Utilization of Textile Waste for Sustainable Product Development With Modular Concept: a Case Study in Gang Tamim Bandung

Muhammad Ridwan Aliah[1], Didit Widiatmoko Soewardikoen[1], Hanif Azhar[1], Mahendra Nurhadiansyah[1], Fajar Ciptandi[1]

Email: ridwanaliah@student.telkomuniversity.ac.id

[1]Master of Design Telkom University, Indonesia

Abstract

This study identifies and analyzes the condition of textile waste volume, explores and determines techniques that can be used to utilize textile waste, and evaluates the effectiveness of the application of techniques used to utilize textile waste produced at the fabric and confection center in Gang Tamim Bandung. The research method uses Design Thinking with the following procedures: empathize, define, ideate, prototype, and testing. The results of the study indicate that the condition of the volume of textile waste is large, in the form of leftover fabric pieces, yarn, and other materials. The techniques in utilizing waste are mechanical recycling, chemical recycling, and upcycling techniques. The results of the effectiveness test with the selected procedure show products that are truly relevant and effective, and according to consumer needs.

Keywords: Modular, Upcycling, Textile Waste

Received: September 9, 2024
Revised: October 15, 2024
Accepted: November 29, 2024

Introduction

The textile industry is a sector that produces various products ranging from raw materials, fabrics, and various other textile products. The rapid development of the textile industry in Indonesia can contribute to the main driver of the national and even global economy, especially in big cities like Bandung. As one of the largest textile production centers in Indonesia, Bandung has a large number of garment factories that produce clothing for local and international markets. However, the rapid growth of the textile industry has also had a significant negative impact, one of which is the problem of waste from leftover fabrics from garment production (Khattab et al., 2020). The problem of waste in Indonesia is currently quite a serious problem. Based on data from the KEMENKO PMK, there are 7.2 tons of waste in Indonesia that have not been managed properly. Not only plastic waste, currently textile waste also contributes to the volume of waste in the world. In National Geographic magazine, The End of The Trash (2020), it was noted that of the 57% of waste in Jakarta, around 8.2% is textile waste (Goldberg, 2020). Reported by the Indonesia Circular Forum, it shows that 470,000 tons of textiles are wasted during the manufacturing process. The current technological developments and especially the garment industry players in the fashion industry are increasing (Akram et al., 2022). Because the development of the fashion industry is very fast. This industry is a global industry that is characterized by short cycles, fluctuating demand, product variations, long supply processes and complex supply chains (Nidia & Suhartini, 2020).

Aryenda Atma, CEO of Pable Indonesia, witnessed a huge pile of garbage in one of the textile warehouses and the waste was removed by simply burning it to dust just to reduce company costs (Shalimar, 2023). The practice of burning textile waste is the most economical and easy

DOI: https://doi.org/10.47667/ijppr.v5i4.335

way. However, this reflects the lack of effective waste management solutions. This condition not only has a negative impact on the environment but also wastes the economic potential of the waste. Apart from its enormous impact on the progress of the nation, the textile industry is known for its very bad reputation, namely textile waste that affects the environment and human health (Aldalbahi et al., 2021). It has even been named the second largest pollution-producing sector in the world after the oil and gas industry.

Gang Tamim in Bandung is one of the important areas for the fabric trade and is a famous garment center. This area is often compared to Tanah Abang in Jakarta due to its variety and competitive fabric prices. Gang Tamim is known as a place that provides various types of fabrics ranging from batik to denim, making it an ideal location for garment entrepreneurs and buyers looking for quality fabrics at affordable prices (Kusumo, 2021). In addition, activities in this fabric and garment center not only contribute to the local economy through the production and sale of fabrics and ready-made garments, but also produce a significant volume of textile waste. One of the famous garment factories in Gang Tamim is Tailor Jeans, which has been established since 1998 and is known for its jeans and other clothing manufacturing services. However, like many other garment factories, Tailor Jeans also faces the problem of waste from production fabric scraps that are piling up every month. This waste creates serious challenges in environmental management in Gang Tamim Bandung and highlights the urgency to implement more sustainable production practices in the garment industry.

