



# Advancing Sustainability in Fashion Accessories: a Circular Economy Approach

Josephine Aboagyewaa-Ntiri<sup>1</sup>

Received: 9 July 2023 / Accepted: 15 October 2023 / Published online: 15 January 2024  
© The Author(s), under exclusive licence to Springer Nature Switzerland AG 2024

## Abstract

Circular economy is an important concept in achieving sustainability. The fashion industry creates enormous amounts of waste that ends up at landfill sites. Therefore, through a circular economy, the fashion industry can reduce the quantity of waste generated. This study aimed to demonstrate the practical application of circular economy in the fashion accessories sector in Ghana. Using pull tabs from used cans, combined with thread, and using a crocheting technique, the paper demonstrates a practical use of circular economy approach in designing and making fashion accessories products in Ghana. Six products were designed and created from pull tabs from used cans and thread. The products were tested to ensure that they were fit for purpose. It was suggested that these designs and products could be commercialised in Ghanaian society and beyond as they represent the cultural and global modern trends in the fashion accessories industry. Besides, due to the low-cost nature of the whole product design and making of the necklaces and earrings, it was suggested that those doing craftwork in low-socio-economic areas may use it as an economic activity. It is recommended that policymakers and the government of Ghana should develop policies that will make it attractive for those in craft-making to adopt such practices and this can attract industry leaders in the Ghanaian fashion accessories sector to consider the outcomes of this study. Many other countries similarly situated can adopt the findings and contextualise it to their settings. This paper is original in its form because it is the first to adopt the principles of circular economy in fashion accessories in Ghana.

**Keywords** Fashion accessories · Sustainability · Circular economy · Fashion design · Ghana · Pull tabs · Reuse

## Introduction

Fashion accessories are generally defined as decorative items that enhance one's garment, including jewellery, gloves, handbags, hats, belts, scarves, watches, sunglasses, pins, stockings, bow ties, leggings, and tights [43]). Secondly, they contribute to the wearer's outfit

---

✉ Josephine Aboagyewaa-Ntiri  
jantiri@amusted.edu.gh; jose.ntiri@gmail.com

<sup>1</sup> Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Kumasi - Campus, Kumasi, Ghana

and complement the wearer's look. Fashion accessories may be categorised in many ways, but in their loose form, two main forms exist: those carried and those worn by the wearer [26]. Accessories such as handbags and purses are traditionally held, but the wearer wears hats, ties, jewellery, scarves, and watches. The significance of fashion accessories includes adding colour, style, and class to an outfit worn by the wearer to create a specific look. However, they may have some other practical functions. For example, whereas handbags function as storage for carrying necessary items such as phones and wallets, hats are worn to protect a person from adverse weather effects.

Jewellery, a part of fashion accessories, consists of small decorative items worn for personal adornment, to complete dressing, and sometimes for protection. It includes necklaces, earrings, bracelets, brooches, and rings. It may be attached to the clothes or body and is comfortable to wear [21]. The primary forms of jewellery vary between cultures that enhance and decorate the wearer and are often long-lived [22, 42, 46]. Typically, pieces of jewellery are made from precious metals and gemstones to create ornaments that enhance and decorate the wearer [22]. However, due to the adverse environmental effects of the extraction of precious metals and gemstones in making jewellery, it is important to explore alternative materials that could be useful in making jewellery, particularly through circular economy approaches of re-using existing items.

In Ghana, jewellery is a vital decorator worn to complement outfits. Through observations, it can be stated that earrings are a compulsory part of the daily dressing of the female gender, whether for formal or informal events. To this end, earrings are part and parcel of the life of the Ghanaian population. Globalisation and cultural adulteration have also impacted the culture of Ghanaians to the extent that some men, particularly in urban areas, are adopting earrings as part of their dressing. For example, Fening [20] obtained results that justified the use of earrings among men between the ages of 20–30 years, citing fashion and copying from Western societies as the reasons for use. However, the elderly population does not support the use of earrings by men because it is argued that the desire to be like Westerners has suddenly made the youth promiscuous [3].

Current earring materials have environmental and personal effects on the wearer. For example, in Ghana, earrings are primarily made from precious metals, gemstones, beads, plastics, and glasses. The use of these materials and the processes involved in turning them into earrings are unsustainable due to the adverse effects on the environment. Besides, due to the heavy weight of the earrings, some wearers often suffer torn earlobes. Figure 1 shows a torn earlobe due to the weight of the earrings. In Fig. 2, different materials used in making earrings are shown. For example, samples labelled 1–3 are made from beads, 4 and 5 are made from metals, and 6 is from plastic. These materials are heavy and cause the earlobes of wearers to tear over time.

**Fig. 1** Torn Earlobe due to the heavy weight of earrings. Source: <https://lasersurgery.com/split-stretched-earlobe-repair/>



**Fig. 2** Different materials for the production of some earrings in Ghana. Source: Photo by the Author (2023)



Consequently, alternative materials that are lightweight and sustainable need to be explored. To this end, in this paper, the author explores the use of can pull tabs and twine thread to develop a concept product (earrings and necklaces). The littering of can pull tabs causes a lot of environmental and health risks to children because they sometimes choke on them when they pick and play with them. According to Burrington [6], children have been treated for complications of indigestion from aluminium can tabs from beverage cans. Furthermore, Alhasan et al. [1] argued that teenagers are not spared from these indigestions of can tabs. Can tabs also cause environmental degradation because of their inability to decay into the soil and the unsustainable ways of extracting bauxite that is converted into aluminium. Reusing can pull tabs has positive implications for the environment as there will be a reduction in the mining of bauxite for making aluminium, and littering will likely reduce due to reuse. Figure 3 shows some can tabs adopted to develop the earrings and necklaces. The use of can pull tabs to develop lightweight earrings and necklaces fits the circular economy agenda. The circular economy is an industrial system that is restorative or regenerative by intention and design. It helps in the replacement of the ‘end-of-life’ concept with restoration, offers a shift towards the use of renewable energy, removes the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, and systems (Ellen MacArthur [19]). Principally, circular economy involves two main concepts: product- and material-specific, where the

**Fig. 3** Can tab or pull tab. Source: Photo by the author (2023)



former focuses on product reuse and life extension and the latter concentrates on post-used waste and resources [48].

