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Utilization of Rose Waste Through Design Thinking as a Source of Essential Oil and Food Ingredients: A Sustainable Approach in Waste Management

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The rose farming industry in Ngliman Village, the largest in Kediri Residency, offers farmers daily income due to frequent harvests. However, their earnings are unstable because of fluctuating rose prices, leading to financial uncertainty. When prices drop, farmers often discard their unsold produce, either on land or in rivers, causing pollution and creating unsanitary conditions. This research seeks to reduce this waste and increase the value of rose harvests. Using a design thinking framework and qualitative methods, the study delves into the challenges faced by rose farmers and proposes solutions, including knowledge management for post-harvest processing. A brainstorming session with multiple stakeholders generated 36 actionable ideas to stabilize farmers' incomes. The research provides guidance on transforming raw rose harvests into finished products with more consistent market value.

Keywords: Waste Management, Design Thinking, Rose, Product Development.

1. Introduction

East Java Province is one of the largest rose producers in Indonesia. According to data from the Central Statistics Agency, rose production in the province reached 105.6 million stems in 2020. One of the main rose-producing areas in East Java is Nganjuk Regency, specifically in Ngliman Village. This village is known as a rose cultivation center, with approximately 95% of its residents growing roses on their front lawns or on slopes of the mountain (Suyanto et al., 2023)

Given the supportive natural potential, the harvest from rose plants is abundant. Rose farmers in Ngliman Village can produce 1 ton of roses per month. However, the selling price of these roses remains fluctuating. Based on the fluctuating selling prices, rose farmers in Ngliman Village often discard their harvests into rivers or leave them to pile up on their land. This practice is carried out because the harvests do not have a significant market value. The offered selling price is very low, approximately IDR 2,000 per bucket(Machfiroh et al., 2022). Farmers assume that it is better to dispose of the roses into the river or let them accumulate on the land rather than sell them at such a low price. These practices have indirect effects on air and water pollution. Disposing of the harvest into the river results in a buildup of both the roses and waste, which can obstruct the flow of water. Meanwhile, leaving the harvest on the land results in scattered petals that become waste and contribute to litter.

Waste is the byproduct of daily human activities.(Suasono et al., 2023). Waste management is a systematic, comprehensive, and continuous activity involving the reduction and handling of waste (Law No. 18 of 2008) (Maskun et al., 2022). According to Waste Management (Suasono et al., 2023), waste management includes activities for managing waste from its inception to disposal, encompassing collection, transportation, treatment, and disposal, accompanied by monitoring and regulation of waste management. There is a need for a solution to reduce the disposal of rose harvest waste.

This study explores problems and potential solutions to enhance the selling price of rose harvests for farmers in Ngliman Village, in collaboration with MSMs KWT located in the village. The aim of this research is to address the issues with effective solutions using design thinking methodology.

2. Literature Review

A. Waste Management

Waste management is often regarded as a crucial step toward achieving sustainable development goals, as it affects many facets of society and the economy (Maskun et al., 2022). (Sahil et al., 2016) However, it can also be perceived as a barrier to progress. Several factors, such as population density, socio-economic and environmental characteristics, along with societal attitudes, behaviors, and cultural norms, play a significant role in shaping waste management practices.

Theories on environmental sustainability encompass various concepts and principles aimed at maintaining ecosystem balance and ensuring the wise and sustainable use of natural resources. One such theory is the resilience theory (Partelow et al., 2020). Resilience theory focuses on the capacity of ecological, economic, and social systems to cope with changes and disturbances while recovering from stresses and disasters. The principles of sustainability include enhancing a system's adaptive capacity and flexibility to remain functional amidst challenges. Resilience theory serves as a conceptual framework for understanding and managing the ability of systems—whether ecological, social, or economic—to navigate change, disturbances, and uncertainty, and to recover from stress and crises (Talubo et al., 2022).

This theory emphasizes the importance of adaptation, flexibility, and the ability of systems to

remain functional in the face of challenges. Resilience theory offers a holistic and adaptive approach to managing systems amid uncertainty and disruptions (Talubo et al., 2022). By applying resilience principles, various systems can better prepare for future challenges, maintain their functionality, and thrive despite significant changes and pressures.

