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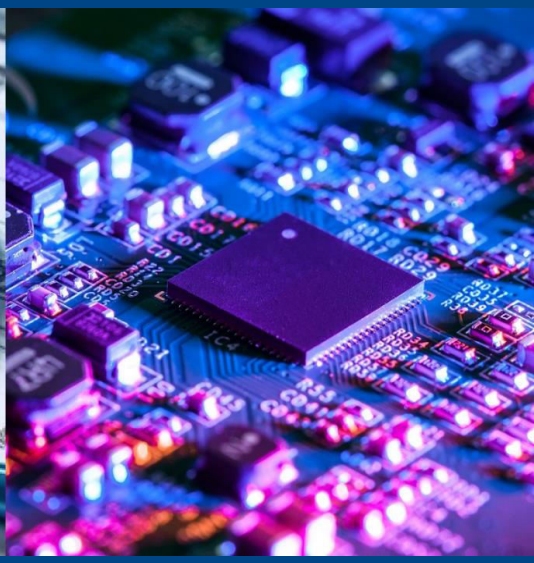

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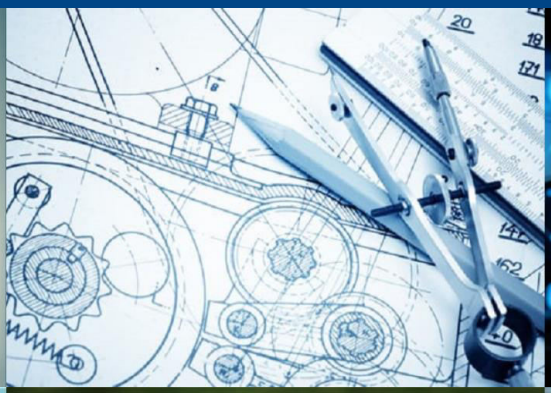

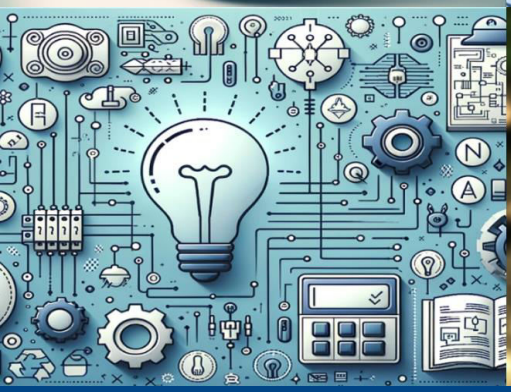

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Multi-Functional Kidswear: Design & Analysis

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ABSTRACT: The fashion industry needs to change to a more sustainable one because it is the second most polluting business in the world. Sustainability in the fashion industry is becoming a top priority as brands and consumers alike seek ways to reduce the environmental impact of clothing production and consumption. The industry, traditionally known for its large carbon footprint, water consumption, and waste production, is now shifting toward more eco-friendly practices. This project explores the development of a multi-functional garment and compares its production efficiency with traditional garment styles, focusing on cost and time. Multi-functional garments, offering versatility like reversible designs or removable parts, are gaining popularity due to growing demand for adaptable and durable clothing. The project involves designing, prototyping, and producing a multi-functional garment, followed by a time and cost comparison with conventional styles. The expected outcome is that multi-functional garments will reduce production time, cut costs, and streamline manufacturing due to their modular design, ultimately benefiting both manufacturers and consumers while increasing industry profitability. As a result, the development of multi-functional garments proves to be more cost-effective and time-efficient than traditional garment styles, as their versatile features, despite adding design complexity, do not lead to higher production costs or longer manufacturing times.

KEY WORDS: Sustainability, Multi-functional garment, Production efficiency, Cost comparison, Modular design

I. INTRODUCTION

The apparel industry's substantial environmental effect is prompting a change towards sustainability. Given that it is the second most polluting industry in the world, change is imperative. The three primary facets of sustainability in fashion are social, economic, and environmental. While social sustainability seeks to guarantee ethical labour practices and secure working circumstances, the environmental side concentrates on lowering emissions, waste, and resource usage. The focus of economic sustainability is on developing lucrative and ecologically conscious company strategies. Collaboration between different industrial functions—from design to production—as well as investments in R&D and innovation to promote systemic change are necessary to achieve sustainability [1].

