FABRIC WASTE DIMENSIONS IN SELECTED SUBURBS OF THE KUMASI METROPOLIS IN GHANA

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ABSTRACT

This study examined the sustainable utilisation pathways of pre-consumer fabric waste generated by tailoring and dressmaking enterprises in Ghana and assessed their contribution to resource efficiency, waste reduction, and sustainable textile production. A descriptive cross-sectional survey design was employed. Data were collected from tailoring and dressmaking enterprises using a structured questionnaire and analysed using descriptive statistics, including frequencies, percentages, means, and standard deviations. The study found that pre-consumer fabric waste is routinely generated during garment production and is primarily utilised through reuse, recycling, and upcycling into value-added products. These practices support resource conservation, waste reduction, and income generation. However, inadequate recycling infrastructure, limited technical expertise, and weak institutional support hinder wider adoption of sustainable utilisation practices. The findings highlight the need for investment in textile recycling infrastructure, capacity building, and stronger stakeholder collaboration to promote circular economy practices and sustainable textile waste management in Ghana. This study contributes to the limited empirical literature on pre-consumer fabric waste by focusing on tailoring and dressmaking enterprises in Ghana, an under-researched segment of the textile value chain, and provides evidence to support sustainable resource utilisation and circular textile systems.

Keywords: Pre-consumer fabric waste; sustainable utilisation; circular economy; textile waste management; Kumasi; Ghana

1.0 INTRODUCTION

The textile and apparel industry is one of the world's largest manufacturing sectors, contributing significantly to economic growth, industrial development, employment creation, and international trade. Beyond its economic importance, the industry plays a vital role in improving livelihoods and preserving cultural heritage through fashion and textile production. However, the rapid expansion of textile manufacturing and garment production has been accompanied by a substantial increase in textile waste, making the industry one of the largest contributors to global environmental pollution. Increasing levels of resource consumption, intensive use of water and energy, and the continuous disposal of textile materials have intensified concerns regarding the long-term sustainability of the sector (Niinimäki et al., 2020; UNEP, 2020).

Textile waste is generated throughout the entire textile value chain, beginning with fibre production and extending through fabric manufacturing, garment construction, retail, consumer use, and final disposal. Among these waste streams, fabric offcuts generated during garment production constitute one of the largest sources of pre-consumer textile waste. These materials are produced during fabric spreading, marker planning, pattern cutting, trimming, and garment assembly. Although they retain useful physical and mechanical properties, they are commonly treated as waste and discarded, representing not only an environmental challenge but also a significant loss of valuable raw materials and economic resources (Shirvanimoghaddam et al., 2020; Textile Exchange, 2021).

Growing awareness of environmental degradation and resource scarcity has stimulated global efforts to transform the textile industry into a more sustainable and resource-efficient sector. Consequently, the concept of the circular economy has emerged as an important framework for reducing waste and maximising material utilisation. Rather than allowing valuable textile materials to follow a linear pathway from production to disposal, circular economy principles encourage materials to remain within productive systems through reuse, recycling, repair, remanufacturing, and value recovery. This approach reduces environmental impacts while creating opportunities for innovation, entrepreneurship, and sustainable economic development (Ellen MacArthur Foundation, 2017; European Environment Agency, 2022).

Despite growing international interest in sustainable textile production, effective textile waste management remains a major challenge in many developing countries. Limited recycling infrastructure, inadequate waste segregation systems, weak policy implementation, and low investment in textile recovery technologies have constrained efforts to recover valuable textile materials before disposal. In many African countries, including Ghana, tailoring shops, dressmaking enterprises, and small fashion businesses generate considerable quantities of fabric offcuts during daily garment production. Much of this waste is disposed of through open burning, indiscriminate dumping, burial, or landfilling, practices that contribute to environmental pollution, blocked drainage systems, greenhouse gas emissions, and the inefficient utilisation of valuable textile resources. These disposal practices also represent missed opportunities for employment creation, enterprise development, and resource recovery within the textile value chain (Nayak et al., 2019).

Existing literature has primarily focused on post-consumer textile waste, discarded clothing, textile recycling technologies, and industrial-scale manufacturing systems. Comparatively fewer studies have examined fabric offcuts generated by small-scale garment producers, particularly within the informal clothing sector of developing countries. This imbalance in the literature has resulted in limited empirical evidence regarding the quantity of fabric waste generated, the composition of fabric offcuts, seasonal variations in waste generation, and the waste management practices adopted by garment producers in Ghana. Without such evidence, policymakers, environmental agencies, and industry stakeholders face considerable difficulty in designing practical strategies that support sustainable textile waste management and circular production systems.

Addressing this knowledge gap is increasingly important as Ghana seeks to promote sustainable industrial development and improve environmental management within the textile and fashion sector. Reliable information on fabric waste generation provides the foundation for developing effective recycling programmes, strengthening resource efficiency, supporting waste valorisation initiatives, and encouraging investment in circular business models capable of transforming textile waste into valuable products. Such evidence also contributes to broader national and global efforts aimed at promoting responsible production and consumption while reducing the environmental footprint of the textile industry.

This study, therefore, investigates the dimensions of fabric waste generated by tailoring and dressmaking workshops in selected suburbs of the Kumasi Metropolis. Specifically, the study quantifies the volume of fabric waste generated over a twelve-month period, identifies the dominant fabric types, examines prevailing waste management practices, and proposes sustainable strategies for improving fabric waste utilisation through recycling, reuse, upcycling, and circular economy principles.

The study makes three important contributions to the existing body of knowledge. First, it provides one of the few empirical assessments of pre-consumer fabric waste generated by small-scale garment producers in Ghana using direct field measurements. Second, it demonstrates the seasonal nature of fabric waste generation associated with fluctuations in garment production throughout the year. Third, it presents practical recommendations that support the transition from waste disposal to resource recovery, thereby contributing to sustainable textile production, environmental protection, and circular economic development in Ghana and other developing economies.

2.0 LITERATURE REVIEW

2.1 Global Perspectives on Textile Waste

The textile and apparel industry has become one of the world's largest manufacturing sectors, contributing substantially to employment, industrialisation, international trade, and economic development. Despite these socio-economic benefits, the industry is increasingly recognised as one of the most resource-intensive manufacturing sectors because of its extensive consumption of water, energy, chemicals, and raw materials. Niinimäki et al. (2020) observed that the environmental footprint of textile production extends across the entire product life

cycle, from fibre cultivation and yarn production to manufacturing, distribution, consumption, and disposal. Similarly, Muthu (2020) argued that the growing complexity of global textile supply chains has intensified environmental pressures, particularly through excessive resource extraction and increasing volumes of solid textile waste. According to UNEP (2020), the textile sector is responsible for significant greenhouse gas emissions, wastewater pollution, and resource depletion, making sustainable waste management an international priority.

