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Report on

**DEVELOPMENT OF A PROTOTYPE HANDMADE LOW-COST
MANNEQUIN FOR FASHION DESIGNERS**

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[Advance in Apparel Manufacturing Technology]

AUTHOR'S DECLARATION

We certify that we are the sole authors of this report. The materials in this report have never before been submitted for evaluation in a structured educational program, with the exception of the instances in which we have provided fully documented references to the work of others. The supervisor has the right to cancel our report at any time if we do anything that would violate the first declaration.



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LETTER OF APPROVAL

This is to certify that Md. Akram Hosen Akash bearing ID: 221-23-1166 and Md. Atik Masud bearing ID: 221-23-1239, students of the Department of Textile Engineering at Daffodil International University, have successfully completed the capstone project they were assigned under my supervision.

The capstone project submission by the mentioned students seems authentic work and up to the mark. I have gone through the final drafts of the submitted report recommended for the partial fulfillment of the degree of B.sc in Textile Engineering.



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DEDICATION

This report is dedicated to our **Parents**, whose unwavering support and encouragement have afforded us the opportunity to pursue our career in Textile Engineering. They have been instrumental in our career as a result of their commitment.

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ABSTRACT

Dress forms and mannequins are indispensable in the practice of designing the garment and developing its design, as they offer three-dimensional forms of the human body on which the garment will be constructed, draped, fitted, and the visualization of the garment. Nevertheless, commercially manufactured mannequins tend to be very costly, not customized to the dimensions of the region, and not accessible to a significant portion of fashion students, independent designers, and small-scale garment producers, especially in the developing nations. The constraints of the given work pose a considerable obstacle to both realistic fashion education and experimental design application. The goal of the given project is to come up with a prototype of a low-cost mannequin/dummy that will be functional to work with by fashion designers and will be inexpensive and simple to assemble using the materials that can be obtained locally. The research methodology is applied, experimental and design-based based research approach that incorporates the anthropometry principles, selection of material, structural stability and ergonomics. Basic body measurements were provided to determine critical dimensional parameters and low cost materials were chosen which combines stability, stability of the structure, and functionality by the use of a layered hand-made process used to construct a full-scale mannequins used to define key dimensional parameters, and the use of a textile based outer surface to ensure the capabilities of pin-holding and fabric draping. The results suggest that the prototype designed has sufficient structural stability, reasonable anthropometric precision, good ability to insert pin and can be used in educational and small scale fashion designing purposes. It was a very economically viable producer since the total cost of production was much lower compared to the commercial mannequins. Although the prototype has slight shortcomings in terms of adjustability and surface life span, it is possible to conclude that a low-cost handcrafted mannequin can be used as a successful substitute of commercial dress forms in fashion education and small-scale design application. The project also adds to the applied research in the field of fashion technology by illustrating how the accessibility and affordability issues of developing apps of the field can be resolved by engineering-based design and material choice.

1. INTRODUCTION

1.1 Background of Fashion Design and Garment Development

The design of fashion and development of garments are interdisciplinary activities that incorporate the world of creativity, engineering, material science, ergonomics, and production technology. To convert a conceptual design into a working garment, one has to be extremely mindful of fabric behavior, the morphology of the body, fit, comfort, and appearance. The key element in this effort is the proper visualization of clothes on a human body, allowing a designer to test parameters of proportion, silhouette, drape, and structural integrity before large-scale production or custom tailoring [1] [2].

Conventionally, the development of garments goes through a number of processes which include ideation of the design, development of the pattern, making and fittings of samples and refinements. All of these stages demand an effective physical or representative model of a human body. Although live models are occasionally employed, they are not useful in continuous fitting and are expensive as well as unreliable owing to changes in posture and unavailability. As a result, the mannequins and dress forms have become essential items in the fashion studios, tailoring workshops and in the learning institutions [3].

Mannequins are not only a display object in engineering-oriented apparel education, but they serve as testing devices. Because of this reason, mannequins can be regarded as some sort of mechanical replacement of the human body in the garment engineering process [4].

1.2 Concept and Definition of Mannequins and Dress Forms

Mannequin is usually referred to as a three dimensional model of human body applied in fitting and making of garments or even in standstill displays. Technically mannequins can be categorized into: display mannequins, tailor dummies and dress forms. Although the two terms are used interchangeably in the popular world, the academic literature makes a distinction between the two, according to structure, material composition, and functional capability [5]. Dress forms are generally torso-shaped constructions, which have the ability to insert pin material on the surface, in which the designer would pin fabric to the form in the process of developing a pattern. They are mostly utilized in garment making and in analysis of fit. Retail displays Mannequins are commonly hard, idealized, and constructed to be seen rather than to work [6].