Secondly, this paper further adopts crocheting as a method to develop the actual products. To the author's best knowledge, the choice of material and the technique are the initial means of creating necklaces and earrings by re-using the can tab within the Ghanaian fashion industry. The paper's contribution to the existing literature and practice is twofold; firstly, it documents the use of a current method in a new context. Secondly, the paper contributes to the literature on sustainability in fashion accessories, which adds to the advances already made in this area.

The paper is arranged into five sections. Firstly, the “**Introduction**” section is used to introduce the paper and build the background to the study. Secondly, the literature review can be found in the “**Literature Review**” section of this paper. This is followed by the materials, concepts, and methods used in developing the report and making the products in the “**Research Methodology**” section. The “**Discussion on the Design and Product Outcomes**” section is dedicated to the findings and discussions of the products and the “**Conclusion**” section is for conclusions and recommendations for further studies.

## Literature Review

Sustainability is an important concept that refers to achieving the triple bottom line (3BL) of environmental, social, and economic goals [16, 30]. It is about finding a balance between these three elements to create a better future for the planet. By focusing on sustainability, individuals and organisations become environmentally responsible, while also fostering a sense of community and social responsibility. There is a growing focus on sustainability and businesses must come up with innovative ways to support this movement. The advancements being made in the fashion industry are particularly encouraging. Over the past few years, many fashion companies have made a conscious effort to become more environmentally friendly by re-engineering their business processes and implementing sustainability programs [7]. The goal is to achieve the 5R principles: reduce, reuse, recycle, re-design, and re-image [24]. This does not only benefit the planet but also enhances the brand's reputation and attracts eco-conscious consumers.

Fashion is widely considered the second most destructive industry, after oil, to the environment [8]. The fashion industry, particularly the fashion accessories sector, is part of the problem. Evidence indicates that the fashion industry is responsible for over 92 million tonnes of waste produced yearly and 79 trillion litres of water consumed [39]. Consequently, although not new, the circular economy has emerged as a total replacement for the linear economy to deal with the negative impacts of current approaches to manufacturing. Unlike the linear economy, the circular economy argues for the restoration of raw materials after use—take, make, use, reuse, and reuse again and again [15]. A circular economy is not new, it began in the 1920s [33], but in recent times, governments and academia have shed new light on it due to its positive impact on the environment. The current paper adopts it for the design of Ghanaian fashion accessories.

Linear economy, based on the notion of unlimited resources, is the taking, making, using, and throwing away of used resources. For a very long time, it has been causing adverse environmental impacts. In this case, large amounts of non-renewable resources are extracted from the environment to make products. The products are used a few times by consumers and disposed of in landfills, creating waste [15]. This has been the industrial

practice, and there has been a continuation of this practice of extracting resources from nature without appropriate plans to reuse or regenerate these resources [41]. Consequently, about 80% of raw materials used in production are disposed of after a single use, thereby resulting in negative environmental, economic, and social impacts (Ellen MacArthur [19]). These negative impacts include natural resource depletion, decreasing forest cover, and global temperature changes putting human health and well-being at risk [13].

Environmentally, it is increasingly evident that the activities of the fashion industry have adverse environmental consequences that are leading to significant issues, particularly in the context of climate change. As fashion businesses are pivotal contributors to these impacts, it is crucial for them to assume responsibility and take proactive measures to address these challenges. It is documented that the fashion industry has been taking limited responsibility for its contribution to the cause of climate change discussion [40] and over-consumption of natural resources because of the production approaches [10] and issues with the disposal of fashion products [51]. Consequently, it is important for fashion businesses to take responsibility for their impact on the environment and to work towards more sustainable practices because many fashion businesses still use linear business models (take and make waste) that ignore the environmental consequences [28]. Changes in business models alone would not aid the attainment of sustainability in the fashion industry, but organisations must consider a specific driver for end-use products [4]. Thorisdottir and Johannsdottir [51] argue that such a driver is often lacking in the design process. The Ellen MacArthur Foundation [19] encourages the rethinking of a products' end-of-life when considering circularity. The current research is focused on adopting circularity principles to design specific fashion accessory products in response to the environmental challenges facing the fashion industry.

Social sustainability in fashion design encompasses the improvement of labour standards and conditions, enhancing communities where production occurs and the creating and delivering socially responsible products and services [35]. Occasionally, fashion designers are required to focus on consumers and how to educate them to promote more sustainable consumption because consumers today are ill-informed about sustainability. As fashion designers who make fashion accessories become responsive to the needs of their communities, it leads to completely satisfied communities, customers, and stakeholders within and beyond the society in which they operate [49]. By doing so, there is the attainment of social well-being, which implies an increase in the quality of life, social justice, and social coherence [32] in communities of operations. In this study, the circularity principles adopted in designing fashion accessories when accepted by the industry in Ghana can enhance the communities within which local fashion designers operate. Thus, through the reuse of materials, there will be reduction in waste in those communities while at the same time enhancing the image of local fashion designers.