Figure 1. Observation of Tamim Gang Activities

Source: (Personal Documentation)

Then, further observations and interviews were conducted in Gang Tamim Bandung on several garment factories and the results showed that the volume of textile waste was quite significant and was no longer managed by the managers of the garment factories. The textile waste produced was combined with other waste such as plastic waste, cigarette butts, and others. The collection of waste was then put together in sacks, each sack was sold and some were just thrown away. The reason they did this was because the human resources they had did not have the skills and time to reprocess the textile waste. This shows that the potential for increasing the economy and employment to produce sustainable products by improving the skills of human resources in Gang Tamim Bandung is very broad. One approach that can be applied in overcoming the problem of textile waste in Gang Tamim, Bandung, is the Sustainable Development Approach. This approach adopts the principles of the Sustainable Development Goals (SDGs) initiated by the United Nations, especially goal number eight. This goal focuses

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on creating inclusive and sustainable economic growth, as well as providing decent work for all. Given the complexity of the fashion industry, this approach requires the development of a holistic strategy, which not only prioritizes environmental aspects but also involves social and economic aspects. The implementation of these principles in the local context of Gang Tamim will involve various stakeholders to formulate policies that support the transformation of the fashion industry to be more environmentally friendly, while improving the quality of life of workers and strengthening the local economy. This approach is expected to produce sustainable solutions and provide broad positive impacts for the community and the surrounding environment. Based on the descriptions above, in accordance with the Sustainable Development Goal (SDGs) number eight, the strategy that can be carried out to reduce textile waste from production is to explore various techniques and processes for utilizing textile waste in order to find effective solutions to be applied to the development of sustainable products with a modular concept. This approach involves identifying and implementing innovative recycling methods, such as upcycling which transforms textile waste into products with high added value, as well as product design that allows component separation to facilitate the recycling process. In addition, collaboration with stakeholders, including local governments, related industries, and communities, will be very important to support the effective implementation of this strategy. Thus, not only does it reduce the waste produced, but it is also hoped that this strategy can create new economic opportunities that support sustainable economic growth and decent work in local communities, such as the community in Gang Tamim Bandung.

Methods

The research method is a procedure or method used to gain an in-depth understanding of a phenomenon, involving a series of systematic and structured steps. The scientific method serves as a foundation for the development of knowledge that has validity and truth that can be accounted for (Soewardikoen, 2021). In this study, the method used is a design approach that involves various important aspects in the field of design.

The design approach shows the practice of developing a structured and general body of knowledge that can be widely applied in various design cases and can be verified or accepted by general academic standards (Kubo & Sato, 2024). This design approach considers several crucial factors, including the visual aspects of the design work, which include the aesthetics and functionality of the resulting product. In addition, the role of the producer or maker of the design work is very important, because they are the party responsible for the manufacture and quality of the final product. The influence felt by the design user is also a major focus, given the importance of the user's response and experience of the design product. Paying attention to these three aspects is very important to gain a comprehensive understanding of the design phenomenon.

The design method used is the Design Thinking method. This method is a method that has five stages, namely, the stages of empathize, define, ideate, prototype, and testing. This study conducted observations, interviews with industry players or garment and tailors on Jalan Tamim, Bandung. Thus, this study aims to not only understand these aspects, but also to create effective solutions in overcoming various problems that arise during the design process. Through this approach, it is hoped that research can provide a significant contribution to the development of better design methods that are more responsive to the needs and problems that exist in the design industry.

DOI: https://doi.org/10.47667/ijppr.v5i4.335

Results and Discussion

Empathize

The Empathize stage is a key phase in the design process that puts humans at the center of attention. In this stage, designers seek to understand the people involved in the design challenge from various aspects. They seek to understand how and why people do things, identify their physical and emotional needs, and understand their perspectives and what is meaningful to them. With this deep understanding, designers can design solutions that are more relevant and effective for users (Plattner, 2010).