The rapid growth of global clothing consumption has further intensified the generation of textile waste. The Ellen MacArthur Foundation (2017) noted that the prevailing linear production model, characterised by resource extraction, production, consumption, and disposal, results in substantial losses of valuable textile materials because products are discarded before reaching the end of their functional life. This situation has been exacerbated by the expansion of fast fashion, shorter product life cycles, and increasing consumer demand for inexpensive clothing. Textile Exchange (2021) reported that global fibre production has continued to increase annually, placing additional pressure on natural resources and generating larger quantities of manufacturing waste. Likewise, Koszewska (2018) emphasised that accelerating consumption patterns continue to outpace improvements in textile recycling and material recovery, thereby undermining progress towards sustainable production systems.

Textile waste is generally classified into two principal categories, namely pre-consumer and post-consumer waste. Sandin and Peters (2018) explained that pre-consumer waste originates during textile manufacturing processes such as spinning, weaving, knitting, dyeing, finishing, and garment construction, whereas post-consumer waste consists of clothing and textile products discarded after consumer use. Although research has predominantly focused on post-consumer waste because of the environmental implications of fast fashion, Shirvanimoghaddam et al. (2020) argued that pre-consumer textile waste deserves equal attention because it comprises relatively clean and uncontaminated materials with considerable potential for reuse, recycling, and value addition. Supporting this view, Rissanen and McQuillan (2021) maintained that improving material utilisation during garment production offers one of the most effective strategies for reducing textile waste before products enter the consumer market.

The environmental consequences of textile waste extend far beyond the loss of valuable materials. UNEP (2020) reported that unsustainable production and disposal practices contribute to greenhouse gas emissions, chemical contamination of water bodies, biodiversity loss, and increasing dependence on landfill disposal. According to the European Environment Agency (2022), improving material efficiency through waste prevention, reuse, recycling, and circular product design is essential for reducing these impacts. Similarly, Henry et al. (2019) argued that transitioning from linear production systems to circular textile models can significantly reduce resource consumption while creating new economic opportunities through secondary material markets and sustainable entrepreneurship.

Although considerable progress has been made in understanding the environmental implications of textile waste, much of the existing literature continues to concentrate on industrial manufacturing systems and post-consumer clothing disposal. Comparatively fewer empirical studies have examined pre-consumer fabric waste generated by small-scale tailoring

and dressmaking enterprises, particularly within developing countries, where informal garment production dominates the sector. As Niinimäki et al. (2020) observed, achieving a circular textile economy requires greater attention to waste prevention at the production stage rather than focusing exclusively on end-of-life waste management. This gap underscores the need for empirical investigations into pre-consumer fabric waste management and sustainable utilisation strategies capable of improving resource efficiency and supporting circular textile production within local manufacturing contexts.

2.2 Fabric Waste Generation in Garment Manufacturing

Garment manufacturing represents one of the most significant sources of pre-consumer textile waste within the textile value chain. Fabric waste is generated during several production stages, including fabric spreading, marker planning, pattern cutting, sewing, trimming, and finishing. Among these operations, the cutting stage has consistently been identified as the principal source of material loss because garment patterns rarely utilise the entire width and length of the fabric. Rissanen (2013) observed that pattern configuration, garment style, fabric width, and marker efficiency are among the most influential factors determining the quantity of fabric waste generated during production. Similarly, McQuillan (2020) argued that conventional garment construction methods inherently generate offcuts because design processes seldom prioritise material efficiency during pattern development. Consequently, even well-managed garment factories inevitably produce varying quantities of fabric remnants during routine manufacturing operations.

The quantity of fabric waste generated differs considerably across production systems. While large-scale manufacturing facilities increasingly employ computer-aided design, automated marker planning, and digital cutting technologies to optimise fabric utilisation, many small and medium-sized garment enterprises continue to rely on manual pattern drafting and cutting techniques. Gwilt (2020) maintained that design decisions made during the earliest stages of product development largely determine the amount of waste generated during production. Likewise, Niinimäki et al. (2020) emphasised that waste prevention should be embedded within product design by integrating resource efficiency principles throughout the manufacturing process. In many developing countries, however, limited access to digital technologies, financial constraints, and inadequate technical capacity continue to reduce material utilisation efficiency and increase production waste (Nayak et al., 2019). Historically, fabric offcuts have been regarded as waste requiring disposal. Recent studies, however, recognise pre-consumer fabric waste as a valuable secondary resource capable of supporting circular manufacturing systems. Shirvanimoghaddam et al. (2020) demonstrated that fabric remnants can be transformed into insulation materials, composite products, furniture filling, cleaning materials, fashion accessories, and decorative products without substantial loss of material quality. Supporting this position, Palm et al. (2022) argued that extending the productive life of textile materials through reuse, remanufacturing, and upcycling significantly reduces virgin resource consumption while strengthening circular economy initiatives. Similarly, Textile Exchange (2021) reported that improving the recovery of production waste

offers considerable opportunities for reducing environmental impacts throughout global textile supply chains.

Contemporary research has therefore shifted from end-of-pipe waste management towards waste prevention and resource optimisation. According to Gwilt (2020), sustainable garment production begins during the design phase, where zero-waste pattern cutting, efficient marker planning, and product redesign can substantially minimise fabric losses. McQuillan (2020) similarly emphasised that zero-waste fashion design requires designers to reconsider conventional pattern construction by integrating waste reduction directly into the creative process. Advances in computer-aided design, digital marker making, automated cutting technologies, and artificial intelligence have further improved fabric utilisation efficiency while reducing production waste (Nayak et al., 2019). These innovations demonstrate that effective textile waste management is most successful when waste prevention strategies are incorporated before manufacturing commences.

Despite these technological advances, fabric waste remains an unavoidable consequence of garment production, particularly within small-scale tailoring and dressmaking enterprises where manual production methods predominate. Koszewska (2018) observed that micro and small enterprises often lack the financial resources, technical expertise, and technological infrastructure required to implement advanced waste reduction systems. Furthermore, UNEP (2020) noted that developing countries continue to experience limited investment in textile recovery infrastructure, restricting opportunities for material reuse and recycling within local production systems. Although industrial manufacturing has received considerable scholarly attention, comparatively fewer empirical studies have quantified the generation, composition, and seasonal variation of pre-consumer fabric waste within informal tailoring enterprises in developing countries. This knowledge gap highlights the need for context-specific investigations capable of informing evidence-based strategies for sustainable textile waste management and circular textile production.