Recently, discussion on sustainable fashion accessories design and manufacturing has been focused on ensuring that the entire life cycle of products is considered during the design stages. As a result, circular economy has become topical, replacing the long-time-dominated concept of linear economy. The Ellen MacArthur Foundation has provided the most widely accepted and used definition of circular economy as an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, provides a shift towards the use of renewable resources, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models (Ellen MacArthur [19]). In principle, circular economy involves two main concepts: product-specific and material-specific, where the former focuses on product reuse and life extension

and the latter concentrates on post-used waste and resources [48]. The paper adopts the first principle of product reuse and life extension of can tabs from cans to develop necklaces and earrings for the fashion accessories market in Ghana.

Many scholars have contributed to the debate regarding circular economy application in fashion accessories product development and testing. Moorhouse and Moorhouse [38] explored sustainable design practices concerning zero-waste fashion and the benefits of implementing a circular economy. The authors adopted waste products and reused them to design new products ranging from sportswear to luxury products. Marques et al. [36] proposed several business models based on a circular economy for the fashion industry. Colucci and Vecchi [11] provided a comprehensive picture of circular economy practices implemented across the fashion industry. The study documented the relationship between sustainability and circular economy, supporting the idea that there is a beneficial relationship between these two concepts. Dissanayake and Weerasinghe [14] offered a holistic understanding of circular fashion by synthesising the existing literature to develop a comprehensive definition. They provided a framework of strategies to facilitate the transition from a linear to a circular fashion.

Elf et al. [18] found that the distinctive development and use of dynamic capabilities enable MSMEs to act in agile ways, allowing them to introduce, test, and advance circular economy solutions, and show that fashion MSMEs adopt circular economy business models (CEBMs) by going beyond conventional, technology-focused approaches currently dominating business thinking. Similarly, Brydges [5] investigated how the Swedish fashion industry has implemented circular economy principles by mapping circular economy strategies across key stages: take, make, and waste. Machado et al. [34] investigated consumer motivation's role in the circular economy's context through the reuse of fashion products and developed a framework showing a virtuous circle of motivations involving the consumer in an active role in the process. Smith et al. [47] focused specifically on the practice of textile and fashion design in the UK to consider a more holistic approach to designing and manufacturing within these sectors and proposed a vision for circular economic production models in fashion and textiles that adopt open design approaches.

Specifically, in craftwork, Dudek and Sparks [17] combined West-African-inspired textiles with European crochet to develop a cohesive lounging ensemble and show an innovative way of adopting a traditional method to create a modern product. The current paper takes inspiration from Dudek and Sparks [17] by adopting the crocheting technique. Still, it differs in the types of products developed, the materials used, and the research context. Thus, the paper adopts crocheting, which is a fabrication technique that involves the manipulation of a continuous strand of yarn into inter-meshed loops in a way that forms a stable final object [23] and combines it with can tabs (a waste material from can tops) and twine threads to make necklaces and earrings to reduce waste from cans to advance the circular economy agenda.

## Research Methodology

### The Research Design

This paper is primarily focused on designs that adopt a circular economy approach. Swann [50] suggests that design is a form of qualitative research that is perfectly suited for human beings, as it allows the interpretation of human actions in a meaningful way.

When conducting qualitative research, it is crucial to shed light on the subjective meanings, actions, and social contexts of the research participants as they understand them. This approach helps to provide a deeper understanding of the phenomena being studied and ensures that the research is meaningful and relevant to those involved. Consequently, qualitative research relies on the subjective opinions of researchers and participants.

The field of design requires a combination of diverse skills and effective communication with other disciplines. It emphasises practical application and skill-based competencies. It is both challenging and rewarding, offering boundless opportunities for creativity and exploration. Since the focus of this research was to create designs and develop outcomes for practice, a practice-based approach was adopted. Practice-based research is an inherently creative process. It begins with current standards of practice, thoroughly examines the literature, and extends into a simple, practical research design to answer specific questions about intervention outcomes [53], p 50). The practice-based research strategy is embedded within qualitative approaches because design involves a cognitive process that includes both problem-finding and problem-solving, and the idea of reflection is integral to this process [52]. One of the biggest challenges in design is connecting research with practice, and these two areas should always be seen as inseparable [31].

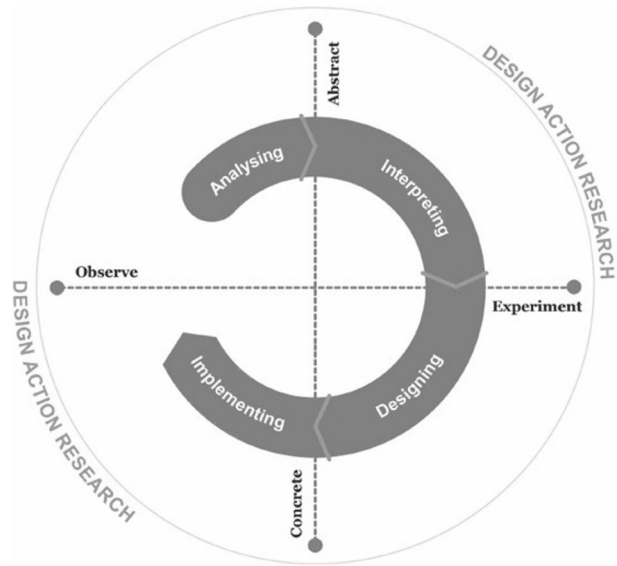
A qualitative research strategy that merges theory and practice is action research—an enquiry model that, as the name suggests, links the reflective dimension of design to practice [52]. Therefore, action research is commonly used and well-explored in the design discipline aimed at acquiring, converting, and experimenting with new information, ideas, and processes through concrete actions [2]. Design research and action research offer alternative approaches for bridging the gap between theory and practice and solving practical problems [29].

