electric vehicle (EV) charging stations.
	Adequacy of the charging infrastructure in Indonesia for daily use

Table 1 presents the operationalization of the main factors examined in this study, namely Range Anxiety, Perception of Technological Sophistication, Customer Support, and Charging Infrastructure. The measurement items for this study will be designed to reflect the defined indicators for each variable, in accordance with the operationalization.

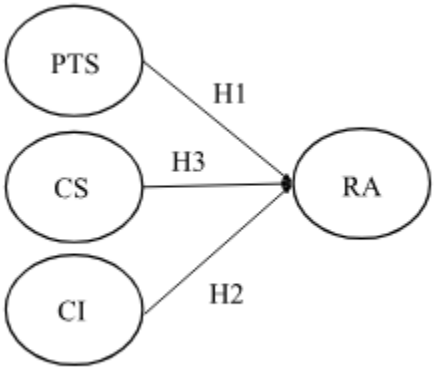

Fig 1. Reseach Model

Figure 1 depicts the research model that illustrates the hypothesized connections among the main variables in the study: Perception of Technological Sophistication (PTS), Customer Support (CS), Charging Infrastructure (CI), and Range Anxiety (RA). Hypothesis 1 (H1) states that Perception of Technological Sophistication (PTS) has a direct impact on Range Anxiety (RA). Hypothesis 2 (H2) suggests that Charging Infrastructure (CI) directly affects Range

Anxiety (RA). Hypothesis 3 (H3) posits that Customer Support (CS) has a direct impact on Range Anxiety (RA). This research will apply Structural Equation Modeling (SEM) with a Partial Least Squares (PLS) approach, using the SmartPLS software, to investigate the given hypotheses.

4. RESULT AND DISCUSSION

A sample of 146 respondents was analyzed to investigate the hypothesized relationships between perceived technological sophistication, charging station density, customer support, and range anxiety, within the context of electric vehicle (EV) adoption in Indonesia. The acquired data from the sample was analyzed using Structural Equation Modeling (SEM) using the Partial Least Squares (PLS) approach through the utilization of the SmartPLS software.

Table 2. Construct Reliability and Validity Result

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
CI	0.678	13.834	0.769	0.644
CS	0.887	1.052	0.943	0.893
PTS	0.767	1.162	0.882	0.79
RA	0.836	0.994	0.92	0.852

Table 2 presents the reliability and validity statistics for the constructs evaluated in the study. The constructs of Customer Support (CS) and Range Anxiety (RA) demonstrate strong internal consistency and validity across all metrics. Furthermore, the construct of Perceived Technological Sophistication suggests high reliability and convergent validity. The reliability of the Charging Infrastructure (CI) is a bit below the appropriate threshold as shown by Cronbach's Alpha. Nevertheless, it is still within acceptable bounds. The abnormal rho_A result shows that recalibration or further study may be necessary. All constructs demonstrate high composite reliability and excellent Average Variance Extracted (AVE), showing that the survey items properly represent their respective constructs.

Table 3. Discriminant Analysis Result

	CI	CS	PTS	RA
CI	0.803			
CS	-0.029	0.945		
PTS	0.01	-0.089	0.889	
RA	0.199	-0.174	-0.202	0.923

Table 3 provides the results of the discriminant analysis using the Fornell-Larcker criterion. The matrix shows that all constructs have necessary discriminant validity. This is demonstrated by the fact that the square root of the Average Variance Extracted (AVE) for each construct (diagonal values) exceeds than its highest correlation with any other construct (off-diagonal values). The AVE square roots for Charging Infrastructure, Customer Support, Perceived Technological Sophistication, and Range Anxiety are 0.803, 0.945, 0.889, and 0.923 respectively. These values suggest the correlations between these factors are lower than their individual AVE square roots. These findings indicate that each construct is unique and encompasses occurrences that are not covered by the other constructs in the study.

Table 4. Model Fit Result

	Saturated Model	Estimated Model
SRMR	0.067	0.067
d_ULS	0.163	0.163
d_G	0.163	0.163
Chi-Square	166.571	166.571
NFI	0.635	0.635

Table 4 exhibits the model fit indices for both the saturated and estimated models in the study. The SRMR (Standardized Root Mean Square Residual), d_ULS (Unweighted Least Squares Discrepancy), and d_G (Geodesic Discrepancy) all show the same values for both models. The SRMR value of 0.067 is below the commonly accepted threshold of 0.08, indicating a satisfactory fit. Furthermore, the d_ULS and d_G values demonstrate equality in both models, demonstrating that there is no apparent disparity in the satisfactory level of fit between the saturated and estimated models. The Chi-Square statistic reveals a significantly high value. Nevertheless, it is important to consider that this statistic is influenced by the size of the sample, which may mitigate any potential concerns. The Normed Fit Index (NFI) has a value of 0.635, which falls below the intended threshold of 0.9. This indicates that there is room for improvement in the fit of the model. Overall, whereas certain indices such as SRMR show a satisfactory fit, others such as NFI imply that the model's ability to explain may be improved with more adjustments.

Table 5 Path Coefficient Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Charging Infrastructure -> Range Anxiety	0.196	0.18	0.119	1.647	0.1
Customer Support -> Range Anxiety	-0.188	-0.185	0.078	2.4	0.017
Perceived Technological Sophistication -> Range Anxiety	-0.22	-0.224	0.078	2.832	0.005

The path coefficients presented in Table 5 provide a clear indication of the degree of correlation and statistical significance of the correlations between Charging Infrastructure, Customer Support, Perceived Technological Sophistication, and Range Anxiety. The examination of the path coefficients shows numerous levels of significance for the connections between the components. The relationship between Perceived Technological Sophistication (PTS) and Range Anxiety is statistically significant, with a p-value of 0.005, which is lower than the standard significance level of 0.05. The correlation between Customer support (CS) and Range Anxiety is statistically significant, as indicated by a p-value of 0.017. This finding reinforces the importance of customer support when measuring Range Anxiety.

However, the relationship between Charging Infrastructure (CI) and Range Anxiety, however it has a p-value of 0.100, does not meet the standard threshold for statistical significance. Within the parameters of this study, the impact of Charging Infrastructure on Range Anxiety is not statistically apparent. Further research is needed to fully understand its significance in relation to the adoption of electric vehicles. The absence of statistical significance in the correlation between Charging Infrastructure (CI) and Range Anxiety, specifically in the Indonesian context, can be attributed to various factors closely associated with the particular characteristics of the respondents and the current type of electric vehicles (EVs) in use.

Table 6. Path Coefficient Result

	CI	CS	PTS	RA
CI				0.196
CS				-0.188
PTS				-0.22
RA				

The examination of the path coefficients in Table 6 offers useful information into the effect of Charging Infrastructure, Customer Support, and Perceived Technological Sophistication on Range Anxiety among electric vehicle (EV) customers.The strong inverse correlation between Customer Support and Range Anxiety underscores the crucial role of high-quality customer service in addressing concerns related to the use of electric vehicles. Professional customer service that provides dependable aid and knowledge on electric vehicle maintenance and charging can significantly reduce users' anxieties. Moreover, the strong inverse correlation between Perceived Technological Sophistication and Range Anxiety highlights the influence of customers' beliefs regarding electric vehicle (EV) technology. An essential approach for reducing range anxiety and promoting wider adoption of electric vehicles (EVs) is to educate both future and present EV users about the sophisticated technology that powers EVs and its capability to meet their transportation requirements. These findings indicate that a comprehensive approach is needed to tackle range anxiety, with a focus on customer assistance and technology education in addition to infrastructure improvement.

The absence of statistical significance between Charging Infrastructure (CI) and Range Anxiety could be attributed to the particular characteristics of the study's respondent pool and the unique nature of the EV market in Indonesia. Firstly, the survey participants, who are mainly individuals aware about EV technology but not necessarily owners, may create their opinions about CI based on theoretical knowledge or information from others, rather than their own firsthand experience with EV charging. The lack of direct experience with charging infrastructure may lead to a diminished understanding of how it affects range anxiety. This is because their evaluations of the sufficiency of the infrastructure are not influenced by the daily need for charging. Furthermore, the prevalence of electric motorbikes in the Indonesian electric vehicle industry may influence the perception of the sufficiency of charging infrastructure. Considering the lower power requirements and more charging flexibility of motorcycles compared to electric cars, respondents may perceive the current charging infrastructure as adequate for their current needs, especially for motorcycle users. This viewpoint may underestimate the importance of a comprehensive public charging infrastructure, consequently impacting the perceived connection between electric vehicle charging infrastructure and the fear of running out of battery power, particularly in a market where motorcycles are widely used for transportation.

After analyzing the path coefficients and gaining a detailed understanding of how Charging Infrastructure, Customer Support, and Perceived Technological Sophistication impact Range Anxiety, several recommendations for EV adoption namely:

- To improve customer support, it is essential for electric vehicle (EV) manufacturers and service providers to invest in enhancing the quality of customer assistance, as there is a strong negative correlation between customer support and range anxiety. This may entail instructing personnel to offer specialized guidance on electric vehicle maintenance and charging, creating extensive web materials, and guaranteeing prompt and supportive customer care channels. It is essential to prioritize the accessibility and informativeness of customer service, specifically focusing on answering often encountered problems and queries regarding the utilization of electric vehicles (EVs).
- Emphasize Technology Education: The strong inverse correlation between Perceived Technological Sophistication and Range Anxiety indicates that educating the general population about the technological progress in electric vehicles (EVs) is crucial for reducing range anxiety. Possible measures could encompass public seminars, informational campaigns, and partnerships with educational institutions to emphasize the efficacy, dependability, and advantages of electric vehicle technology. The objective of these initiatives

should be to clarify the technology behind electric vehicles (EVs), highlighting how it fulfills the transportation requirements of customers and underscoring its ongoing progress.

- Tailoring Communication for Various EV Types: To effectively engage with the Indonesian EV market, particularly electric bikes, it is crucial to customize communication and marketing approaches to cater to the unique needs and preferences of motorcycle consumers. This may entail emphasizing the convenience and adaptability of charging alternatives for motorcycles and using specific strategies to instill trust and assurance among this particular group of users.

By implementing a comprehensive strategy that encompasses customer assistance, advanced technological education, and customized charging infrastructure development to cater to the specific requirements of the Indonesian market, stakeholders may successfully mitigate range anxiety and encourage greater acceptance of electric vehicles.

5. CONCLUSION

The analysis performed in this research presents compelling data concerning the hypothesized relationships that impact Range Anxiety among electric vehicle (EV) customers in Indonesia. The observed inverse correlation between Customer support and Range Anxiety reinforces the idea that proficient customer assistance plays a vital role in mitigating concerns over the use of electric vehicles, underscoring the need of dependable and informed customer care. The presence of a strong negative correlation between Perceived Technological Sophistication and Range Anxiety confirms the hypothesis that consumers' perceptions of the technological advancement of electric vehicles (EVs) are crucial in alleviating concerns about limited driving range. This emphasizes the need to educate consumers about EV technology. Nevertheless, the idea that the presence of Charging Infrastructure would have a substantial effect on Range Anxiety was not corroborated, as this correlation did not demonstrate statistical significance. The limitation of this research arises from the relatively small sample size of 146 respondents, as well as the fact that not all participants definitely had an electric vehicle (EV). Notwithstanding this constraint, the study provides significant perspectives on potential approaches to alleviate range anxiety among a wider demographic. It emphasizes the need of improving customer assistance and utilizing technological education as crucial methods for overcoming a major obstacle to the adoption of electric vehicles. Further investigation utilizing a more extensive and heterogeneous sample, which includes individuals who currently possess electric vehicles, might be advantageous in corroborating and broadening the scope of these discoveries.

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Improving the Platform in the Lecture Scope with the Implementation of the TF-IDF Algorithm

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Abstract: Information plays a crucial role in the lives of everyone, including students. One of the most important types of information that students need is related to lecture events. However, students often have difficulty finding suitable lecture event information, and they sometimes forget to attend events they have registered for. As a result, this research focuses on designing and implementing a website-based recommendation system for lectures. The recommendation system utilizes the TF-IDF (Term Frequency-Inverse Document Frequency) algorithm in its development. The primary goal of developing this recommendation system is to help students easily find event information and receive event activity notifications. In alignment with the established objectives, a significant number of respondents agree that the recommendation system simplifies event registration. Consequently, with the aid of this system, students can become more proactive and participate more readily in events. Following a survey conducted with 47 respondents, it was found that 84.4% of them had never used a recommendation system for college activities. Furthermore, 53.1% expressed satisfaction with this recommendation system. It is hoped that the recommendation system, employing the TF-IDF algorithm, can be further optimized to yield even better results.

Keywords: Information, lecture, event, recommendation, TF-IDF, activity

1. INTRODUCTION

Information is important and inseparable from everyday human life. Information itself means notification, news, or news about something [1]. Information has a very important role for a student, one of which is information about lecture events such as seminars from within and outside the university, academic and non-academic competitions, social activities, and workshops. However, students sometimes experience obstacles in the form of limited information on existing lecture events. One example of a problem is that lecture events are only shared via social media platforms in group chats, and some students sometimes do not open the group chat so that information about the lecture event is not received by students. In fact, with the use of the right information technology, students can access a variety of events easily [2]. To overcome the problems that have been described previously, this research wants to create a website that contains events about lectures equipped with a recommendation system. A recommendation system is a step approach to existing problems in providing solutions in handling the selection of things that are suitable according to user preferences from the many existing items [3]. The website will be built using the React and Express frameworks with TF-IDF as the main method for the recommendation system, and all data will be stored in MongoDB. This application is expected to be a solution for every student to become more active and easier to participate in an event because students can get event information more efficiently and easily. In order to enhance the platform within the lecture scope, the implementation of the TF-IDF (Term Frequency-Inverse Document Frequency) algorithm is proposed. This algorithm will be utilized to improve the platform's functionality and effectiveness in providing relevant information to users. By implementing the TF-IDF algorithm, the platform will be able to analyze and

evaluate the importance of different terms within the lecture materials and documents. This will allow the platform to provide more accurate and relevant recommendations to users based on their specific needs and preferences.

2. LITERATURE REVIEW

A recommendation system is a step approach to existing problems in providing solutions to handle the selection of things that are suitable according to user preferences from many existing items [3]. One example of recommendation system methods that can be used is TF-IDF. TF-IDF (Term Frequency-Inverse Document Frequency) is an algorithm used to calculate the weight of the statistical value of a word to determine how important a word is in an existing text collection. TF represents the number of similar words that appear in a group of texts. While IDF represents the weight of the importance of a word in a collection of texts as a whole [4]. One example of implementing the TF-IDF algorithm can be done in the information retrieval process. Information retrieval is a system that is used to search for related or relevant information from a set of information automatically based on user-defined search keywords [5]. In implementing a recommendation system, it takes a display of the computer system to be used. The science that studies the interaction between humans and computers from theory, design, implementation, and evaluation is called HCI (Human Computer Interaction) [6]. That way, HCI is very important in making an application in order to create a good user experience. Application developers must pay attention to the design contained in the application; otherwise, the appearance of the application becomes laborious and reduces the user experience [7]. There are four important components in HCI, including user, purpose, appearance, and context.

To create an application that can satisfy in terms of user experience and also appearance, several components are needed in making the system, such as the React framework and also a database like MongoDB for data storage. Framework itself is a function that assists developers in developing applications by creating predefined methods such as URL routing, state management, bundling, and others [8]. Framework has the advantage that it can be used repeatedly and also has better security because it has been identified by many expert developers and continues to be developed [9]. React is a JavaScript library developed by Facebook that can be used to create website applications. React can divide a complex user interface into smaller parts called components [8]. Some of the advantages of React compared to other website application development methods are:

1) Composable

   React divides complex web applications into smaller components that can be built to produce many combinations of components
2) Declarative

   Application development only needs to mention the desired display, it doesn't need to include the steps in it
3) Multi-Platform

   The code in React can be extended and used on various platform
4) Easy to use and learn

   Application developers only need to master the HTML, CSS, JavaScript programming languages where HTML and JavaScript programming in React can be combined into JSX (JavaScript XML) to facilitate development.