2.3 Circular Economy and Sustainable Textile Waste Management

Growing environmental concerns associated with textile production have shifted global attention from conventional waste disposal towards circular economy principles that promote resource efficiency and sustainable material management. Unlike the traditional linear model of extraction, production, consumption, and disposal, the circular economy seeks to maintain the value of products and materials through reuse, repair, remanufacturing, and recycling. The Ellen MacArthur Foundation (2017) described the circular economy as a regenerative system that minimises waste while extending material life. Similarly, Geissdoerfer et al. (2017) and Kirchherr et al. (2017) argued that circularity represents a systemic transition that integrates environmental sustainability with economic development through efficient resource utilisation.

Within the textile industry, circular economy principles encourage manufacturers to redesign production systems by prioritising eco design, cleaner production, material efficiency, and responsible consumption. Koszewska (2018) observed that treating textile waste as a secondary raw material rather than as refuse reduces dependence on virgin fibres while improving environmental performance. Likewise, de Aguiar Hugo et al. (2021) and van der Velden et al.

(2022) demonstrated that improved product design, fibre recovery, and closed-loop manufacturing significantly enhance textile circularity and resource conservation.

Material efficiency remains central to circular textile production. According to UNEP (2020), sustainable textile systems require interventions across the entire product life cycle, from fibre selection and manufacturing to product use and end of life management. Korhonen et al. (2018) similarly maintained that maintaining materials at their highest value through multiple production cycles reduces waste generation and improves overall resource productivity. Recycling, reuse, and upcycling are therefore essential components of circular textile systems. Bukhari et al. (2018) reported that textile recycling conserves natural resources, reduces landfill disposal, and lowers greenhouse gas emissions. Beyond recycling, Nayak et al. (2019) and Dissanayake and Weerasinghe (2022) highlighted that upcycling transforms fabric remnants into higher-value products, including fashion accessories, home furnishings, and decorative items, thereby creating economic opportunities while reducing environmental impacts.

Successful implementation of circular textile systems requires collaboration among industry, government, researchers, and consumers. Textile Exchange (2021) emphasised the importance of sustainable supply chains, while the European Environment Agency (2022) and OECD (2022) advocated stronger policy frameworks, investment in recycling infrastructure, and extended producer responsibility to accelerate the circular transition. However, UNIDO (2021) noted that many developing countries continue to experience technological, financial, and institutional barriers that limit circular economy implementation within small and medium-sized enterprises. Although circular economy principles are increasingly recognised worldwide, empirical evidence concerning their application to pre-consumer fabric waste generated by small-scale tailoring and dressmaking enterprises remains limited, particularly in developing countries. This knowledge gap reinforces the need for context-specific studies that examine sustainable utilisation pathways capable of improving resource efficiency, promoting entrepreneurship, and supporting circular textile production within local garment manufacturing systems.

2.4 Textile Waste Management in Developing Countries

Textile waste management remains a major challenge in developing countries because of inadequate recycling infrastructure, weak institutional support, and increasing volumes of textile waste. UNEP (2020) reported that many low- and middle-income countries continue to rely on open dumping, open burning, and landfilling owing to limited investment in waste recovery technologies. Similarly, Kaza et al. (2018) observed that rapid urbanisation and weak municipal waste management systems have reduced opportunities for textile resource recovery while increasing environmental pollution.

The expansion of small-scale tailoring and garment enterprises has further intensified this challenge. Although these enterprises generate considerable quantities of pre-consumer fabric waste, they often operate outside organised waste collection and recycling systems. Nayak et al. (2019) attributed this situation to limited technical expertise, inadequate financial resources, and poor access to recycling technologies, while Desore and Narula (2018) emphasised that cleaner production practices and efficient manufacturing processes are essential for reducing waste

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generation at source. Across many developing countries, textile waste management remains disposal-oriented rather than recovery-based. Sandin and Peters (2018) argued that weak recycling infrastructure limits material recovery, whereas Shirvanimoghaddam et al. (2020) demonstrated that pre-consumer textile waste retains considerable economic and environmental value through reuse, recycling, and upcycling. Likewise, Schroeder et al. (2019) argued that effective implementation of the circular economy depends on supportive policies, institutional coordination, and stakeholder collaboration.

Ghana reflects similar conditions. Despite the rapid growth of tailoring and dressmaking enterprises, relatively little empirical evidence exists on the management of pre-consumer fabric waste. Current practices are largely characterised by temporary storage, indiscriminate disposal, open burning, and disposal through municipal waste systems, leading to the loss of reusable textile materials. Textile Exchange (2021) emphasised the need for stronger collaboration among industry, government, and research institutions to improve textile resource recovery, while UNHSP (2020) advocated integrated waste collection, segregation, and recycling systems to enhance sustainable urban waste management. Addressing these challenges requires coordinated investment in recycling infrastructure, cleaner production technologies, policy support, entrepreneurship, and public awareness.

The European Environment Agency (2022) emphasised that sustainable textile management should prioritise waste prevention, reuse, recycling, and value recovery throughout the product life cycle. These strategies are particularly relevant to Ghana, where improving the management of pre-consumer fabric waste can support circular textile production, reduce environmental pollution, and create new economic opportunities within the garment sector.

2.5 Conceptual Framework

The conceptual framework underpinning this study is informed by the principles of the circular economy and sustainable resource management. It assumes that fabric waste is an inevitable by-product of garment manufacturing, the quantity and composition of which are influenced by production-related factors such as fabric type, production volume, cutting efficiency, pattern layout, and the technical skills of garment producers. Once generated, fabric waste is subjected to different management practices, including disposal, burning, reuse, recycling, and upcycling.

The framework further assumes that sustainable waste management practices improve resource efficiency by reducing the quantity of fabric waste disposed of in the environment while promoting value recovery through recycling and reuse. Consequently, effective management of pre-consumer fabric waste contributes to environmental protection, economic value creation, and the implementation of circular economy principles within the textile and apparel industry. The framework, therefore, provides a basis for examining the relationships between fabric waste generation, current management practices, and opportunities for sustainable resource utilisation among tailoring and dressmaking enterprises in the Kumasi Metropolis.