Action Research is a research methodology that emphasises the connection between theoretical and practical activities. It also emphasises the importance of the relationship between researchers and the communities involved in the research process. This methodology involves working closely with these communities to ensure that research is relevant, useful, and meaningful to them. By doing so, action research can help to bridge the gap between theory and practice and promote positive change in the world. Reason and Bradbury [44] argue that action research is unique in that it involves active participation from those involved, allowing for a more accurate representation of the reality of the situation being studied. Additionally, the focus on action and practice allows for the development of effective solutions to real-world problems. By embracing this approach, researchers can create designs that truly meet the needs of the people who will be using them. This approach is adopted in this paper where the researcher reflects on issues in fashion design in Ghana and develops a solution to the problem by creating designs that respond to the needs of the population.

In Fig. 4, a process for merging action research and the design process is presented. As shown, this is described and visualised as an iterative process. The four main stages of merging action research with design are described as analysing, interpreting, designing, and implementing [52]. The analysis and interpreting stages involve context setting and identifying research problems and stakeholders involved. In this research, the researcher clarified the roles of the stakeholders who were mainly colleagues and students helping in the laboratory work to develop the designs. In total, there were 8 stakeholders, comprising colleague lecturers and students. However, it was the researcher who analysed to determine the potential use of pull tabs for developing fashion accessories.

Armed with this idea, the researcher develops an interpretation of the needs of the potential target group based on the researcher's own background knowledge of the

**Fig. 4** Design in action research process. Source: Villari [52]



community. Essentially, many women in the Ghanaian community admire lightweight fashion accessories, including necklaces and earrings. As a wearer of necklaces and earrings, the researcher is not alien to the many issues that accompany weighty fashion accessories. Through such a qualitative approach of using experience, the iterative process resulted in a developing design for fashion accessories. The main goal of the interpretative phase is to build a shared design approach to describe the critical elements identified during analysis and the opportunities that emerge (the design areas) related to the research context [52]. This consisted of formulating some design scenarios related to fashion and describing frameworks/techniques for developing project proposals that can be transformed into actual designs and products.

The next stage is designing and implementing the developed proposals because initial ideas are not outcomes. Some of the activities implemented during these two phases are aimed at transforming the acquired knowledge in design products into outcomes. At this stage, the researcher, together with the help of the students, defined the potential areas of intervention and the target scenarios and described frameworks where project proposals were to be developed [52]. After many iterations, the researcher settled on the necklaces and earrings because stakeholders thought that they were the best fashion accessories amenable to the designs. An important aspect of this was the selection of the crocheting technique for developing the outcomes after the designs.

### Crocheting Technique

Crocheting is a type of lace needlework that involves interlocking loops of a single thread using a hooked needle [9]. Fundamentally, it is a different technique than knitting, quilting, and embroidery, although these are all craft techniques.

Cunningham [12] argued that a crochet uses a single hooked tool rather than a pair of straight knitting needles. Karp [27] also suggested that knitting and crocheting are differentiated by the loops in crochet ‘interworking’ and that crocheting is a doubly interloped

structure' because a single row of chain stitches is not crochet. Crochet has many basic stitches. They include chain stitches, single crochet in a row, single crotchet-round, double crochet, half-double crochet, and triple crochet [25, 45]. Furthermore, other common crocheting stitches include broomstick, puff, shell, star, and V which this study adopted to construct the final products. These crochet stitches were used as an idea inspiration.

Table 1 shows a studio work of six selected crochet stitches made into flat drawings of necklaces. The first column in Table 1 lists crochet samples from 1–6. Whereas in column 2, the author shows a sample of a flat-designed product using a specific crocheting design, column 3 is used to provide comments on the samples of designed products. In designing and making the necklaces and earrings in this paper, these different samples of crocheting stitches have been considered and made into flat designs.

In the initial stages, all twenty samples of flat designs were produced to assess the cohesion of the crochet design and can tabs into flat designs; strength, aesthetic, and total appearance of the intended products. The number was reduced through critical reviews. Some of the samples of the flat designs were rejected based on a lack of durability and aesthetic qualities. Others were also rejected based on the inability of the crochet stitches to hold the can tabs down and conceal the metal completely.

In crocheting, crochet hooks are used to construct the stitches and designs. There are aluminium and steel hooks [9], of different sizes depending on the need and requirement for specific designs. The hooks come in various forms and brands, with no standardised hooks in the market today. It has four parts: point, throat, thumb rest, and shank. Casey [9] explained that whereas the throat catches that yarn, the point goes into the crocheted fabric, and the shank holds the loops in place and determines the sizes of the stitches. Finally, the thumb rest supports the thumb to aid the turning off the hook while working. This research used a size 4 crochet hook because it sleekly holds twine threads.













Designs were made based on some principles and guidelines for making jewellery. For example, jewellery should be attractive, smooth, comfortable, durable, flexible, and trendy [37]. Guided by the principles of jewellery designing, the shape and width of can taps (not forgetting the durability of the final product), the earrings and necklaces were designed. The different types of the production of initial flat designs were guided by the characteristics of selected crochet designs and the positioning of can tabs.

