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ACCESSORY DEVELOPMENT FROM RECYCLED KNITTED WASTE FABRICS

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ABSTRACT

The rapid increase in textile waste generated by the fashion industry has created an urgent need for sustainable waste management strategies and value-added recycling approaches. Knitted waste fabrics, owing to their softness, elasticity, durability, and availability, offer significant potential for upcycling into functional textile products. This study aimed to develop sustainable accessories from recycled knitted waste fabrics and evaluate consumer acceptance of the developed products. Discarded knitted garments were collected, sorted, cleaned, and manually converted into continuous yarns using an upcycling technique that preserved the original fabric properties without the use of chemicals or energy-intensive machinery. The recycled yarns were used to develop six accessories, namely a water bottle holder, sunglasses cover, crochet backpack, hand gloves with an earphone holder, shoe storage bag, and tote bag. A structured consumer survey was conducted to assess awareness of sustainable products, environmental concerns, purchasing behaviour, product aesthetics, functionality, willingness to purchase, and willingness to pay. The findings indicated a high level of consumer preference for eco-friendly accessories, with functionality, durability, appearance, and colour combination emerging as the major factors influencing purchase decisions. Most respondents expressed positive purchase intention and willingness to pay for the developed products, demonstrating strong market acceptance of accessories produced from recycled knitted waste garments. The study confirms that manual upcycling of knitted textile waste into recycled yarns is an environmentally sustainable and economically feasible approach for developing aesthetically appealing and functional accessories. The research contributes to the promotion of circular economy principles by extending the life cycle of textile waste, reducing environmental impact, and encouraging sustainable product development within the textile and fashion industry.

INTRODUCTION

The global textile and apparel industry is one of the largest manufacturing sectors and plays a significant role in economic development. However, it is also recognized as one of the most resource-intensive and environmentally challenging industries due to its high consumption of water, energy, chemicals, and raw materials, along with the generation of substantial amounts of textile waste. The rapid growth of fast fashion, increasing consumer demand, and shortened product life cycles have further intensified textile waste generation, creating serious environmental concerns related to landfill accumulation, greenhouse gas emissions, and resource depletion. Consequently, the adoption of sustainable waste management strategies has become a major priority for both researchers and the textile industry.

Among the different types of textile waste, knitted fabrics constitute a significant proportion because of their widespread use in products such as T-shirts, sportswear, leggings, innerwear, and casual garments. Knitted fabrics possess desirable characteristics including softness, elasticity, flexibility,

durability, and breathability, making them suitable for reuse and value-added applications. Nevertheless, a large quantity of knitted waste generated during garment manufacturing and after consumer use is either disposed of in landfills or incinerated, resulting in considerable environmental impacts. Conventional textile recycling methods generally involve mechanical shredding of waste fabrics into fibres, which often reduces fibre length and strength, thereby limiting the quality and application of recycled materials.

In recent years, upcycling has emerged as an effective and environmentally responsible alternative to conventional recycling. Unlike mechanical recycling, upcycling transforms discarded textile materials into products of equal or higher value without significantly degrading their physical properties. Knitted fabrics are particularly suitable for manual upcycling because their looped structure allows them to be converted into continuous yarns with minimal processing. This approach preserves the original strength, elasticity, colour, and texture of the material while eliminating the need for energy-intensive machinery or chemical treatments. Consequently, manual upcycling represents a sustainable and cost-effective method for extending the service life of textile materials and reducing environmental burdens.

Simultaneously, consumer awareness regarding sustainability has increased substantially. Growing concerns about environmental pollution, climate change, and resource conservation have encouraged consumers to seek products manufactured from recycled and environmentally friendly materials. Sustainable fashion accessories have gained considerable attention because they combine functionality, aesthetics, and environmental responsibility. Accessories generally require less material than garments, involve simpler construction techniques, and provide greater flexibility in design, making them ideal products for utilizing recycled textile waste. Furthermore, accessories developed from recycled knitted fabrics can contribute to the principles of the circular economy by extending material life cycles, minimizing waste generation, and promoting responsible consumption.