B. Principles of Resilience

The principles of resilience encompass various strategies and approaches to enhance a system's ability to cope with change and disruptions (Jackson & Ferris, 2013). Here are some key principles of resilience:

1. Diversity and Redundancy: Diversity in a system's components (such as species in an ecosystem or resources in an economy) and redundancy (duplication of essential functions) can increase the system's ability to adapt and survive unexpected situations.

2. Modularity: Systems structured in relatively independent or modular units are more likely to continue functioning when parts of the system are disrupted.

3. Adaptive Capacity: The ability to learn from experience, modify behaviors, and adopt innovations is crucial for enhancing a system's resilience.

4. Connectivity: Strong networks of interaction within and between systems can help distribute risks and resources, though excessive connectivity can also exacerbate the spread of disruptions.

5. Rapidity of Recovery: The ability of a system to quickly return to a functional state after being disturbed is essential for maintaining resilience.

6. Proactive Management: Proactively managing systems by identifying and mitigating potential risks before they become threats can help maintain stability.

7. Social Capacity: In social contexts, resilience also involves community strength, social networks, and collective ability to respond to change.

8. Long-term Sustainability: Focusing on long-term outcomes rather than just short-term solutions ensures that systems not only survive but also thrive over time.

By applying these principles, systems can be better prepared to face uncertainties, maintain functionality, and adapt to changing circumstances and challenges.

C. Design Thinking

Design thinking is a problem-solving methodology that centers on human needs, emphasizing empathy, collaboration, co-creation, and stakeholder involvement to foster creativity and innovation. This approach strives to generate meaningful and appropriate ideas or solutions. At its core, design thinking involves a deep understanding of the end users of a product to identify unmet needs. This is achieved through a comprehensive insight into their beliefs, values, motivations, behaviors, challenges, benefits, and difficulties, with the goal of presenting innovative solution concepts (Hwa et al., 2016).

According to (Roterberg, 2018), design thinking is a holistic approach aimed at solving problems and addressing the needs of target audiences to create and develop creative business models or a series of business models. Fundamentally, design thinking is employed as an

approach to identify strategies and solutions by gaining an understanding of the people who are the focus of product or service design. The design thinking method, as outlined by Christian Mueller-Roterberg, can be divided into six stages: understand, observe, point of view (define), ideate, prototype, and test (Roterberg, 2018).

According to (Ambrose & Harris, 2009) design thinking is a process that transforms initial guidelines or requirements into a product or solution. Their approach to design thinking is outlined in seven stages: define, research, ideate, prototype, select, implement, and learn. Each of these stages requires design thinking. Combining the theories presented by Hwa et al. (2016), Roterberg (2018), and Ambrose and Harris (2009), design thinking can be understood as a method that emphasizes empathy, collaboration, and stakeholder participation to stimulate creativity and innovation in problem-solving with a human-centered focus. The goal is to generate significant solutions by deeply understanding the values, motivations, behaviors, and challenges of the end users. Generally, the design thinking process involves stages such as understanding the problem, observing, defining the problem from various perspectives, ideating and selecting ideas, developing prototypes, and testing (Fannisa et al., 2021).

D. Product Development

The strategic significance of user engagement in new product development has gained increasing recognition among both academics and practitioners (Leclercq et al., 2017; Liu et al., 2024). Customers have become a crucial source of information and insights for companies aiming to create products that closely align with user needs (Santoro et al., 2017; Tang & Marinova, 2020; Von Hippel, 2006, 2007). Rather than being passive recipients of innovations, users now play an active, constructive, and empowered role in the new product development process (Baldwin & von Hippel, 2011; Fuchs & Schreier, 2011; Rathore et al., 2016; von Hippel, 1976; Von Hippel et al., 2011). They often demonstrate enthusiastic involvement in the development process. Insights from customers can significantly improve the effectiveness of new product development (Bano & Zowghi, 2015a; Liu et al., 2024) and potentially help companies strengthen their competitive edge in the market.

A commonly accepted view of user engagement defines it as users' interactions with a focal object, such as a new product in development, which involves cognitive, emotional, and behavioral commitment to maintaining an active relationship with that object (Bano & Zowghi, 2015b; Brodie et al., 2011; Mollen & Wilson, 2010). Specifically, user engagement includes both observable participation and subjective involvement, reflecting users' behavioral actions and their psychological state related to their identification with and attitudes toward the object (Bano & Zowghi, 2015b; Barki & Hartwick, 1989; Hwang & Thorn, 1999).