HTML (Hypertext Markup Language) is a markup language used by developers in making websites [10]. CSS (Cascading Style Sheets) is also needed to determine how the HTML elements on the website will be displayed. This is because without CSS, elements in HTML will only give an ordinary and unattractive appearance. CSS can also determine the layout and position of the HTML elements used on the website [11]. While JavaScript is used to adjust the flow of logic on websites that previously have been designed using HTML and CSS. JavaScript itself can be used for various ways of programming, such as imperative programming, object-oriented programming, and also functional programming [12].

To handle data displayed from the frontend side, a backend side such as Node.js is needed. Node.js is a fast and reliable platform for handling heavy files and networks in making applications because the approach is event-driven, uses non-blocking types, and uses an asynchronous method [13]. One example of a node.js-based framework is Express.js. Express.js is a flexible node.js backend framework useful for making it easier to create node.js-based applications in managing the functionality of a website [14]. Some of the advantages of Express.js compared to other backend platforms are [15].

1) Supports Google V8 Engine

   With Google V8 Engine, it increases website performance and ensures that any errors can be handled quickly during development process

2) Provides server-side caching

   Doing server only need to respond once for each client request for the same page to improve user experiences

3) Dynamic and more powerful

   Has lot of modules available on NPM (Node Package Manager)

4) Reducing development costs

   Express is an open source based node.js framework and also doesn't require a lot of resources because API used in it is very light.

Data that has been processed from the backend side is then stored in the database. One example of an existing database is MongoDB. MongoDB is a NoSQL based database that is used to store data in a different format than Relational Database Management System (RDBMS) tables that focus on scalability, query speed, and compatibility with application changes [16]. MongoDB provides faster performance, does not require a complicated table structure, is able to accommodate a lot of varied data, and manage queries better [17].

3. METHOD

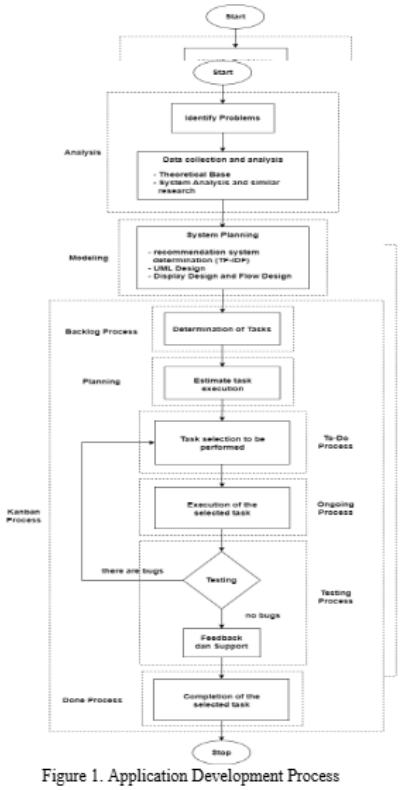

Figure 1. Application Development Process

Process in Figure 1 starts with the identification of the problems that were the cause of this research being carried out first. After the problem is found, the process of data collection and analysis will be carried out to determine application requirements such as the algorithm, programming language, and also database to be used. Methods of data collection will be carried out by means of reference theory, literature study, and also analysis of similar research. The study of literature and reference theory is intended for the purpose of collecting topical reference data that supports system development. Then, a similar research analysis is used to determine the recommendation system algorithm used. After the process of collecting data is carried out, the process continues with the system design stage. At this stage, a system recommendation algorithm has been established, namely the TF-IDF algorithm. Modeling of the flow design and appearance design is done at this stage. The flow design is described using UML diagrams, which consist of a use case diagram, an activity diagram, a sequence diagram, and a class diagram. For display design, the author used Figma as a place to make it. Display design starts from low-fidelity design to finished display. After all modeling has been completed, the process will then implement the Kanban Method. Kanban method starts with the backlog process. The backlog process is used to make a determination of how many tasks are needed to finish the project. A task will be created in the form of a card. Tasks can be broken down into smaller parts to ease the application development process. After every task has been made, a planning process will be carried out to determine the estimated length of time every task can be completed. After the estimated processing time for each task has been completed, Process will proceed to the next stage. The next stage consists of a series of stages starting from the to-do stage, which will be iterated continuously until the cards previously set in the backlog run out. The to-do is a stage for determining which tasks will be carried out in one iteration. At this stage, the cards in the backlog column will be shifted to the To-Do column to list the tasks to be carried out. After the listing is completed, the tasks will be carried out at the ongoing process stage. At this stage, the tasks in the To-Do column will be done one by one. The way to make changes to the Kanban board is still the same, namely by shifting the card task that you want to do to the destination column. After a task in the ongoing process is finished, it will be shifted to the testing column. At this stage, the task will be tested by means of black box testing. If the task passes the requirements, then the task card will be shifted to the done column on the Kanban board to indicate that the task has been completed. If there are still bugs, the card will be returned to the To-Do column. After all tasks have been completed, the development process is finally complete.

4. RESULT AND DISCUSSION

System recommendation event platform development starts with every step the author previously mentioned, with each step as a follow.

A. Requirement Definition

System recommendation event platform application starts with specifying and defining all feature requirements needed for the application. Following is a list of requirements needed to develop this application:

1) Creating an event recommendation system so that students can easily find an event based on their preference
2) Create a system that can help students remember the event they are participating in by giving notifications to students
3) Create a system that can help organizers manage an event.

B. Software and Design System

After all of the requirements listed above have been defined, the author starts with designing the system using a use case diagram.

1) System Design

At the beginning of the system design, a use case diagram was made with as many as 13 use cases to inform about all activities, which can be seen in figure 2. There are 3 actors in the system environment, consisting of students, organizers, and admins.

- Use Case Diagram

Figure 2. Use Case Diagram System Recommendation Event Platform

- Activity Diagram

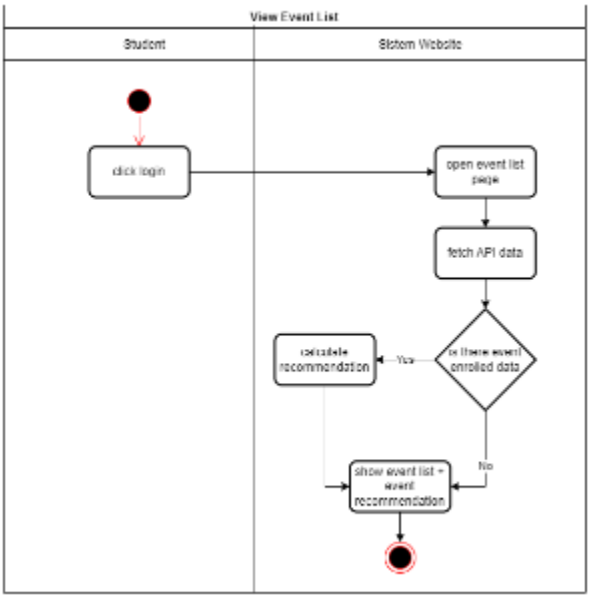

Figure 3. Activity Diagram for View Event List in Student Role

- Class Diagram

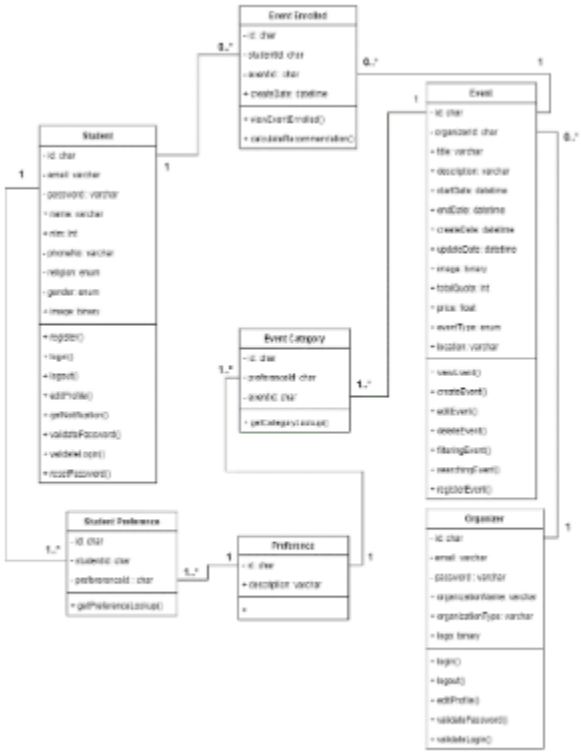

Figure 4. Activity Diagram for View Event List in Student Role

Figure 4 describes the class diagrams used to create a database for the System Recommendation Event Platform application. There are a total of 7 tables, with 3 of them being the main table in the diagram, which is the student table, organizer table, and event table. Admin can directly access the class in the database mentioned above.

2) User Interface

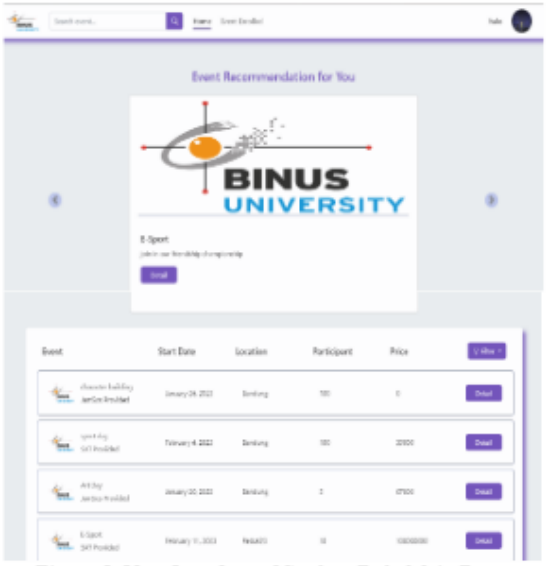

Figure 5. User Interface of Student Role Main Page

Figure 5 is a student role view main page of the System Recommendation Event application. In this page, there are 2 components: the first component is a carousel to show student events recommended, and the event table list to show students every event listed in the application.

C. Application Development

After system design for the application is completed, the author begins with creating a base server for the application. Below are details of the server used to deploy both React for the frontend application and the Express for the backend:

- Host Name: 89.116.229.148
- Cores: 2 CPU
- RAM: 2GB
- Storage: 39.06 GB

After the server is deployed, the Express and React application can be deployed to the server. In the Backend, there are 2 services that are deployed, which are binus event authentication and binus event service. The service list server can be seen in figure 6.

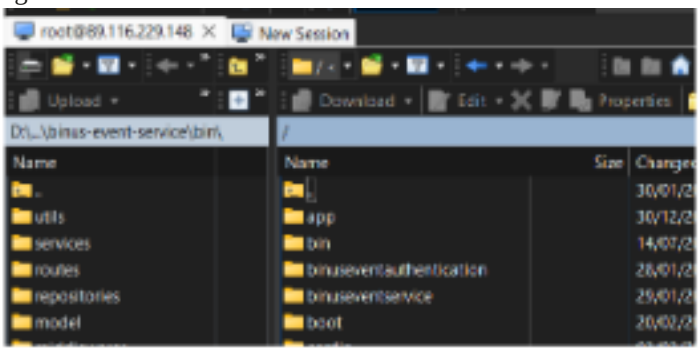

Figure 6. Express.js backend service list used for the application

```
const termFrequency = {};
tokens.forEach((token) => {
  if (!termFrequency[token]) {
    termFrequency[token] = 1;
  } else {
    termFrequency[token]++;
  }
});
```

```
    termFrequency[token] = 1;
  } else {
    termFrequency[token]++;
  }
```

```
const inverseDocumentFrequency = {};
tokens.forEach((token) => {
  if (!inverseDocumentFrequency[token]) {
    inverseDocumentFrequency[token] =
      Math.log(data.length / tokens.filter(
      (t) => t === token
    ).length);
  }
});
```

```
Object.keys(termFrequency).forEach((token) => {
  if (!scores[token]) {
    scores[token] = termFrequency[token] *
inverseDocumentFrequency[token];
  } else {
    scores[token] += termFrequency[token] *
inverseDocumentFrequency[token];
  }
});
```

D. Testing

After developing the System Recommendation Event Platform application, testing is carried out to ensure the application created runs smoothly and safely. The type of testing that author used was black box testing. Black Box testing is used to ensure every function of the application is running as planned. The System Recommendation Event Platform application was tested with a total of 47 test cases, with the distribution of 25 test cases for the student role, 21 test cases for the organizer role, and 1 test case for the admin role. The overall test result from 47 test cases went well and was declared a pass.

E. Questionnaires

Questionnaires are one of the most important things in evaluating system recommendation event platform applications. Questionnaires can be used to get valuable input so that the author can improve the applications that have been made. The results of this question are also useful for determining whether the design of the application is suitable for its purpose or not. Here are some questions asked to students about the application:

1) Have you ever used a recommendation system application for lecture activities before?

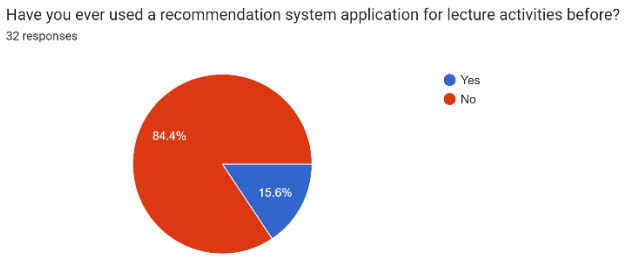

Figure 7. Student once use about recommendation system for lecture activities

Figure 7 shows that 27 respondents (84.4%) had never used the recommendation system application for lecture activities before, while only 5 respondents (15.6%) had used the recommendation system application for lecture activities. So, most respondents never had the opportunity to use an application recommendation system before in the scope of lectures.

2) How consistent do you think the look and theme of these recommendation system apps are?

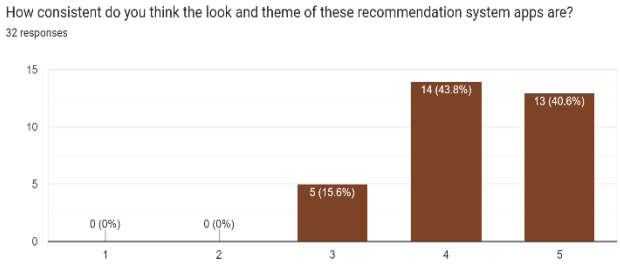

Figure 8. Student opinion about application design and theme consistency

Figure 8 shows that as many as 27 respondents (84.4%) agreed that the system recommendation event platform application design was consistent, and 5 respondents (15.6%) were neutral about it. It shows that the system recommendation event platform application has achieved good design consistency in its appearance.

3) How satisfied are you in future use of this app?

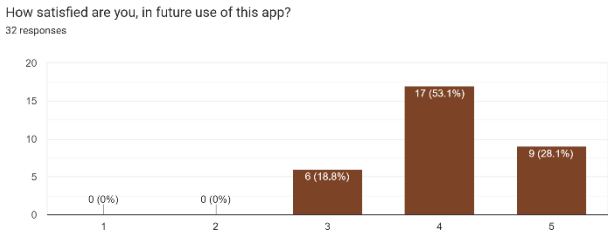

Figure 9 shows that in general, respondents felt quite satisfied with the results of the development and design of the system recommendation event platform application that had been made with the criteria of 9 respondents (28.1%) feeling very satisfied, 17 respondents (53.1%) feeling satisfied, and 6 respondents (18.8%) feeling neutral.