Several studies have investigated textile recycling, waste management, and sustainable product development. Previous research has primarily focused on mechanical and chemical recycling technologies, fibre regeneration, and the production of recycled yarns for conventional textile manufacturing. Other studies have explored the application of textile waste in home furnishings, insulation materials, composite products, and low-value applications. However, relatively limited research has examined the manual conversion of knitted waste fabrics into recycled yarns for the development of functional fitness accessories while simultaneously evaluating consumer acceptance of such products. In particular, studies integrating sustainable product development with consumer perception, purchase intention, and willingness to pay remain scarce.

To address this research gap, the present study investigates the potential of recycled knitted waste fabrics as a sustainable raw material for developing functional fitness accessories. Discarded knitted garments were manually converted into recycled yarns and utilized to develop six accessories, namely a water bottle holder, sunglasses cover, crochet backpack, hand gloves with an earphone holder, shoe storage bag, and tote bag. In addition to product development, a structured consumer survey was conducted to assess awareness of sustainable products, purchasing behaviour, product acceptance, willingness to purchase, and willingness to pay for the developed accessories.

The findings of this study provide practical evidence that recycled knitted waste fabrics can be successfully transformed into attractive, durable, and functional accessories with positive consumer acceptance. The research contributes to sustainable textile product development by demonstrating an

environmentally friendly approach to textile waste utilization while supporting the principles of resource conservation, circular economy, and sustainable consumption. The outcomes may serve as a useful reference for designers, manufacturers, researchers, and entrepreneurs seeking innovative approaches for value addition through textile waste upcycling and sustainable accessory development.

REVIEW OF LITERATURE

Antonella Patti et al. (2020) highlighted textile waste as a major environmental issue and emphasized textile recycling as an important strategy for sustainable waste management and circular economy practices.

Shirvanimoghaddam et al. (2020) discussed the environmental challenges caused by fast fashion and textile waste and recommended circular economy approaches such as recycling, reuse, eco-design, and producer responsibility to reduce waste generation.

Sandin and Peters (2018) explained that knitted fabrics possess valuable properties such as softness, elasticity, and flexibility but are difficult to recycle because of blended fibres, elastane content, and fabric finishes.

Hye Won Lee (2023) demonstrated that clothing waste can be transformed into aesthetically appealing and functional textiles using innovative handcrafted weaving techniques, thereby extending the life of textile materials.

Waseem Ullah Khan et al. (2023) emphasized the environmental pollution caused by textile processing and wastewater, highlighting the need for sustainable textile manufacturing practices and eco-friendly processing technologies.

Zunjarrao Kamble et al. (2022) discussed the increasing generation of textile waste due to fast fashion and emphasized recycling and upcycling as sustainable solutions for developing value-added products.

Alenka Pavko Cuden (2023) reported that advancements in knitting technology, Industry 4.0, and circular economy practices have improved the development of sustainable and functional knitted products while identifying technological and economic challenges.

Saptarshi Maiti et al. (2022) highlighted the sustainable potential of knitting technology and suggested that advanced knitting methods such as seamless knitting can significantly reduce textile waste.

Dr. Ritu Madhan and Prachi Bharthwal (2024) demonstrated that post-consumer textile waste can be effectively converted into value-added products such as bricks using different binding agents, promoting sustainable waste management and circular economy principles.

Dr. Pratima Goyal and Shreya Mistry (2025) developed sustainable household products from discarded upholstery swatch cards and highlighted their potential for reducing textile waste, promoting sustainability, and generating income.

Dr. Ritu Madhan and Sara Dalvi (2022) utilized discarded upholstery swatch cards to develop sustainable household products through quilting, patchwork, and surface ornamentation while promoting social entrepreneurship and environmental sustainability.

Prof. Dr. Vishaka Karnad and Zainab Shabbir (2022) found that consumer awareness programmes, workshops, and exhibitions increased acceptance of recycled and upcycled products and encouraged sustainable wardrobe management practices.

Overall, the literature indicates that recycling and upcycling of textile waste provide an effective solution for reducing environmental pollution and supporting circular economy practices. However,

limited research has focused on the development of accessories from recycled knitted waste fabrics and the evaluation of consumer acceptance.