3. Case and Methodology

This research utilizes a qualitative method to investigate and understand the meanings that individuals or groups attribute to social or personal issues (Creswell & J. David Creswell, 2018) Qualitative research produces data in the form of words, which can be derived from extensive responses to interview questions, answers to open-ended questions in questionnaires, observations, or readily available information gathered from various sources such as the Internet (Sekaran & Bougie, 2016). This study employs an experimental method, which is a

systematic approach used to investigate cause-and-effect relationships by controlling specific variables. The experimental method applied here is the field experiment, which involves direct engagement in the field. Data was collected through in-depth interviews with six participants to explore challenges. The participants, who were rose farmers, were interviewed in the village of Ngliman.

In the effort to explore and formulate solutions for the SMEs of the Sidodadi farmer group, the design thinking method is employed. This approach aligns with the concept described by (Roterberg, 2018), where design thinking is a holistic approach focused on problem-solving and meeting target needs to create and develop creative business models or a series of business models. Generally, design thinking is used as an approach to identify strategies and solutions by understanding the needs of the target audience in designing products or business services. The design thinking framework proposed by Christian Mueller-Roterberg consists of six stages: understand, observe, point of view (define), ideate, prototype, and test (Roterberg, 2018) In this research, the design thinking concept is developed based on (Roterberg, 2018) theory, as illustrated in Figure 1.

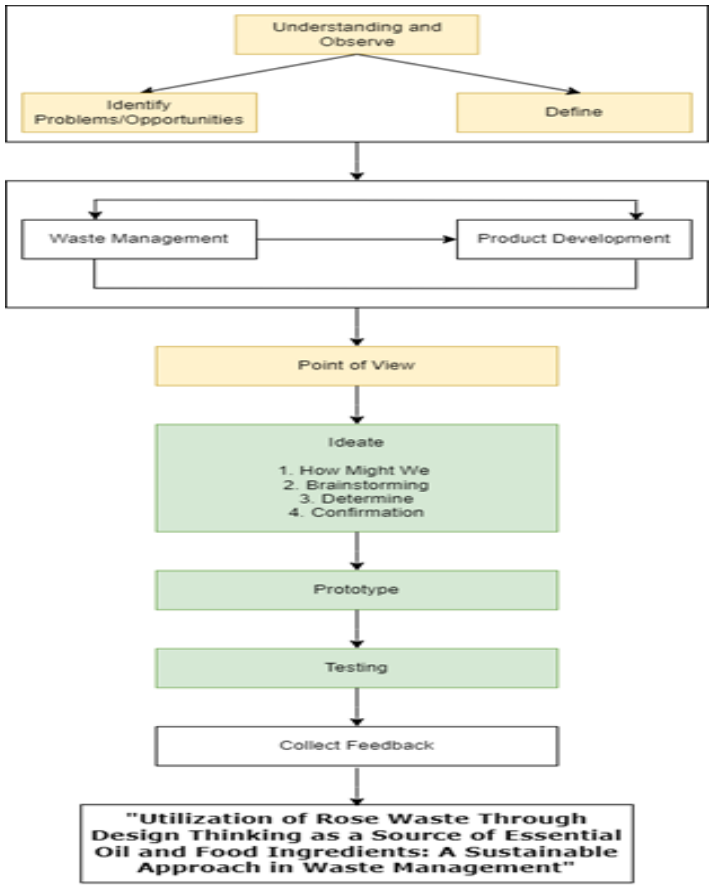

Figure 1. Development of Design Thinking Concept

Source: Author's elaboration (2024)

Fase 1: "Understanding"

In this initial phase, the primary step is to develop a deep understanding of the existing challenges, problems, or needs. Researchers must clarify who needs to be involved in the process, particularly from a technical perspective (organizational processes) that is required. Additionally, it is important to clearly define how questions can be well-formulated so that customer needs or problems can be accurately identified. This phase is highlighted in the research background to comprehend the phenomena occurring within the context of the study. In this research, the respondents for solution formulation include rose farmers, small and medium-sized enterprises (SMEs) involved in herbal food processing, and potential consumers. This stage involves creating an empathy map for the rose farmers. The results of the empathy map for this group are presented in Tables 1.