Mind Map 360

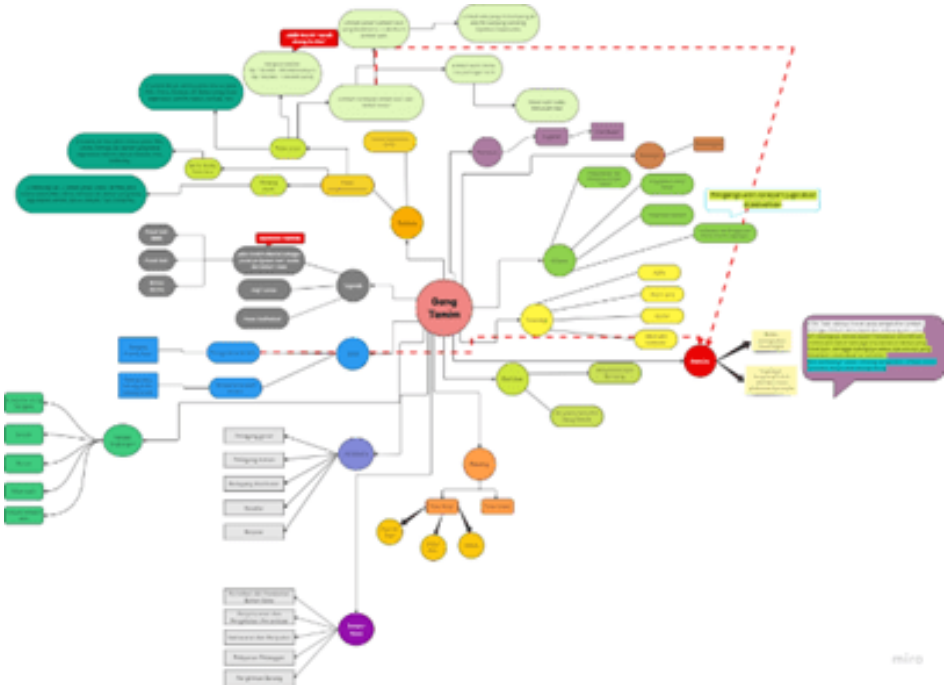

Figure 2. Mind Map 360

Source: (Personal Document)

Through this 360 mapping, the researcher found a problem that occurred in the Gang Tamim Bandung confection, namely the remaining fabric from clothing production. The waste fabric from production in Gang Tamim Bandung is an urgent problem because there is no place to distribute or dispose of the waste fabric. In addition, problems were also found in the skilled workers, namely tailors who are less skilled in innovating in designing new clothing products through waste fabric from production.

Observation Results

Observations were conducted in Gang Tamim Bandung. Gang Tamim is known as a traditional market and denim fabric center that offers more affordable prices than other places. In addition to denim, Gang Tamim also offers various other types of fabrics such as cotton, canvas, and satin. Along Gang Tamim there are many tailors or confections, including; Tailor Jeans, Warung Jeans, Rere Teddy Collection, and others. The confection offers clothing manufacturing services from various types of materials, including denim

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Figure 3. Observation Results of Tamim Gang Bandung

Source: Personal Data

Gang Tamim, a famous fabric center in Bandung, offers operating hours from Monday to Sunday and has employees who are predominantly male. In Gang Tamim, customers can easily choose the appropriate confection and can interact warmly with the workers. However, in addition to being a fabric confection center, Gang Tamim is not environmentally friendly because the streets are narrow due to the untidy fabrics, messy fabric waste, tailors who are on the pedestrian path, street vendors who are in the road area, and irregular vehicles.

Interview Results

The first interview was conducted with an employee of the Tailor Jeans confection which is one of the confectioneries located in Gang Tamim, namely Mr. Wendy on March 6, 2024. With a summary of the interview results as follows; (1) Taylor Jeans was founded in 1998; (2) In 2001, it started opening sewing services; (3) The types of clothing that are sewn are jeans, chinos, shirts, jackets, PDL; (4) Price IDR 130,000 - 190,000 (unit); (5) Price IDR 100,000 - 150,000 (per dozen); (6) Produces waste from production, there are 2 types of waste: Waste that has a large size with dimensions of -+ 40-70cm; (7) Waste that has a small size of patchwork fabric; (8) Large waste is collected to be made into fashion accessories such as; shoes or bags in the Nanjung Soreang area. Small waste is thrown away and piled up at the production site, because there is no special storage; (9) Large waste can be sold per kg with a price tag of IDR 13,000 to IDR 15,000 (depending on the type of material). In 1-2 months, small pieces of scrap fabric waste pile up per sack; (10) Monthly turnover can generate 50-150 million.

Through the results of the interviews conducted, the researcher concluded that the Tailor Jeans confection located in Gang Tamim Bandung is a confection that has been established for a long time, offers cheap sewing service prices, can make clothes with several types of fabrics, has good turnover, and there is a pile of fabric waste. The second interview was conducted with the owner of Teddy Collection, one of the confections located in Gang Tamim, namely Mr. Teddy on May 8, 2024. With a summary of the interview results as follows; (1) Teddy Collection was founded in 2000; (2) Teddy Collection sews clothes in the form of jeans, chinos, shirts, jackets, PDL; (3) The production is 50% jeans, and the other 50% is chinos, shirts, jackets, PDL; (4) Price per piece IDR 130,000 - IDR 190,000 (Unit); (5) Price per piece IDR 100,000 - IDR 150,000 (per dozen / large batch); (6) Teddy Collection produces clothes around 500 pcs - 1,000 pcs each month; (7) Teddy Collection produces fabric waste in the form of scrap fabric measuring 2cm, 3cm, and 5 cm, etc.; some are also 1/2 meter in size; (8) Fabric waste is not sorted, but just mixed in large sacks; (9) Fabric waste piles up at the production site because there is no special storage; (10) Fabric waste is taken directly by consumers (subscribers and non-subscribers), meaning anyone who needs it, including students who want