1.1. Sustainability in apparel industry:

Addressing urgent environmental issues requires the textile, clothing, and fashion industries to use ecologically friendly practices. Using environmentally friendly materials, such as recycled fibres, organic cotton, and biodegradable fabrics, is one of the key tactics. These materials assist reduce manufacturing and disposal pollution and lessen reliance on petrochemical resources. By reducing water consumption and chemical waste, dyeing process innovations like digital printing and the use of natural dyes also support sustainability. Additionally, the emergence of the circular economy has prompted companies to create long-lasting products and to encourage recycling, upcycling, and take-back initiatives in order to cut waste. To ensure a more sustainable future for the sector, a comprehensive strategy to sustainability is required to strike a balance between environmental responsibility and economic competitiveness. [2]

Reducing the industry's carbon footprint also requires the use of sustainable production techniques. Water and energy usage are being reduced through the implementation of efficient manufacturing procedures. Furthermore, technological developments like automation and artificial intelligence are assisting in maximizing production efficiency, cutting waste, and consuming less energy. In an effort to lower greenhouse gas emissions, brands are also investigating renewable energy sources like wind and solar [3].

The textile sector still faces several obstacles on its journey towards sustainability, notwithstanding these developments. Cost is still a major obstacle because sustainable materials and procedures frequently call for larger upfront expenditures. Additionally, there are technological limitations that prevent broad adoption, especially in underdeveloped nations. Since

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government backing and well-informed customer choices can increase demand for sustainable practices, regulatory frameworks and consumer awareness are crucial in determining the industry's sustainability trajectory. [4]

1.2. Sustainability in kids' wear design:

As more parents look for environmentally friendly solutions for their kids' clothes, there is a growing demand in India for sustainable children's apparel. Safety, comfort, and sustainability are important factors, and there is growing demand for clothing made of organic materials. Furthermore, by eliminating the need for numerous items of clothing, the popularity of multipurpose children's apparel, which offers adaptable designs for a range of circumstances, promotes sustainability and pragmatism [5][6]. Multipurpose designs are emerging as a major trend in fashion as awareness of sustainability grows, encouraging more durable and environmentally friendly consumption habits [7].

1.3. Multifunctional kids' wear:

Multipurpose children's clothing is a design idea that blends functionality, sustainability, and adaptability to satisfy the changing demands of parents and kids. It focusses on designing clothing that may be worn in a variety of scenarios, including social ones, weather, and changing sizes. Multifunctional features like adjustable hems, elastic bands, and snaps are introduced to prolong the lifespan of the garment for children, especially those between the ages of 2 and 6 years, whose rapid growth and active lifestyles necessitate flexible clothes. By reducing waste, this design strategy promotes sustainability by lowering the frequency of replacements [8]. Furthermore, through customisable components, the clothing promotes social relationships and encourages youngsters to express their uniqueness [9].

Key elements of multipurpose children's clothes include reversible garments, modular design, transformable elements, and multipurpose use. Because of these characteristics, clothing can be worn in a variety of ways and for a variety of purposes. The utility of these clothes is further improved by the use of sustainable materials and intelligent technology, such as temperature-sensitive textiles or health-monitoring sensors, which also promote environmentally beneficial behaviours [10]. In general, multipurpose children's clothing not only provides useful options for energetic kids but also satisfies the rising need for eco-friendly, multipurpose clothing that has a minimal negative influence on the environment [6].

1.4. Fabric Selection for Kids Winter Wear:

Fabric properties are mostly determined by the choice of material; different fibres, such as cotton, polyester, or blends, have distinct qualities, including moisture control, breathability, and warmth retention. While natural fibres are favoured for their comfort and breathability, synthetic fibres provide superior insulation and durability. When these materials are combined, textiles that are appropriate for particular uses, such as bedding or outdoor equipment, are produced [11].

Durability, comfort, breathability, and moisture control are important considerations while designing children's apparel. Fabrics ought to be soft against the skin and able to withstand energetic play. Eco-friendly solutions like organic and recycled materials are becoming more and more popular as consumer awareness rises. In order to accommodate a variety of contexts, from informal playdates to formal events, fabric design must be versatile [12].

Commonly used fabrics for thermal insulation include double combined knitted fabrics and quilted textiles, which effectively retain warmth and provide comfort in colder climates by trapping air through interlocking layers and using multiple layers to create air pockets [13].

1.4. 1 Spacer Fabric:

Spacer fabrics are three-dimensional textiles that are usually created by knitting or weaving techniques. They have exterior layers and a cushioned inside layer. By establishing an air gap, this design enhances comfort, breathability, and thermal insulation. Lightweight and insulating, spacer fabrics are frequently used in bedding, sportswear, and car interiors. Example: Quilt fabric [14].