Tabel 1. Summary Results of Internal Empathy Map Rose Farmers

<table>
<tr><td>THINK</td><td>FEEL</td></tr>
<tr><td>a. Farmers consistently produce abundant harvests.
b. The selling price of roses is unstable.
c. The lowest prices are detrimental to farmers.
d. Not all farmers have access to middlemen.
e. There is often a significant gap between maintenance costs and selling prices.
f. This situation contributes to the farmers' lack of prosperity.
g. Harvests sold at low prices are better left in the field or discarded into the river.</td><td>a. The harvest of nearly one ton per week is an attractive opportunity to pursue.
b. The fluctuating and generally low selling prices cause frustration among farmers.
c. Farmers are concerned about potential losses.
d. Farmers worry about the possibility of their harvests not being distributed.
e. Farmers are dissatisfied with the gap between production costs and harvest income.
f. Farmers feel that their quality of life is not improving.
g. Farmers are dissatisfied with the low prices of their harvests.</td></tr>
<tr><td colspan="2">DO</td></tr>
<tr><td colspan="2">a. Cultivating rose plants.
b. Seeking alternative solutions to increase selling prices.
c. Innovating to enhance the selling price of products.
d. Transforming raw materials into finished products.
e. Commercializing products.
f. Reforming raw materials with low selling prices.
g. Finding solutions to prevent the harvest from becoming waste.</td></tr>
<tr><td>PAIN</td><td>GAIN</td></tr>
<tr><td>a. Decreased interest among farmers due to fluctuating selling prices.
b. Insufficient knowledge management among farmers.
c. Lack of extension services on product processing.
d. Underdeveloped information systems accessible to farmers.
e. Market prices are uncontrollable.
f. Farmers are constrained by local regulations.
g. Limited alternatives available in the field.</td><td>a. Desire for profitable simultaneous rose cultivation.
b. Desire for training in product creation.
c.Adequate information systems for farmers.
d. Ability to process harvests into high-value products.
e. Ability to improve the well-being of rose farmers.
f. Freedom from local regulations that hinder the development of rose farmers.
g. Transforming raw materials into finished products.</td></tr>
</table>

Source: Author’s Compilation (2024)

A. Fase 2 “Observe”

In this phase, in-depth research and observation of customer needs and problems are conducted, focusing on identifying the consumer groups that will be targeted in the development of the solution formulation concept. Identifying the target consumers is crucial, as the design thinking approach emphasizes the importance of developing solutions centered around the end user. Additionally, in this stage, rose farmers are observed based on their perceptions and experiences gathered through direct field visits. This research involves interviews for data collection, and the data obtained from these interviews will serve as the basis for designing an appropriate strategy for rose farmers in Ngliman Village. Observations are conducted directly in Ngliman Village.

B. Phase 3: "Point-of-View"

After observing the potential target customers, researchers must analyze the problem from the customer's perspective, focusing on the challenges they encounter and the appropriate solutions to address them. This stage is crucial for clarifying general conditions, precisely defining the target group, and gaining a comprehensive understanding of customers' needs and behaviors. The outcomes of this point-of-view analysis are presented in Table 2.

Table 2. Source Point of View Mapping Results

USER	NEED	INSIGHT
Rose Farmer	a. Requires knowledge management to address fluctuating prices. b. Requires solutions to address the issue of wasteful disposal of harvests.	a. The market cannot accept raw harvest materials; processing is required to enhance their value. b. Maximizing the processing of harvests to help increase the market value of rose-based products.

Source: Author’s Compilation (2024)

C. Phase 4: "Ideate"

In the ideation phase, the actual brainstorming process takes place. To generate the final idea that will be developed into a solution, the researchers follow four stages adapted from IDEO (2015): How Might We, Brainstorming, Determination, and Confirmation. These stages are used to validate whether the proposed solution effectively addresses the issues identified by rose farmers. The "How Might We" stage is particularly focused on identifying potential opportunities for designing a solution, and the insights gained from the previous phase are used to formulate questions that are mapped out in the "How Might We" process, as shown in Table 2.