5. CONCLUSION

1) By implementing the TF-IDF algorithm, the platform will be able to analyze and evaluate the importance of different terms within the lecture materials and documents. This will allow the platform to provide more accurate and relevant recommendations to users based on their specific needs and preferences.
2) Overall, the implementation of the TF-IDF algorithm represents a significant step towards improving the platform's performance and user experience within the lecture scope. By leveraging this algorithm, the platform will be able to provide more personalized and accurate recommendations, ultimately benefiting users and enhancing their learning experience.

3) With this event recommendation system, it will simplify students' ability to determine which events they are interested in. Then, students can also more quickly check the types of activity events based on the preferences they want to follow.
4) The research and development of this activity event recommendation system has produced an application that can be used to facilitate students who want to register for an event and to simplify the sharing of information from organizers to students.
5) The UI of the system recommendation event platform application is suitable for use, but there can still be many improvements, such as improving the color theme and also making improvements like code refactoring to reduce unnecessary loading time, which would enhance the UX in the application.

SUGGESTION

1) In further development, it can be done by adding multiple organization accounts to make it easier for various organizations and university administrators to add, edit, and delete events without waiting for the organizer role provided by the administrator to proceed.
2) In further development, the application can add features like a like button, a dislike button, and chat features to make it easier for students to find out whether an event is in based on student preference.
3) Future system development will not only focus on computer resolution but on phone resolution too. This is done because many people access websites via smartphones.

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The Influence of Digital Marketing Strategy in the Development of MSMEs on Economic Growth 2018 – 2022 (Case Study of Digital Advertising MSMEs in Jakarta)

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Abstract: This research examines the influence of digital marketing strategies on the development of Micro, Small and Medium Enterprises (MSMEs) and their contribution to economic growth with a focus on the 2018-2023 period in DKI Jakarta. This research investigates how digital marketing empowers MSMEs to expand their reach, increase customer engagement, and ultimately drive business growth. By analyzing the case of MSMEs in Jakarta that utilize digital advertising, this research aims to explain the correlation between effective digital marketing strategies and economic development. The results of the research on the relationship between digital marketing strategies in MSMEs and economic growth in DKJ Jakarta have a significant positive influence or relationship on both the variable number of MSMEs on GDP per capita and the variable of MSME workforce on GRDP per capita DKJ Jakarta 2018 - 2022.

Keyword: Digital Marketing, MSMEs, Economic Growth

1. INTRODUCTION

Technology has experienced extraordinary progress and has become an inseparable part of human life today. The development of science and technology is interrelated, encouraging the creation of various new innovations. This innovation aims to provide convenience, positive benefits, and become the newest solution in various human activities. Indonesian people have also experienced many benefits from various technological innovations that have emerged in the last decade. The fact that so many people in Indonesia utilize the internet attests to the convenience that has been brought about by the advancement of contemporary technology. The internet has become an inseparable part of many people's lives, including the use of social media. Based on data from the Asosiasi Penyelenggara Jasa Internet Indonesia (APJII), it shows that internet users in Indonesia will reach 221 million people in 2023, placing Indonesia in third place with the most internet users in Asia.[1]

Digital technology and the internet provide practical, easy and efficient solutions for marketing activities in the midst of busy daily lives. Marketing communication strategies are the key to marketing products, both online (display to face) and offline (face to face). Implementing appropriate and fast communication strategies within a company can avoid losses due to ineffective and inefficient promotions. Internet advertising is widely used as an intermediary for marketing communications, and social media has become a popular platform for promoting products or services.
The digital era has brought major changes in various aspects of life, including the business world. Micro, Small and Medium Enterprises (MSMEs) as one of the important pillars of the Indonesian economy need to adapt to this digital era so that they can continue to develop and increase their contribution to national economic growth. The economic growth of a country cannot be separated from regional economic development activities. Regional economic development is a process by regional government and the private sector in creating new jobs and also stimulating the development of economic activities in a region.[2]

Digital marketing is a marketing activity that uses digital media and the internet to reach target markets and achieve marketing goals. Digital marketing can be done through various online platforms such as websites, social media, email marketing, search engine optimization (SEO), and paid advertising.[3] Digital Marketing is becoming a favorite in the modern marketing world. Many people choose it to support various buying and selling activities. Conventional

marketing is starting to be abandoned and replaced by Digital Marketing which is more modern and practical. The scope of marketing with Digital Marketing is much wider, and communications and transactions can be carried out at any time in real time. One of the key areas of the Indonesian economy is the micro, small, and medium-sized enterprise sector. According to figures from the Ministry of Cooperatives and SMEs, MSMEs would account for 60.5% of the country's GDP in 2023.[4] MSMEs are the largest business actors, accounting for 99.9% of the total national workforce absorption in Indonesia. Data from the Ministry of Cooperatives and SMEs in 2023, the number of Micro, Small and Medium Enterprises will reach 67 million MSMEs in Indonesia.[5] In comparison to other commercial entities, the national workforce is absorbed by MSMEs, which is why empowering MSMEs has been shown to be a driving force for the national economy. This demonstrates how MSMEs can lower poverty and unemployment in Indonesia.

One of the current uses of digital marketing that has had significant development or success in Indonesia is e-commerce, apart from that, digital advertising has become a very important tool for business people to reach target markets and achieve marketing goals with the various benefits offered. Digital advertising will continue to develop and become an important part of marketing strategies in the future. Digital advertising is the practice of promoting products or services using digital platforms and technology. Advertisements are displayed to audiences through various online channels, such as: Websites, Search engines, Social media, Email, Mobile applications.[6] The main goal of digital advertising is to reach a specific target market, increase brand awareness, generate prospects (potential customers), and ultimately encourage sales or conversions.

Based on the background explanation above, the researcher wants to analyze the influence of digital marketing strategies in developing MSMEs on economic growth, as well as identifying digital marketing strategies that are effective in increasing the economic growth of MSMEs in Jakarta. Apart from that, it is also to find out the obstacles faced by MSMEs in implementing digital marketing strategies. Lastly, namely to formulate solutions to overcome obstacles in implementing digital marketing strategies in MSMEs.

2. LITERATURE REVIEW

Digital Marketing Strategy

Digital marketing is the use of various online platforms or media such as social media, email and various other online platforms to promote, market and communicate a product or service. The main goal of digital marketing is to increase sales and attract the attention of potential customers. Digital Marketing has a broad definition with various concepts and different implementation systems. According to Chaffey (2011) digital marketing is digital marketing which is a form of company business in marketing its products and services using digital technology online to get a global and specific market.[10] Digital Marketing strategies will continue to develop with developments in technology and information. The company will also continue to update and innovate to survive in this dynamic market. Digital marketing is not just about advertising, but also interacting with potential customers and building long-term relationships. Digital marketing has an important role in the modern business world and plays a core role in attracting the attention of visitors to online platforms and websites that market the product.[11]

Enterprises, Micro, Small, Medium (MSME)

Micro, Small, and Medium-Sized Enterprises (MSMEs) frequently employ digital marketing techniques. According to Law of the Republic of Indonesia No. 20 of 2008, MSMEs are defined as productive businesses owned by individuals or individual business entities that meet the requirements of the law to qualify as micro businesses and have a net worth of up to IDR 300 million, with a maximum of IDR 50 million.[12] A stand-alone, profitable economic enterprise run by a person or even one that is owned, controlled, or a direct or indirect component of a medium-sized or big enterprise that satisfies the requirements for small business as defined by this legislation is considered a small business. starting at IDR 50 million and going up to IDR 500 million at most. Menengah business is a productive

economy that operates independently of firms and is run by people or even companies that are not subsidiaries or branches. The net worth of medium-sized businesses can reach up to IDR 10 billion.[13] According to Sumodiningrat, the success indicators used to measure the implementation of community empowerment programs within the scope of Small and Medium Enterprises include the following: (1) Number of MSMEs; (2) Absorption of MSME labor: (3) MSME capital; (4) Profit or benefits obtained by MSMEs.[14]

Economic Growth

Economic growth can be interpreted Economic growth quantifies the accomplishments of an economy's development throughout time, just as the expansion of economic activity leads to an increase in the quantity of products and services produced in society and an increase in its affluence. A nation's capacity to generate products and services will rise because of improvements in the quantity and quality of production elements. Aside from that, there is a growing workforce due to rising levels of education and population development, as well as expanding investments in capital goods and technology.[15] An economy's ability to produce more commodities and services is referred to as economic growth. Economic growth is a crucial metric for assessing a nation's economic progress since it indicates the degree to which economic activity will raise the general public's standard of living within a given time frame.[16]
A country sometimes experiences slow economic growth and sometimes also experiences rapid growth. Here's how to calculate the economic growth rate, namely as follows:

$$g = \frac{GDP_1 - GDP_0}{GDP_0} x\ 100\%$$

Information:

g = level (percentage) of economic growth

GDP_1 = (gross domestic product or gross domestic product or briefly

GDP = Real national income (national income calculated at fixed prices achieved in one year (Year 1).

GDP_0 = Real national income in the actual year (0).

3. METHOD

Research Design

Types of Research

This kind of research combines a quantitative methodology with qualitative and descriptive analysis. The goal of descriptive research is to produce an organized, factual, and precise account of the features and circumstances of the people living in a certain location. The process begins with data collection, analysis, and interpretation.[17] Causality research is research that explains the relationship between variables by changing one variable and causing changes in other variables without the possibility of the opposite effect.[18] This research is quantitative research which aims to reduce data into numbers. This research uses a lot of numbers starting from collecting data, interpreting data and interpreting data from the results of data management. The scope of this research is to analyze the influence of digital marketing strategies in Advertising MSMEs which will be the independent variable and Economic Growth as the dependent variable.

Research Sites

This research will focus and be carried out in the Jakarta Special Region with research data collection points regarding digital advertising MSMEs registered in DKI Jakarta on the BPPBJ Jakarta e-order platform and workforce data obtained from BPS Jakarta through open data, namely the website.

Research variables, Population, Sample

The independent variable used in this research is Digital Marketing Strategy in MSMEs (Variable X), while the dependent variable used in this research is Economic Growth (Variable Y).
In accordance with the research title "The Influence of Digital Marketing Strategy in MSMEs on Economic Growth in digital advertising MSMEs in Jakarta for the period 2018 - 2023, the population in research on economic growth in Jakarta Province from 2018 - 2023 as well as the number of digital advertisings MSMEs and the number of workers in each district /city in Jakarta Province. The sample in this research is the number of MSMEs and workers as well as data on economic growth per capita inside the administrative cities of Central Jakarta, East Jakarta, West Jakarta, North Jakarta, South Jakarta, and East Jakarta.

Data Management and Analysis Techniques

In this research, time series data is used, namely data arranged based on the time sequence of events.[19] Time Series data covers all MSMEs in 5 Administrative Cities in Jakarta Province during 2018 – 2023. Data analysis in this research will use the SPSS version 25 software application. The steps in data analysis are: (1) The Kendall Tau and Spearman tests are tests that have The aim is to test the level of closeness between the independent and dependent variables ordinally. The Kendall Tau test is better to use compared to Spearman if the data is normally distributed, while the Spearman test is better to use if the data is not normally distributed. After carrying out the normality test to choose between Kendall Tau or Spearman, you can then see the value of the magnitude of r and its significance. The amount r shows the level of closeness between two variables or more, while the significance is used for hypotheses with the condition <0.05 which can be said to have a significant effect; (2) Normality test, namely a test to test independent variable data (X) and dependent variable data (Y) in the resulting regression equation. Normally distributed or not. The normality test used in this research is Kolmogorov-Smirnov with the provisions that the variable is normally distributed if the sig value is > 0.05, and the variable is not normally distributed if the sig value is < 0.05; (3) Multicollinearity test, namely a classification assumption test which aims to predict the influence of each indicator or dimension. The condition is that if the correlation coefficient value is greater than 0.60, it can be said that multicollinearity occurs, and if it is less than 0.60, multicollinearity does not occur.

Furthermore, after the class assumption test has been carried out, hypothesis testing can be carried out with two main tests, namely (1) T test, namely the t statistical test to show how far individual explanatory or independent variables are in explaining variations in the dependent variable. The condition is that if the t-count > t-table then each independent variable studied has a positive influence on the dependent variable and if t-count < t-table then there is no positive influence between the dependent variable and the independent variable; (2) The F-test is a statistical tool used to determine whether all of the independent variables in a model have an effect on the dependent variable simultaneously or jointly. The test's limitations state that if F-count is less than F-table, Ha is rejected and H0 is accepted, or if all of the independent variables have no effect on the dependent variable, or if F-count is greater than F-table, Ha is accepted and H0 is rejected, indicating that the independent variables have a joint effect on the dependent variable.

4. RESULT AND DISCUSSION

Classic Assumption Test

In this research, the data used is secondary data from data on the number of MSMEs in DKJ Jakarta Province which use the BPPBJ DKJ Jakarta e-order from 2018 - 2022 as an independent variable or X1, following data on the number of MSMEs in DKJ Jakarta:

Table 1. Data on the number of MSMEs in DKJ Jakarta Province 2018 – 2022

Wilayah	Tahun				
	2018	2019	2020	2021	2022
Jakarta Selatan	6831	13780	13298	11108	10174
Jakarta Utara	5419	11078	9761	17036	9143
Jakarta Barat	12244	16969	15929	10035	15297
Jakarta Timur	7390	14187	13524	19729	14040
Jakarta Pusat	5588	6322	6025	11413	6160
Kepulauan Seribu	378	593	480	480	349
DKJ JAKARTA	37850	62929	59017	69801	55163

Furthermore, data on the number of workers in MSMEs in DKJ Jakarta Province from 2018 - 2022 as an independent variable or X2 is as follows:

Table 2. Number of MSME workers in DKJ Jakarta 2018 – 2022

Wilayah	Tahun				
	2018	2019	2020	2021	2022
Jakarta Selatan	19376	33785	28562	28628	24466
Jakarta Utara	19133	36407	31305	28226	28473
Jakarta Barat	12244	77537	73773	62089	65499
Jakarta Timur	23761	42016	41404	38166	34442
Jakarta Pusat	64497	23842	18688	20596	21579
Kepulauan Seribu	621	1143	1014	767	506
DKJ JAKARTA	139632	214730	194746	178472	174965

Next, the economic growth data seen from the GDP Per Capita DKJ Jakarta 2018 – 2022 as the dependent variable (Y), namely:

Table 3. GDP Per Capita DKJ Jakarta 2018 – 2022

PDRB Per Kapita	Tahun				
	2018	2019	2020	2021	2022
Jakarta Selatan	260945	283969	289569	299330	730224
Jakarta Utara	271806	288449	279767	300342	587224
Jakarta Barat	168585	168094	192975	202371	540696
Jakarta Timur	155398	168094	155287	163795	546887
Jakarta Pusat	690857	769827	665829	682994	794935
Kepulauan Seribu	338932	317724	234079	292214	101346
DKJ JAKARTA	247678	268052	262702	274709	318646

This data will be used to determine the influence of digital marketing strategies in DKJ Jakarta MSMEs on the economic growth of DKJ Jakarta from 2018 - 2022. To find out this, data analysis was carried out using the SPSS Version 25 application. The initial data analysis carried out was a normality test with the condition that if Sig value. (2-tailed) > 0.05 then the data is normally distributed but if the Sig. (2-tailed) < 0.05 with the following results using the One-Sample Kolmogorov-Smirnov Test for normality:

Table 4. Normality Test Results

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		5
Normal Parameters[a,b]	Mean	0,0000000
	Std. Deviation	25258,958
Most Extreme Differences	Absolute	0,344
	Positive	0,344
	Negative	-0,270
Test Statistic		0,344
Asymp. Sig. (2-tailed)		.054[c]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

From table 4 above it can be seen that the Sig. (2-tailed) of 0.054 is greater than 0.05 or 0.054 > 0.05 so it can be concluded that the data for each variable is normally distributed and can be continued with a multicollinearity test using SPSS version 25 provided that the VIF value is < 10 and the Tolerance value more than 0.01, it is concluded that there is no multicollinearity problem. The results of data analysis for the multicollinearity test can be seen from the following table:

Table 5. Coefficients

	Collinearity Statistics	
Variabel	Tolerance	VIF
Jumlah UMKM	0,920	1,089
Tenaga Kerja UMKM	0,920	1,089

From Table 5 above, the Tolerance value is more than 0.01, namely 0.919 and the VIF value is less than 10, namely 1.088, so it can be concluded that there is no multicollinearity problem. After all the classical assumption tests have passed the test or met the requirements, hypothesis data analysis can be carried out using the Kendall's Tau test to determine the relationship between digital marketing strategies, in this case there are two variables, namely the number of MSMEs and the number of workers in MSMEs and the economic growth variable with the variables GDP per capita in DKJ Jakarta Province 2018 – 2022.