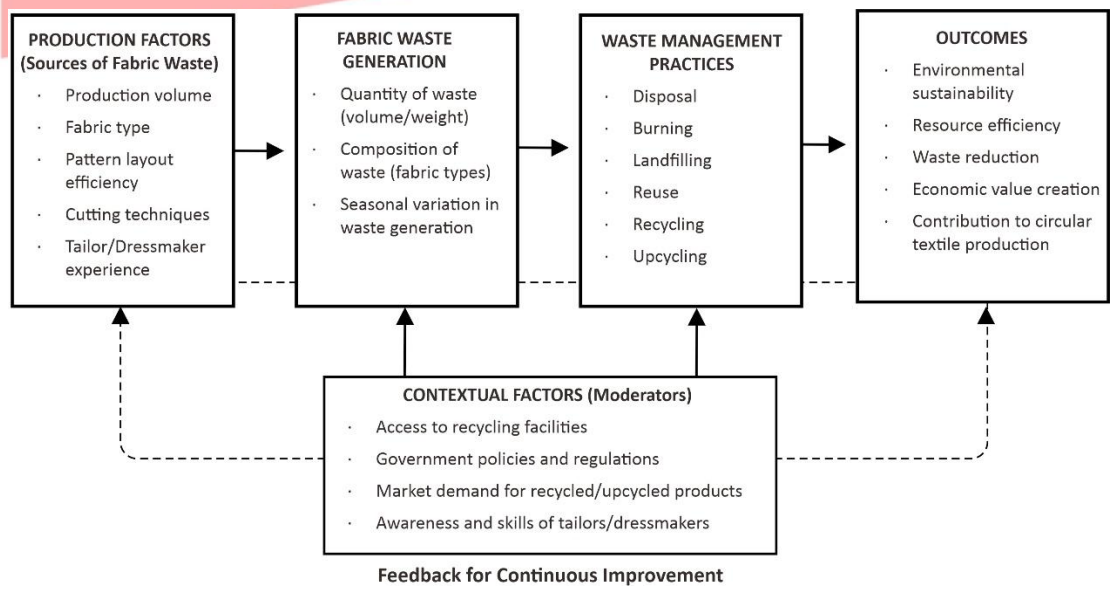


Figure 1. Conceptual framework

2. METHODOLOGY

3.1 Research Design

This study adopted a descriptive cross-sectional research design to investigate pre-consumer fabric waste generation and management among tailoring and dressmaking enterprises within the Kumasi Metropolis, Ghana. The design was appropriate because it enabled the systematic collection, quantification, and analysis of fabric waste generated during routine garment production without manipulating the production environment. The study further examined enterprise characteristics, production capacity, waste composition, and existing waste management practices to identify opportunities for sustainable fabric waste utilisation.

3.2 Study Area

The study was conducted in the Kumasi Metropolis in the Ashanti Region of Ghana. Kumasi is recognised as one of Ghana's principal commercial and manufacturing centres and hosts a large concentration of tailoring and dressmaking enterprises that supply customised garments for households, educational institutions, religious organisations, and commercial clients. Four major garment production groups were purposively selected for the study as shown on the map Kumasi (fig 3.2) in the Ashanti region: Central Market, Alabar, Asafo, and Asokwa. These locations were selected because they represent the largest concentration of garment producers within the metropolis and account for a substantial proportion of custom garment production activities.

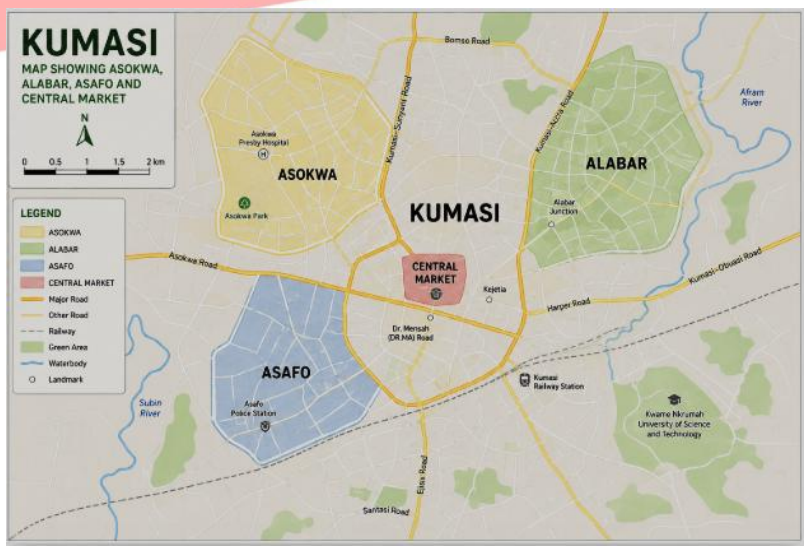


Figure 2. Map of the Kumasi Metropolis Showing the Selected Study Areas

3.3 Population of the Study

The study population comprised registered tailoring and dressmaking enterprises operating within the selected production groups, together with garment makers directly engaged in garment production. The enterprises constituted the production units where fabric waste was generated, while the garment makers provided information regarding production processes, fabric utilisation, and waste management practices.

3.4 Sample Size and Sampling Procedure

A total of 60 participants were involved in the study, comprising 21 tailoring shops and 37 garment makers. Four garment production shops were purposively selected based on the concentration of tailoring and dressmaking activities within the metropolis. Subsequently, tailoring shops were selected from each study area, after which two garment makers were recruited from each participating enterprise.

Table 1. Distribution of Sampled Enterprises and Respondents

Study Area	Tailors	Dressmakers	Total
Central Market	7	13	20
Alabar	7	13	20
Asafo	4	8	12
Asokwa	3	5	8
Total	21	39	60

Source: Field Survey (2021)

3.5 Data Collection Instruments

Primary data were collected using structured questionnaires, direct observation, and physical measurement of fabric waste generated by the sampled enterprises. The questionnaire elicited information on respondents' demographic characteristics, production capacity, fabric utilisation practices, and existing waste management strategies. An observation checklist was used to

assess cutting practices, waste segregation methods, storage conditions, and disposal techniques within each enterprise. Fabric waste generated during production was physically collected and weighed using calibrated digital weighing scales. Only pre-consumer fabric waste generated during fabric spreading, marker making, cutting, trimming, and waste fabric assembly was included in the study.

3.6 Fabric Waste Measurement

Fabric waste generated by each participating enterprise was monitored throughout the 2021 production year. Measurements were undertaken monthly within the four study locations. Waste generated from each location was aggregated to determine monthly production and annual waste generation.

3.7 Data Analysis

Descriptive statistical techniques were employed to summarise the data. Frequencies and percentages were used to analyse respondents' demographic characteristics, enterprise profiles, fabric composition, and waste management practices. Monthly fabric waste generation was analysed using totals, percentages, means, medians, standard deviations, ranges, and coefficients of variation to describe temporal variations in waste generation. The analysed data were presented using tables, bar charts, pie charts, and line graphs to facilitate comparison and interpretation.