As an engineering and design, body size, stability and surface attributes of a mannequin or a dress form directly influences the consistency of garment fitting and assessment. Thus, mannequins in educational and design settings need to meet the anthropometric and functional criteria [7].

1.3 Role of Mannequins in Fashion Design Education

Mannequins are very important teaching aids used in fashion and textile engineering education. They allow the students to learn about how to construct garments in three-dimensional manner, the way fabrics react to being draped, and how space interacts between the body and clothing. Draping on a mannequin, in contrast to flat pattern drafting, enables students to perceive how fabric responds to the body shape in real-time, and this operation of space thinking and understanding of design processes is improved [8].

- Mannequins are used in educational courses in institutions around the globe including:
- Impression designing and illustration.
- Pattern making and draping
- Technology of manufacturing clothing.
- Fit and sizing analysis

Research in the area of fashion pedagogy suggests that a practical experience with tangible dresses can significantly enhance the student knowledge of clothing structure and fit than a strictly theoretical approach to the topic [9]. Nevertheless, there is a challenge on availability of enough numbers of mannequins especially in institutions with limited available budgets or large number of students.

1.4 Limitations of Commercial Mannequins

Even though they are essential, mannequins commercially manufactured have a number of restrictions, particularly in developing nations and those of small-scale design.

1.4.1 High Cost

Commercial mannequins, especially those that can be adjusted or whose anthropometric probability is high, are costly. It even gets higher in importing mannequins through shipping, customization and taxes. This poses a financial setback to students, independent designers and small tailoring businesses [10].

1.4.2 Lack of Body Diversity

The majority of mannequins sold commercially are founded on standard body sizes that do not necessarily represent anthropometric data of regions and populations. Studies have revealed that there is a high degree of difference between the body shape and proportion of various ethnic and demographic groups, and this restricts the use of standard mannequins in the local garment development [11].

1.4.3 Limited Customization

Most of these mannequins are fixed and non-adjustable, so it is hard to change them into other sizes, postures and body shapes. Although there are adjustable dress forms, mostly mechanically complicated and even costlier, making them unaffordable to many of the users [12].

1.4.4 Maintenance and Durability Issues

Fiberglass or plastic mannequins used in commercial applications are often dense, delicate and hard to repair in case of a broken one. On the contrary, cheap homemade options can be easily maintained and repaired locally with the help of the readily available materials [13].

1.5 Motivation for Developing a Low-Cost Handmade Mannequin

The flaws of commercial mannequins emphasize the necessity of finding new solutions that would allow to set a balance between price, capabilities, and availability. In the third world, where fashion education and small scale clothing manufacture are booming, there is a vast need in inexpensive tools to support the concrete learning and experimentation by design.

A low-cost mannequin made by hand could have a number of potential benefits:

- Utilization of locally found materials.
- Reduced production cost
- Local body measures Customization.
- Educational and experimental appropriateness.

Energetically speaking, the creation of such a mannequin is also a chance to test the concepts of material choice, structural integrity, ergonomics and product design, thus it is a good undergraduate management project [14].

1.6 Problem Statement

Even though mannequins are a necessary production tool in the field of fashion designing and garment development, they are so costly and inaccessible that they are not accessible to the majority of students and small-scaled designers. The available low-cost options tend to be not structurally stable, dimensionally accurate, and durable, which makes them less useful in the professional context of garment fitting and draping.

It is thus necessary to design a prototype hand-made low cost mannequin that:

- Realistically depicts the size of the human body.
- Structural adequate to garment-fitting?
- Is cheap and rudimentary to build.
- Uses materials of easy availability.
- Addresses the needs of fashion designers and students.

1.7 Objectives of the Project

The main aim of the project will be creating and designing a prototype of a low cost mannequin/dummy handmade to be used by fashion designers.

The specific objectives are:

- To examine current mannequins and dress forms of garment development.
- To examine anthropometric needs that are applicable in mannequins construction.
- To choose the right types of low-cost material to use in the mannequins.
- In order to design and make a working prototype mannequin.
- To test the prototype on the usability, stability and cost-effectiveness.

1.8 Scope of the Study

The project is aimed on the creation of one prototype mannequin which can be used mainly in the educational process and small-scale fashion design.