Hypothesis Testing

In obtaining research results, a time series hypothesis test was carried out using the Kendall Tau Test, this was done because the time series data was normally distributed. From these data, the results of research and calculations using SPSS Version 25 are as follows:

Table 6. Hasil Uji Kendall Tau

			X1	X2	Y
Kendall's tau_b	Jumlah UMKM	Correlation Coefficient	1,000	,200	,400
		Sig. (2-tailed)		,624	,034
		N	5	5	5
	Tenaga Kerja UMKM	Correlation Coefficient	,200	1,000	,543
		Sig. (2-tailed)	,624		,023
		N	5	5	5
	PDRB Perkapita	Correlation Coefficient	,400	,543	1,000
		Sig. (2-tailed)	,034	,023	
		N	5	5	5

From Table 6 above in the Sig row. (2-tailed), the results of the Kendall Tau correlation test for the digital marketing strategy variable, namely the number of MSMEs, show a significance of 0.034, which means the value is smaller than 0.05. So it can be interpreted that there is a significant relationship between the number of MSMEs and the GDP per capita of DKJ Jakarta Province in 2018-2022. The closeness between the variable number of MSMEs and GRDP per capita can be seen through the correlation coefficient line with a value of 0.400 which is included in the sufficient closeness category. Furthermore, for the digital marketing strategy variable, namely MSME labor, it shows a significance of 0.023, less than 0.05, so it can be concluded that there is a significant relationship between MSME labor in Jakarta DKJ Province and GDP per capita in 2019 - 2022. Closeness between the MSME labor variable with GDP per capita, it can be seen from the correlation coefficient of 0.543, which is included in the strong relationship category.

Discussion

Based on the results of the Kandall's Tau correlation test in table 6, it is known that the relationship between each Digital Marketing Strategy variable in MSMEs in DKJ Jakarta (the number of MSMEs which has a score of 0.034 and the MSME workforce which has a value of 0.023) is less than 0.05 so it can be interpreted that There is a significant relationship between digital marketing strategies in MSMEs and economic growth.

At the level of closeness for the digital marketing strategy variable, namely the number of MSMEs, the correlation coefficient is only 0.400, which is included in the sufficient closeness category, while for the digital marketing variable in the MSME workforce, it has a value of 0.543 and is included in the strong closeness category.

Research conducted by Fatmawati (2023) shows the relationship between e-marketing and the competitive advantage of MSMEs, where the results of this research are directly proportional to the research currently being carried out, namely choosing the real level of significance between variables. So the impact of this digital marketing strategy is directly proportional or has a positive impact on MSMEs that have been registered in the BPBJJ DKJ Jakarta e-order, especially in the digital advertising sector as well as increasing economic growth in the DKJ Jakarta Province. [20]

This digital marketing is a strategy for MSMEs in Jakarta to increase business growth and can contribute to economic growth in DKJ Jakarta Province. The Digital Advertising Services MSME case study also shows that with the right strategy, MSMEs can take advantage of digital opportunities to achieve success and drive economic progress.

5. CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that the relationship between digital marketing strategies in MSMEs and economic growth in DKJ Jakarta has a significant positive influence or relationship both on the variable number of MSMEs on GDP per capita and the variable of MSME workforce on GRDP per capita DKJ Jakarta in 2018 - 2022. Apart from that, at the level of closeness, the influence of digital marketing strategies in MSMEs on the economic growth of DKJ Jakarta has a sufficient and strong relationship. This is proven that every year GDP per capita in DKJ Jakarta increases along with the increase in MSMEs in DKJ Jakarta Province. Apart from that, the existence of MSMEs can create jobs and in the national realm economic competitiveness will also increase.

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Factors Affecting Purchase Intention for Environmentally Friendly Packaged Cosmetics Among Young Consumers

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Abstract: Current environmental and sustainability issues increase consumer attention in consuming products by choosing more environmentally friendly products. One of the products that has a fast turnover, and many types, is cosmetic products. This study explores the factors influencing consumer intentions in purchasing cosmetic products with environmentally friendly packaging. Survey data on students as representatives of Generation Z were processed and showed that perceived value, environmental concern, attitude, willingness to pay, social influence, and brand image influence purchase intention. The results of this study can support companies in producing products with environmentally friendly packaging.

Keyword: purchase intention, sustainable packaging, sustainability

1. INTRODUCTION

In recent decades, global environmental issues have become a major concern for governments, businesses, and consumers worldwide. The problem of waste has become a pressing global issue, affecting ecological health, human well-being, and ecosystem sustainability. An estimated 2.01 billion tons of waste is generated globally each year, and this number is projected to increase with population growth and urbanization (Kaza et al., 2018). Plastic waste is a major concern because only about 9% is recycled, while the rest contaminates oceans, land, and air, causing severe impacts on biodiversity (Brooks et al., 2018). The world's oceans already host more than 8 to 10 million tons of plastic waste each year, threatening marine life and coastal ecosystems (Fava, 2022). In developing countries, waste management challenges are further complicated by a lack of infrastructure, ineffective policies, and low public awareness (Liang et al., 2021). The consequences of inadequate waste management include soil and water pollution, greenhouse gas emissions, and human health risks (Mahajan & Sudan, 2023; Rahman & Ahmed, 2024). One significant issue that has emerged is cosmetic packaging waste. Conventional packaging made from plastic and other non-biodegradable materials has contributed significantly to environmental pollution, negatively impacting ecosystems and human health (Mugobo et al., 2022).

In Indonesia, the problem of cosmetic packaging waste is increasingly worrying, along with the increasing consumption of beauty products by the public. Indonesia is a major hotspot for plastic waste leakage, with plastic accounting for approximately 10.6% of the country's total annual waste (Mustard, 2022). Plastic packaging waste has worsened environmental problems (Yu et al., 2023). Plastic, glass, and paper packaging are difficult to recycle, and small sachets dominate cosmetic waste, making it more challenging to manage and often end up in landfills or polluting the environment. Seeing this phenomenon, several cosmetic manufacturers have released products with more environmentally friendly packaging. Several cosmetic brands with environmentally friendly packaging products in the Indonesian market are The Body Shop, NPure, Avoskin, Sensatia Botanica, etc. Generation Z in Indonesia, born

between 1997 and 2012 (Dimock, 2019), is a demographic group that grew up amidst the rapid development of technology and information. This generation also shows a high awareness of social, environmental, and sustainability issues, influencing their preferences in choosing products and brands (The Deloitte Global, 2022). By examining the purchase intention of Generation Z, this study can provide a deeper understanding of this generation's values, attitudes, and consumption preferences towards cosmetic products with environmentally friendly packaging so that it can help cosmetic companies or industries design effective and relevant marketing strategies.

Several previous studies have explored how cosmetics with eco-friendly packaging affect the preferences of Generation Z consumers. One showed that environmental concern has no significant effect. However, it has been mediated by eco-friendly purchase intention and eco-friendly purchase behavior on eco-friendly cosmetic products in Indonesia (Marbun et al., 2024). This study reveals consumers' intention to purchase eco-friendly cosmetic products by examining several factors. This study was conducted to answer the question of what factors influence the purchase intention of Generation Z consumers towards cosmetic products with environmentally friendly packaging. To answer this question, this study aims to look at several factors that influence purchase intention, including the perceived value of sustainable packaging, environmental concern, attitude towards sustainable packaging, willingness to pay, social influence, and brand image. Several studies have shown factors influencing purchase intention towards environmentally friendly products. However, there is still room for analysis by combining factors that influence the purchase intention of Generation Z toward ecologically friendly cosmetic products.

2. LITERATURE REVIEW

Perceived value of sustainable packaging

The perceived value of sustainable packaging refers to consumers' assessment of the benefits and perceived value of using environmentally friendly product packaging (Anjimoon et al., 2024; Vrabič-Brodnjak & Jestratijević, 2024). This value encompasses functional, emotional, and social aspects related to sustainability. Functionally, consumers evaluate sustainable packaging based on its quality and performance, such as durability, recyclability, or waste reduction. Emotionally, consumers may feel satisfaction or a sense of responsibility for supporting an environmentally conscious brand (L. Chen et al., 2023). From a social perspective, using environmentally friendly packaging can enhance consumers' self-image as individuals who care about environmental issues, in line with social norms that support green behavior (Lan et al., 2023).

Environmental concern

Environmental concern refers to the degree to which an individual is concerned about environmental issues and the negative impacts that human activities have on ecosystems (Borgwardt et al., 2019). This concern can cover many issues, such as climate change, pollution, biodiversity loss, and natural resource depletion. The higher a person's level of environmental concern, the more likely they are to engage in environmentally friendly behaviors, such as purchasing sustainable products, supporting environmental policies, and reducing environmentally damaging consumption (Yang et al., 2024). In the context of consumer behavior, environmental concern plays an essential role as a motivating factor in shaping preferences for products or brands that implement sustainable practices, such as using environmentally friendly packaging or reducing carbon emissions (Ghaffar et al., 2023).

Attitude toward sustainable packaging

Attitude toward sustainable packaging refers to consumers' attitudes or perceptions toward environmentally friendly packaging, such as recyclable, biodegradable, or recycled materials (Tanzares et al., 2024; Veronika et al., 2023). This attitude reflects how consumers consider sustainability important in product packaging and how this influences their purchasing decisions. Consumers with positive attitudes toward sustainable packaging tend to value brands committed

to environmentally friendly practices more and see sustainable packaging as a tangible contribution to environmental preservation (Mongula et al., 2023).

Willingness to pay

Willingness to pay measures how much consumers are willing to pay for a product or service, reflecting their subjective value on the good (Shah & Yang, 2022). Various factors, including perceived quality, perceived benefits, past experiences, and personal preferences influence willingness to pay. In the context of green products, willingness to pay is often related to the consumer's concern for sustainability and social responsibility issues (Civero et al., 2017; Narayanan, 2022). Consumers who are more concerned about environmental impacts, for example, may be willing to pay more for products that are packaged in an environmentally friendly manner or that have sustainability certification (García-Salirrosas et al., 2024).

Social influence

Social influence is how others directly or indirectly influence a person’s attitudes, behaviors, or decisions (Cialdini, 1984). Social influence in marketing and consumer behavior can come from various sources, including family, friends, social groups, celebrities, or social media. This social influence can take the form of social norms, social approval, or peer pressure, which encourages individuals to conform to expectations or trends around them. Social influence is crucial in forming purchasing decisions, as consumers are often influenced by the opinions and recommendations of others, especially in the digital age, where online reviews and testimonials play a significant role (Romadhoni et al., 2023). Studies have shown that social influence also strengthens a person’s social identity, where individuals feel more connected to a particular group by adopting products or services recommended by that group (Wickes et al., 2022).

Brand image

Brand image is a consumer's perception of a brand that is formed through their interaction with the brand's products, services, and communications (Kotler & Keller, 2016). This perception includes associations regarding the quality, uniqueness, and reliability of the product, as well as the emotional experience consumers feel. Brand image is essential in differentiating a brand from its competitors, influencing purchasing decisions, and creating customer loyalty (Dam & Dam, 2021). In the context of the brand image of products with environmentally friendly packaging, the brand image focuses more on the values of sustainability and the company's environmental responsibility. Consumers tend to associate the product with ecological awareness, good business ethics, and a commitment to reducing environmental negative impacts (Metekohy et al., 2024)

Prior relevant research models

Duarte et al., (2024) tested the relationship between several factors influencing consumer purchase intention towards sustainable packaging. The factors tested were the perceived value of sustainable packaging, willingness to pay, environmental concern, and attitude toward sustainable packaging. The results showed that the variable perceived value of sustainable packaging has an influence and is the weakest predictor compared to other variables. This study emphasizes the importance of understanding consumer motivation and the factors influencing their decision to choose sustainable packaging. It also provides insight for stakeholders in designing more effective marketing strategies for sustainable products. Another study by Polanco et al. (2021) examined the relationship between consumer behavior that cares about the environment and sustainable packaging and considered brand image and its impact on purchase intention for ecological wine. The results of his study showed that brand image, together with brand dimensions, are the most powerful and relevant variables in the purchase decision for ecological wine. Brands help consumers feel confident that they are buying high-quality products.

Lan et al. (2023) identified five main factors influencing purchase intention for environmentally friendly packaging products among Ho Chi Minh City urban residents. One of the factors is social influence. The results of the study showed that social influence has a significant impact on purchase intention for products with environmentally friendly packaging. This influence comes from various sources of social information, including family, friends, and the media. This study indicates that consumers exposed to positive environmental norms and values from their social groups are more likely to purchase environmentally friendly products. Research by Nicolae (2024) also supports the idea that the greater the social influence felt by individuals from their social groups, the more likely they are to engage in sustainable purchasing behavior. Therefore, this study proposes to add social influence and brand image from the previous research model Duarte et al., (2024) to determine the purchasing interest of young generation consumers towards cosmetic products with environmentally friendly packaging. According to the theory of planned behavior (TPB) proposed by Icek Ajzen, three main factors influence a person's intention to take action, including attitude, subjective norms and perceived behavioral control (Ajzen, 1991). This study positions the perceived value of sustainable packaging, attitude towards sustainable packaging, environmental concern, willingness to pay, social influence, and brand image as related to attitude, subjective norms, and perceived behavioral control.

Figure 1 illustrates the research framework. The study verifies the influence of the perceived value of sustainable packaging (H1), environmental concern (H2), attitude towards sustainable packaging (H3), willingness to pay (H4), social influence (H5), and brand image (H5) on the intention to purchase cosmetic products with environmentally friendly packaging.

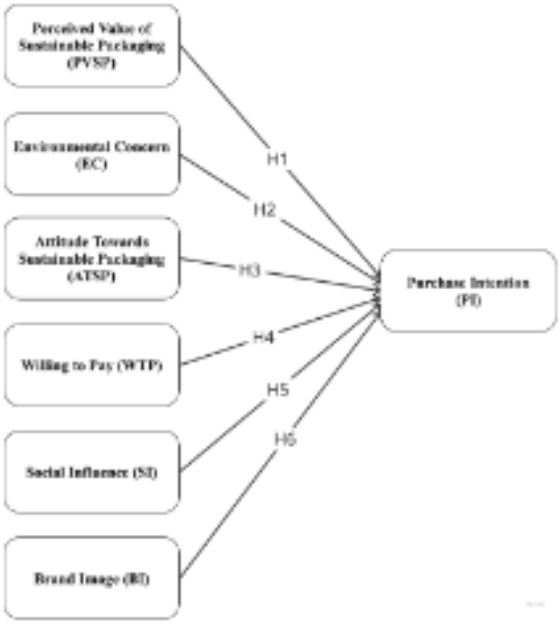

Figure 1. Research Framework

3. METHODS

Sample, data collection, and questionnaire development

The quantitative approach was chosen in this study to explain the relationship between variables. The instrument used was a questionnaire, and a hypothesis was also developed that predicted the results of the relationship between the variables studied. This study examines Generation Z, who were born in 1997 - 2012 (Dimock, 2019) and who are currently in the general range who are studying. The sample in this study focuses on students because it is one of the

right age groups for this study that discusses the intention of using cosmetics with environmentally friendly packaging. Student samples were also selected to reduce the potential for random errors compared to public samples (Andrade, 2021). The survey was conducted on consumer groups of students at a college in Bandung City, West Java, Indonesia. The students are included in the age range of Generation Z (12-27 years). This study used non-probability sampling to target groups of students who use cosmetics with environmentally friendly packaging. Purposive sampling techniques were applied to select respondents based on specific criteria relevant to the study's objectives.