### **Collection and Preparation of Can Tabs for Necklaces and Earrings Based on Crochet Technique**

The can tabs were collected from various sources, including scrap metal workers, restaurants, pubs, and after-party celebrations over 3 months (July to September, (2022)). The can tabs were washed and dried to make them suitable for the project. The sharp ends attached to the empty cans were removed with a knife and filed to smoothen the rough edges (Fig. 5).

Regarding crocheting, many threads available in the market were considered based on their strength, lustre, colour, unravel nature, durability, sustainability, width, and availability for the current project and the future. Blended twine thread (70% cotton and 30% nylon) was chosen because it is a natural cotton fibre that absorbs sweat and makes the wearer feels relaxed and comfortable even under sunny conditions. Cotton is a strong fibre that lasts over an extended period making it durable. Nylon, a synthetic fibre, is strong and adds lustre to natural cotton when blended.

**Table 1** Samples of flat drawings in crocheted necklaces and studio works on the necklaces

S/ N	Examples of Crotchet	Flat Design of Necklace in a Selected Crotchet Pattern (Studio works)	Comments on Designs
1.	  V stitch		Necklace made with V stitch and can tabs.
2.	  Broom stitch		Necklace made with broomstick stitches and can tabs.
3.	  Puff stitch		Necklace made with puff stitches and can tabs.
4.	  Star crochet		Necklace made with star crochet stitches and can tabs
5.	  Shell stitch		Necklace made with shell stitches and can tabs (A)
6.	  Shell stitch		Necklace made with shell stitches and can tabs (B). This shows a full grasp of pull tabs.
	Shell stitch		

Source: Hubert [25] and Ryan [45]



Clean can tabs

Filling of rough edges of can tabs

**Fig. 5** Preparation of can tabs for the crocheting project. Source: Author's studio work photos (2022)

## The Crocheting Technique for Making Each Design/Product

### Design/Product 1

In design/product 1, a necklace was produced with two can tabs to begin a pendant in a row (Fig. 6). Subsequent rows were made in ascending order by four, eight, and twelve can tabs on each row. The pieces were arranged with one slightly on top of the other and woven to secure. Blended twine thread in orange-red colour was used. Chain stitches with a wrapping of threads were employed to attach the can tabs one over the other. Again, chain stitches were securely used at the wide ends of the pendant and served as extensions to tie at the back of the wearer's neck. Knots were made at the ends of the chain stitches to prevent the threads from fraying. Round pieces of can tabs were painted orange-red colour and were made into earrings by fixing ear bars.

**Fig. 6** Necklace based on crochet-chain stitches (product 1). Source: Author's Design/Product Outcome (2022)



## Design/Product 2

In design two (2), eight (8) can tabs were arranged in a slightly curved position to form a pendant (Fig. 7). Blue blended twine thread with blue beads was used. Chain stitches with the wrapping of threads were used to securely join the can tabs together on the narrow-curved sides. The other side of the can tabs forming the down part of the pendant was decorated with 3 threaded beads in each hole. Pearl and glass beads were arranged and attached to the ends of the pendant to form a rope with a lock at the back of the necklace. Earrings were produced in the same method to match the pendant design, and ear bars were attached.

## Design/Product 3

With design/product three, double chain stitches were used to attach can tabs to each other (Fig. 8). The can tabs were overlapped at the middle section of each. Threaded pearl beads were joined onto the lower part of the double chain stitches. The colours of the beads were gold and wine. The wine beads were smaller than the gold beads. Blended twine thread in orange was used to match the other colours. A single chain stitch was used at the end of the necklace to secure a lock.

## Design/Product 4

For design/product four, chain stitches with thread wrapping and shell crochet design were used (Fig. 9). Blended twine thread in peach colour was chosen. The pendant was created in a 'V' shape with five (5) can tabs. Chain stitches with thread wrapping technique were used to cover each can tab. With the bottom part of the pendant, a shell crochet pattern was constructed to accentuate the 'V' shape. Three can tabs were joined at each top side of the pendant with chain, shell stitches, and thread wrapping. A single row of chain stitches was produced to complete the two lengths of the necklace. A lock and bar were attached to the

**Fig. 7** A necklace and earring in crochet-chain stitches and beads (product 2). Source: Author's Design/Product Outcome (2022)



**Fig. 8** A necklace based on crochet-chain stitches (product 3). Source: Author's Design/Product Outcome (2023)



**Fig. 9** A necklace and earring in shell and chain-crochet stitches (product 4). Source: Author's Design/Product Outcome (2023)



ends of the necklace. The same pattern was created for the earrings, and the earbars were fixed.

### Design/Product 5

With design/product five (5), chain stitches with thread wrapping and shell crochet design were used to produce the necklace and earrings (Fig. 10). Seventeen (17) can tabs were used for the necklace. Each of the can tabs was joined to the other by double chain stitches. Chain stitches with thread wrapping were used to cover the can tabs in orange twine thread. A cream twine thread was used to produce chain stitches at the inner edges of the can tabs. A layer of shell crotchet pattern was introduced around the necklace and finished with chain stitches in a cream colour of twine thread. A pair of earrings was produced from the same design and finished with earring bars.