AIM AND OBJECTIVES

AIM: To develop different accessories from recycled knitted waste fabrics and promote sustainable product development.

OBJECTIVES

1. To design and develop various accessories using recycled knitted waste materials.
2. To evaluate the aesthetic, functional, and sustainable aspects of the developed accessories.
3. To assess consumer awareness, acceptance, and preferences regarding the accessories made from recycled knitted waste fabrics.
4. To promote textile waste utilization and support circular economy.

METHODOLOGY

Research Design

This study adopted an experimental product development research design combined with a quantitative consumer survey to investigate the feasibility of converting recycled knitted waste fabrics into sustainable fitness accessories. The research consisted of four sequential phases:

1. Collection and preparation of knitted waste fabrics
2. Manual production of recycled knitted yarns
3. Design and development of functional accessories
4. Consumer evaluation of the developed products

Collection and Preparation of Knitted Waste Fabrics

Post-consumer knitted waste garments were collected from household sources. The collected materials primarily included T-shirts, leggings, shorts, and other single-jersey knitted garments, which were selected because of their softness, elasticity, flexibility, durability, and ease of conversion into continuous yarns. After collection, the garments were cleaned and inspected to remove dust and contaminants.

The materials were subsequently sorted according to fabric type, colour, thickness, stretchability, print, and overall condition. Garments exhibiting excessive wear, severe damage, stains, or contamination were excluded to ensure the quality and durability of the recycled yarns. This sorting process facilitated uniform yarn production while preserving the original colour and aesthetic characteristics of the fabrics.

Preparation of Recycled Knitted Yarns

The prepared knitted fabrics were manually cut into continuous strips of uniform width. Owing to the looped structure of knitted fabrics, the strips naturally curled to form yarn-like structures suitable for further textile applications. The yarns were produced entirely through manual upcycling techniques without the use of chemical treatments, mechanical shredding, or energy-intensive machinery. Consequently, the recycled yarns retained the original colour, texture, elasticity, and strength of the knitted fabrics while minimizing environmental impact. The manually prepared yarns served as the primary raw material for accessory development.

Product Development

The recycled knitted yarns were first evaluated through the development of experimental samples using various surface-decoration and textile construction techniques, including macramé, crochet, and embroidery, weaving, tufting, and layered cording. These preliminary samples were prepared to

assess the handling properties, flexibility, durability, and aesthetic potential of the recycled yarns for functional product development.

Based on the outcomes of the sampling stage, six sustainable accessories were designed and developed: a water bottle holder, sunglasses cover, and crochet backpack, hand gloves with an earphone holder, shoe storage bag, and tote bag. Product designs emphasized functionality, durability, user convenience, and visual appeal while maximizing the utilization of recycled knitted materials. Additional components such as sewing thread, fabric lining, buttons, handles, adhesives, and zippers were incorporated only where necessary to improve product performance and usability.

Consumer Evaluation

A structured questionnaire was developed to evaluate consumer awareness, acceptance, and market potential of the developed accessories. The questionnaire consisted of two sections. The first section collected demographic information and examined respondents' awareness of sustainable products, participation in fitness activities, purchasing behaviour, environmental concerns, and preference for eco-friendly accessories. The second section assessed the developed accessories based on appearance, colour combination, functionality, and suitability for fitness activities, purchase intention, and willingness to pay.

The survey was administered to **50 respondents** representing different age groups and professional backgrounds. Participants were asked to examine the developed products before providing their responses using structured rating scales and multiple-choice questions. Participation was voluntary, and respondents were informed about the purpose of the study before completing the questionnaire.

Cost Analysis

An economic assessment of the developed accessories was performed to determine production feasibility. The total production cost for each accessory was calculated by considering labour charges, trims and accessories, supporting materials, and miscellaneous expenses. Since recycled knitted waste fabrics constituted the primary raw material, no additional raw material cost was incurred for the recycled textile component. Comparative cost analysis was subsequently performed to evaluate the economic viability of each developed product.