Data were collected using an online questionnaire prepared following the objectives of this study. Researchers distribute links to fill out the survey in areas where students gather. According to Hair et al., the minimum number of samples needed is 130 because there are 26 parameters from six variables (Hair et al., 2006). Respondents who filled out the survey were obtained, and as many as 230 were tested valid and reliable for further analysis. The questionnaire was divided into three sections: where the first section asked for respondents' agreement to take the survey, the second section asked for demographic data from respondents, and the third section asked for data on variables including perceived value of sustainable packaging, environmental concern, attitude towards sustainable packaging, willingness to pay, social influence, brand image, and purchase intention (see Table 1).

Table 1. Measurement scales

Perceived value of sustainable packaging (PVSP) 1. The intended performance of the product with sustainable packaging meets my expectations. 2. The environmental function of products with sustainable packaging creates value for me. 3. I buy products with sustainable packaging because they have more environmental benefits than products with conventional packaging. 4. I buy products with sustainable packaging because they show more environmental concern than products with conventional packaging. 5. I buy products with sustainable packaging because they are sustainable	(Duarte et al., 2024)
Environmental Concern (EC) 1. I am very concerned about the situation of the environment. 2. I am willingness to reduce my consumption to help protect the environment. 3. Major social changes are needed to protect the environment.	(Petkowicz et al., 2024)

4. Major policy changes are needed to protect the environment.	
Attitude Towards Sustainable Packaging (ATSP) 1. I believe that buying products with sustainable packaging is favourable 2. I believe that buying products with sustainable packaging is a good idea 3. I believe that buying products with sustainable packaging is safe	(Petkowicz et al., 2024)
Willingness to Pay (WTP) 1. I agree to pay more for products with sustainable packaging. 2. I am proud to have products with sustainable packaging in my home, even though they are more expensive than products with conventional packaging. 3. I would be willingness to pay more to buy products with packaging that is less harmful to the environment.	(Duarte et al., 2024)
Social Influence (SI) 1. People important to me encourage me to use products with environmentally friendly packaging. 2. Information in the media encourages me to try products with environmentally friendly packaging. 3. I learned that consuming environmentally friendly packaging products contributes to a better environment.	(Lan et al., 2023)
Brand Image (BI) 1. The brand is considered as the benchmark of environmental commitment. 2. The brand's environmental reputation is outstanding. 3. The brand's environmental performance is successful. 4. The branding is based on its emphasis on environmental protection. 5. The brand's environmental commitment is trustworthy.	(Y. S. Chen et al., 2017)
Purchase Intention (PI) 1. For sustainability, I'm going to consider switching to brands that sell their products with sustainable packaging. 2. In the future, I hope to buy products with sustainable packaging for their positive contribution to the environment. 3. I will consider buying products with sustainable packaging because they are less polluting.	(Duarte et al., 2024)

Likert scale: 5 (1 - strongly disagree; 5 - strongly agree)

Data analysis

The statistical analysis used in this study is descriptive statistics, analysis of measurement quality using validity and reliability analysis, correlation analysis, multiple regression analysis, and hypothesis testing. Descriptive statistical analysis includes simple frequency and mean values based on demographic and behavioral data. Furthermore, validity and reliability tests are carried out using the Cronbach alpha coefficient. Correlation analysis identifies relationships between variables, and multiple regression tests hypotheses and evaluates the influence of independent variables on dependent variables.

4. RESULT AND DISCUSSION

Results

Profiles of the respondents

The sample of this study consisted of 25.2% male and 74.8% female. In terms of income that can come from family, work, and others, it is dominated by student respondents who earn less than Rp 2,000,000 as much as 74.3%, those who earn from the range of Rp 2,000,000 - Rp 4,999,999 as much as 20.4% and more than Rp 5,000,000 as much as 5.2%. The results of respondents related to the frequency of using cosmetics: the average value of respondents is 20% using cosmetics 1-3 days a week, 21.3% of respondents using cosmetics 4-6 days a week, and 58.7% of respondents using cosmetics daily.

Table 2. Descriptive statistics

Variable	N	Mean	Std deviation
Perceived Value of Sustainable Packaging (PVSP)	230	3.975	0.7694
Environmental Concern (EC)	230	4.386	0.7104
Attitude Towards Sustainable Packaging (ATSP)	230	4.310	0.7154
Willingness to Pay (WTP)	230	3.765	0.8194
Social Influence (SI)	230	4.064	0.7082
Brand Image (BI)	230	4.062	0.7072
Purchase Intention (PI)	230	4.239	0.7207

Hypothesis testing

Correlation analysis

In this research, the dependent variable is Purchase Intention (PI). There are six independent variables, namely perceived value of sustainable packaging (PVSP), environmental concern (EC), attitude towards sustainable packaging (ATSP), willingness to pay (WTP), social influence (SI), brand image (BI), and purchase intention (PI). The data from this study were processed using SPSS. Measurement quality testing was conducted by conducting reliability, validity, and standard method bias tests, as shown in Table 3. The test showed adequate reliability ($\alpha > 0.7$), the calculated r-value is more significant than 0.3 (Pearson correlation), and convergent validity (AVE > 0.5), as well as the absence of multicollinearity between independent variables (VIF < 10).

Table 3. Reliability, convergent validity, and common bias testing result

	Cronbach's Alpha	Pearson Correlation	Averate Variance Extracted (AVE)	Variance Inflation Factor (VIF)
PVSP	0.927	0.884	0.684	3.181
EC	0.916	0.894	0.763	3.673
ATSP	0.919	0.896	0.753	4.148
WTP	0.938	0.696	0.814	1.621
SI	0.923	0.856	0.589	3.026
BI	0.917	0.908	0.687	3.866
PI	0.917	0.922	0.738	

The Spearman correlation is the non-parametric technique used to calculate the strength and direction of the relationship between two variables. Determining the level of strength of the relationship between variables can be guided by the correlation coefficient value, which is the result of SPSS output, with the following provisions: A correlation coefficient value of 0.00 - 0.25 means the relationship is very weak, a correlation coefficient value of 0.26 - 0.50 means the relationship is sufficient, and A correlation coefficient value of 0.51 - 0.75 means the relationship is strong. Table 4 shows that each variable has a positive correlation with the others.

Table 4. Spearman correlation

	PVSP	EC	ATSP	WTP	SI	BI	PI
PVSP		0.640**	0.664**	0.454**	0.626**	0.660**	0.628**
EC	0.640**		0.735**	0.558**	0.473**	0.618**	0.678**
ATSP	0.664**	0.735**		0.559**	0.531**	0.696**	0.758**
WTP	0.454**	0.558**	0.559**		0.488**	0.497**	0.547**
SI	0.626**	0.473**	0.531**	0.488**		0.617**	0.662**
BI	0.660**	0.618**	0.696**	0.497**	0.617**		0.795**
PI	0.628**	0.678**	0.758**	0.547**	0.662**	0.795**	

** Correlation is significant at the 0.01 level (2-tailed).

Multiple linear regression model analysis

Multiple regression is conducted to measure the relationship between dependent and independent variables and to test hypotheses related to the relationship. In Table 5, R square shows good results. Variations in the dependent variable can be explained by the independent variables included in the regression model. The resulting model is as follows:

1. PVSP predicting PI ($R^2 = 0.562$)
2. PVSP, EC predicting PI ($R^2 = 0.722$)
3. PVSP, EC, ATSP predicting PI ($R^2 = 0.774$)
4. PVSP, EC, ATSP, WTP predicting PI ($R^2 = 0.777$)
5. PVSP, EC, ATSP, WTP, SI predicting PI ($R^2 = 0.811$)
6. PVSP, EC, ATSP, WTP, SI, BI predicting PI ($R^2 = 0.840$)

The sixth model has the highest R2 value, which shows that PSVP, EC, ATSP, WTP, SI, and BI simultaneously predict PI, with a value of 84% of the variance in the PI variable. The Durbin-Watson value is used to evaluate autocorrelation. Autocorrelation occurs if there are residual values that are correlated with each other. The calculation results in Table 5 show a Durbin-Watson value of 1.990, which indicates no autocorrelation.

Table 5. Regression model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.750[a]	0.562	0.560	0.4782	
2	0.850[b]	0.722	0.720	0.3816	
3	0.880[c]	0.774	0.771	0.3446	
4	0.881[d]	0.777	0.773	0.3434	
5	0.901[e]	0.811	0.807	0.3168	
6	0.917[f]	0.840	0.836	0.2922	1.990

a. Predictors: (Constant), PVSP
b. Predictors: (Constant), PVSP, EC
c. Predictors: (Constant), PVSP, EC, ATSP
d. Predictors: (Constant), PVSP, EC, ATSP, WTP
e. Predictors: (Constant), PVSP, EC, ATSP, WTP, SI
f. Predictors: (Constant), PVSP, EC, ATSP, WTP, SI, BI

ANOVA tests whether there is a significant difference between the means of two or more groups. The test results show a simultaneous relationship (Table 6).

Table 6. ANOVA test

Model	Sum of Squares	Degree of freedom	Mean Square	F	Sig.
1	66.831	1	66.831	292.311	0.000[b]
	52.128	228	0.229		
	118.959	229			
2	85.907	2	42.954	295.010	0.000[c]
	33.051	227	0.146		
	118.959	229			
3	92.117	3	30.706	258.534	0.000[d]
	26.842	226	0.119		
	26.533	225			
4	92.426	4	23.106	195.944	0.000[e]
	26.533	225	0.118		
	118.959	229			
5	96.473	5	19.295	192.212	0.000[f]
	118.959	229			
	22.486	224	0.100		
6	99.925	6	16.654	195.122	0.000[g]
	19.034	223	0.085		
	118.959	229			

a. Dependent Variable: PI
b. Predictors: (Constant), PVSP
c. Predictors: (Constant), PVSP, EC
d. Predictors: (Constant), PVSP, EC, ATSP
e. Predictors: (Constant), PVSP, EC, ATSP, WTP
f. Predictors: (Constant), PVSP, EC, ATSP, WTP, SI
g. Predictors: (Constant), PVSP, EC, ATSP, WTP, SI, BI

Linear regression (Partial)

The results of linear regression calculations are used to see the magnitude of the influence (R Square) of each independent variable (PVSP, EC, ATSP, WTP, SI, and BI) on the dependent variable, namely PI. The R-square value of PVSP on PI is obtained at 0.562, EC on PI is obtained at 0.684, ATSP on PI is obtained at 0.701, WTP on PI is obtained at 0.332, SI on PI is obtained at 0.623, and BI on PI is obtained at 0.733.

Figure 2. Model results

Conclude from the hypothesis that the research results show the impact of six factors: (1) the perceived value of cosmetic products with environmentally friendly packaging, (2) environmental concern, (3) willingness to pay, (4) the consumer's attitude towards the cosmetic products with eco-friendly packaging, (5) social influence, (6) brand image to intention to buy cosmetic products with environmentally friendly packaging of college student as young generation group.

Discussion

This study's results align with and complement the models of previous studies produced by Polanco et al., (2021), and Lan et al., (2023), and Duarte et al., (2024). Based on multicollinearity measurements, willingness to pay has the lowest value, and these results align with prior studies' results. Spearman correlation analysis and hypothesis testing show a strong relationship between all variables in this research model. The results show a positive relationship between the perceived value of sustainable packaging and the purchase intention of cosmetic products with environmentally friendly packaging. These results are in line with the research of Lan et al., (2023) and Wu et al., (2024). The higher the green perception value consumers feel, the more likely they will have a high purchase intention for the product (Wu et al., 2024). Likewise, this study shows that environmental concern influences purchase intention and attitude positively influences purchase intention, and these results support previous research conducted by Lan et al., (2023). Duarte et al., (2024) revealed that environmental concerns and perceptions of product quality mainly support consumer willingness to pay for sustainable products. This study also shows that consumer willingness to pay affects their purchase intention for cosmetic products with environmentally friendly packaging. This study also confirms the results of Nicolae (2024) and Lan et al., (2023) that social influence has a positive and significant influence on sustainable purchasing behavior. The greater the social influence individuals feel from their social group, the more likely they are to engage in sustainable purchasing behavior, such as buying organic products (Nicolae, 2024) or products with environmentally friendly packaging, as studied in this study. Chen et al. (2017) and Polanco et al., (2021) explained that brand image shapes consumer perceptions of environmentally friendly brands. This study also shows that brand image influences consumers' intention to purchase cosmetic products with environmentally friendly packaging and brand image shows the most significant influence on purchase intention. This study contributes to previous studies by conducting several tests on factors that impact consumer purchasing interest. However, it still needs to be deepened by adding additional evidence to strengthen the analysis of consumer interest in products with environmentally friendly packaging.

5. CONCLUSION

This study contributes to the existing literature by increasing our understanding of the factors influencing consumer purchase intention towards products with environmentally friendly packaging, especially in this study, consumers from the younger generation (Gen Z). It can be concluded that perceived value, environmental concern, attitude, willingness to pay, social influence, and brand image have a significant influence on the purchase intention of cosmetic products with environmentally friendly packaging. Therefore, cosmetic companies need to increase campaigns that focus on the value of sustainable packaging and continue to make various efforts to build brand image. Companies can also strengthen by attracting several influencers whose impact is felt to be positive and good to increase consumer willingness to switch to types of cosmetic product offerings with environmentally friendly packaging. In addition, the results of this study have respondents with a dominant female gender. This shows a higher interest and positive attitude among women towards purchasing cosmetics with environmentally friendly packaging. Therefore, companies must consider targeting women to increase purchase intention towards cosmetic products with environmentally friendly packaging. Some limitations in this study are the sample size, which is still relatively small, and the scope that can still be expanded in the sampling area. So that further research can be conducted with wider and more samples. In addition, it can also use other factors that influence consumer purchase intention to buy cosmetic products with environmentally friendly packaging.

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The Effect of Profitability on Firm Value with Corporate Social Responsibility Disclosure as a Moderating Variable

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Abstract: The assessment of social responsibility and its impact on the company is challenging mathematically because it is a qualitative study. This study aimed to examine the effect of profitability as measured by ROA and ROE on Tobin's Q firm value and to analyze Corporate Social Responsibility (CSR) in moderating the relationship between profitability and firm value. The findings of this research, which is descriptive quantitative and examines multiple regression models on independent variables (ROA and ROE) as well as the moderating effect of variables (CSR) on firm value (Tobin's Q), have significant implications for the field of corporate governance. The population of this study consists of public companies listed on the Indonesia Stock Exchange (IDX) during 2018-2021, with a total of 619 issuers. The sample was obtained using a purposive sampling technique for as many as 64 companies. The results of this study indicate that ROA does not affect Tobin's Q, while ROE has a positive effect on Tobin's Q. CSR cannot strengthen the influence of ROA on Tobin's Q. On the other hand, CSR weakens the influence of ROE on Tobin's Q.