### Design/Product 6

The crochet stitches used for the design/product 6 necklace and earrings were chain stitches, thread wrapping techniques, and shell stitches (Fig. 11). Ash-blended twine thread was used for the construction. A dozen can pull tabs were used on the wearer's right-hand side in an asymmetric design. The left-hand side was made with a shell crochet design without can tabs. Equally, chain stitches with thread wrapping were used to conceal and hold the can tabs together. A shell crochet design was made around the necklace. Single chain stitches were used at the end with an attachment of a lock. Wine pearl beads were used to decorate the necklace and to provide a weight that allows the necklace to lie flat on a wearer. The design was asymmetric.

**Fig. 10** A necklace and earring in chain and shell crochet stitches (product 5). Source: Author's Design/Product Outcome (2023)





**Fig. 11** Necklaces and earrings based on crochet-chain stitches (product 6). Source: Author's Design/Product Outcome (2023)

On the right-hand side product, a broader-size shell crochet stitches were used. Seventeen can tabs were used in this product and were decorated with wine pearl beads in a full-circle design.

In Fig. 12, the final products were worn by some of the stakeholders to assess acceptability. The assessment was based on some principles and guidelines for making jewellery. For example, jewellery should be attractive, smooth, comfortable, durable, flexible, and trendy [37]. Apart from principles and guidelines for making jewellery, consumers expectation on the environment, quality materials, innovative designs, and product durability [8]



**Fig. 12** Necklaces and earrings worn by some stakeholders. Source: Photo by the researcher (2023)

were also considered. Based on these factors, products 4, 5, and 6 (Fig. 12) were selected among the six products made from this study for plausible mass production for the market.

## Discussion on the Design and Product Outcomes

The circular economy has become an essential means of reducing waste to avoid the environmental effects of excessive waste from the fashion and textile industries. In this paper, it has been demonstrated that can tabs could be combined with crochet techniques to ensure their reuse. Cappellieri et al. [8] argued that consumers today request higher standards of respect for the environment and a deeper search for quality materials, innovation in style/design, and durability of the products they purchase to minimise their actions on the environment. As a result, the opportunity to reuse can tabs in fashion accessories can appeal to craft work technicians, policymakers, and consumers in Ghana and beyond.

The findings of this study demonstrate the possibility of reusing can pull tabs and twine threads in a crochet technique to design and make sustainable fashion accessories. The results are an addition to the existing literature and differ from previous studies, including Moorhouse and Moorhouse [38], who explored sustainable design practices in implementing a circular economy to design new sportswear products and luxury products. Methodology-wise, the paper is similar to Dudek and Sparks [17] in using crochet but differs and contributes to the literature regarding fashion accessories products. The paper has demonstrated that a circular economy can be adopted to design and make fashion accessories. Contextually, the use of the Ghanaian fashion accessories sector is an initial contribution to the literature as this paper. To the author's best knowledge, this paper is the first to use crocheting to design and make fashion accessories for the Ghanaian fashion industry.

In Ghana and many other parts of the world, recycling is a topical issue to avoid sending waste to landfill sites. However, Ghana has limited availability of recycling facilities to process waste, including fashion items. As of today, there is no large-scale segregation of household waste into recyclables and non-recyclables in Ghana. Consequently, waste that can be recycled or reused is sent to landfill sites. Through the products designed and created from this study, can tabs can be reused to avoid them from ending up in landfill sites. The outcomes of this research could open up the possibility of exploring further applications. For example, an entire beverage can by far outweigh a pull tab because there can be many pull tabs generated from a can. As a result, experiments can be conducted to determine the possibility of cutting different shapes out of cans to make similar products to promote a circular economy in Ghana, Africa, and beyond.

The commercial significance of the outcomes of the study is critical to emphasise because the economic effect of reusing materials in fashion accessories endorses a new opportunity for various sectors of the Ghanaian economy, both directly (jobs for those directly involved) and indirectly (those who are indirectly going to benefit). For example, crocheting is a vital cottage industry in many parts of the world. It is a creative but less regimented craft that is easier to learn. As a result, this can serve as a knowledge base for many women involved in craft work in Ghana and other parts of Africa to explore the possibility of expanding their small-scale businesses into this sector. As the concept relies on reusing can tabs that are free to source, it would not require significant economic resources to begin it on a small-scale basis. It is suggested that policymakers consider the possibility of enacting policies that encourage the reuse of can tabs and other similar materials to reduce their environmental effects and promote the reuse of other similar bi-products.

## Conclusion

Through the circular economy approach of reusing existing materials for making selected fashion accessories, the fashion industry can aid in the reduction of materials that end up at landfill sites. This study explored the application of the circular economy approach in the Ghanaian fashion accessories sector, especially in making necklaces and earrings. Adopting crocheting, a typical craft-making technique in Ghana, pull tabs from cans were combined with twine thread to make selected necklaces and earrings to demonstrate sustainable ways of making fashion accessories. It has theoretically and practically demonstrated contribution to the circular economy approach.

Using the crocheting technique, six different styles of necklaces and earrings were made from can tabs and twine threads. Consequently, wearers can select from various fashion accessory designs and products made from crochet techniques. It was argued that crocheting is an old craft that can be revived into the modern Ghanaian fashion accessories industry trend. The necklaces and earrings made from crochet designs are light in weight and, therefore, will not cause torn earlobes to the potential wearers. Crochet projects are attractive and can fit well as part of fashion accessories. Due to the use of can tabs, the paper further indicated that the effect of raw materials extraction on the environment would be reduced. Besides, the littering of the environment by pull tabs from cans will decrease because there is the potential for collectors to be paid by those who would adopt these and commercialise the production.