Data Analysis

The collected survey data were compiled and analysed using descriptive statistical techniques. Frequency distributions and percentages were calculated to summarize respondents' demographic characteristics, awareness of sustainable products, purchasing behaviour, product preferences, willingness to purchase, and willingness to pay. The findings were presented using tables and graphical representations to facilitate interpretation and comparison of consumer responses. The overall results were used to assess the functional, aesthetic, and commercial potential of accessories developed from recycled knitted waste fabrics.

DEVELOPMENT OF SUSTAINABLE ACCESSORIES

Product 1: Water Bottle Holder

The water bottle holder was developed using crochet techniques and recycled knitted yarns prepared from post-consumer knitted waste garments. The product was designed to securely hold reusable water bottles while providing ease of carrying during everyday use, travel, and outdoor activities. The inherent elasticity and flexibility of the knitted yarn ensured a firm grip around bottles of different sizes. A crochet shoulder strap was incorporated to enhance portability and user convenience. The product demonstrated the effective utilization of recycled knitted yarn in creating a durable, lightweight, and aesthetically appealing accessory.



Product 2: Sunglasses Cover

A protective sunglasses cover was developed using a matty sheet as the base material and decorated with recycled knitted yarn through the Bargello embroidery technique. The embroidered surface enhanced the aesthetic value of the product while utilizing textile waste creatively. A button closure was incorporated to provide secure storage and protect sunglasses from scratches during transportation. The product combined functionality with decorative surface design, demonstrating the potential of recycled knitted yarn for value-added accessory development.



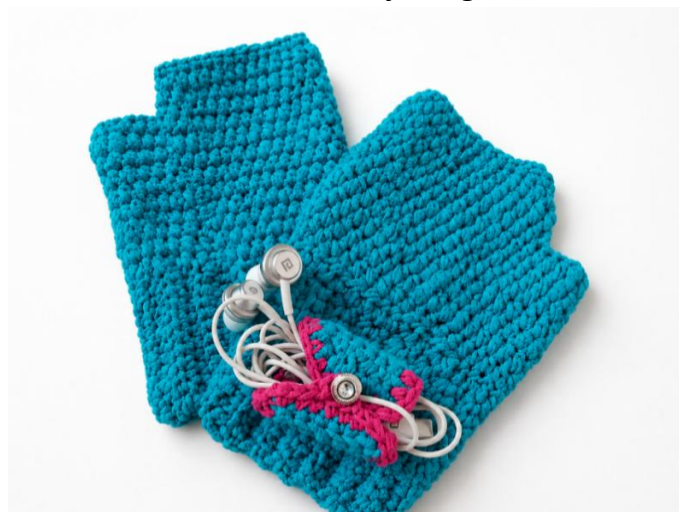
Product 3: Backpack

The crochet backpack was entirely handcrafted using recycled knitted yarn produced from discarded knitted garments. Dense crochet stitches were employed to develop a strong and durable structure capable of carrying personal belongings during daily use and travel. The backpack featured sturdy shoulder straps and a drawstring closure to improve comfort, usability, and storage capacity. Owing to its larger size and extensive handcrafted construction, the backpack represented one of the most functional and value-added products developed during the study.



Product 4: Hand Gloves with Earphone Holder

Fingerless hand gloves were developed using crochet techniques and recycled knitted yarn to provide comfort, flexibility, and ease of movement. An integrated earphone holder was incorporated into the glove design to enable users to securely organize earphone cables, thereby minimizing tangling and improving convenience. The stretchability and softness of the recycled knitted yarn contributed to a comfortable fit and enhanced user experience. This product illustrates the integration of sustainability with functional and innovative accessory design.



Product 5: Shoe Storage Bag

A shoe storage bag was developed using recycled knitted fabric and decorated with recycled knitted yarn through embroidery techniques. The product was designed to protect footwear from dust and moisture while allowing convenient storage during travel and everyday use. A drawstring closure was incorporated to facilitate easy opening and secure closure. The shoe storage bag demonstrated that discarded knitted fabrics could be transformed into practical and reusable products with minimal processing while maintaining aesthetic appeal.