The cushioning effect of quilted textiles, which are made up of several layers stitched together, traps air and offers superior thermal insulation. They are perfect for bedding, clothing, and other items that need to be cosy and toasty. Quilted textiles provide protection, comfort, and insulation for outdoor apparel during a variety of activities. Maintaining comfort in a variety of weather circumstances requires striking the right balance between breathability, moisture

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management, and thermal efficiency. Different quilting patterns have an impact on insulation; some designs enhance heat retention while permitting breathability [15].

Thermal conductivity influences heat transport, which affects sleep comfort. Higher thermal conductivity fabrics keep the temperature constant, but lower conductivity fabrics retain heat. By wicking away moisture, moisture management helps control body temperature, which is crucial for avoiding discomfort from sweat accumulation [16,17].
Weft-knit spacer fabrics' interior structure affects their air permeability and insulation. Although they may lessen permeability, thicker inner layers trap more air for improved heat insulation [14].

The qualities and performance of quilted fabrics are influenced by their manufacture, which includes the selection of materials, stitching methods, and environmental factors. Stitching techniques like diamond quilting and channel stitching ensure uniform thermal qualities while enhancing appearance and distributing insulation. Ballistic performance is improved by increasing yarn-yarn friction, which enables textiles to bear higher loads without losing their integrity [11,18].
Air permeability is important as well. In addition to improving insulation by trapping warm air, wider diamond patterns in textiles may also decrease fabric density, increasing ventilation and avoiding overheating when exercising. Although they increase ventilation, narrower patterns may marginally reduce heating. Comfort in a range of climatic situations is maximized by striking a balance between these factors [19].

1.5. Kids Wear Market in India:

Sustainability is becoming a bigger concern in the fashion business, as many brands guarantee fair compensation for workers, ethical labour practices, and transparent supplier chains. With the growth of rental and second-hand options providing sustainable alternatives, this enables parents to make well-informed decisions that are consistent with their values. Teaching kids about sustainable fashion promotes understanding and responsibility, which in turn leads to future consumption that is more thoughtful. A trend towards eco-fashion is also being fuelled by rising consumer awareness of the negative environmental effects of rapid fashion, where decisions are influenced by perceived quality, cost, and brand values. In line with a larger trend towards sustainable consumption that aims to reduce garment waste, marketing techniques that emphasize eco-friendly qualities can increase consumer interest and involvement [5,20].

Brands are starting to use multifunctional designs in children's apparel as a differentiator since they provide adaptable solutions that can be worn in a variety of settings and from casual to formal attire. Customers looking for value and flexibility in their purchases are drawn to these designs. Because of their improved quality and value, multipurpose items frequently fetch higher price points, and the growing popularity of minimalist lifestyles feeds this desire. Customers are shifting away from the fast-fashion mindset and towards high-quality, multipurpose things that can be combined and rearranged. This desire can be satisfied by brands who embrace multifunctional designs, coming up with creative solutions that promote longer use and lower overall consumption [6].

II.OBJECTIVES

- To design multi-functional garment styles for kids' wear.
- To develop multi-functional kids' wear garments.
- To analyse the effectiveness of garments developed.
- To perform time study & cost study.

III. METHODOLOGY OF PROPOSED SURVEY

3.1. Problem identification:

- Excessive children's clothing consumption as well as increasing children's clothing and fabric waste cause environmental concerns.
- Frequent disposals of garments which results in landfills.
- Purchasing many children's clothes for a few months due to physical changes (growing up) that may influence the actions of parents towards the purpose of buying children's clothing.

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3.2. Trend analysis:

Observations from 10 stores revealed that 70% had dedicated winter wear sections, with insulated jackets being top sellers. The price range for kids' winter jackets typically varied from ₹800 for basic options to ₹7,000 for premium brands. Notably, 80% of stores offered discounts, and there was a growing demand for eco-friendly and matching set options. The competitor analysis highlighted that specialty stores focus on organic materials, while discount retailers emphasize affordability. Fabric trends showed that polyester, fleece, and quilted fabrics are favored for their durability, warmth, and functionality, with an increasing interest in sustainable materials like organic cotton and wool. Bright colors, pastel tones, and earthy shades were popular, reflecting a blend of fun and practicality in kids' winter wear.