It was suggested that policymakers and the government of Ghana should develop policies that will make it attractive for those in craft-making to adopt such practices. This can attract industry leaders in the Ghanaian fashion accessories sector to consider the outcomes of this study. Since there is no policy on waste separation (recycling) in the country, using pull tabs can potentially reduce the amount of waste on various landfill sites. As a further study to this paper, it was suggested that other countries in Africa and beyond with similar circumstances could study the use of the whole can cut into pieces of pull tabs or different shapes to make fashion accessories. Again, other techniques could be adopted to test whether it is possible to create new products out of used cans or can-pull tabs.

**Acknowledgements** I acknowledge the help I received in the form of comments and feedback to improve the original article from colleagues, friends, and students who participated in the initial and final stages of the action research.

**Author Contribution** I declare that this research is authored solely by me.

**Funding** There is no funding for the research.

**Data Availability** N/A. However, the author is happy to send copies of the designed items if required.

## Declarations

**Ethics Approval and Consent to Participate** This research was purely on design basis, and therefore, it did not use any participant in data collection and analysis.

**Consent for Publication** I am the sole author and give my consent for the publication of this manuscript.

**Competing Interests** The author declares no competing interests.

## References

- Alhasan N, Elghouche BCL, Jonathan YT (2017) Aspiration of aluminum beverage can tab: case report and literature review. *Hindawi Otolaryngol* 2017(1010975):1–4. <https://doi.org/10.1155/2017/1010975>
- Archer B (1995) A view of the nature of design research. In *Design: science: method*, edited by Robin Jacques and James A, Powell, 30–47. Westbury House, Guildford, UK.
- Arhinful K (2021) Nonsensical fashions and fashions' nonsensicalities – men in earrings ladies...in 'aware' dresses, available at <https://www.modernghana.com/news/496171/nonsensical-fashions-and-fashions-nonsensicalities-8211.html>, accessed on 07/01/2023.
- Blowfield M, Murray A (2008) *Corporate responsibility*, 3rd edn. Oxford, Oxford University Press
- Brydges T (2021) Closing the loop on take, make, waste: investigating circular economy practices in the Swedish fashion industry. *J Clean Prod* 293:126245. <https://doi.org/10.1016/j.jclepro.2021.126245>
- Burrington JD (1976) Aluminum 'Pop Tops': a hazard to child health. *J Am Med Assoc* 14;235(24):2614–7
- Caniato F, Caridi M, Crippa L, Moretto A (2012) Environmental sustainability in fashion supply chains: an exploratory case-based research. *Int J Prod Econ* 135:659–670
- Cappellieri A, Borboni E, Tenuta L, Testa S (2019) Circular economy in fashion world. *Sharing Soc* 112.
- Casey C (2013) *All about crochet - a beginner's guide*, 1st edn. Lulu Press Inc, New York
- Claudio L (2007) Waste couture. *Environ Health Perspect* 115:448–454
- Colucci M, Vecchi A (2020) Close the loop: evidence on the implementation of the circular economy from the Italian fashion industry. *Bus Strateg Environ* 30(2):856–873. <https://doi.org/10.1002/bsc.2658>
- Cunningham SJ (1996) Crochet technique. *Hist Sci Knots* 11:317
- Didenko NI, Klochkov YS, Skripnuk DF (2018) Ecological criteria for comparing linear and circular economies. *Resources* 7(3):48. <https://doi.org/10.3390/resources7030048>
- Dissanayake DGK, Weerasinghe D (2020) Towards circular economy in fashion: review of strategies, barriers, and enablers. *Circ Econ Sustain* 2:25–45. <https://doi.org/10.1007/s43615-021-00090-5>
- Doppelt B (2003) Overcoming the seven sustainability blunders. *Syst Thinker* 14(5):2–7
- Drake D, Spinler S (2013) Sustainable operations management: an enduring stream or a passing fancy? *Manuf Serv Oper Manag* 15:689–700
- Dudek S, Sparks D (2015) Digital West-African-inspired batik meets traditional European crochet. In *International Textile and Apparel Association Annual Conference Proceedings (Vol. 72, No. 1)*. Iowa State University Digital Press.
- Elf P, Werner A, Black S (2022) Advancing the circular economy through dynamic capabilities and extended customer engagement: insights from small sustainable fashion enterprises in the UK. *Bus Strateg Environ* 31:2682–2699
- Ellen MacArthur Foundation (2013) *Towards the circular economy. Opportunities for the consumer goods sector*. Retrieved from [https:// www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE\\_Report-2013.pdf](https://www.ellenmacarthurfoundation.org/assets/downloads/publications/TCE_Report-2013.pdf) accessed on 08/01/2023
- Fening PA (2015) The changing face of the Ghanaian culture: a case of earring in men. *Asian J Humanit Soc Sci* 3(1):110–119
- Fortmann J, Heuten W, Boll S (2015) User requirements for digital jewellery. In: *Proceedings of the 2015 British HCI Conference, July 13 - 17, 2015. HCI, Lincoln, Lincolnshire, United Kingdom*, pp 119–125
- Galton E (2012) *Basics fashion design 10: Jewellery design: from fashion to fine jewellery*. Fairchild Books, New York
- Guo R, Lin J, Narayanan V, McCann J (2020) Representing crochet with stitch meshes. In *Proceedings of the 5th Annual ACM Symposium on Computational Fabrication*. (pp. 1–8).
- Ho HPY, Choi TM (2012) A five-R analysis for sustainable fashion supply chain management in Hong Kong: a case analysis. *J Fash Mark Manag* 16:161–175
- Hubert M (2010) *The complete photo guide to crochet*. Creative Publishing International, Minnesota
- Jain SA (2022) *fashion accessories: types, trends and importance*. <https://textilelearner.net/fashion-accessories-types-trends-and-importance/> (Accessed on 20/03/2023).
- Karp C (2018) Defining crochet. *Text Hist* 49(2):208–223. <https://doi.org/10.1080/00404969.2018.1491689>
- Kerr J, Landry J (2017) Pulse of the fashion industry. In *Copenhagen Fashion Summit 2017; Global Fashion Agenda & The Boston Consulting Group: Copenhagen, Denmark, 2017*; pp. 2–134. Available online: [https://www.copenhagenfashionsummit.com/wpcontent/uploads/2017/05/Pulse-of-the-Fashion-Industry\\_Executive-summary.pdf](https://www.copenhagenfashionsummit.com/wpcontent/uploads/2017/05/Pulse-of-the-Fashion-Industry_Executive-summary.pdf) (Accessed on 18/09/2023).