Keyword: ROA, ROE, Firm Value, Tobin's Q, Corporate Social Responsibility.

1. INTRODUCTION

A publicly listed company is a corporation whose shares or ownership are publicly traded on the capital market. The stock or company value reflects the market's perception of the company's ability to generate sustainable profits, risk management, innovation, and other aspects that contribute to business continuity and growth. The capacity to generate profits is gauged through profitability ratios that assist stakeholders, including investors, management, creditors, and regulators, in making prudent decisions, formulating business strategies, and assessing operational efficiency and risk management. Consequently, a comprehensive grasp of the elements influencing a company's value is vital to ascertain the present condition of the company and its prospective trajectory. Investors and the general public evaluate the company based on the information presented in its published reports. As stakeholders, they can influence market value, necessitating companies to fulfill their social responsibilities. One method of fulfilling corporate social responsibility (CSR) is to publish a sustainability report (SR). Preparing a sustainability report (SR) constitutes a qualitative study conducted by the company in collaboration with relevant stakeholders. Investors evaluate the sustainability of the company's business operations by analyzing this report in conjunction with its financial data. This follows the fundamental principles of corporate social responsibility (CSR), namely the 3P approach (people, planet, profit). Using GRI guidelines in Indonesia is voluntary and not a mandatory requirement imposed by the government. Following POJK Number 51/POJK.03/2017, public companies must incorporate sustainability-related information into annual reports. In the case of public companies, integrating sustainability aspects with annual reports is a common practice, resulting in what is known as an integrated report. A review of publicly listed companies on the Indonesia Stock Exchange (IDX) revealed that only 64 out of 619 listed companies had published sustainability reports as of December 2018. In some reports, there was no cross-index of disclosure items and their sustainability codes. The creation of such an index is essential to ensure the validity of CSR measurement in the study and to align it with the information reported by the company to the public and other related parties.

Previous studies have yielded contradictory results regarding the impact of profitability on firm value, as measured by Tobin's Q. The study's findings conducted by (Ardianto et al., 2017) indicate a positive relationship between ROA and firm value. Moreover (Muslim & Junaidi, 2020) assert in their research that ROE positively affects firm value.

Both studies concur that an increase in profitability results in greater responsiveness from investors, which in turn leads to an increase in the value of the company. However, research by Anggraini & Widhiastuti (2020) indicates that ROA has no effect on firm value. Similarly, (Prasetyo et al., 2020) propose that ROE has no impact on firm value. These disparate findings underscore the imperative need for a deeper understanding of the factors influencing firm value. Prior research on the moderating effect of corporate social responsibility (CSR) on profitability has yielded inconsistent results. Savitri (2017) found that CSR can reinforce the impact of ROA on firm value, yet it is unable to enhance the influence of ROE on firm value. This contrasts with the findings of Itsnaini & Subardjo (2017). The research conducted by Saridewi (2018) indicates that CSR can reinforce the relationship between ROE and firm value. Conversely, the research conducted by Itsnaini & Subardjo (2017) suggests that CSR is unable to enhance the impact of ROA on firm value. The existing research on corporate social responsibility (CSR) disclosure highlights a need for novel approaches to stimulate further investigation. The forthcoming GRI standardization updates are anticipated to motivate more companies to publish sustainability reports. This study employs CSR moderation variables that either reinforce or attenuate the influence of return on assets (ROA) and return on equity (ROE) on firm value. In contrast to previous studies, this study utilizes the GRI standard as a reference for CSR assessment, replacing the Guidelines version, which is no longer valid.

1) In light of the aforementioned description, the issues inherent to this study can be distilled into the following questions: Does ROA exert a notable and positive influence on firm value?
2) Does ROE have a discernible and positive impact on firm value?
3) Does CSR serve to reinforce the relationship between ROA and firm value?
4) Does CSR have a noticeable and reinforcing effect on the relationship between ROE and firm value?

2. LITERATURE REVIEW

The signaling theory

The concept of signaling theory was introduced by Spence (1973) in his research entitled Job Market Signaling. By this theory, information can serve as a signal whereby the entity possessing said information (the sender) endeavors to convey pertinent details to the recipient. The recipient then modifies its conduct following its interpretation of the signal. As defined by Brigham & Houston (2018), signal theory refers to the actions undertaken by company management to provide information or instructions to investors regarding the company's performance and future prospects. Rachman & Priyadi (2022) posit that within the corporate realm, internal parties (management) endeavor to disseminate favorable signals to external parties, particularly investors. It can be inferred that within the framework of signal theory, information is orchestrated in a manner that enables internal stakeholders (managers) to transmit positive or negative signals to stakeholders (shareholders/investors). The objective is to elicit the desired response that will facilitate attaining organizational goals.

Stakeholder theory

Freeman first introduced the stakeholder theory (in Suharyani et al., 2019) to assess the relationship between companies and the various groups that exist beyond the realm of shareholders. These stakeholders, as defined by the theory, are individuals or entities that can be affected by or affect a company's actions. The term "stakeholder" is used to describe any individual or entity with an interest in a company that can potentially influence or be influenced by the company's actions. (dalam Chumaidah, 2018) asserts that stakeholder theory represents a company's dedication to promoting sustainable economic growth through a concentration on corporate social responsibility and pursuit of equilibrium between considerations of economic, social, and environmental factors, in addition to attention to suppliers, customers, governments, communities, investors, employees, political associations, and trade. This is because these stakeholders possess rights to the actions undertaken by company management.

Legitimacy theory

Legitimacy theory posits a social contract between a company and society. Ghozali and Chariri (in Chumaidah, 2018) posit that legitimacy theory is founded upon the concept of a "social contract" between a company and the community in which it operates and utilizes economic resources. In order for institutions to achieve goals in line with the wider community, legitimacy theory is a necessary concept. In conclusion, legitimacy theory can be defined as the concept of a "social contract" between companies and society. Companies fulfill their social obligations, such as publishing reports on their activities, while society supports these activities. When companies meet the expectations of society, they can ensure the legitimacy of their activities and the sustainability of their corporate life. This allows them to attract external investors, which ultimately increases the value of the company.

Profitability

The term "profitability" refers to the ability of a company to generate profits. The profitability ratio is a financial ratio that describes the effect of a combination of liquidity, asset management, and debt on operating results (Brigham & Houston, 2018). A company with a good level of profitability allows stakeholders, including creditors, suppliers, and investors, to ascertain the extent to which the company generates profits. This is a factor that increases the value of the company (Itsnaini & Subardjo, 2017).

Return On Assets (ROA)

The return on assets (ROA) is the ratio of net income to total assets. This ratio quantifies the earnings generated after accounting for interest and taxes on total assets. The ROA demonstrates the efficacy of managerial decision-making concerning the utilization of the company's assets for generating profits. Other names for ROA include the Economic Rentability ratio (RE ratio), Asset Return Rate, Asset Income Ratio, and Asset Profitability (Wahyuningsih & Widowati, 2016)..An elevated ROA indicates a greater return, which, in turn, has a beneficial impact on the company's value. Following Appendix 1 of OJK Circular Letter Number /SEOJK.03/2019, the evaluation criteria for ROA in public companies are classified into several categories, as outlined as follows: The first rank is assigned to those companies with a ROA exceeding 1,450%. The second rank is defined by a ROA value between 1.215% and 1.450%. A ROA of 0.999% defines the third rank to 1.215%. The fourth rank is associated with a ROA of 0.765% or less, inclusive of the range of 0.999%. The fifth rank comprises those with a ROA of 0.765% or less.

Return On Equity (ROE)

Return On Equity (ROE) is defined as the ratio of income generated on invested capital. roe serves as an indicator of the efficacy of managerial efforts in optimizing returns on shareholder investments. the roe is calculated by dividing the net income attributable to common shareholders by the common equity, thereby measuring the return on shareholder investment. roe is the most comprehensive indicator of profitability for investors. A high ROE indicates that the company's top management has been successful in achieving the mission of the company owner, namely profit per rupiah of invested capital (Wahyuningsih & Widowati, 2016). An elevated ROE corresponds with a greater return, which, in turn, has a beneficial effect on the company's value. In accordance with appendix 1 of OJK circular letter number/SEOJK.03/2019, the ROE assessment criteria for public companies are classified into several categories, as outlined below:

The ranking system is as follows: RANK 1: ROE > 23%, Rank 2: 18% < ROE ≤ 23%, Rank 3: 13% < ROA ≤ 18%, Rank 4: 8% < ROA ≤ 13%, Rank 5: ROA ≤ 8%

Firm Value

The company's value is defined as the present value of the future cash flows that the company is expected to generate. In this study, the firm value is calculated using Tobin's Q ratio, which was introduced by Prof. James Tobin in 1969.

This ratio is calculated by dividing the market value of a company (market value of shares and liabilities) by the replacement value of its assets (replacement cost). The Tobin Q ratio is a widely utilized measure in academic research due to its integration of fundamental financial elements and replacement cost, which enhances the relevance of the firm value assessment (Pratiwi et al., 2017). Calculating Tobin's Q requires the application of lengthy and complex processes to determine the replacement cost value. This resulted in the development of subsequent studies that sought to simplify the fundamental Tobin's Q equation. The version of Tobin's Q developed by Lindenberg & Ross (1981) introduced a simplified market value of debt formula and replaced the replacement value of assets with the book value of assets. This version is frequently employed in diverse research simulations due to its consistent accuracy and proximity to the original Tobin's Q formula. These findings are also corroborated by Black et al. (2003), whose research employs the book value of total assets as a means of approximating replacement cost. The findings indicate that the discrepancy between the replacement value and the book value of total assets is not substantial, thereby suggesting that the two variables can be effectively substituted for one another (Pratiwi et al., 2017). The measurement of firm value employs the formula developed by Lindenberg & Ross (1981). However, the use of the book value of debt instead of the market value of debt, as observed in the research conducted by Rajagukguk et al. (2019), enables a more conservative analysis. This is due to the fact that the research sample comprises public companies from diverse sectors, which exhibit varying credit risk and debt market value characteristics.

Corporate Social Responsibilities (CSR)

According to the World Business Council for Sustainable Development (WBCSD), corporate social responsibility (CSR) is a business's commitment to sustainable economic growth by working with employees, their representatives, their families, their communities, and society. The goal is to improve the quality of life in a way that benefits both business and development. The assessment of CSR can be seen in the Sustainability Report (SR) or Sustainability Report published by the company. One organization that actively publishes guidelines or standards related to the sustainability reporting framework is the Global Reporting Initiative (GRI). GRI standards are dedicated to disclosure reporting that focuses on material issues. Reporting to these standards can provide a comprehensive picture of the company's material issues, related impacts, and how those impacts are managed. Any company can use some or all of the GRI Sustainability Reporting Standards. The GRI Standard includes 3 universal standard modules: GRI 101 Foundation, GRI 102 General Disclosure, GRI 103 Management Approach, and other specialized modules: GRI 200 Economy, GRI 300 Environment, and GRI 400 Social. The CSR variable is measured by observing the number of information items disclosed in the sustainability report divided by the total number of disclosure items. If the information item is not present, it is assigned a score of 0. If the information item is present, it is assigned a score on a scale of 1 to 5, depending on the completeness of the disclosure. Based on this calculation, the evaluation results become $0 \leq CSR \geq 1$, so the closer to 1, the better because it shows the seriousness of the company in fulfilling its social responsibility.

Hypothesis formulation

The Effect of ROA on Company Value

Return On Asset (ROA) is a ratio that compares net income (after interest and taxes) to total assets. Company management and investors want their assets to be productive to have a high ROA because the higher the ROA value, the more effective the company is in managing its assets. This is in accordance with signal theory, where companies that have high ROA make investors respond positively (Wahyuningsih & Widowati, 2016). Some previous studies provide results in accordance with signal theory, where the higher the ROA, the better the feedback given by investors is to increase the company's value. The previous research was conducted by (Rozaq, 2020), (Dwiast et al., 2019), (Lestari & Rahmayanti, 2017), and Ardianto et al. (2017). In contrast to research conducted by Rahmantio et al. (2018), Anggraini & Widhiastuti (2020), and (Robiyanto et al., 2020), which showed that the ROA results had an insignificant effect on firm value. Based on the theory used and the description of previous research, the hypothesis that can be formulated is as follows:

H1: ROA has a significant and positive effect on firm value.

The Effect of ROE on Firm Value

Return On Equity (ROE) is a ratio that measures the ratio of net income (after interest and taxes) to total equity. ROE indicates the success or failure of management in maximizing returns on shareholder investment. This is in line with signal theory, where the higher the roe, the higher the success of company management in fulfilling the owner's mission, namely profit per rupiah of capital invested in the company (Wahyuningsih & Widowati, 2016). Several previous studies agree that roe has a significant effect on firm value, as conducted by Rahmantio et al. (2018), (Mega Wahyu Vebriany, 2015), (Muslim & Junaidi, 2020), (Salma & Sulasmiyati, 2021). In contrast to research conducted by Nafisah et al. (2018), Dama & Tulung (2017), Robiyanto et al. (2020), dan Silalahi (2016) where ROE has an insignificant effect on firm value. Previous research still has inconsistent results, so new data analysis is needed. Based on the theory used and the description of previous research, the hypothesis that can be formulated is as follows:
H2: ROE has a significant and positive effect on firm value.

CSR strengthens the effect of ROE on Firm Value

Corporate Social Responsibility (CSR) is a concept in which a company is committed to continuing to behave ethically and fulfill its responsibilities in its business activities, as well as paying attention to the balance between stakeholders in the company (Wahyuningsih & Widowati, 2016). Referring to signal theory and stakeholder theory, stakeholders will evaluate how well the company's financial performance and social responsibility. The company legitimizes its activities to manage assets effectively and responsibly by publishing sustainability and financial reports. previous research on social responsibility that significantly moderates the effect of ROA on firm value can be seen in research conducted by (Lestari & Rahmayanti, 2017), (Chumaidah & Priyadi, 2018), and (Savitri, 2017). Some studies conclude that CSR does not significantly moderate the effect of ROA on firm value, which can be seen in the research (Rozaq, 2020), (Itsnaini & Subardjo, 2017), (Rachman & Priyadi, 2022), and (Harningsih et al., 2019). Based on the theory used and the description of previous research, the hypothesis that can be formulated is as follows:
H3: CSR has a strengthening effect on the relationship between ROA and firm value.

CSR strengthens the effect of ROE on Firm Value

Based on signal and stakeholder theory, it is important for management to disclose CSR information to provide positive signals to stakeholders regarding future economic benefits because investors will choose to invest in companies that provide the information they need. Companies publish sustainability reports and financial reports as a form of legitimization and commitment to managing investor capital. Previous research supports that CSR significantly moderates the effect of ROE on firm value, as conducted by (Saridewi, 2018). As for research done by (Savitri, 2017), and (Karimah & Arifin, 2019) where CSR does not significantly moderate the effect of ROE on firm value. Based on the theory used and the description of previous research, the hypothesis that can be formulated is as follows:
H4: CSR has a strengthening effect on the relationship between ROE and firm value.

3. METHOD

Population and Sample

The population in this study are all publicly listed companies listed on the Indonesia Stock Exchange (IDX) for 2018-2021. The total number of public companies as of December 2018 is 619 issuers. The selection of the time period was with the consideration that the 2016 GRI Standard was officially enforced in 2018. The sampling method used in this study is non-probability sampling, which uses a purposive sampling method to obtain a representative sample following the specified criteria. This research sample has the following criteria: 1) Public companies from all sectors

listed on the Indonesia Stock Exchange (IDX) during 2018-2021; 2) Public companies that publish both separate and integrated sustainability reports during the 2018-2021 period; 3) Public companies that publish annual reports consecutively in the 2018-2021 period. The number of selected samples that meet the criteria is 64 companies from all sectors except technology because it has just become one of the sectors on the IDX on August 5, 2019.