1. Requires knowledge management for post-harvest processing.
2. Needs special attention for post-harvest management.
3. Waste management.
4. Requires a solution to reduce waste.

Tabel 2. How Might We

INSIGHT	HOW MIGHT WE
a. Farmers receive training on processing harvests by transforming raw materials into high-value products. b. Farmers can reduce waste from unsold harvests by converting them into products with higher market value than the prices offered by middlemen.	a. How can knowledge management be provided for post-harvest processing? b. How can waste management be addressed in rose farming?

Source: Author's Compilation (2024)

Based on the problem ranking, which is the result of prioritizing the issues faced by rose farmers, the following are 36 ideas addressing these problems. These ideas were generated using the 365 method, as presented in Table 3.

Table 3. List of Ideas Based on Problems

NO	IDEA	EXPLANATION
1	Rose Essential Oil	Transforming rose petals into high-quality essential oil for use in the perfume, aromatherapy, and beauty industries.
2	Rose Water	Producing natural rose water that can be used as a facial toner, a base ingredient in cosmetics, or as an additive in food and beverages.
3	Rose Tea	Drying rose petals to produce herbal tea with health benefits, such as calming the mind and boosting the immune system.
4	Soap and Rose skincare	Creating skincare products such as soap, lotion, and cream containing rose extract, with a focus on antioxidant benefits and hydration.
5	Rose culinary products	Developing culinary products such as rose jam, rose syrup, or dried rose petals for food decoration, which can be marketed as premium ingredients for the food industry.
6	Rose potpourri	Transforming dried rose petals into potpourri by blending them with spices and essential oils, marketed as a natural air freshener for rooms or closets.
7	Crystalized rose petals	Crystallizing rose petals with sugar to create beautiful and edible decorations for cakes, chocolates, or candies.
8	Natural rose dye	Extracting natural pigments from rose petals to be used as natural dye in food products, cosmetics, or textiles.
9	Recycled rose paper	Creating recycled paper from rose petals, which can be used for greeting cards, invitations, or other high-aesthetic craft products.
10	Artisan rose perfume	Creating handmade rose perfume with a distinctive and exclusive fragrance, packaged in artistic bottles to appeal to a niche market that values premium products.

11	Mawar infused honey	Developing honey infused with rose petals, adding a floral touch to the honey that can be used in tea, on bread, or as a topping.
12	Rose compost	Processing leftover rose petals, stems, and leaves into high-quality organic compost that can be reused as fertilizer for rose plants or sold to other farmers.
13	Biogas from rose waste	Processing leftover rose petals, stems, and leaves into high-quality organic compost that can be reused as fertilizer for rose plants or sold to other farmers.
14	Biochar from rose waste	Transforming rose waste into biochar through pyrolysis, which can be used to improve soil quality and sequester carbon.
15	Fermented animal feed	Processing rose waste into nutrient-rich fermented animal feed, particularly for ruminants such as cattle and goats.
16	Production of enzymes from rose waste	Developing enzymes from rose residues for use in the agricultural industry or other biotechnological applications.
17	Production of textile fibers	Investigating the feasibility of processing rose stems into textile fibers for use in producing eco-friendly fabrics.
18	Rose mulch soil cover	Using rose waste to create mulch for covering soil surfaces, helping to reduce erosion and retain soil moisture.
19	Rose compost mushrooms	Utilizing rose waste as a growing medium for mushroom cultivation, providing an additional source of income for farmers..
20	Production of eco-bricks	Combining rose waste with other materials to produce eco-bricks for use in building construction.
21	Biopesticide research	Exploring the potential of rose waste as a raw material for developing safe and eco-friendly biopesticides for plants.
22	Production of liquid biofertilizer	Transforming rose waste into nutrient-rich liquid biofertilizer for direct application on plants, enhancing plant health and crop yield.
23	Natural deodorant	Processing leftover rose petals into natural deodorant by incorporating other eco-friendly ingredients, creating a body care product free from chemicals.
24	Raw material for scented paper	Utilizing rose waste to create scented paper, which can be used for greeting cards, letters, or packaging, adding both aesthetic and functional value.
25	Development of body scrub products	Utilizing unused rose petals as a base ingredient for natural body scrub products, which can be marketed as exclusive beauty items with exfoliating and hydrating benefits.
26	Antioxidant extraction	Utilizing rose petal waste to extract antioxidant compounds for use in health supplements or as additives in food and beverage products.