The mannequins are created to fit a typical size of an adult, by typical sizing systems, and should be used to drape, fit, and visualize garments, and not to display the garments in the retail stores.

1.9 Significance of the Study

The development of a mannequin, which is a handmade low-cost mannequin, has the potential benefits to:

- Students in fashion and textile engineering.
- Underprivileged educational establishments.
- Free-dress fashion designers and tailors.
- Minimal production units of garments.

This work makes academic contributions to the applied research in fashion product development and design of educational tools where engineering concepts are implemented to find a solution to real-life issues in the clothing industry [15].

2. LITERATURE REVIEW

2.1 Introduction to the Literature Review

Any research project whether engineering-based or design based uses a literature review as a critical basis to give a systematic analysis of what is existing in relation to the research problem. Within the package of apparel and fashion, the literature of mannequins, dress forms, anthropometry and garment fit forms constitutes a multidisciplinary literature which includes fashion design, ergonomics, materials engineering, and manufacturing science.

The current project is concerned with development of a prototype of hand-made cheap mannequins to fashion designers. Thus, the current literature review critically analyzes the past researches and the existing knowledge concerning the development, categorization, functional demands, anthropometry, and material making of the mannequins and dress forms. Through the analysis of these areas, research gaps are realized that makes it reasonable to develop a cheaper and useful alternative to commercially-obtained mannequins.

2.2 Historical Evolution of Mannequins and Dress Forms

2.2.1 Early Origins of Body Representation in Garment Making

Human body representation to construct clothes is not new to the modern systems of fashion. According to history, the early tailors used wooden frames, padded shapes and carved torsos to assist in the shaping of the garments in the process of construction [16]. They were not in any way standardized and tended to be handcrafted to fit measurements of particular clients.

In the eighteenth and nineteenth centuries, when tailoring became a more professional organization, the desire to have methods of recreating garments grew. This resulted in the creation of dress stands and padded dummies, which enabled the creation of garments to be made without repeatedly relying on live fittings [17]. The early dresses were normally made out of wood, metal wire, canvas, and padding layers of horsehair or straw.

2.2.2 Industrialization and Standardization

The industrial revolution contributed a lot to the manufacturing of garments and creation of mannequins. With the advent of ready-to-wear garments, producers needed some standard body shapes in order to produce en masse. This led to the establishment of the standard sizing systems and subsequent establishment of the standardized dress forms [18].

According to research by Ashdown, the initial shapes of industrial dresses were directly related to the anthropometric surveys that took place in Europe and North America, where the intention was to establish the average body sizes of certain groups of people [19]. These surveys were the basis of standardized mannequins, which were in most cases not able to represent body shape diversity.

2.2.3 Modern Developments

During the twentieth century the mannequins took two main forms:

- Functional garment dresses worn and home created dress styles.
- Visual merchandising mannequins.

Functional dresses started to be more elaborate with the addition of pin inserting ability surfaces, adjustable elements, and more realistic shapes. Meanwhile, the retail figures grew to stylized and aesthetic displays with more stress placed on visual appeal rather than realistic depiction [20].

2.3 Classification of Mannequins and Dress Forms

The dress form and mannequins may be categorized into functional, structural, adjustable, and uses. This knowledge of these classifications is needed to determine the appropriateness of available models and to find the prospects of low-cost alternatives.

2.3.1 Functional Classification

Cooklin [21], has broadly divided mannequins into:

- Tailor dummies: This is mostly applied in fitting and constructing garments.
- Dress forms: Dress forms were much used in developing patterns and for draping.
- Display mannequins: Display mannequins are applied in retail and exhibition.

Stability, surface pin-ability and dimensional accuracy should be the key features of functional mannequins whereas posture and worldly appearance are the main focus of display mannequins.

2.3.2 Structural Classification

Mannequins can be:

- Half-body mannequins
- Torso-only mannequins
- Half-scale mannequins

Half scale mannequins are finding wide application in the learning sector to lower consumption in materials and cost with conceptual exploration of design [22]. Nevertheless, they cannot measure full scale garment fit and construction.

2.3.3 Adjustable vs. Fixed Mannequins

Adjustable dress forms are designed to have mechanical systems giving the circumference at the busts, waist and hips adjustment. Although these models bring in versatility, research has shown that they tend to lose shape accuracy with expansion beyond the base of the models [23]. Fixed mannequins are less pliant, but offer stable and dependable body shapes in the development of garments.