29. Khan S, Tzortzopoulos P (2018) Using design science research and action research to bridge the gap between theory and practice in lean construction research. In Proceedings of the 26th Annual Conference of the International Group for Lean Construction. Chennai (pp. 209–219).
30. Kleindorfer P, Singhal K, van Wassenhove LN (2005) Sustainable operations management. *Prod Oper Manag* 14:482–492
31. Koskinen I, Thomas B, Johan R (2008) Lab, field, gallery, and beyond ArtiKoskinen, fact. *J Des Pract* 2(1):46–57. <https://doi.org/10.1080/17493460802303333>
32. Lang A, Murphy H (eds) (2014) Between government pressure and self-regulation, In: Business and sustainability, Springer Cham. <https://doi.org/10.1007/978-3-319-07239-5>
33. Leontief W (1991) The Economy as a circular flow. *Struct Chang Econ Dyn* 2(1):181–212
34. Machado MAD, de Almeida SO, Bollick LC, Bragagnolo G (2019) Second-hand fashion market: consumer role in circular economy. *J Fash Mark Manag* 23(3):382–395
35. Mahler D, Kearney AT (2007) The sustainable supply chain. *Supply Chain Manag Rev* 11(8):59–60
36. Marques AD, Marques A, Ferreira F (2020) Homo Sustentabilis: circular economy and new business models in fashion industry. *SN Appl Sci* 2:306. <https://doi.org/10.1007/s42452-020-2094-8>
37. McGrath J (2007) The complete jewellery making course: principles, practice and techniques: a beginner's course for aspiring jewellery makers. B. E. S. Publishing, New York
38. Moorhouse D, Moorhouse D (2017) Sustainable design: circular economy in fashion and textiles. *Des J* 20(sup1):S1948–S1959. <https://doi.org/10.1080/14606925.2017.1352713>
39. Niinimäki K, Peters G, Dahlbo H, Perry P, Rissanen T, Gwilt A (2020) The environmental price of fast fashion. *Nat Rev Earth Environ* 1(4):189–200
40. Nordic Fashion Association (2016) Background. Available online: [www.nordicfashionassociation.com/background](http://www.nordicfashionassociation.com/background) (accessed on 1 June 2023).
41. Provasnek AK, Sentic A, Schmid E (2017) Integrating eco-innovations and stakeholder engagement for sustainable development and a social license to operate. *Corp Soc Responsib Environ Manag* 24(3):173–185. <https://doi.org/10.1002/csr.1406>
42. Rajili NAM, Olande E, Warell A (2015) Characteristics of jewellery design: an initial review. Paper presented at Proceeding of the International Conference on Research into Design (ICoRD'15), Bangalore: India Institute of Science.
43. Rani S, Rani B (2018) Preference of fashion accessories among college going girls. *Ann Agri-Bio Res* 23(1):122–125
44. Reason P, Bradbury H (2001) Handbook of action research: participative inquiry and practice. Sage Publications, London
45. Ryan MG (1981) The complete encyclopaedia of stitchcraft. The Chaucer Press Ltd, Bungay, UK
46. Skinner D (2013) Contemporary Jewelry in Perspective. New York: an imprint Sterling Publishing.
47. Smith P, Baille J, McHattie LS (2017) Sustainable Design Futures: an open design vision for the circular economy in fashion and textiles. *Des J* 20(sup1):S1938–S1947
48. Stahel WR (1994) The utilization-focused service economy: resource efficiency. In: Allenby BR, Richards DJ (eds) The greening of industrial ecosystems. National Academy Press, Washington, DC, pp 178–190
49. Strähle J, Müller V (2017) Key aspects of sustainability in fashion retail. *Green Fashion Retail* 7–26 <https://doi.org/10.1007/978-981-10-2440-5>
50. Swann C (2002) Action research and the practice of design. *Des Issues* 18(2):49–61. <https://doi.org/10.1162/07479360252756287>
51. Thorisdottir TS, Johannsdottir L (2019) Sustainability within fashion business models: a systematic literature review. *Sustainability* 11(8):2233
52. Villari B (2023) Action research approach in design research, in *The Routledge Companion to Design Research*, edited by Paul A. Rodgers, and Joyce Yee, Taylor & Francis Group, available at <http://ebookcentral.proquest.com/lib/rmit/detail.action?docID=7260406> (Accessed on 29/08/2023).
53. Wade K, Allen KM (2007) Practice-based research: changing the professional culture and language of social work. *Soc Work Health Care* 44(4):49–64

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.