There is a significant shift towards sustainability, with 15% of retailers adopting eco-friendly dyes and materials. Polyester remains a preferred fabric for 60% of brands, and fleece continues to be a popular choice for warmth. Style-wise, oversized fits are gaining traction, with 35% of brands focusing on relaxed, comfortable clothing, while activewear remains influential. Comfort and durability are key priorities for parents, with 70% prioritizing comfort and 60% emphasizing durability, while half are willing to pay more for eco-friendly options. The market is expected to grow by 5% annually, reaching $200 billion by 2025, with an increasing demand for gender-neutral clothing and versatile layering options.

3.3. Design development:

3.3.1 Mood board:

The mood board evokes a blend of nostalgia, warmth, and tranquility. The board suggests innocence and joy, capturing a fleeting moment of carefree childhood days. It also symbolizes love and affection for simplicity. It reinforces a positive message, encouraging kids to express themselves boldly while promoting kindness.

Figure 1: Mood board

3.3.2 Color board:

A color board serves as a visual representation of a specific theme or concept, effectively guiding the aesthetic direction of a project. In this case, the color board for our autumn collection features a warm and neutral palette that captures the essence of the season. The color board includes shades of brown which gives the feelings of coziness and nostalgia. This combination not only reflects the changing leaves but also inspires warmth and comfort, suggesting a playful yet sophisticated mood ideal for families seeking stylish winter wear. Overall, the color board acts as a guiding vision for our upcoming collection, emphasizing natural beauty and warmth while illustrating how the colors can be applied effectively in product design.

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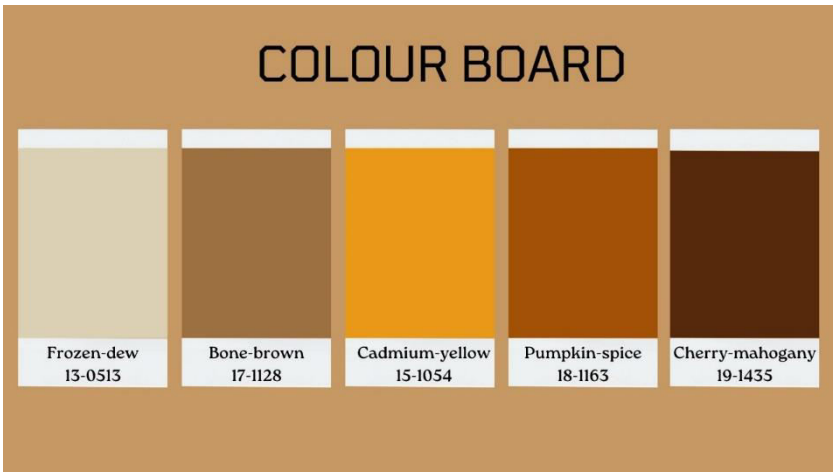

Figure 2: Color board

3.3.4 Fabric board:

This fabric board provides a visual representation of textiles used for kids' winter wear, highlighting a selection of materials that blend warmth, comfort, and style while also emphasizing the practicality and insulation properties of each fabric choice, ensuring that children stay cozy, active, and stylish throughout the cold weather season. Quilted fabric offers excellent insulation with a lightweight feel, ideal for jackets and coats. Loop knit fabric provides stretch and softness, perfect for cozy sweaters and sweatshirts. Fur fabric is a popular choice for adding luxury and warmth to winter garments. With its superior insulation, it keeps kids toasty warm and gives winter clothing a chic, glitzy look. Fleece fabric is breathable, moisture-wicking, and lightweight, making it perfect for layering in jackets, hats, and mittens. Together, these fabrics form the foundation of a functional, stylish, and comfortable winter wardrobe for children, ensuring they stay warm, dry, and active throughout the cold weather season.

Figure 3: Fabric board

3.3.5 2D flats:

Product 1:

The quilted jacket is a versatile, multi-functional garment that features a seamless pattern, effortlessly transitioning from a practical jacket to a floor bed, offering both comfort and convenience for parents and children. As shown in Fig. 3.5 & 3.6, this innovative design allows the jacket to serve dual purposes, making it an ideal solution for families looking for

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flexible, space-saving, and functional products. When not worn as a jacket, the garment can be transformed into a cosy & portable floor mattress, providing an additional layer of comfort when needed. This dual-functionality makes it particularly useful for situations like travel, outdoor picnics, or as a temporary sleep surface during naps or overnight stays.