2.4 Role of Anthropometry in Mannequin Design

2.4.1 Importance of Anthropometric Accuracy

Anthropometry is the scientific discipline of being able to measure the human body, and it forms a fundamental part of the mannequins. Proper body size depiction is critical to proper garments, comfort, and utility [24].

The most common reasons of consumer dissatisfaction in the apparel products include the Garment fit concern. Studies have always proven that poor fit is mostly associated with the incongruity of body shape and mannequins or sizing systems utilized in the development of garments [25].

2.4.2 Standard Sizing Systems

Normalization systems are normally developed based on extensive anthropometric surveys. But there are a number of dissatisfactions in those systems that have been raised by many studies, such as:

- Simplification of body forms
- Variability of posturing was not considered.
- Lacks representation of local populations [26]

For the developing countries, use of the western anthropometric data might produce dummy that does not correspond to the local body size.

2.4.3 Implications for Low-Cost Mannequin Development

In the case of a hand-made low-cost mannequin, it may not be possible to accomplish perfect anthropometric matching. Literature indicates however, that..." Sufficient for educational and small scale design activities is functional adequacy not absolute accuracy [27]. Attention to balance and proportion, defining girth dimensions.

2.5 Mannequins in Garment Fit and Draping Processes

2.5.1 Draping as a Three-Dimensional Design Method

Draping is a design method of a garment that is made by laying a piece of fabric over a mannequin or a dress form. This process enables designers to see the behaviour of fabrics and structure of garment at the same time [28]. Draping is also good with complicated silhouette and asymmetrical designs.

The dresses employed in draping should furnish:

- Stable support
- Waveless and pinable surfaces.
- Accurate torso shape
- Proper posture alignment

2.5.2 Fit Evaluation and Iteration

Mannequins also facilitate the ability to conduct iterative fittings to the evaluation of fits which would have been logistically difficult due to multiple live fittings. According to researchers, mannequins enable designers to detect problems to do with ease, balance and the placement of seams during initial stages of development [29].

Nonetheless, mannequins do not support dynamic movement and, that is why, complementary fit evaluation techniques are required. This disadvantage notwithstanding, mannequins cannot be dropped because they are consistent and available.

2.6 Materials Used in Mannequin Construction

2.6.1 Conventional Materials

The mannequins used in commerce are typically made out of:

- Fiberglass
- Polyurethane foam
- Thermoplastics
- Metal stands and supports

These materials offer stability in duration and stability on the surface but cost and manufacturing issues are highly enhanced [30].

2.6.2 Textile-Based and Hybrid Materials

Dress forms may have textile coverings on rigid or semi-rigid cores. Padded fabric surfaces can be pinned and manipulated with fabrics and it is important in development of patterns and draping [31].

The construction of hybrid structures with rigid internal structures and soft outer layers is popularly considered as the best way to construct mannequins that can be used effectively. Nonetheless, cost and reparability is an issue.

2.6.3 Low-Cost and Handmade Materials

The literature of educational tools indicates that prototyping using cardboard composites, recycled textiles, foam, paper-made and binding materials that are available locally can prove to be cheap to use [32]. Although these materials might not have the durable nature of the commercial products, they have great benefits in accessibility and sustainability.

2.7 Use of Mannequins in Fashion and Textile Education

Experiential learning is promoted through education research about fashion design. Manipulation of mannequins contributes to the spatial form, proportion, and construction logic learning of the students [33].

Nevertheless, in resource-constrained institutions, there is a tendency to have the problems with the availability of sufficient numbers of mannequins. This has created an urge to look into DIY and low-cost mannequins to use in classrooms as long as they fulfill minimum functional requirements [34].

2.8 Summary and Research Gap Identification

The literature review demonstrates the importance of mannequins in the development of garments, education, and design practice. Though commercial mannequins are highly accurate and durable, they are expensive, and cannot be customized as well as are not readily available to many users.

The research on more advanced solutions that can be 3D body scanning or adjustable mannequins has been done, but there is limited academic literature that deals with straightforward, low cost, and handmade mannequins prototypes specific to the learning and small-scale design environment. This gap gives good reasons as to why this project is being presented.