27	Production of Rose Dish Soap	Processing rose waste into liquid dish soap infused with a rose fragrance, offering an effective and aromatic cleaning solution.
28	Wardrobe fragrance production	Using dried rose petals as a natural wardrobe fragrance, packaged in small bags or sachets to eliminate odors and provide freshness.
29	Utilizing waste for rose tissue paper	Developing rose-scented tissue paper from petal waste, which can be marketed as a premium hygienic product with a refreshing fragrance.
30	Biodegradable packaging	Transforming rose waste into eco-friendly biodegradable packaging material, suitable for packaging agricultural or food products.
31	Rose massage oil	Creating rose-based massage oil blended with carrier oils, designed for relaxation and skin care.
32	Rose paste for culinary use	Processing rose petals into a paste or sauce for culinary use, adding a floral touch to gourmet dishes.
33	Rose-infused vinegar	Producing vinegar infused with rose, which can be used in salad dressings or as an ingredient in various culinary recipes.
34	Dried rose food products	Processing rose petals into ingredients for dried food products such as snacks or granola, featuring a distinctive rose aroma.
35	Rose petal powder	Processing dried rose petals into a fine powder that can be used in baking, smoothies, or as an ingredient in various food products.
36	Herbal preservative from rose	Developing a natural rose-based food preservative that can be used to extend the shelf life of food products.

Source: Author's Compilation (2024)

After developing the ideas, rose farmers can map the results onto a 2x2 matrix to determine the priority scale for knowledge management in harvest processing. The 2x2 matrix is a grid divided into four quadrants, each representing a different category or dimension (Kaushal, 2023). However, before utilizing the 2x2 matrix, the number of votes for each idea from the respondents will be presented. Out of the 36 ideas voted on, only four will be selected to be positioned in the quadrants of the 2x2 matrix. The selected ideas are dried rose food products, artisan rose perfume, rose compost, and antioxidant extraction.

D. Phase 5 "Prototyping"

Ideas are placed according to their respective quadrants in the 2x2 matrix. The quadrants are divided into four sections: low effort, low value; low effort, high value; high effort, low value; and high effort, high value. By placing the ideas into these quadrants, the results of the brainstorming session will be categorized based on their levels of effort and value. This can be seen in Figure 3.

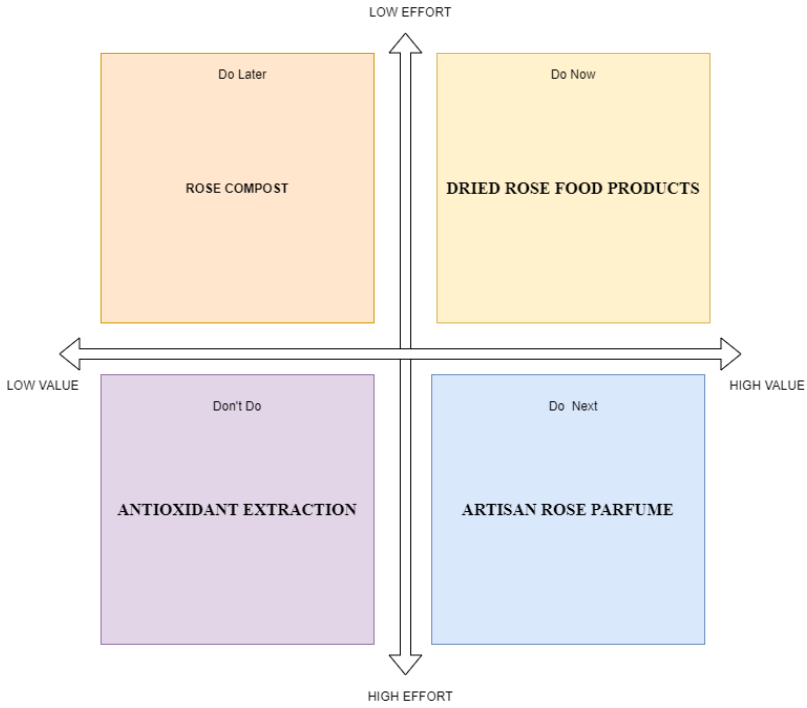

Figure 3. Matrix 2x2

Source: Author's Documentation (2024)

The concept in the high-value, low-effort quadrant is "DRIED ROSE FOOD PRODUCT." This idea focuses on enhancing the value of rose flowers by creating products that are easy to market and process. Dried rose food products can include a variety of items, such as rose chips, rose sticks, rose chocolates, and more, all of which have a long shelf life.