The floor bed component is constructed with quilt-knitted fabric. The quilt-knitted fabric used in the jacket has a GSM (grams per square meter) of 200 to 300, which indicates a moderate weight that provides both warmth and durability without being overly bulky. This range of GSM ensures that the fabric is thick enough to provide insulation and comfort, but still lightweight and breathable, making it comfortable to wear as a jacket in various weather conditions. The quilted construction also adds an extra layer of thermal protection, ensuring that the wearer remains warm during cooler months, while still being flexible enough for ease of movement.

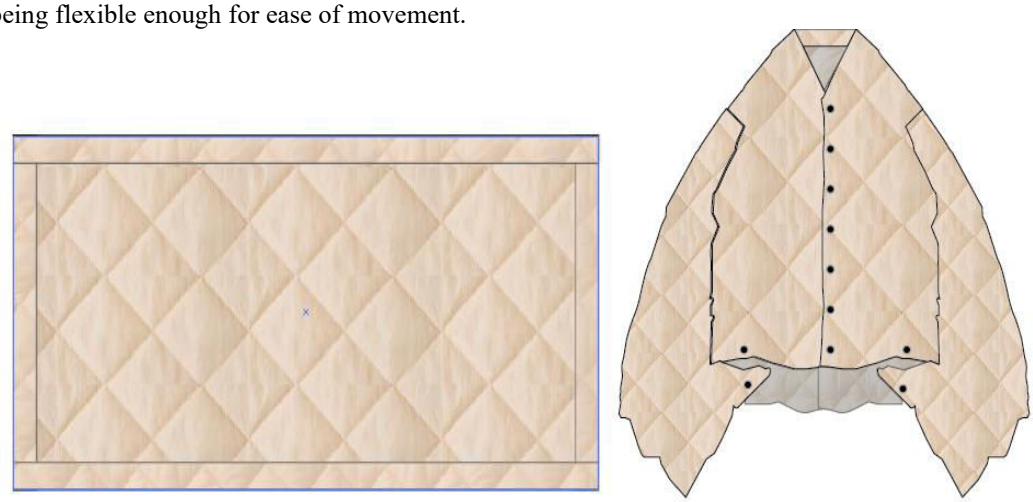

Figure 4: Quilted floor mattress to Quilted jacket

- **Product 2:**

The second product is an extendable kids' jacket designed to accommodate the growth of children aged 3 to 5 years. This jacket incorporates a flexible design solution, allowing it to adapt to different sizes by utilizing a unique construction technique. Specifically, two inches of extra fabric are tucked into the length of the bodice. This tucked fabric serves as an adjustable feature, enabling the jacket to fit both a 3-year-old and a 5-year-old without needing a complete redesign or purchase of a new garment.

For younger children (around 3 years old), the extra fabric is concealed, creating a more tailored fit. As the child grows, the jacket can be easily extended by releasing the seams that hold the additional fabric in place. The tucked fabric is pulled out to add length to the bodice, providing a larger fit suitable for a 5-year-old. This makes the jacket a versatile, long-lasting option, reducing the need for frequent replacements due to growth.

Additionally, the jacket is designed with a two-piece placket and snap button fasteners, which make it easy for parents and children alike to put on and take off the garment. Snap buttons are an ideal choice for young children, as they are simple to use, safe, and secure. The overall design of this jacket emphasizes practicality, longevity, and comfort, making it an ideal solution for eco-conscious parents looking for functional, adaptable children's wear.

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Figure 5: Extendable kids jacket for 3-year kid

Figure 6: Kids jacket for 5-year kid

- **Product 3:**

The third product is a modular kids' winter jacket, designed with versatility and practicality in mind. This innovative jacket features detachable sleeves, allowing it to function as both a half-sleeve jacket and a full-sleeve jacket, depending on the weather or the child's preference. The detachable sleeve design provides flexibility, making it an ideal garment for transitioning between seasons or for different outdoor activities.

When worn as a half-sleeve jacket, the sleeves can be easily removed, offering a more breathable option for warmer days or active play. The transition from half sleeves to full sleeves is facilitated by metal snap buttons strategically placed along the armholes. These sturdy snap fasteners securely hold the sleeves in place, ensuring that they stay attached when desired and can be removed just as easily when needed. This simple yet effective design ensures that the jacket can be worn comfortably in various conditions, offering both warmth and freedom of movement.

Additionally, the modular winter jacket is likely designed with insulating materials and weather-resistant fabrics to keep children warm and dry. This ensures that the jacket is not only stylish and adaptable but also functional in keeping young wearers comfortable during the colder months. Whether the sleeves are on or off, the jacket remains an essential outerwear item that is both functional and fashionable.