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to do activities; (11) The fabric waste is processed by consumers according to their needs. For example, they make it for pot holders, foot mats / footcloths, but it is not certain; (12) The most fabric waste is jeans, because it is scraps from jeans and jeans jackets; (13) Fabric waste in a week is 2 to 4 sacks, so in a month it reaches 16 sacks; (14) Teddy Collection employees have never received a workshop and/or training, as well as assistance in managing fabric waste; (14) Monthly turnover can generate 75-150 million

Based on the results of interviews conducted by researchers, it can be concluded that the Teddy Collection confection has been established for a long time, offers cheap sewing costs, serves sewing with various types of fabrics, produces large production. And has never been given a workshop on managing fabric waste, into a product that has high value and sustainability.

Define

At this stage, the findings from the empathize stage are collected and synthesized to formulate the main problem that needs to be solved. The goal is to create a clear and focused problem statement that can guide the next steps in the design process.

SWOT Analysis

The data that has been collected is then analyzed using a SWOT analysis to evaluate the confection located in Gang Tamim Bandung. This analysis is carried out to identify potential strengths and opportunities that can be utilized, as well as to find strategies to overcome weaknesses or problems that occur in Gang Tamim Bandung. The following is a SWOT analysis of the confection located in Gang Tamim Bandung:

Table 1. SWOT Analysis

SWOT ANALYSIS	
Strength	• Has a shop and production site • Offering various types of materials for production such as denim, cotton, canvas, and satin. • Offering production services for trousers, chinos, shirts, jackets, PDL, etc. • Offering more affordable prices than other places • The processing time provided is fast
Weaknesses	• Lack of product innovation development • Lack of employee awareness of fabric waste from production • Production waste is not managed properly, so it piles up in every corner of the production site. • There are several similar competitors along Jalan Tamim and Bandung City Strategic
Opportunities	• location in the center of traditional markets and denim fabric center • Make it easier for customers and attract customers • Have opportunities for business development • Opening job opportunities
Threats	• Fierce competition along the shops and streets offers similar production services. • The garment industry in Indonesia is very competitive with many small, medium and large companies competing in the market. • . The need for skilled and creative human resources is a challenge in facing rapid industrial growth.

Source: (Personal Document)

Based on the SWOT analysis conducted on the fabric confection located in the Gang Tamim area, it has an opportunity to increase turnover in its business because it is located in a strategic area in Bandung City, close to the clothing sales center (Pasar Baru). The confection also offers cheaper clothing manufacturing services compared to similar confection located in Bandung City and faster processing times so that it can attract consumers to come to Gang Tamim.

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However, with the many confection businesses located around Gang Tamim, it is not free from waste or waste from used fabric pieces that are produced and cannot be managed properly, so through this problem the researcher is interested in discussing waste from leftover fabric pieces.

Brainstorming Problem

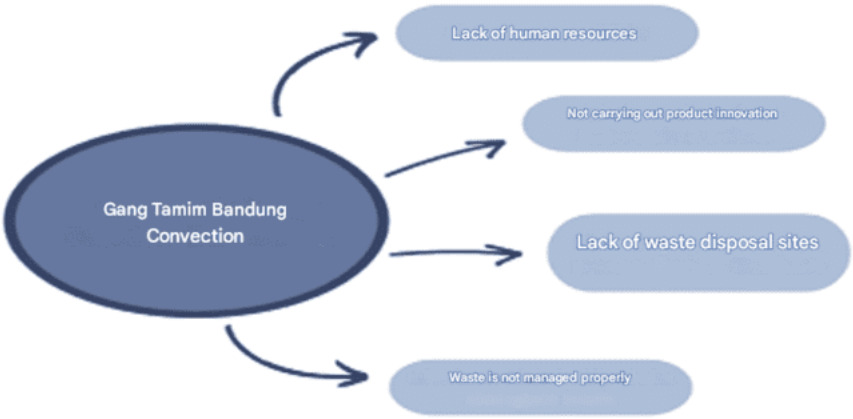

Figure 6. Urgency of the Problem

Source: (Personal Document)

From the results of observations, interviews, and analysis, several urgent problems identified in Konfeksi Gang Tamim Bandung are as follows:

Lack of Human Resources: The lack of skilled and trained workers in textile waste management is an urgent problem. Without adequate human resources, the confection will have difficulty implementing sustainable and effective production practices in managing waste.

Not Innovating Products: One of the urgent needs is to increase awareness and understanding of human resources about the use of waste from production in product innovation. Without this awareness, the confection will fail to utilize the creative potential of textile waste and be trapped in a conventional production cycle that has a negative impact on the environment.