The concept of a dried rose food product represents an effort to add value to the harvest of rose plants. By processing the harvested roses, they can be sold not only as raw materials but also as products with a stable market value. This stable value can provide consistent income for rose farmers in Desa Ngliman. Moreover, the product can be processed by anyone or collectively by involving small and medium enterprises SMEs and women farmer groups (KWT) as partners in the production of dried plant-based foods. Additionally, rose-based processed products offer a unique advantage, as they have not been previously produced elsewhere, making this a novel product for Nganjuk city and a potential signature product of the region.

At this stage, the development of dried food products is being conducted in collaboration with the small and medium enterprises SMEs and the women farmer groups (KWT). The development involves creating several ready-to-eat dried products. Two trial products have been produced: rose-based cookies, which incorporate rose flour and sweetened rose filling, and rose sticks combined with roasted sesame seeds. These products were developed using recipes from the SMEs and KWT, who have undergone trial and error in creating rose-based food items. The next step involves consumer testing, which will be carried out during the

SMEs bazaar event in Nganjuk and among students from Bandung.

Phase 6: "Testing"

In the testing phase, products are packaged using clip-on plastic bags and tested by gathering feedback on taste to assess potential consumer response. This testing is essential to determine the product's acceptance among a broader consumer base. The feedback collected will serve as valuable input for UMKM and farmers, helping them to refine both the flavor and packaging of the products, ensuring they are suitable for commercial sale.

Figure 4. Product Visualization

Source: Author's Documentation (2024)

Phase 7: "Collect Feedback"

Based on the product testing conducted with potential consumers, it was found that these rose-based food products have a unique flavor that blends sweet and savory notes with the fragrance of roses. The taste of each product varies according to its specific type. According to the feedback from the potential consumers who sampled the products, these rose-based food items are suitable for commercialization as processed goods, which can help reduce waste and stabilize the market price of roses. A stable economy aligns with the SDG's goal 8.

Design thinking is an innovative and effective approach to exploring problems and generating optimal solutions. It starts with the empathy phase, where researchers aim to understand the emotional and psychological needs of users or stakeholders. Through observation, interviews, and direct interaction, they uncover issues that are often overlooked or unnoticed by users themselves. This deep understanding allows for a more accurate and relevant problem definition.

Following the empathy phase is the definition stage, where the team organizes and synthesizes the gathered information to identify the core problem they intend to address. During this stage, researchers develop a clear and concise problem statement, which serves as a foundation for

generating solutions. This focused approach helps save time and ensures that the team concentrates on a specific problem area, avoiding the pitfalls of broad or irrelevant solutions.

The design thinking process also includes a brainstorming phase, where researchers encourage creative and collaborative thinking to generate a wide range of possible solutions. In this phase, no idea is dismissed as too far-fetched or unrelated, allowing for creative exploration. The team can then test and refine these ideas through prototyping and other iterative methods, leading to a practical and feasible solution that meets the needs of all stakeholders. Ultimately, this approach brings real value to the organization or community involved, as the solutions are both innovative and grounded in a deep understanding of the problem.

The research employed the design thinking method for problem exploration and solution formulation to help rose farmers transform their harvests into higher-value and more stable finished products, as opposed to selling them as low-priced and fluctuating raw materials. Design thinking has demonstrated its effectiveness in swiftly identifying critical issues and devising suitable solutions. Accuracy and timeliness in addressing these issues are crucial for maintaining a sustainable business. By applying design thinking, business challenges related to selling harvests as value-added finished products can be promptly addressed, whether in the form of processed food products or other items such as rose oil and extracts.

Moreover, design thinking has proven to be an effective tool for quickly pinpointing essential problems and finding appropriate solutions, particularly in the context of SMEs and rose farmers. This effectiveness is evidenced by the increased engagement during the product testing phase, where the processed products were introduced.