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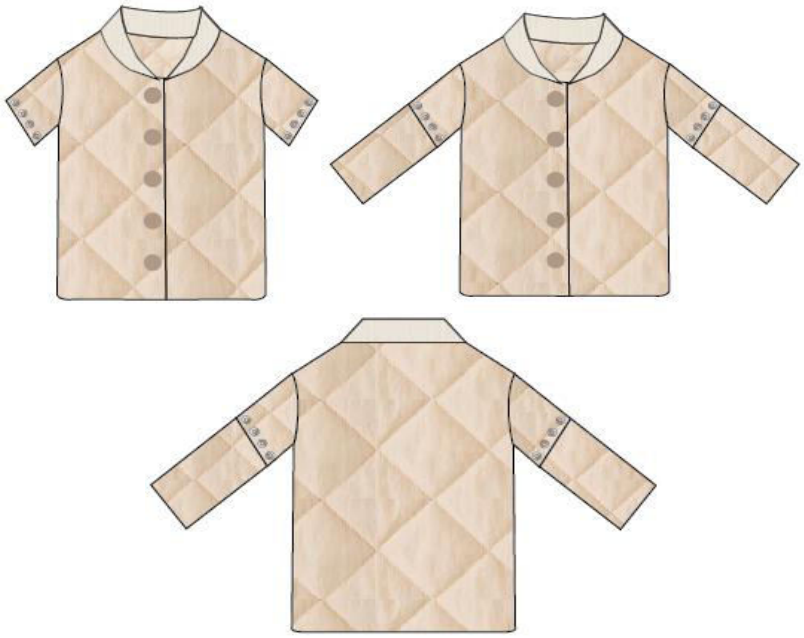


Figure 7: Half sleeve jacket to full sleeve jacket

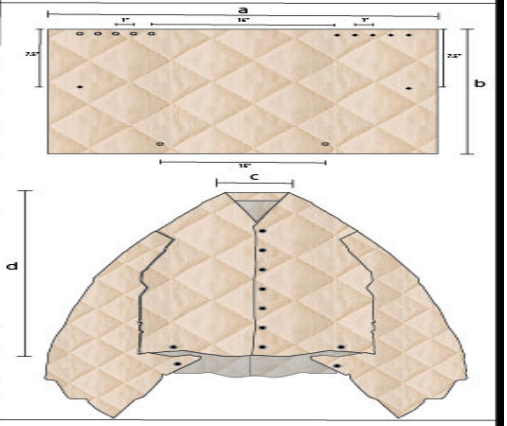
3.3.6 Spec sheets:

MULTIFUNCTIONAL QUILTED BED INTO KIDS WINTER JACKET

DESIGNER: Saranya. S	FABRIC: Cotton quilted fabric & water reppelent quilted fabric
DESCRIPTION: Quilted bed to jacket	COLOR: Cream white & dark brown
STYLE NO.: #001	CATEGORY: Kids wear
SEASON: Winter	SIZE RANGE: 3-4 years kids

S.NO	MEASUREMENTS	INCHES
a	Width	42"
b	Height	25"
c	Neck circumference	16"
d	Length of the jacket	17"

DETAILED DIAGRAM



Measurements in inches

SPECIAL COMMENTS:

Cotton knitted quilt fabric is used.
Snap buttons are attached to transform it to a jacket.-

Figure 8: Spec sheet 1

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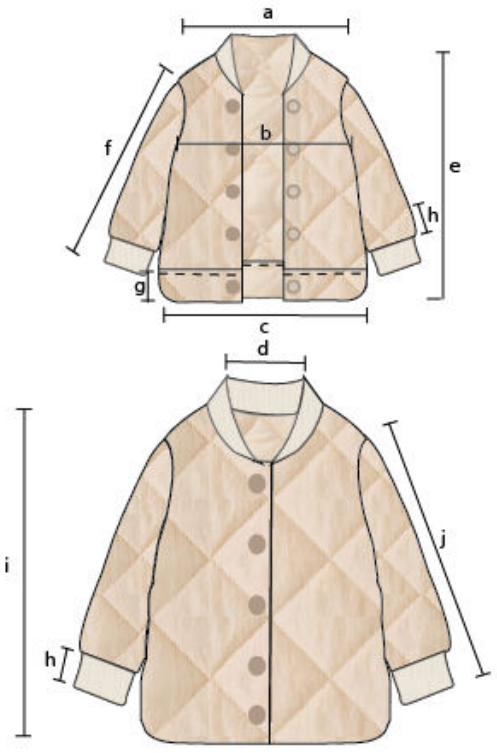
EXTENDABLE KIDS WINTER JACKET