Data and Data Collection Methods

The type of data used in this study is secondary data originating from third parties. This data has undergone a professional audit process according to government policy and is officially published to be processed immediately and considered valid and reliable. The data source is downloaded from the official company website, which is the sample. The data collection technique is a document study that observes and records the company's annual and sustainability reports. This research data is recorded as panel data (balanced), a combination of time series and cross-section data with the same number of observations for all groups.

Multiple linear regression analysis

Linear regression analysis in studies with moderator variables is called moderated regression analysis (MRA). This analysis uses a regression equation that includes an element of interaction, which is the multiplication of two or more independent variables (Ghozali, 2016). This research implements panel data regression because the data used are panel data by choosing the common effect model, fixed effect, or random effect model (REM). The regression equation is as follows:

$$Y = c + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_1 * M + \beta_4 X_2 * M + e$$

Where:

Y = Company value (Tobin's Q)	= (Market Value of Stock + Debt)/TA
c = Constant	
β1 - β4 = Regression coefficient	
X1 = Independent variable (ROA)	= EAT/Total Assets
X2 = Independent variable (ROE)	= EAT/Total Equity
M = Moderator variable (CSR)	= Corporate Sustainability Index Disclosure $firm_i = \frac{\sum Xi}{n_i}$
X1*M = Interaction between ROA with CSR moderator	∑Xi = Number of GRI standard items disclosed
X2*M = Interaction between ROE with CSR moderator	
e = error term	

4. RESULT AND DISCUSSION

Descriptive statistics

Variable Y (Tobin's Q as Company Value)

Variable Y is the company value proxied by Tobin's Q; from the statistical data, it can be seen that the maximum value is 17.72 owned by Unilever Indonesia Tbk. in 2018, while the minimum value is 0.47 belonging to the Herbal and Pharmaceutical Industry Sido Tbk. in 2018. Variable Y has a median value of 1.02 and an average of 1.51. It can be concluded that the market highly values the average company. The standard deviation of 2.08 indicates that the data

tends to be more widely spread and diverse than the average value. This can happen because the data sample comes from various industrial sectors.

Variable X1 (ROA)

Variable X1 is ROA; from the statistical data, it can be seen that the maximum value is 0.92, owned by Merck Tbk. in 2018, while the minimum value (-0.58) belongs to Garuda Indonesia (Persero) Tbk in 2021. The X1 variable has a median value of 0.03 and an average value of 0.04. It can be concluded that, on average, the company is included in the first rank of good ROA criteria according to OJK. The standard deviation of 0.11 indicates that the data tends to be more widely spread and diverse than the average value. This can happen because the data sample comes from various industrial sectors.

Table 1. Descriptive Statistics

Statistic	Y (Tobin's Q)	X1 (ROA)	X2 (ROE)	M (CSR)
Mean	1.513419	0.039899	0.131115	0.543707
Median	1.023513	0.025651	0.087909	0.525078
Maximum	17.71587	0.920997	5.445534	0.935294
Minimum	0.474422	-0.580308	-2.543396	0.336306
Std. Dev.	2.082184	0.112998	0.469555	0.103785
Observasion	256	256	256	256

Variable X2 (ROE)

Variable X2 is ROE; from the statistical data, it can be seen that the maximum value is 5.45, owned by Waskita Beton Precast Tbk. in 2020, while the minimum value (-2.54) belongs to Bumi Resources Tbk. in 2020. The X2 variable has a median value of 0.09 and an average value of 0.13. It can be concluded that, on average, the company is included in the third rank of good ROE criteria according to OJK. The standard deviation of 0.47 indicates that the data tends to be more widely spread and diverse than the average value. This can occur because the data sample comes from various industrial sectors.

Variable M (CSR)

Variable M is CSR as a moderator variable; from the statistical data, it can be seen that the maximum value is 0.94 owned by ABM Investama Tbk. in 2021, while the minimum value is 0.34 owned by Bank OCBC NISP Tbk. in 2018. The X2 variable has a median value of 0.53 and an average value of 0.54. It can be concluded that on average the company only discloses about 54% of the applicable GRI standards. The standard deviation of 0.10 indicates that the data is homogeneous and gathers closer to its mean value. This happens because the observation data is calculated using the same GRI standard indicator.

Variable X1 (ROA)

Variable X1 is ROA; from the statistical data, it can be seen that the maximum value is 0.92, owned by Merck Tbk. in 2018, while the minimum value (-0.58) belongs to Garuda Indonesia (Persero) Tbk in 2021. The X1 variable has a median value of 0.03 and an average value of 0.04. It can be concluded that, on average, the company is included in the first rank of good ROA criteria according to OJK. The standard deviation of 0.11 indicates that the data tends to be more widely spread and diverse than the average value. This can happen because the data sample comes from various industrial sectors.

Linear Regression Test

Chow Test

The calculated Prob. Chi-square value is 0.0000. This indicates that the probability value is less than the standard significance level (0.0000 < 0.05). Upon examination of the criteria for hypothesis determination, it can be concluded that the null hypothesis (Ho) is rejected, and the alternative hypothesis (Ha) is accepted. The results of the analysis indicate that the panel data multiple regression model selected for the Chow test is the fixed effect model (FEM).

Hausman Test

The probability Chi-square value is 0.0000, as indicated by the calculation results. This indicates that the probability value is less than the standard significance level (0.0000 < 0.05). Upon examination of the criteria for hypothesis determination, it can be concluded that the null hypothesis (Ho) is accepted, and the alternative hypothesis (Ha) is rejected. The results of the analysis of the suitability of the panel data multiple regression model in the selected Hausman test are the fixed effect model (FEM).

In this study, the Chow and Hausman tests yielded identical results, namely the fixed effect model. Consequently, the LM (Lagrange Multiplier) test was deemed unnecessary. Ultimately, it can be posited that the optimal model for investigating the influence of ROA and ROE on firm value (Tobin's Q) with CSR as a moderating variable is the fixed effect model (FEM).

Classical Assumption Test

This study employs the fixed effect model (FEM), which is an ordinary least squares (OLS) approach. Consequently, only two classical assumption tests were conducted: the multicollinearity test and the heteroscedasticity test. The results of the assumption tests are presented below:

Heteroscedasticity Test

The objective of the heteroscedasticity test is to ascertain whether there is an inequality of variance in the residuals of observations in a regression model. The results of the heteroscedasticity test were processed using the Eviews program. The probability of the variables X1, X2, and M having a value greater than the real level $\alpha = 0.05$ was calculated, indicating that these variables are homoscedastic or exhibit no symptoms of heteroscedasticity.

Multicollinearity Test

As this study employs more than one independent variable, it is essential to assess the presence of multicollinearity. The cutoff value employed is Tolerance ≥ 0.10, equivalent to VIF ≤ 10 (since VIF = 1/Tolerance). A tolerance value of 0.10 or greater indicates that the level of collinearity must be less than 0.90. The results of the multicollinearity test indicate that the variables X1, X2, and M exhibit a low correlation value and a collinearity level of ≤ 0.90, thereby demonstrating the absence of multicollinearity. Similarly, the Variance Inflation Factors (VIF) test in Table 4.6 indicates that the variables X1, X2, and M have a VIF value of less than 10, confirming the absence of multicollinearity.

Multiple linear regression analysis

Multiple linear regression models are used to test the effect of ROA and ROE variables on Tobin's Q with moderation of CSR variables. Multiple regression models are calculated using Eviews 13, and the estimation results are as follows:

Table 2. Multiple Regression Results - Partial (FEM)

Dependent Variable: Y				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	1.393762	0.053059	26.26840	0.0000
X_1	1.006378	3.632654	0.277037	0.7821
X_2	3.972865	1.165683	3.408187	0.0008
X_1*M	2.559404	6.836779	0.374358	0.7086
X_2*M	-7.087596	2.211111	-3.205446	0.0016
F-statistic	33.78261			0.0000
Adjusted R-squared	0.895979			

The t-test shows the effect of the relationship between the independent variable and the dependent variable partially. Based on Table 2 above, the effect of the independent variable on the dependent variable is as follows:

The t-test value of the ROA variable (X1) is 0.277037 is smaller than the t-table of 1.969. The result indicates no significant and positive effect of the ROA variable (X1) on Tobin's Q company value (Y). The results of the t-test on the ROE variable (X2) with the obtained t-statistic value of 3.408187 is greater than the t-table of 1.969. This shows that the ROE positively impacts company value. The t-test results on the interaction variable (X1*M) is 0.374358, smaller than the t-table value of 1.969. These results indicate that there is no significant and reinforcing effect of CSR variable (M) on the relationship between ROA (X1) and Tobin's Q (Y) company value. The t-test results on the interaction variable (X1*M) obtained a t-statistic value of -3.205446, smaller than the t-table of 1.969. This indicates that the Ho hypothesis is accepted at the 5% real level. These results indicate that there is no significant and reinforcing effect of the CSR variable (M) on the relationship between ROE (X2) and Tobin's Q (Y) company value.

Discussion

The influence of ROA on company value.

The results of the t-test on profitability (ROA) and firm value (Tobin's Q) indicate that the t-statistic value of 0.277037 is less than the t-table value of 1.969, thereby providing evidence that the null hypothesis is accepted. This indicates that the null hypothesis is accepted at the 5% significance level. Therefore, the Ha hypothesis is rejected, as there is no significant and positive effect of the ROA variable on Tobin's Q firm value. The results of this study contradict signal theory, which states that ROA disclosure is a company's effort to provide positive signals to investors. There are several reasons that cause ROA to have no effect on firm value, including the possibility that investors in the observation period do not consider asset aspects as a consideration for their investment decisions.

The results of the analysis align with those of previous research conducted by, (Anggraini & Widhiastuti, 2020), (Rahmantio et al., 2018), and (Robiyanto et al., 2020) concluded that ROA has no effect on firm value because it is not a factor investors consider when making investment decisions during the observation period. In contrast to these findings, several studies have demonstrated that ROA positively impacts firm value. For instance, (Rozaq, 2020), (Dwiastuti & Dillak, 2019), (Lestari & Rahmayanti, 2017), (Ardianto et al., 2017) and (Nafisah et al., 2018). The studies by (Mumtazah & Purwanto, 2020), (Dama & Tulung, 2017), (Chumaidah & Priyadi, 2018) (Silalahi, 2016) and (Savitri, 2017) also reached this conclusion.

The effect of return on equity (ROE) on company value.

The t-test results on profitability (ROE) and firm value (Tobin's Q) indicate that the t-statistic value of 3.408187 is greater than the t-table value of 1.969, thereby proving that the null hypothesis is rejected. This indicates that the null hypothesis is rejected at the 5% significance level. Therefore, the alternative hypothesis is accepted, indicating the ROE variable's significant and positive effect on Tobin's Q company value. The findings of this study align with the

tenets of signal theory, which posits that the disclosure of ROE by a company is an attempt to disseminate positive signals to investors. A high ROE indicates that the company has healthy finances, particularly regarding capital management. This signal is responded to positively by investors interested in investing their capital to increase stock demand. Furthermore, high stock demand will impact the company's share price increase. The level of ROE is positively related to the stock price, which determines the company's value. The significant positive effect of ROE on firm value (Tobin's Q) is consistent with the findings of previous research conducted by (Rahmantio et al., 2018), (Mega Wahyu Vebriany, 2015), (Salma & Sulasmiyati, 2021). In contrast with the findings of (Nafisah et al., 2018), (Dama & Tulung, 2017), (Robiyanto et al., 2020), (Silalahi, 2016), and (Prasetyo et al., 2020), who concluded that ROE has no effect on firm value.

The strengthening effect of CSR on the relationship of ROA to firm value

Based on the results of the t-test on the interaction variable (X1*M), which symbolizes the moderation of CSR on the relationship between ROA and firm value (Tobin's Q), the t-statistic value of 0.374358 is smaller than the t table of 1.969. This shows that the Ho hypothesis is accepted at the real level of 5%. It can be concluded that the Ha hypothesis is rejected because there is no significant and reinforcing effect of CSR variables on the relationship between ROA and Tobin's Q firm value. The results indicate that, statistically, CSR in sustainability reports cannot strengthen the effect of ROA on firm value. This is not in accordance with signaling theory, where CSR disclosures in sustainability reports that show the company's alignment with stakeholder interests do not get the desired reciprocity. The company's communication with stakeholders, especially capital market investors, should be a positive signal to strengthen the company's value. This can be caused by other factors outside research that influence investors' decisions.
This study supports studies conducted by (Rozaq, 2020), (Itsnaini & Subardjo, 2017), (Rachman & Priyadi, 2022), (Harningsih et al., 2019), (Khasanah & Istikhoroh, 2019), and (Putri, 2017) who concluded that CSR is unable to moderate the effect of ROA on firm value. In contrast to the research results of (Lestari & Rahmayanti, 2017), (Chumaidah & Priyadi, 2018), and (Savitri, 2017) which reveals that CSR moderates the effect of ROA on firm value.

The effect of CSR on the relationship of ROE to firm value

Based on the results of the t-test on the interaction variable (X2*M), which symbolizes the moderation of CSR on the relationship between ROE and firm value (Tobin's Q), the t-statistic value of -3.205446 is smaller than the t table of 1.969. This shows that the Ho hypothesis is accepted at the real level of 5%. It can be seen that the t-statistic (X2*M) is negative while the probability value of 0.0016 is smaller than the real level α 0.05. It can be concluded that CSR variables have a significant and weakening effect on the relationship between ROA and Tobin's Q firm value. The results show that CSR in sustainability reports statistically weakens ROE's effect on Tobin's Q firm value. This is still in accordance with the signal theory put forward by (Chumaidah & Priyadi, 2018), which states that CSR disclosure in sustainability reports can contain positive or negative signals depending on the company's condition. In other words, a sustainability report that contains negative CSR information indicates that the company's condition is not good. The company's poor condition will reduce investors' assessment of the company's ROE, reducing the company's value. Since CSR content contains economic information, including the company's financial health, sustainability reports can be influenced by company performance and external environmental influences such as economic recession. CSR results that weaken the influence of ROE on firm value are supported by research conducted by (Febriana, 2013). This is different from the research by (Saridewi, 2018), which concluded that CSR strengthens the influence of ROE on firm value. As for research that suggests that CSR cannot moderate the relationship between ROE and firm value at all, as conducted by (Savitri, 2017) and (Karimah & Arifin, 2019). The regulation of environmental aspects based on Financial Services Authority Regulation Number 51/POJK.03/2017 at least, includes 1) energy use (including electricity and water); 2) reduction of emissions produced (for Financial Institutions, Issuers, and Public Companies whose business processes are directly related to the environment); 3) reduction of waste and effluent (waste that has already entered the environment) generated (for Financial Services Institutions, Issuers and Public Companies whose business processes are directly related to the Environment); or Environment); or 4) preservation of biodiversity (for

Financial Services Institutions, Financial Institutions, Issuers and Public Companies whose business processes are directly related to the Environment); or Environment) (Peraturan Otoritas Jasa Keuangan, 2017). For example, BRI actively manages greenhouse gas emissions and endeavors to address climate change as part of responsible and environmentally conscious business practices. BRI is developing green banking products and services following regulations in response to the market demand for green finance (BRI, 2023). PERTAMINA 's aspiration to implement green and sustainable energy is translated into energy transition pillars, namely improving PERTAMINA's refineries to generate eco-friendly fuel, further developing bioenergy into biomass and bioethanol, optimizing potentials, as well as increasing installed geothermal capacity and hydrogen commercialization (Pertamina, 2023). In ESG management, in 2023, PERTAMINA implemented a series of emission reduction programs from operational activities and successfully recorded 1,135 million tons of CO2e reduction in emissions. With this achievement, overall, from 2010 until the end of 2023, PERTAMINA has contributed to reducing carbon emissions by 8.5 million tons of CO2e from the 2010 emission baseline. The sale of B35 biodiesel reduced emissions by 28 million tons of CO2e annually. PERTAMINA also develops methane gas (CH4) emissions management and decarbonization efforts, contributing to a reduction in methane gas (CH4).