Table 2. Summary of Variables and Statistical Analysis

Research Objective	Variable	Analysis	Presentation
Determine the quantity of fabric waste	Waste generated (kg)	Frequency, Percentage, Mean, Standard Deviation	Tables, Line Graph
Determine waste composition	Fabric type	Frequency, Percentage	Table, Pie Chart
Assess waste management practices	Disposal method	Frequency, Percentage	Table, Bar Chart
Examine sustainable utilisation	Utilisation option	Frequency, Percentage	Table, Flow Diagram

3.8 Validity and Reliability

The questionnaire and observation checklist were reviewed by experts in textile design, waste management, and research methodology to establish content validity. A pilot study was conducted among garment enterprises outside the selected study locations to assess the clarity and suitability of the research instruments. Minor revisions were made before the commencement of the main survey. To ensure measurement reliability, all fabric waste measurements were undertaken using the same calibrated digital weighing scale, while standardised procedures for collection, sorting, and weighing were maintained throughout the study period.

4. RESULTS AND DISCUSSION

4.1 Demographic and Enterprise Characteristics of Respondents

The demographic and enterprise characteristics of respondents were analysed to provide contextual information for interpreting the patterns of fabric utilisation and pre-consumer fabric waste generation among tailoring and dressmaking enterprises. Variables analysed included gender, age, educational attainment, years of professional experience, enterprise type, and average weekly garment production.

Table 3. Demographic and Enterprise Characteristics of Respondents (n = 60)

Variable	Category	Frequency	Percentage (%)
Gender	Male	12	20.0
	Female	48	80.0
Age (Years)	Below 30	12	20.0
	30 to 39	32	53.3
	40 to 49	12	20.0
	50 and above	4	6.7
Educational Level	Basic	13	21.7
	Secondary	12	20.0
	Technical or Vocational	27	45.0
	Tertiary	8	13.3
Years of Professional Experience	Below 5	8	13.3
	5 to 10	22	36.7
	11 to 20	24	40.0
	Above 20	6	10.0
Enterprise Type	Tailoring	11	18.3
	Dressmaking	49	81.7
Average Garments Produced per Week	1 to 10	11	18.3
	11 to 20	18	30.0
	More than 20	31	51.7

Source: Field Survey (2021)

Table 3 shows that females constituted the majority of respondents, accounting for 80.0%, while males represented 20.0% of the sample. This distribution reflects the dominance of women in Ghana's informal garment manufacturing sector, particularly within dressmaking enterprises where customised apparel production is largely undertaken by female artisans. According to the International Labour Organisation (2021), women continue to constitute the largest proportion of workers in small- and medium-scale garment enterprises across developing economies because of their extensive involvement in apparel production and related entrepreneurial activities.

The age profile indicates that the industry is largely driven by economically active individuals. More than half of the respondents (53.3%) were between 30 and 39 years, while only 6.7% were aged 50 years and above. The relatively youthful workforce suggests that garment production

within the study area benefits from an active labour force capable of sustaining continuous production and responding to changing market demands. Similar observations have been reported by the International Trade Centre (2021), which identified the garment sector as a principal source of employment for economically active populations in developing countries.

Educational attainment varied among respondents, with 45.0% possessing technical or vocational education, followed by 21.7% with basic education, 20.0% with secondary education, and 13.3% with tertiary qualifications. The predominance of technically trained respondents suggests that practical vocational education remains the principal pathway into garment production. Such training enhances competencies in pattern drafting, fabric handling, marker planning, and garment construction, all of which influence fabric utilisation efficiency and waste generation. UNESCO (2021) observed that technical and vocational education significantly improves occupational competence and productivity within manufacturing industries.

The findings further indicate that 76.7% of respondents had between 5 and 20 years of professional experience, demonstrating substantial practical knowledge of garment production processes. Experienced garment makers generally possess a better understanding of fabric behaviour, cutting accuracy, and production planning, which may contribute to improved material utilisation. Nevertheless, increased production volumes can still lead to greater quantities of fabric offcuts, particularly during periods of high consumer demand. Enterprise characteristics revealed that 81.7% of the sampled businesses specialised in dressmaking, whereas 18.3% operated tailoring enterprises. Furthermore, more than half of the enterprises (51.7%) produced over 20 garments per week, indicating relatively high production capacity among the sampled businesses. Higher production volumes are associated with increased fabric consumption and, consequently, greater quantities of pre-consumer fabric waste. Niinimäki et al. (2020) reported that production intensity is a major determinant of textile waste generation, as larger production volumes inevitably yield more cutting remnants even under efficient manufacturing conditions.

The demographic and enterprise characteristics indicate that the respondents possessed adequate technical knowledge, practical experience, and production capacity to provide reliable information on fabric utilisation and waste management practices. The predominance of experienced dressmakers producing relatively high numbers of garments each week also suggests that the sampled enterprises provide an appropriate basis for assessing the magnitude and management of pre-consumer fabric waste within the Kumasi Metropolis. The subsequent section, therefore, examines the quantity and temporal distribution of fabric waste generated by the participating enterprises during the study period.

4.2 Quantity and Temporal Distribution of Pre-Consumer Fabric Waste

The quantity and temporal distribution of pre-consumer fabric waste generated by tailoring and dressmaking enterprises were analysed using monthly measurements collected from four major garment production areas in the Kumasi Metropolis, namely Central Market, Alabar, Asafo, and Asokwa. The analysis provides an overview of seasonal variations in fabric waste generation and identifies periods of increased production that contribute significantly to textile waste.

Table 4. Monthly Pre-Consumer Fabric Waste Generated by Tailoring and Dressmaking Enterprises

Month	Alabar	Asokwa	Asafo	Central Market	Total (kg)
January	3	4	4	5	16
February	3	3	2	3	11
March	2	3	4	5	14
April	2	6	9	6	23
May	12	8	7	21	48
June	2	3	2	3	10
July	11	6	5	13	35
August	5	5	6	8	24
September	4	5	6	4	19
October	3	3	4	4	14
November	4	8	7	9	28
December	5	15	14	23	57
Total	56	69	70	104	299

Source: Field Survey (2021)

Table 4 shows that the participating enterprises generated a cumulative 299 kg of pre-consumer fabric waste during the 2021 study period, with an average monthly generation of 24.9 kg. Waste generation varied considerably throughout the year, ranging from 10 kg in June to 57 kg in December, indicating that fabric waste generation was strongly influenced by seasonal garment production. The highest quantities of fabric waste were recorded in December (57 kg), May (48 kg), and July (35 kg). Field observations revealed that these peaks coincided with periods of heightened garment production associated with Christmas, Eid al-Fitr, and Eid al-Adha, during which garment makers experienced increased customer orders and extended production schedules. Conversely, the lowest quantities of waste were observed in June (10 kg) and February (11 kg), reflecting relatively low production activity during these periods.