Lack of waste distribution sites: This problem indicates an urgent need for adequate infrastructure to manage textile waste. Without adequate distribution sites, textile waste tends to accumulate in the confection or is disposed of irresponsibly, increasing the risk of environmental pollution. Strategic steps are needed to find solutions in this regard, such as developing cooperation with related parties or finding alternative waste distribution that is more effective and sustainable.

Waste is not managed properly: The urgency of this problem is related to the environmental and health impacts caused by textile waste that is not managed properly. Waste that is not managed properly can pollute the surrounding environment and endanger public health, thus requiring immediate action in its management..

Validation of Problems

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PROBLEM AREA	INFORMATION	SCIENTIFIC FIELD
Social Campaign	Lack of introduction of the 3R "Reduce, Reuse, Recycle" in product innovation to tailors and the community of Konveksi Gang Tamim Bandung.	DKV
Production	Lack of innovation in diversifying products from materials and also the remaining production materials produced, resulting in a lack of variation in the products produced to be sold to customers.	Product Design
Waste treatment	There is no innovation in waste processing, so that waste piles up and is wasted.	Kriya Textile and Fashion

Figure 7. Problem Grouping

Source: (Personal Document)

After determining the urgency of the problem, validation was carried out by grouping based on the problem areas found in Konfeksi Gang Tamim Bandung. The problem areas are as follows:

The first area, namely Social Campaign, the problem found was the lack of introduction of the 3R concept "Reduce, Reuse, Recycle" in product innovation to tailors and the community of Konfeksi Gang Tamim Bandung. This problem can be solved with the Visual Communication Design (DKV) science approach, which is able to create effective social campaigns and attract public attention to sustainable production practices.

The second area, namely Production, the problem found was the lack of innovation in diversifying products from materials and also the remaining production materials produced, so that there is a lack of variation in the products produced to be sold to customers. This problem can be solved with the Product Design (DP) science approach, which allows the confection to develop new products that are more innovative and diverse from existing materials.

The third area, namely Waste Processing, the problem found was the lack of innovation in waste processing, so that waste accumulates and is wasted. This problem can be solved with the approach of Textile and Fashion Craft science, which allows garment factories to develop waste processing techniques with craftmanship techniques, more efficiently and creatively, so that waste can be reused or recycled better.

Ideate

In the ideate stage, various potential solutions to the defined problem are generated. This is the stage for creative thinking and generating as many ideas as possible without being limited by initial limitations.

Mind map

Data is collected from various sources, including literature reviews and observations. Comprehensive data is summarized in a mind map, covering points from various perspectives.

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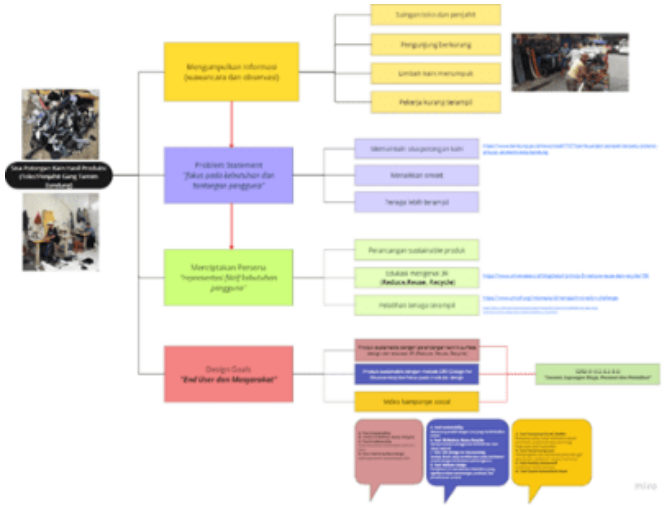

Figure 8. Mind Map

Source: Personal Data

This mind map illustrates the design project plan that focuses on the textile waste problem in Gang Tamim, Bandung. The project began with information gathering through interviews and observations to identify key issues, such as competition between shops and tailors, declining visitor numbers, accumulation of fabric waste, and lack of skilled labor. Based on these findings, the problem statement is focused on user needs and challenges. The main objectives of the project are to utilize leftover fabric scraps, increase turnover, and improve workforce skills.

The design strategy includes creating personas to represent the fictional needs of users and setting design goals that are centered on end users and society. In an effort to achieve these goals, the project will design sustainable products with a modular concept that involves education on the 3R principle (Reduce, Reuse, Recycle) and training skilled workers. In addition, the project also ensures compliance with the Sustainable Development Goals (SDGs) related to decent work and economic growth.