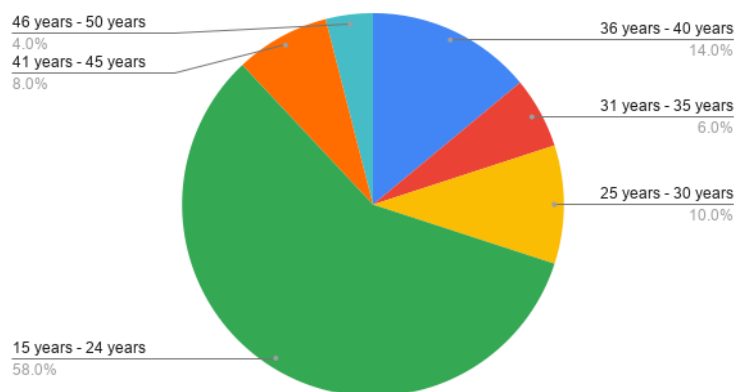
Product 6: Tote Bag

The tote bag was developed using grey cotton fabric reinforced with non-woven interlining, while recycled knitted yarn was applied on the front panel using a layered cording technique to create decorative surface embellishment. The textured design enhanced the visual appeal of the bag without compromising functionality. Fabric handles were securely attached to ensure durability and ease of carrying. The tote bag demonstrated the versatility of recycled knitted yarn in producing fashionable, reusable, and environmentally sustainable accessories suitable for everyday use.

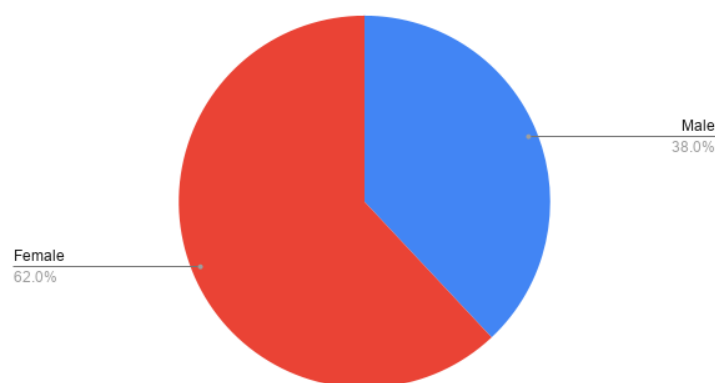


RESULTS AND DISCUSSION

Consumer Awareness

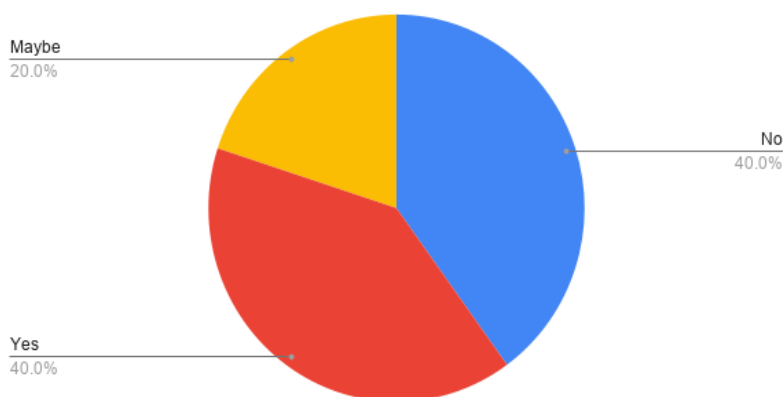


Age-wise Distribution



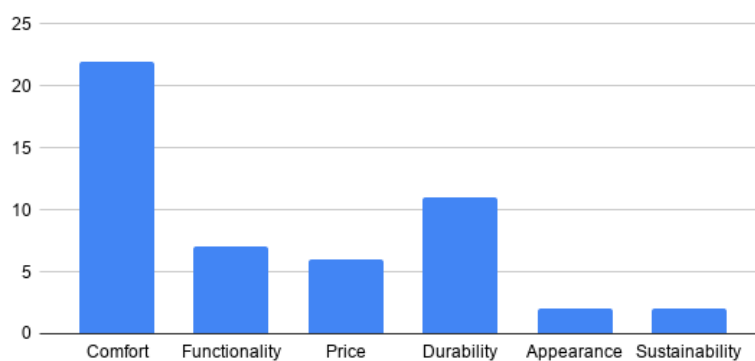
Gender Distribution

A consumer survey involving **50 respondents** was conducted to evaluate the acceptance of accessories developed from recycled knitted waste fabrics. The respondents represented different age groups, genders, and occupations, with the majority (58%) belonging to the 15–24 years age group and 62% being female. The findings indicated that young consumers showed considerable interest in sustainable accessories.