Among the four study areas, Central Market generated the highest quantity of fabric waste (104 kg; 34.8%), followed by Asafo (70 kg; 23.4%), Asokwa (69 kg; 23.1%), and Alabar (56 kg; 18.7%). The relatively higher waste generation recorded at Central Market is attributable to the concentration of garment enterprises and the larger production volumes observed during field visits. Enterprises within this commercial hub generally handled a greater number of customer orders, resulting in increased fabric consumption and higher volumes of cutting offcuts.

The observed temporal pattern agrees with previous studies that identify production volume and seasonal consumer demand as major determinants of textile waste generation. Niinimäki et al. (2020) reported that increases in apparel production are accompanied by corresponding increases in pre-consumer textile waste, particularly during periods of intensified manufacturing. Similarly, UNEP (2020) observed that fluctuations in consumer demand influence material throughput across the textile value chain, resulting in seasonal variations in waste generation. The present findings further demonstrate that festive and institutional clothing demands, such as school uniforms and ceremonial garments, significantly influence fabric waste generation within Ghana's informal garment sector. Overall, the results indicate that pre-consumer fabric

waste generation is not constant throughout the production year but closely follows fluctuations in garment demand. This finding highlights the importance of introducing improved fabric utilisation strategies and waste recovery systems during peak production periods, where the greatest opportunities exist for reducing material losses and promoting circular resource use.

Table 5. Descriptive Statistics of Monthly Fabric Waste Generation

Statistic	Value
Number of Months	12
Annual Total (kg)	299
Mean (kg/month)	24.9
Median (kg)	21.0
Minimum (kg)	10
Maximum (kg)	57
Range (kg)	47
Standard Deviation (kg)	15.4
Coefficient of Variation (%)	61.8

Source: Field Survey (2021)

The relatively high coefficient of variation (61.8%) indicates substantial month-to-month fluctuations in fabric waste generation, confirming that waste production was strongly influenced by seasonal demand rather than remaining uniform throughout the year. These variations suggest that waste-reduction interventions should focus on peak production periods, when the greatest quantities of fabric offcuts are generated, and the potential for material recovery is highest.

4.3 Fabric Composition of Pre-Consumer Waste Across the Study Localities

The composition of pre-consumer fabric waste was examined to identify the predominant fibre types processed by tailoring and dressmaking enterprises across the four study locations. Following collection at three-day intervals, all fabric offcuts were manually sorted and weighed, then classified by fibre type, size, shape, colour, and reuse potential. The offcuts were subsequently graded into Grades 1, 2, and 3 to facilitate the identification of suitable applications for reuse and value addition. Grade 1 comprised large remnants suitable for direct reuse; Grade 2 consisted of medium-sized offcuts appropriate for patchwork and composite production, while Grade 3 represented small, irregular fragments with limited reuse potential (Figure 3).



Figure 3. Fabric Waste Collection, Sorting, and Classification Process- Source: Field Survey (2021)

Considering the waste generated in the study area, the core materials were influenced by culture and religion. Ashantis, or for that matter Akan, are fond of "Ntama ne Kaba", so in most areas one could see traces of a wide design range of African prints or Ankara prints, which are more cotton-based. The sorting exercise revealed that three fibre groups dominated garment production across the four study locations. As presented in Table 7, cotton accounted for 80% of all fabric offcuts collected, followed by polyester (14%) and linen (6%).

Table 6. Predominant fabrics waste generated per study area

Study Area	Dominant Characteristics	Predominant Garment Demand	Likely Dominant Fabrics
Central Market	Major commercial centre	Corporate, casual, ceremonial, and school uniforms	Cotton, Ankara, damask, lace
Alabar	Predominantly Muslim community and trading area	Religious and traditional attire, school uniforms	Ankara, damask, brocade, voile
Asokwa	Mixed residential and commercial area	Everyday wear and school uniforms	Cotton, Ankara, denim
Asafo	Mixed residential and commercial area	Casual wear, uniforms, customised clothing, school uniforms	Cotton, Ankara, denim

Table 7. Summary Fibre Composition of Pre-Consumer Fabric Waste

Fibre Type	Percentage (%)
Cotton	80
Polyester	14
Linen	6
Total	100

Source: Field Survey (2021)

The predominance of cotton waste was evident across all four production areas, although the volume generated varied according to the commercial and demographic characteristics of each locality. Central Market, which serves the most diverse customer population, processed large quantities of cotton fabrics for school uniforms, corporate wear, casual clothing, and traditional garments, contributing substantially to the overall cotton waste recorded. In Asokwa and Asafo, where residential communities are more prominent, cotton and Ankara fabrics were widely used for everyday clothing, church programmes, school uniforms, weddings, and festive occasions, resulting in relatively consistent waste generation throughout the year. In Alabar, cotton fabrics were also dominant, but increased production was particularly evident during Eid Al-Fitr and Eid Al-Adha, when demand for traditional and religious garments intensified.

Field observations indicated that respondents preferred cotton fabrics because of their comfort, breathability, affordability, and suitability for Ghana's tropical climate. Consequently, cotton generated the largest proportion of cutting offcuts during garment production. Many

respondents retained larger cotton remnants for children's clothing, patchwork, appliqué, decorative accessories, and household textile products, whereas smaller, irregular fragments were commonly discarded because of their limited commercial value.

The dominance of cotton waste is consistent with global trends in apparel manufacturing. Niinimäki et al. (2020) observed that cotton remains the most widely used natural fibre in clothing production and therefore contributes significantly to pre-consumer textile waste. Similarly, Textile Exchange (2021) reported that cotton continues to dominate fibre consumption worldwide because of its versatility and consumer acceptance. The findings of the present study demonstrate that this dominance extends to the informal garment sector in Ghana, where cotton-based fabrics underpin most tailoring and dressmaking activities.