Main Idea

After finding the important points and also the main problems faced in the mind map, the main idea that was chosen was to create a product in the form of a Modular Bag. Developing the concept of a modular bag made from textile waste from production is very relevant and beneficial for the people of Bandung City, which is known for its high environmental awareness and rapidly growing creative industry. The use of textile waste not only helps reduce the volume of waste produced by the fashion industry, but also creates a product that has added value in terms of aesthetics and function. With the modular concept, the bag can be customized to meet the various needs of its users, whether for daily activities, work, or travel, thus increasing the practical value and appeal of the product. This is very much in line with the growing sustainability trend in Bandung, where people are starting to pay more attention to the environmental impact of their consumption habits. By utilizing textile waste, this modular bag can also be a symbol of local Bandung innovation and creativity, increasing pride and environmental awareness among its people.

Furthermore, with the high interest in purchasing various types of bags through e-commerce platforms such as Shopee in Bandung City, presenting modular bags made from textile waste

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offers significant economic potential. This innovative and sustainable product is not only attractive to environmentally conscious buyers, but also opens up new opportunities for local industries to capture this growing market segment.

Design Guidelines

After the main idea is determined, the next step is to create design guidelines as follows. These design guidelines aim to ensure that every aspect of the product design meets the expected standards of quality, functionality, and aesthetics. These guidelines cover five main points that must be considered in the design process, namely the combination of materials, modularity and adaptability, comfort and ergonomics, safety and protection, and aesthetics and style. By following these guidelines, it is hoped that products can be created that are not only innovative and sustainable, but also able to optimally meet the needs and desires of users. The five main points of the design guidelines that will be used at this stage are as follows:

Material Combination. Material combination is a step that focuses on the utilization of textile waste from production with fabrics available around the related textile industry. By integrating these materials, products can be created that are not only sustainable but also support the circular economy. Reusing textile waste helps reduce the volume of waste that ends up in landfills and gives new value to materials that were previously considered waste.

Modularity and Adaptability. The principles of modularity and adaptability in bag design ensure that products can be adjusted, modified, or expanded according to user needs. The modular system allows users to add or reduce bag components, thereby increasing flexibility and functionality. This also supports the concept of sustainability, because bags can be adjusted for various purposes without having to buy a new bag for each specific need.

Comfort and Ergonomics. Comfort and ergonomics are important aspects to consider when designing a bag. The design must ensure that the bag is comfortable to use and does not cause discomfort or injury to the user, especially when used for long periods of time. Factors such as load distribution, shoulder strap padding, and strap adjustment must be considered to create an ergonomic product.

Security and Protection. Security and protection are important elements in bag design to protect the contents from theft and damage. Bags should be equipped with security features such as high-quality zippers, locks, and durable materials. Designs that take security into account provide peace of mind for users, especially when carrying valuables or electronics. 5. Aesthetics and Style. While the main focus is on sustainability and function, aesthetics and style should not be neglected. An attractive design that is in line with fashion trends helps increase the appeal of a product in the market. Good aesthetics can also strengthen the brand image and provide a more enjoyable user experience. Therefore, it is important to find a balance between function and aesthetics in every bag design.

Sketching

After making the design guidelines, it is continued to the sketching stage of the modular bag product. At this stage, the ideas that have been formulated in the design guidelines begin to be visualized through sketches.

DOI: https://doi.org/10.47667/ijppr.v5i4.335

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ISSN: 2709-023X

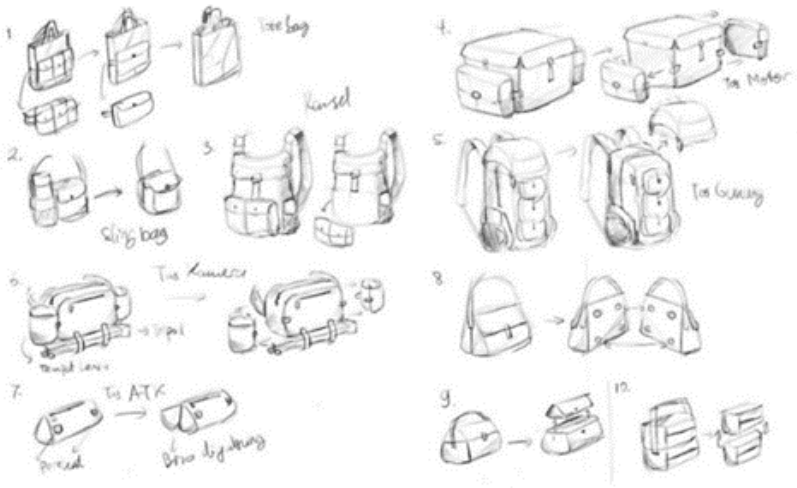

Figure 9. Rough Sketch of Modular Bag

Source: (Personal Document)

This sketch will be the basis for further discussion and evaluation before moving on to the next stage of the design process. With a clear and detailed sketch, it will be easier to explore various aspects of the design in more depth, ensuring that the final product will be in accordance with the needs and desires of the users and meet the standards set out in the design guidelines.