Utilizing design thinking in exploratory research enables the effective identification of problems and the development of appropriate solutions. This approach aims to thoroughly understand the specific challenges faced by a business or SME in a precise and systematic manner. Initial assumptions made by researchers may not always align with the actual needs of the business or SME. Therefore, design thinking plays a critical role in problem identification and solution development, as it involves collecting insights from diverse sources and perspectives to ensure the accuracy and relevance of the results.

Not only did this research focus on dried rose-based processed products, but it also included testing to realize the second idea located in the High Value, High Effort quadrant: Artisan Rose Perfume. Laboratory-scale tests were conducted to determine the essential oil content in the rose harvest from local farmers. The essential oil, derived from rose petals, was processed through isolation using steam distillation for 5 hours. This method is the most commonly used. The plant material, consisting of rose petals, is heated with steam, causing the essential oil to evaporate. The oil vapor is then condensed back into a liquid, which can be separated from the water. The research was conducted on a laboratory scale using 0.5 grams of rose petals mixed with 10 liters of water in a rotary evaporator. Processing was carried out for 5 hours in the laboratory. Using the steam distillation method, an essential oil content of 0.1% was obtained. This yield falls into the low concentration category. In this study, the essential oil yield was too low at 0.1%, resulting in the essential oil not separating from the water, a condition known as miscible. To enhance the visibility of the essential oil product for commercialization, further processing using solvent extraction methods is necessary. However, this research aimed to explore the most basic and cost-effective method that could be implemented in Ngliman

Village. Given the low yield of the essential oil distillation at only 0.1%, further testing is needed in future research. You can observe several processes in the laboratory-scale essential oil testing in Figure 5.

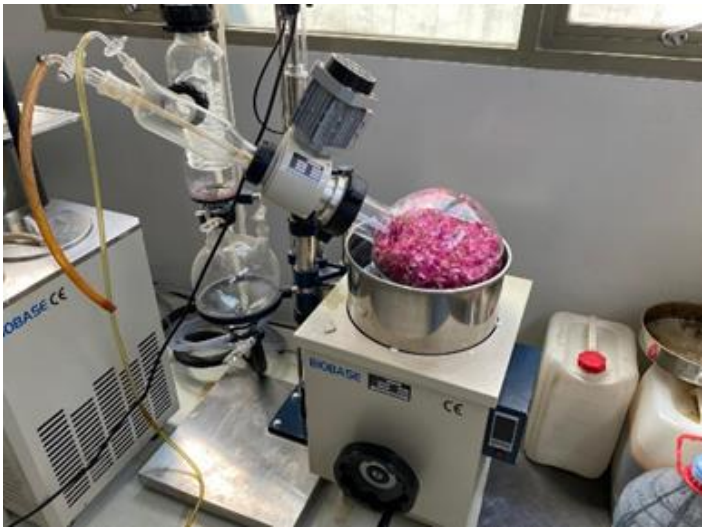

Figure 5. Process of Converting Rose Petals into Essential Oil

Source: Author's Documentation (2024)

This study aims to investigate the challenges faced by rose farmers and explore solutions that can be implemented efficiently within a short timeframe. Four key problems were identified through the exploration of these issues. According to research conducted using design thinking, the primary challenge is the need for effective knowledge management in post-harvest processing. This issue arises from the fact that rose farmers have concentrated primarily on innovation without adequately communicating with their consumers.

The solution concept explored in this research involves utilizing design thinking methodologies, which include understanding, observation, point of view, ideation, prototyping, testing, and feedback collection. By following this systematic design thinking process during the ideation phase, four primary solution concepts emerged: "Rose Compost," "Dried Rose Food Products," "Antioxidant Extraction," and "Artisan Rose Perfume." Among these, the idea selected based on the 2x2 matrix with low effort and high-value characteristics was "Dried Rose Food Products." This concept aims to enhance community engagement by producing sample products and distributing them to potential consumers.

This research contributes to both academic and practical fields. Academically, the interview protocol developed can serve as a reference and source of information for similar research areas, though further refinement is necessary based on specific conditions and research objectives. Practically, the findings suggest that collaboration between rose farmers and SMEs KWT can lead to the development of products with significant market potential, which could reduce waste management issues and increase income for rose farmers.

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