DESIGNER: Saranya. S	FABRIC: Cotton quilted fabric
DESCRIPTION: Extendable kids jacket	COLOR: Cream white
STYLE NO.: #002	CATEGORY: Kids wear
SEASON: Winter	AGE CATEGORY: 3 year kid & 5 year kids

S.NO	MEASUREMENTS	INCHES
	3 year kid measurement	
a	Across back	12″
b	Chest circumference	30″
c	Hem circumference	30″
d	Neck circumference	16″
e	Length (HPS to Hem)	17″
f	Sleeve length	12″
g	Inner tucked fabric length(bodice)	2″
h	Cuff length	2″
	5 year kid measurement	
i	Length (HPS to Hem)	19″
j	Sleeve length	14″
	Measurements in inches	

DETAILED DIAGRAM



SPECIAL COMMENTS:

- The neck and hem of the sleeves are finished with rib fabric.
- Plastic snap buttons are used as fasteners.
- 2 inches of fabric tucked in bodice which extends and used for 5 year kid as well.

Figure 9: Spec sheet 2

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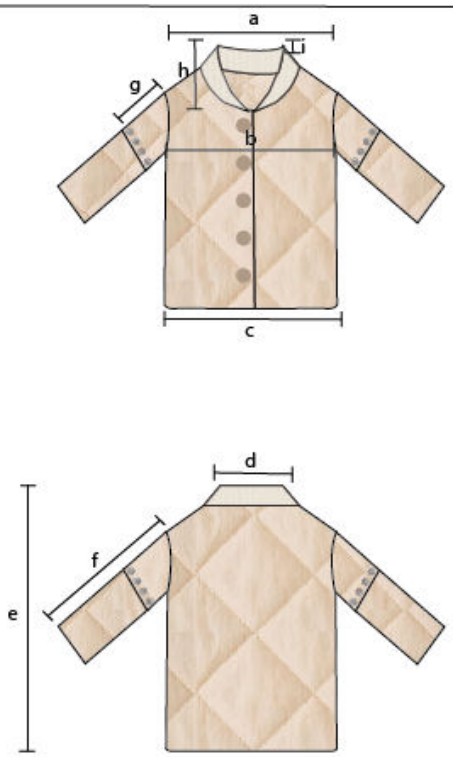
MODULAR KIDS WINTER JACKET

DESIGNER: Saranya. S	FABRIC: Cotton quilted fabric
DESCRIPTION: Modular sleeves kids jacket	COLOR: Cream white
STYLE NO.: #003	CATEGORY: Kids wear
SEASON: Winter	AGE CATEGORY: 3 year kid

S.NO	MEASUREMENTS	INCHES
a	Across back	12″
b	Chest circumference	30″
c	Hem circumference	30″
d	Neck circumference	16″
e	Length (HPS to Hem)	17″
f	Sleeve length (full)	12″
g	Sleeve length (half)	5″
h	Front neck drop	3″
i	Back neck drop	1″
	Measurements in inches	

DETAILED DIAGRAM



SPECIAL COMMENTS:

- The garment is a kids winter wear garment with modular sleeves.
- Half sleeves are extended by attaching extra piece using fasteners.
- Metal snap buttons are used as fasteners for sleeves and plastic snap buttons for bodice.

Figure 10: Spec sheet 3

IV. RESULT AND DISCUSSION

Manufacturability and functionality are crucial for the success of a multi-functional garment design. The aim of this project is to explore how a versatile garment can be created while maintaining the aesthetic and functional qualities of

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regular styles. In addition, the comparison study of cost of production and the time study for manufacturing this multi-functional style versus a traditional style, single-purpose garment is carried out. This study will provide insights into the practicalities and efficiencies of producing garments with enhanced functionality, and how such designs might impact the apparel industry's production processes and cost structures. The results of the comparison study are explained below.