Selecting Ideas

Once the various ideas have been visualized through sketches, the next stage is to select the best ideas to be developed further. This process involves assessing and evaluating each idea based on certain criteria such as feasibility, potential impact, and relevance to user needs. This selection of ideas aims to identify the most promising solutions that will be turned into prototypes and tested further.

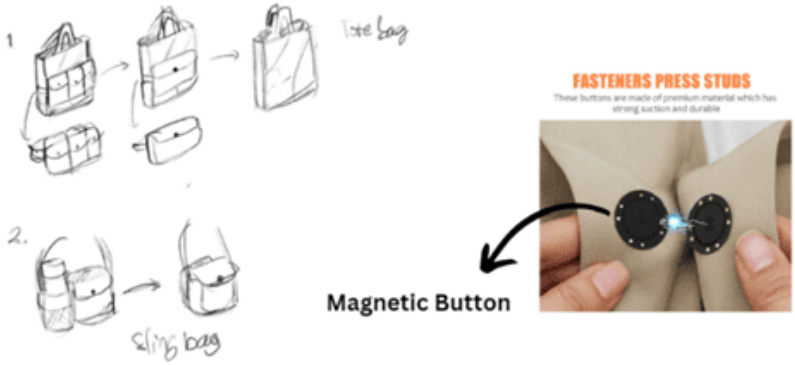

Figure 10. Selected Idea

Source: (Personal Document)

The selected idea is to combine the concept of two sketches, namely sketch number 1 and 2. The sketches are a tote bag and a sling bag, so that later it will create a modular bag that can function as a large bag and a small bag. With the modular component used being a magnetic button, this design allows the two bags to be easily combined or separated according to user needs

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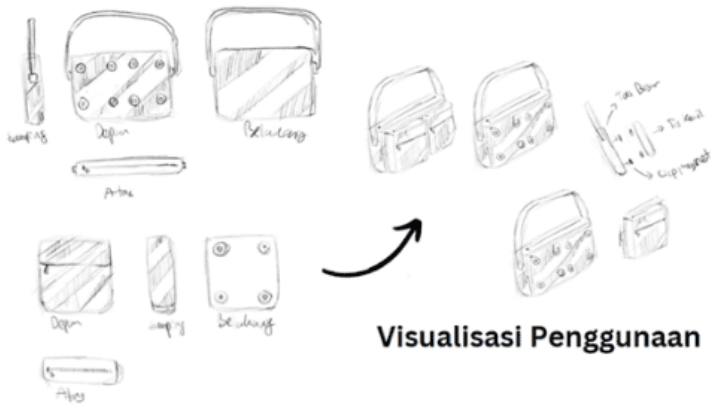

Figure 11. Concept Merger Visualization

Source: (Personal Document)

The large bag will provide more space for larger items, while the small bag can be used for smaller items or used separately when needed. The use of magnetic buttons ensures ease in changing the function of the bag without sacrificing safety and comfort aspects. Thus, this design is not only functional but also flexible, meeting various user needs in one practical and innovative product.

Prototype

The next stage is entering the prototype stage, where two stages will be carried out, namely 3D rendering of the concept and then concept revision. This prototype stage aims to bring the ideas that have been visualized through sketches into a more real and detailed form. At the 3D Rendering concept stage, the concept that has been visualized through sketches is continued to the modeling stage by creating a 3D Model of the concept. This step allows designers to present the design more clearly and realistically to users, so that they can obtain constructive feedback. This process is important to ensure that the design developed is truly in accordance with user expectations and needs. Feedback from users will be very valuable in identifying areas that need to be improved or enhanced.

Figure 12. 3D Rendering of Initial Concept

Source: (Personal Document)

After performing 3D rendering of the concept, proceed to the concept revision stage. This stage involves making design changes based on feedback received from users. This revision is the final revision that aims to ensure that every aspect of the design has been improved and adjusted according to the feedback given. This revision process is carried out until an agreement is reached with the user, ensuring that the final product truly meets their expectations and needs. With continuous iteration and effective communication with users, the resulting prototype will

DOI: https://doi.org/10.47667/ijppr.v5i4.335

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ISSN: 2709-023X

be closer to the best solution that is optimal and in accordance with the design objectives. Concept Finalization is presented in several images as follows:

Figure 13. Final Concept Visualization

Source: (Personal Document)

Figure 14. Visualization of Big Bag

Source: (Personal Document)