Although polyester (14%) and linen (6%) constituted a smaller proportion of the waste stream, these materials remain valuable resources for recycling and product development. Polyester offcuts possess considerable potential for fibre recovery and composite manufacturing, while linen remnants can be utilised in decorative textile products and craft applications. As emphasised by UNEP (2020), effective segregation of textile waste according to fibre composition improves the efficiency of recycling systems and enhances the economic value of recovered materials. The composition of pre-consumer fabric waste within the Kumasi Metropolis suggests that there is a close association between production characteristics and consumer preferences of the different garment production collections. Despite variations in production intensity among the localities, cotton remained the dominant waste stream, highlighting its considerable potential for reuse, recycling, and value addition within a circular textile economy.

4.4 Existing Fabric Waste Management Practices

The study examined the methods adopted by tailoring and dressmaking enterprises to manage pre-consumer fabric waste. As presented in Table 8 and Figure 4, reuse was the dominant waste management practice, followed by upcycling, while formal recycling was limited. Textile composting was absent, and fabric remnants that could not be recovered were primarily disposed of through landfilling or open burning.

Table 8. Existing Fabric Waste Management Practices

Waste Management Practice	Observation
Reuse	Commonly practised
Recycling	Limited
Upcycling	Increasingly practised
Textile Composting	Not practised
Landfill or Incineration	Predominant disposal method

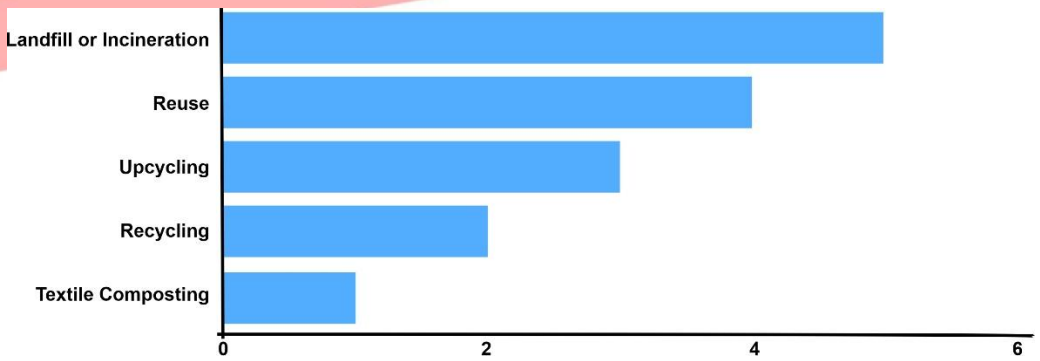


Figure 4. Existing Fabric Waste Management Practices - Source: Field Survey (2021)

The predominance of reuse demonstrates that enterprises recognise the residual value of larger fabric remnants, which are commonly converted into children's garments, patchwork products, appliqué, and decorative items. Similar practices have been reported among small garment enterprises in developing countries, where reuse represents the most accessible strategy for extending material life and reducing production waste (UNEP, 2020; Sai et al., 2022). Upcycling was also gaining acceptance because it transforms fabric offcuts into marketable products with minimal capital investment. However, the limited adoption of recycling and the absence of textile composting indicate inadequate recovery infrastructure, low technical capacity, and weak institutional support. These findings are consistent with Niinimäki et al. (2020), who argued that effective textile waste management requires coordinated investment in collection systems, recycling technologies, and enterprise awareness. Collectively, the findings suggest that while reuse forms the foundation of fabric waste management within the study area, expanding organised recycling and upcycling initiatives would significantly improve material recovery and reduce dependence on landfill and open burning.

4.5 Factors Influencing Pre-Consumer Fabric Waste Generation

Table 9 shows that limited utilisation of fabric remnants (26.7%) was the principal factor contributing to pre-consumer fabric waste generation, followed by high production during festive periods (23.3%) and inefficient fabric layout and marker planning (21.7%). Together, these factors accounted for over 70% of respondents' views, indicating that waste generation is primarily influenced by production practices rather than fabric characteristics alone.

Table 9. Factors Influencing Pre-Consumer Fabric Waste Generation

Factor	Frequency (n = 60)	Percentage (%)
Limited utilisation of fabric remnants	16	26.7
High production volume during festive seasons	14	23.3
Inefficient fabric layout and marker planning	13	21.7
Inadequate technical skills in fabric optimisation	9	15.0
Complex garment designs	5	8.3
Fabric width and pattern matching	3	5.0
Total	60	100.0

Source: Field Survey (2021)

Respondents explained that smaller and irregular fabric offcuts were often discarded because they had limited immediate commercial value, whereas larger remnants were retained for secondary products. Increased production during Christmas, Easter, Eid al Fitr, Eid al Adha, and school reopening periods also resulted in greater fabric consumption and higher quantities of cutting waste. These findings corroborate UNEP (2020), which identified inefficient remnant utilisation as a major challenge in sustainable apparel production, and support the observations of Niinimäki et al. (2020) and Nayak and Padhye (2015) that production intensity, marker planning, and operator competence significantly influence material utilisation efficiency. Although garment complexity and fabric width contributed less to waste generation, they remain important technical considerations during customised garment production.

4.6 Sustainable Utilisation Opportunities for Pre-Consumer Fabric Waste

The study further explored respondents' preferred strategies for the sustainable utilisation of pre-consumer fabric waste. As shown in Figure 5, upcycling into fashion accessories was the most preferred utilisation strategy (33.3%), followed by the production of home furnishing items (21.7%) and patchwork and quilting (20.0%). Recycling into new textile products (11.7%) and the production of composite materials and insulation (10.0%) received comparatively lower responses.