4.1. Time study and cost of production for regular style:

Figure 11: Kids regular winter jacket

S.No	Operations	Time taken (in mins)
1	Pattern making	39.09
2	Cutting	24.5
3	Shoulder seam	2.06
4	Sleeve attachment	4.3
5	Collar attachment	4.4
6	Neck finishing	4.6
7	Zipper placket attachment	7.8
8	Placket facing	4.9
9	Side seam	1.14
10	Bodice hem finishing	4.9
11	Sleeve cuff attachment	2.8
12	Ironing and packing	10.07
	TOTAL PRDUCTION TIME	110.56

Table 1: Time study for regular style

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The above table clearly gives the data of time taken for the construction of the regular-style kids quilted jacket. The above data was recorded in the industry simultaneously while constructing garments. The total time taken for the construction and finishing of the garment is 1 hour 55 minutes approximately, and the labour required for completing the garment is 8 approximately. As industries work under the division of labour method, each step is carried out by each labourer.

S.No	Particulars	Cost in rupees
1	Material cost Fabric Zipper	 Rs. 409 Rs. 89
2	Labor cost Pattern drafting Cutting and sewing	 Rs. 25 Rs. 40
3	Overheads	Rs. 15
	TOTAL COST OF PRODUCTION	Rs. 578

Table 2: Cost of production for regular style

4.2. Quilted mattress to jacket:

Figure 12: Quilted mattress to jacket

S.No	Operations	Time taken (in mins)
1	Pattern making	9.9
2	Cutting	5.09
3	Bound seam on 4 edges	20.5
4	Snap fastener attachment	10.8
	TOTAL PRODUCTION TIME	46.29

Table 3: Time study for quilted mattress to jacket

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S.No	Particulars	Cost in rupees
1	Material cost Fabric Wadding material Snap buttons	 Rs. 272 Rs. 51 Rs. 10
2	Labor cost Pattern drafting Cutting and sewing	 Rs. 10 Rs. 25
3	Overheads	Rs. 10
	TOTAL COST OF PRODUCTION	Rs. 378

Table 4: Cost of production (Quilt bed to jacket)

4.3. Extendable quilt jacket:

Figure 13: Extendable kids jacket

S.No	Operations	Time taken (in mins)
1	Pattern making	30.05
2	Cutting	25.01
3	Shoulder seam	2.05
4	Sleeve attachment	4.9
5	Side seam	2.8
6	Sleeve cuff attachment	1.7
7	Collar attachment	5.03
8	Neck finishing	2.01
9	Placket finishing	3.01
10	Bodice hem finishing	5.0
11	Button attachment	5.03
12	Tucking fabric	1.7
	TOTAL PRODUCTION TIME	88.29

Table 5: Time study for extendable quilt jacket

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S.No	Particulars	Cost in rupees
1	Material cost Fabric Wadding material Shirt buttons	 Rs. 384 Rs. 72 Rs. 10
2	Labor cost Pattern drafting Cutting and sewing	 Rs. 25 Rs. 35
3	Overheads	Rs. 15
	TOTAL COST OF PRODUCTION	Rs. 541

Table 6: Cost of production (Extendable kids jacket)

4.4. Modular winter jacket:

Figure 14: Modular kids winter jacket

S.No	Operations	Time taken (in mins)
1	Pattern making	30.05
2	Cutting	24.9
3	Shoulder seam	2.05
4	Sleeve attachment	4.9
5	Side seam	2.8
6	Sleeve edge finishing	4.7
7	Collar attachment	4.9
8	Neck finishing	2.01
9	Placket finishing	5.03
10	Bodice hem finishing	5.04
11	Button attachment	5.02
12	Snap fastener attachment	5.01
	TOTAL PRODUCTION TIME	96.41

Table 7: Time study for modular winter jacket

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S.No	Particulars	Cost in rupees
1	Material cost Fabric Wadding material Shirt buttons Snap buttons	 Rs. 344 Rs. 65 Rs. 10 Rs. 10
2	Labor cost Pattern drafting Cutting and sewing	 Rs. 25 Rs. 40
3	Overheads	Rs. 15
	TOTAL COST OF PRODUCTION	Rs. 509

Table 8: Cost of production (Modular kids jacket)

V.CONCLUSION

This project highlights the advantages of multi-functional garments over traditional styles, particularly in terms of production cost and time efficiency. By incorporating versatile features like adjustable elements or reversible designs, multi-functional garments can be produced more cost-effectively and efficiently. Despite some additional complexity in design, these garments streamline production by reducing unique process steps, minimizing material waste, and requiring fewer garment variations. The use of versatile fabrics and efficient production techniques further lowers costs. The findings suggest that multi-functional garments not only meet the demand for versatility and sustainability but also offer manufacturers a competitive edge by improving operational efficiency and profitability. This approach aligns with market trends, enhances sustainability, and presents a cost-effective alternative to traditional garment styles, paving the way for innovative solutions in the apparel industry.

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