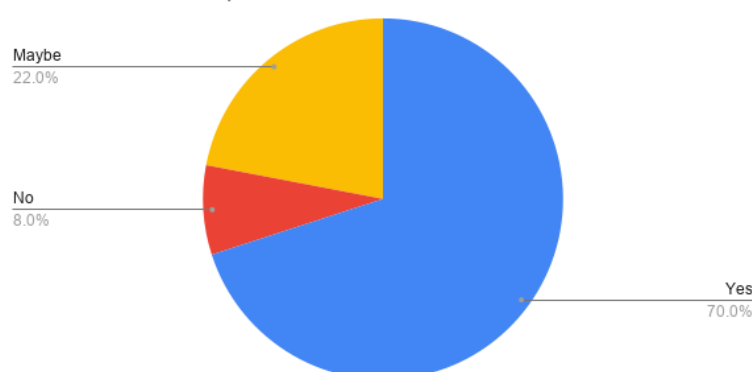
Awareness of Products Made from Recycled Textile Waste

The survey revealed moderate awareness of products made from recycled textile waste. While 40% of the respondents were aware of such products, an equal proportion were unaware, and 20% were uncertain.



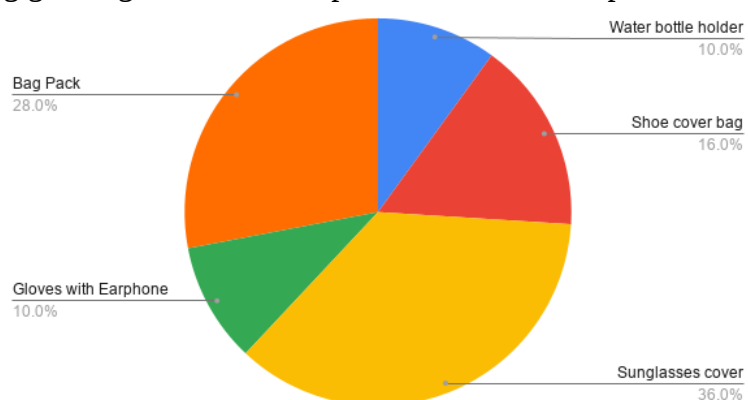
Factors Influencing the Purchase of Accessories

Environmental concerns influenced purchasing decisions for many respondents; however, product attributes such as comfort, durability, functionality, and appearance were identified as the primary factors affecting purchase decisions. Sustainability was considered an additional benefit rather than the main purchasing criterion.



Preference for Eco-Friendly Accessories

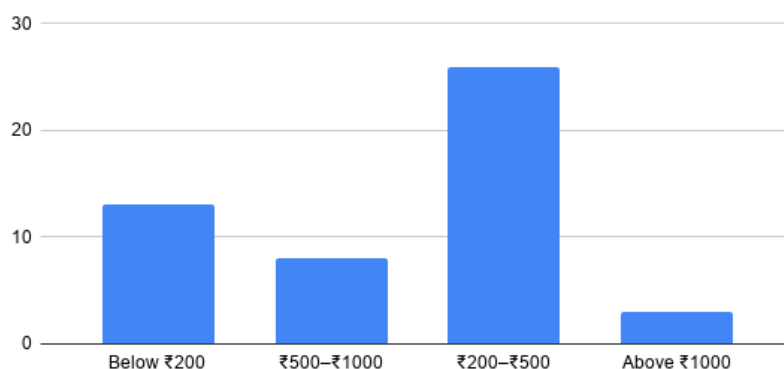
Overall, respondents expressed a positive attitude towards accessories developed from recycled knitted waste fabrics. Approximately 70% preferred eco-friendly accessories over conventional alternatives, indicating growing consumer acceptance of sustainable products.