Figure 15. Visualization of Small Bag

Source: (Personal Document)

This modular bag is made with a fabric slashing technique on the outside, which involves cutting and peeling layers of fabric to create a unique and interesting texture effect. This fabric slashing technique provides an additional visual dimension to the bag, making it more aesthetic and eye-catching. In addition, this bag is also combined with strong and durable base materials to ensure that the bag still meets design guidelines related to material integration, modularity and adaptability, comfort and ergonomics, safety and protection, and aesthetics and style. The

DOI: https://doi.org/10.47667/ijppr.v5i4.335

combination of the fabric slashing technique and the use of these base materials not only enriches the aesthetic value of the bag, but also ensures optimal functionality and durability.

Testing

The testing stage is an important step in the design process where the product is tested and validated to ensure that it meets the needs and expectations of users. In this stage, the prototype that has been developed is tested by real users to get valuable feedback. The main purpose of the testing stage is to identify and fix deficiencies before the product is officially launched, thus ensuring the quality and suitability of the product in the market.

Although the testing phase has not been implemented in real terms, planning this phase is still very important to ensure that the resulting modular bag product can optimally meet user needs and expectations. With good planning, every aspect of the design can be tested and validated before mass production begins, reducing the risk of errors and increasing the chances of product success in the market.

The testing phase is planned by conducting interviews with users who will use this modular bag. The goal is to gain direct insight into their experiences and expectations of the product. After the interview, the results will be discussed with the project team to evaluate the feedback received. This discussion is very important to identify areas that need improvement and determine the best way to implement changes.

This testing phase begins with in-depth interviews with several community members to find out their views on the sustainable modular bag that has been prototyped from various aspects, such as functionality, comfort, aesthetics, and safety. This interview aims to understand user interaction with the product, what they like, and what needs to be improved. From this interview, the design team can gain valuable insights for further product development.

After the interview, a discussion with the project team was held to discuss the feedback that had been received. The purpose of this discussion is to ensure that every feedback can be implemented well, so that this modular bag product can continue to be refined. Good collaboration between the team and users will ensure that the resulting product has high quality and is in accordance with user expectations.

Conclusion

The results of the study indicate that the condition of the volume of textile waste produced in the fabric and garment center in Gang Tamim, Bandung, is quite concerning. Every day, this area produces various types of fabrics and clothing in large quantities, which indirectly produces significant amounts of textile waste. This waste consists of scraps of fabric, yarn, and other materials that are not used in the production process. The increase in production volume along with high market demand has caused the accumulation of textile waste that is difficult to manage properly. As a result, this waste often piles up around the production site, polluting the environment and causing serious hygiene problems. Suboptimal waste management efforts have worsened this condition, requiring attention and effective solutions to overcome the problem of textile waste in Gang Tamim. Implementation of better recycling and waste management practices is needed to reduce environmental impacts and improve the sustainability of the textile industry in the area. Textile waste in Gang Tamim Bandung can be utilized into sustainable products with a modular concept.

Techniques that can be used to utilize textile waste in Gang Tamim Bandung into sustainable products with a modular concept. The techniques are (a) mechanical recycling techniques, (b) chemical recycling techniques, and (c) upcycling techniques. In this study, the upcycling

DOI: https://doi.org/10.47667/ijppr.v5i4.335

technique was chosen where textile waste is converted into new products with higher added value, such as bags, accessories, or decorative items. The use of textile waste in the manufacture of building materials, such as insulation panels or composite materials, is also an innovative method that can reduce waste volume while creating useful products. This technique not only helps reduce environmental impact but also opens up new economic opportunities through the utilization of materials that were previously considered worthless. The results of the analysis of the effectiveness of the application of techniques in the utilization of textile waste in Gang Tamim Bandung into sustainable products with a modular concept that explains the five stages of design thinking. The first stage, Empathize, involves an in-depth understanding of user needs and problems. The second stage, Define, is the process of formulating the main problem based on the findings from the empathize stage. The third stage, Ideate, includes brainstorming to generate various potential solutions. The fourth stage, Prototype, involves creating an initial model of the solution to be tested. Finally, the Test stage is testing the prototype with users to get feedback and make improvements. This approach ensures that the resulting product is truly relevant and effective, and in accordance with user needs.

Recommendations

Based on the results of this study, it is recommended to continue to involve users in every stage of product development to ensure that the resulting design is always relevant and meets market needs. In addition, it is important to continue to iterate and improve based on feedback received from consumers. Collaboration between the design team and users must be maintained and improved to ensure the success of the product in the market. Finally, the application of sustainable principles in design must remain a top priority to support more environmentally friendly industry practices.

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