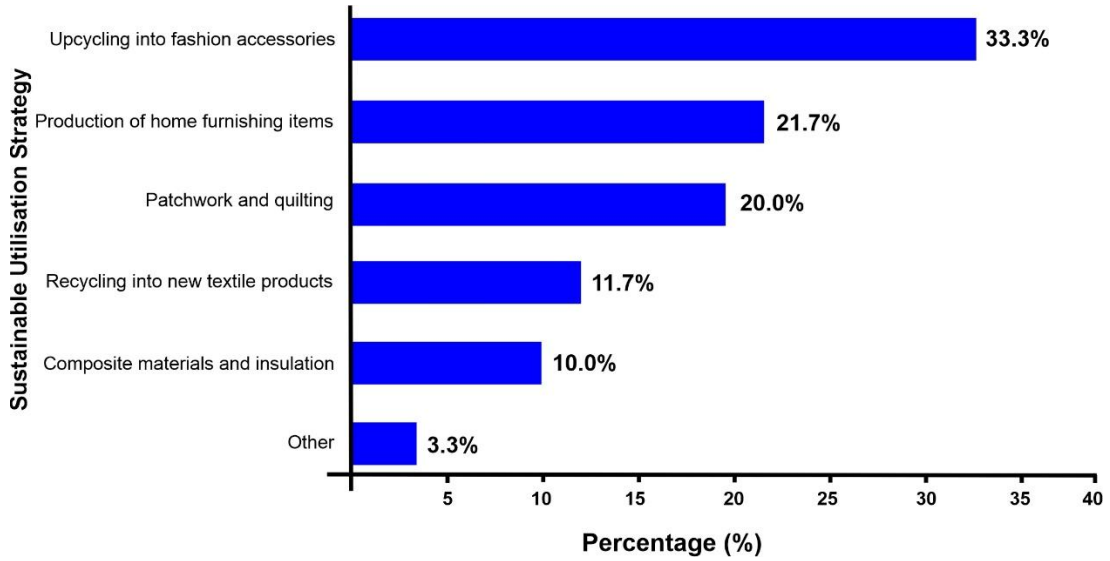


Figure 5. Ranking of Sustainable Utilisation Opportunities - Source: Field Survey (2021)

The dominance of upcycling demonstrates a growing appreciation of fabric offcuts as valuable secondary resources capable of generating additional income while reducing environmental impacts. Products such as bags, purses, decorative items, cushions, and patchwork furnishings require relatively low investment yet offer considerable commercial potential for small enterprises. These findings support Niinimäki et al. (2020) and the Ellen MacArthur Foundation (2021), who argued that extending the useful life of textile materials through reuse and upcycling improves resource efficiency and strengthens circular textile systems. Although industrial recycling and composite production remain underdeveloped, they represent important opportunities for future collaboration among garment producers, researchers, and manufacturing industries.

4.7 Circular Utilisation Pathway for Pre-Consumer Fabric Waste

Figure 6 presents the proposed circular utilisation pathway developed from the findings of this study. The framework illustrates how systematic sorting and classification enable pre-consumer fabric waste to be channelled into reuse, recycling, and upcycling, resulting in value-added products that support income generation, resource efficiency, and environmental protection. Rather than viewing fabric offcuts as waste, the framework positions them as secondary raw materials capable of contributing to sustainable entrepreneurship and circular textile production.

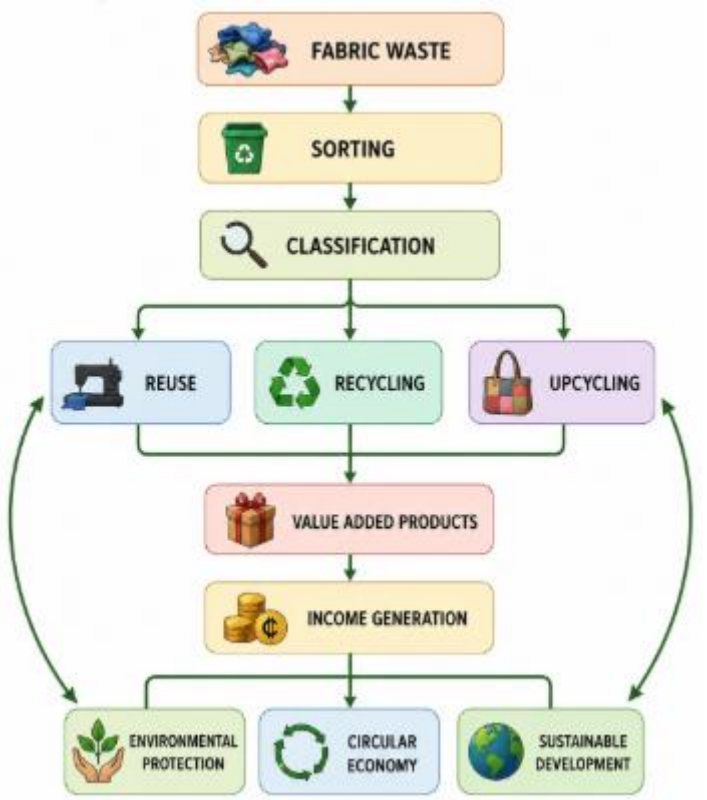


Figure 6. Circular Utilisation Pathway for Fabric Waste- Source: Field Survey (2021)

The pathway aligns with the circular economy principles advanced by UNEP (2020) and the Ellen MacArthur Foundation (2021), which advocate maintaining materials in productive use for as long as possible through value recovery and resource optimisation. Within the Ghanaian context, the framework provides a practical model for reducing landfill disposal and open burning while encouraging innovation among tailoring and dressmaking enterprises. It therefore offers both environmental and economic benefits and demonstrates how pre-consumer fabric waste can contribute to a more sustainable and circular textile and apparel industry.

5. CONCLUSION

This study examined the generation, management, and sustainable utilisation of pre-consumer fabric waste produced by tailoring and dressmaking enterprises in Kumasi, Ghana. The findings revealed that considerable quantities of reusable fabric waste are generated during garment production, with cotton constituting the dominant fibre because of its widespread use in

garment construction. Waste generation was influenced by production volume, inefficient market planning, limited utilisation of fabric remnants, and seasonal demand, particularly during festive periods. The study further established that reuse and upcycling are the predominant waste management practices, whereas organised recycling remains limited. Respondents identified upcycling into fashion accessories, home furnishing items, and patchwork products as the most viable utilisation options, demonstrating the potential of fabric offcuts to support resource efficiency, entrepreneurship, and circular textile production. Overall, the study highlights that pre-consumer fabric waste should be viewed as a valuable secondary resource rather than an unavoidable production by-product. The findings provide useful evidence for policymakers, practitioners, and researchers seeking to promote sustainable textile waste management and circular economy practices within Ghana's textile and apparel industry.

6. IMPLICATION FOR FUTURE STUDIES

Future research should extend this study to other regions of Ghana to provide a broader understanding of pre-consumer fabric waste generation and management. Studies examining the economic viability and environmental impacts of upcycling and recycling through Life Cycle Assessment and cost-benefit analysis are also recommended. In addition, experimental research on digital marker planning, zero-waste garment design, and innovative recycling technologies would provide practical solutions for improving fabric utilisation efficiency and advancing circular textile systems within the Ghanaian textile and fashion industry.

7. LIMITATION OF THE STUDY

This study was limited to tailoring and dressmaking enterprises in Kumasi, Ghana; therefore, the findings may not be fully generalisable to other regions or large-scale garment manufacturing firms. In addition, the study relied on self-reported responses, which may be subject to respondent bias. Despite these limitations, the study provides valuable empirical evidence on the sustainable utilisation of pre-consumer fabric waste within Ghana's informal garment sector.

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