5. CONCLUSION

In conclusion, the results of the analysis indicate that there is a significant positive relationship between profitability and firm value. The findings suggest that firms with higher profitability levels tend to have higher firm values. The analysis of the effect of profitability (ROA and ROE) on firm value (Tobin's Q) with Corporate Social Responsibility (CSR) as a moderating variable, carried out in public companies listed on the Indonesia Stock Exchange (IDX) in 2018-2021, yielded the following results: 1) The ROA variable does not exert a significant and positive effect on Tobin's Q company value, thereby accepting the Ho hypothesis; 2) The ROE variable exerts a significant and positive influence on Tobin's Q company value, thereby rejecting the Ho hypothesis; 3) Corporate Social Responsibility is categorized as a potential moderating variable (homogenizer moderating) based on MRA analysis. The results indicate no significant and reinforcing effect of CSR variables on the relationship between ROA and Tobin's Q firm value. Consequently, the Ho hypothesis is accepted. Similarly, the analysis shows no significant and reinforcing effect of CSR variables on the relationship of ROE to Tobin's Q firm value. The company must comply with the provisions of the Financial Services Authority Regulation Number 51/POJK.03/2017 on implementing sustainable finance for financial services institutions, issuers, and public companies institutions (Peraturan Otoritas Jasa Keuangan, 2017). Most companies, such as BRI and PERTAMINA, comply with this provision described in the discussion session. In light of the aforementioned analysis, discussion, and conclusions, the following recommendations can be put forth:

1) Future research may wish to consider alternative proxies for firm value, such as PBV (price to book value), as the dependent variable
2) Future research is expected to take a sample of companies from one particular sector in order to ensure more accurate representation of the results.

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Fostering Waste Management Skill on Coastal Community in Kelan Village Through Organic Fertilizer Production Workshop

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Abstract: This research focuses on a training programme conducted in a coastal village to enhance the community's knowledge and skills in producing liquid organic fertiliser. The initiative aimed to increase awareness and proficiency in managing organic waste generated by households and businesses. The training centred on utilising a 200-litre drum for anaerobic fermentation to produce nutrient-rich liquid organic fertiliser. The process harnesses the potential of anaerobic decomposition to transform organic waste into a valuable resource for agricultural purposes. The results displayed a substantial positive shift in the community's understanding of liquid organic fertiliser production, with a remarkable 75% increase in comprehension achieved. This underscores the efficacy of community engagement and practical training in fostering sustainable waste management practises. This research contributes to the field of sustainable waste management by demonstrating an effective approach to empowering coastal communities to repurpose organic waste. The utilisation of locally available resources and the promotion of circular economy principles enhance the practicality and replicability of the approach. The outcomes of this initiative can serve as a model for similar communities facing waste management challenges, ultimately contributing to the broader goal of achieving environmental sustainability.

Keyword: coastal community, organic fertilizer, waste management, workshop

1. INTRODUCTION

The Kelan Village, Kuta District, Badung Regency is a beach tourism village which is positioned side by side with Ngurah Rai International Airport. The length of the Kelan Village beach reaches one kilometers of white sand, which is a very beautiful place to watch the sunset as well as watch airplanes take off and landing. In addition, on the coast there are restaurants and cafes managed by the local community and the Pokdarwis (Tourism Awareness Group) of Kelan Village. The existence of domestic waste reaches four tons per day and during holidays it can reach twelve tons per day. Until now, this waste problem has not been handled properly, while the disposal of waste to the Suwung Landfill as a place for waste disposal for Denpasar, Badung and Gianyar residents is currently no longer accommodated. Piles of waste are increasing in volume along with the increase in population, especially from immigrants whose number has exceeded the native population. This is in addition to having a positive impact on improving the community's economic, it also has an impact on increasing the volume of waste. Until now, the Kelan Village does not yet have a TPS3R, but the TPS (Temporary Disposal Site) building already exists and it seems that it only transfers waste and there is no good management. This makes the waste problem a priority problem for Kelan Village. Bendesa Adat also hopes to develop the potential for costal farming considering that there is still a lot of land belonging to traditional villages that has not been utilized, and at the same time for educational media for school children and the public to see directly the use of organic fertilizer which will be made from organic waste from restaurant or household waste (Lango et al., 2021). The costal farming locations that have been prepared by Kelan Village cover an area of more than one hectare in three locations in the local village area.

The various solutions that are planned to be implemented are in accordance with the needs of partners and are downstream of research results that have been published and also simple patents. Research results Putu Eka Pasmidi Ariati, namely Agro-Entrepreneurship Socialization for Pengani Farmer Groups Towards Environmentally Friendly Agriculture in Kintamani-Bali (Komang Suparyana et al., n.d.), Critical Soil Optimization Strategy Through The Utilization Of Agricultural Waste, Livestock, and Fisheries (Ketut Widnyana, Alit Wiswasta, Eka, & Ariati, 2019). The research results from the proposing team I Ketut Widnyana which have been published include Strategy of Optimization Integrated Waste Management in Sanur Kauh Village – Denpasar (Putu, Adi, Suarna, & Windia, 2015), Critical soil optimization strategy through the utilization of agricultural waste, livestock, and fisheries, Agro-Entrepreneurship Socialization for Mengani Farmer Groups Towards Environmentally Friendly Agriculture in Kintamani-Bali, Empowerment of the Baha Village community, Mengwi sub-district, Badung district in the field of household waste management (Ketut Sumantra et al., 2020), Building community-based agricultural and tourism sector synergy in the Subak Lepud area of Baha Village (Widnyana & Wiswasta, 2019), Preparation of liquid organic fertilizer made from snail mas plus (pocmas plus) and its application to rosella plants in the seedling phase (Sumantra & Widnyana, 2022). In addition to these research results related to the manufacture of liquid organic fertilizer (POC). There are simple patents that are applied, namely Liquid Organic Fertilizer Formulation Registered number S00202103911 on May 27 2021 (Patent No. IDS000006518, 2023), and Bio-charcoal Briquette Formulation for starch starch adhesive Registered number S00202302462 on March 18 2023. Research results from the proposing team member: I Made Wahyu Wijaya, related to waste processing organic matter into compost and briquettes has been published under the titles Refuse Derived Fuel Potential Production from Temple Waste as Energy Alternative Resource in Bali Island (M. W. Wijaya, Wiratama, Putra, & Aris, 2023), Recycling Temple Waste into Organic Incense as Temple Environment Preservation in Bali Island (I. M. W. W. Wijaya et al., 2021), Compost Production through Household Waste Management Using Composter Bag in Ayunan Village, Badung Regency (Cokorda, Wijaya, & Paramita, 2022). The purpose of this activity is to help the indigenous people of Kelan Village in dealing with waste with the 3R program, namely reduce, reuse and recycle.

2. LITERATURE REVIEW AND METHODOLOGY

The implementation of the PDB activities Strengthening Kelan Village, Kuta District, Badung Regency, Bali towards Tangguh and Pro-Environmental Tourism Village specifically prioritized in the environmental sector is carried out by managing household waste and restaurant waste into new products. Methods for implementing this activity include preparation, counseling, training, mentoring, monitoring and evaluation, as well as planning follow-up programs.

Table 1. Mapping community group problems, solution plans and activity achievement indicators.

Priority Issues	Solution Plan	Achievement Indicator
Handling of household waste (PKK Group)	a. Extension of household waste management b. Assistance with household waste processing installation technology c. Training on making liquid organic fertilizer (POC) from household waste	a. 100% of PKK members understand household waste management b. 20 installation units for processing household waste into POC c. 80% of PKK members are skilled in making POC fertilizer
Handling of restaurant waste (culinary/ Restaurant Business Group)	a. Extension of restaurant waste management b. Liquid waste processing installation assistance c. Training on making liquid organic fertilizer (POC) from restaurant waste	a. 90% of culinary managers understand restaurant waste management b. 10 installation units for processing restaurant waste into POC c. 80% of culinary managers are skilled in making POC fertilizer

Education

Extension activities aim to provide information and education for partner groups related to the components of program activities. Education activities were attended by partner groups according to the type of activity with resource persons from the proposing team and experts. There were several outreach activities during the first year namely Education on Organic Waste Management and Education on Making Liquid Organic Fertilizer (POC).

Training

Training activities aim to improve the competence of partner groups so that they can overcome the problems experienced by partners. The training activities will be attended by the waste management group, the Kelan Village PKK and the Kelan tourism awareness group (Pokdarwis). The training activities that will be carried out in this program are as follows: source-based waste sorting training, POC manufacturing technique training, and organic plant cultivation technique training. Making liquid organic fertilizer in this program aims to handle organic waste in households and restaurants. Making POC will be carried out on a household and communal scale at TPS. The process of making POC consists of chopping and fermenting in a drum with a capacity of 200L with an estimated processing time until it is ready to be harvested for 2 months. The harvested POC is then collected and standardized before being used and commercialized. The technological scheme for processing organic waste into POC is presented in Figure 1.

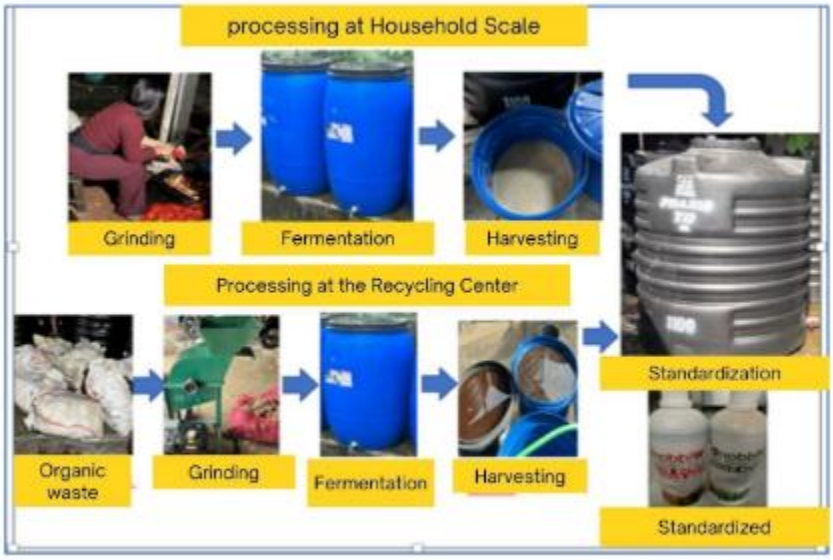

Figure 1. Stages of making liquid organic fertilizer (POC) from household/restaurant organic waste materials

3. RESULT AND DISCUSSION

The Kelan Village area is still in the beautiful category but in environmental management it really needs a touch to be developed. Various problems that are very urgent in nature to be addressed, especially related to tourism, the environment, and the management of waste and organic waste. In carrying out the service activities "GDP Strengthening Kelan Village, Kuta District, Badung Regency, Bali towards a Tangguh and Pro-Environmental Tourism Village" the activity begins by coordinating the initial activities, preparing the tools and materials needed, and implementing the activities. Based on these problems, the activities that have been carried out are: Socialization of Waste Management and Organic Waste, Manufacture of POC Fermentation Installation (Organic Liquid Fertilizer), and Training on making POC based on household and restaurant waste.

Socialization of Waste Management and Organic Waste

Socialization activities for Waste and Organic Waste Management have been carried out by inviting community groups including representatives from the PKK, Pokdarwis, and Restaurant Managers. The number of participants who were given socialization was 20 people plus 3 traditional village administrators. From initial observations of community understanding of the utilization of household waste and restaurant waste, the following data is obtained:

Table 2. Preliminary survey about the participant knowledge

No	Question	Response (%)	
		Yes	No
1	Do you know that household waste and restaurant waste can pollute the environment	100	0
2	Do you experience difficulties in managing household waste and restaurant waste	90	10
3	Do you want Kelan Village to be clean and free of waste?	100	0
4	Do you know that kitchen waste and restaurant waste can be used to fertilize plants	5	95
5	Do you know that kitchen waste and restaurant waste can be used as Liquid Organic Fertilizer (POC)?	5	95
6	Do you know that kitchen waste and restaurant waste have economic value	5	95
7	Have you ever made Liquid Organic Fertilizer (POC) from kitchen and restaurant waste?	0	100
8	Are you willing to make Liquid Organic Fertilizer (POC) from kitchen and restaurant waste	100	0

Based on the analysis of the answers to the questions above, further counseling and training activities are carried out on the utilization of household and restaurant waste into organic liquid fertilizer (POC). Through counseling in the form of utilizing household and restaurant waste in the manufacture of liquid organic fertilizer (POC), there was an increase in the understanding of the Kelan Village community in managing organic waste, this can be seen in the results of the pre-test and post-test carried out during community service activities (Suanda, Budiasa, Suta, Ariati, & Widnyana, 2021). The results of the pre-test and post-test can be seen as follows:

Table 3. Pre-test and post-test results of partners' understanding of liquid organic fertilizer (POC)

No	Question	Pre Test (%)		Post Test (%)	
		Yes	No	Yes	No
1	Do you know that kitchen waste and restaurant waste can be used to fertilize plants	5	95	100	0
2	Do you know that kitchen waste and restaurant waste can be used as Liquid Organic Fertilizer (POC)?	5	95	100	0
3	Do you know what is meant by Liquid Organic Fertilizer (POC)	10	90	100	0
4	Do you know the materials used in the manufacture of liquid organic fertilizer	10	90	100	0
5	Do you know how the process of making liquid organic fertilizer	0	100	100	0
6	Do you know what is called a fermenter and its benefits?	5	95	100	0
7	Do you know what molasses is and its benefits?	5	95	100	0
8	Do you know how to harvest and store liquid organic fertilizer (POC)?	0	100	100	0
9	Do you know how to use liquid organic fertilizer (POC) for plants?	10	90	100	0

The results of the pre-test showed that most of the participants did not know what liquid organic fertilizer (POC) was made from household/restaurant waste, how to make it, how to store it, and how to use it. After conducting socialization and practice regarding the use of organic waste in the manufacture of liquid organic fertilizer, a post test was carried out with very significant results. POC socialization activities are presented in Figure 2.

Figure 2. Workshop on production of Organic Liquid Fertilizer (POC) for household waste and restaurant waste

Liquid Organic Fertilizer (POC) installations were handed over to partners from PKK women's groups, Pokdarwis and Restaurant Managers each with 10 units so that the total assistance reached 30 units. In an effort to maximize the utilization of the installation, training is carried out with the aim that each installation recipient can use the installation properly and according to standards. The installation consists of 3 parts: plastic drums with a capacity of 200 liters, organic material nets, internal supports, faucets and outer supports. This installation is made simply but has maximum function and is very practical for use by the general public. The results of measuring the increase in the skills of community groups in the use of liquid organic fertilizer installation are as shown in the following figure.

4. CONCLUSION

The undertaken activities yield the following conclusions: firstly, the effective management of household and restaurant waste constitutes a primary concern for the Kelan customary village, underscored by the enthusiastic participation of community groups in counseling and training initiatives. Secondly, the counseling sessions have evidenced a commendable improvement, with community knowledge on kitchen and restaurant waste management surpassing a 75% increase. Lastly, after undergoing four training sessions, the proficiency of community groups in employing liquid organic fertilizer installations experienced a full 100% augmentation.

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