Most Preferred Products

The developed accessories received favourable evaluations for their appearance, colour combination, functionality, and overall quality. The water bottle holder, sunglasses cover, crochet backpack, hand gloves with an earphone holder, shoe storage bag, and tote bag were all well accepted by consumers.

Among these, the **sunglasses cover** was the most preferred product (36%), followed by the **crochet backpack** (28%) and the **shoe storage bag** (16%). The water bottle holder and hand gloves with an earphone holder each received 10% preference.



Willingness to Purchase

Most respondents also expressed willingness to purchase the products if they were commercially available and indicated an acceptable price range of **₹200–₹500**.

Cost Analysis of Developed Accessories

Costing of Water Bottle Holder

Particulars	Amount (₹)
Recycled knitted yarn	0
Labor charges	100
Miscellaneous expenses	50
Crochet Needle	30
Total Cost	180

Costing of Sunglasses Cover

Particulars	Amount (₹)
Recycled knitted yarn	0
Matty Sheet	10
Embroidery needle	10
Labor charges	80
Miscellaneous expenses	50
Total	150

Costing of Crochet Backpack

Particulars	Amount (₹)
Recycled knitted yarn	0
Crochet Needle	30
Button	5
Labor charges	500
Miscellaneous expenses	100
Total	635

Costing of Hand Gloves with Earphone Holder

Particulars	Amount (₹)
Recycled knitted yarn	0
Crochet needle	30
Button	5
Labor charges	200
Miscellaneous expenses	100
Total	335

Costing of Shoe Storage Bag

Particulars	Amount (₹)
Recycled knitted fabric	0
Recycled knitted yarns	0
Sewing thread	5
Labor charges	90
Glue	10
Miscellaneous expenses	40
Total	145

Costing of Tote Bag

Particulars	Amount (₹)
Recycled knitted yarns	0
Grey cloth	20
Non-Woven	10
Bond 700	100
Labor charges	200
Miscellaneous expenses	50
Total	380

The cost analysis demonstrated that the crochet backpack had the highest production cost (₹635) because of its larger size and labour-intensive construction, whereas the shoe storage bag (₹145) and sunglasses cover (₹150) were the most economical products. The use of recycled knitted waste fabrics eliminated the cost of the primary raw material, making the products economically feasible while promoting sustainable resource utilization.

LIMITATIONS

- The study was limited to recycled knitted waste garments collected from selected sources.
- Only six accessories were developed due to limitations in time, resources, and material availability.
- Consumer evaluation was conducted with a sample of 50 respondents, which may not represent the preferences of the wider population.
- The study focused on product development and consumer acceptance and did not include detailed laboratory testing of the developed accessories.

DISCUSSION

The findings demonstrate that recycled knitted waste garments can be effectively upcycled into functional and aesthetically appealing accessories. Consumer evaluation indicated positive acceptance of the developed products, with functionality, durability, and appearance being the key factors influencing purchasing decisions. The study also showed that the use of recycled knitted waste can reduce raw material costs while promoting sustainable product development. Overall, the research highlights the potential of textile waste as a valuable resource and supports the adoption of circular economy practices within the textile and fashion industry.

CONCLUSION

The study demonstrated that recycled knitted waste garments can be successfully upcycled into functional, durable, and aesthetically appealing accessories through simple manual techniques. The developed products confirmed the potential of textile waste as a valuable resource for sustainable product development.

Consumer evaluation indicated positive acceptance of the accessories, with functionality, durability, comfort, and design identified as the key factors influencing purchasing decisions. The findings also highlighted the economic feasibility of using recycled knitted waste by reducing raw material costs while creating value-added products.

Overall, the study emphasizes that upcycling recycled knitted waste garments is an effective approach to reducing textile waste, promoting resource conservation, and supporting circular economy practices. The research provides valuable insights for designers, artisans, and small-scale entrepreneurs interested in developing sustainable and environmentally responsible textile products.

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