2.9 Low-Cost and Handmade Mannequin Approaches

2.9.1 Rationale for Low-Cost Design in Fashion Tools

Creation of the low-cost versions of traditional fashion tools has increasingly become a focus of scholarly and educational research, especially when resource availability restricts the use of commercial equipment. Mannequins are a large expenditure category in fashion and textile engineering, and can often cost more than the funds of students, small-scale designers, and institutions in the developing world can afford [35]

Low-cost design strategies are based on functional adequacy as opposed to perfection, being aimed at accomplishing the necessary operational requirements at minimum cost. The philosophy is supported by Ashby in his structure of appropriate technology which proposes that engineering solutions ought to be designed to match to the local, economic, material, as well as skill constraints instead of depending on imported, expensive systems [36].

2.9.2 Handmade Prototyping in Product Development

Prototyping is a well-known engineering and design education technique based on handmade prototyping. It enables designers to prototype ideas quickly and perfect form and functionality and test usability without large-scale manufacturing infrastructure [37]. Handmade prototypes are especially useful in product development in apparel as the processes of designing a garment are more tactile and spatial.

Design methodology literature suggests the handmade prototyping [38]:

- Promotes the idea of designing in loops.
- Reduces development cost

- Supports the refinement of its user-centeredness.
- Improves knowledge in material behavior.

The above features render man-made prototyping particularly appropriate in development of practical mannequins that can be used in education.

2.10 Existing Low-Cost Mannequin and Dress Form Solutions

2.10.1 Simplified Commercial Models

There are other manufacturers who provide simplified dress forms that are targeted at people with a low income. These frameworks frequently save on the cost by restricting flexibility, deploying reduced-density materials or simplifying structural units. Nonetheless, research has shown that even these low-end commercial types are out of financial reach of a large number of students and small businesses in developing countries [39].

Also, reduced-cost commercial mannequins may compromise the quality of surface or structural integrity, reducing their usefulness in draping and pinning again.

2.10.2 DIY and Educational Prototypes

College institutions have discussed DIY mannequins made as part of product design and fashion courses. Such projects usually deal with the utilization of:

- Rigid frame textile padding.
- Composite shells or papier-mâché.
- Fabric and foam layering.

The work by Bye et al. has shown that the student-built dress forms can attain a competent degree of functional accuracy in case directed by anthropometric statistics, and designed construction approaches [40]. Nonetheless, due to the absence of a set of standard design guidelines, the quality of DIY solutions is not always consistent.

2.10.3 Limitations of Existing Low-Cost Approaches

In literature, repetitive restrictions are found:

- Poor durability
- Inaccurate proportions
- Limited reusability

These constraints demonstrate the necessity of a systematic, engineering-oriented design of developing low-cost mannequins as opposed to making them ad-hoc.

2.11 Structural Design Considerations for Mannequins

2.11.1 Stability and Load-Bearing Requirements

During the process of garment construction, pinning and sewing with fabric, a mannequin should be stable. Unsteadiness may undermine user security as well as garment precision.

According to engineering studies, it is necessary to focus on the essential design of the base, the correct center of gravity, and adequate structural rigidity [41].

Mannequins that are low in cost have to strike a balance between the economy of material and structurally functioning.

2.11.2 Internal Support Systems

A commercial mannequins usually uses metal rods or internal frames to support it in the vertical direction. Within handmade versions, wood dowels, or PVC pipes, or composite wooden-layered cardboard can be proposed to act as an efficient internal support in case properly designed [42].

The finite element research on lightweight structures shows that geometry is one of the most important factors in stiffness and strength that is usually more important than the choice of material itself [43]. This principle justifies the possibility of cheap structural solutions of mannequins.

2.12 Surface Characteristics and Functional Requirements

2.12.1 Pinnability and Surface Compliance

The pins will fit in the dress form, and as a result, this is one of the most crucial functional needs. Pinnability enables the designers to handle the fabric on the form itself when it is being draped and fitted [44].

Experiments on the usability of dress forms have shown that moderate firmness surfaces with slight compliance are the best in pin retention and not too firm [45]. This purpose is usually suggested as foam-textile composites.

2.12.2 Surface Smoothness and Fabric Interaction

The smoothness of the surfaces influences the fabric behavior in the process of draping. Dirty or bumpy surfaces can deform the flow of the fabrics and cause misjudgment of the garments. Consequently, mannequins of low cost still have to be smooth enough on the outside to be functional [46].

2.13 Anthropometric Adaptation in Handmade Mannequins

2.13.1 Simplified Anthropometric Modeling

Complete anthropometric accuracy demands a lot of measurement data and accuracy in manufacturing and this may not be possible with hand-made prototypes. Nonetheless, it is affirmed in the literature that the use of critical measurement points can be used in the functional development of garments, including bust, waist, hip, and torso length, as being adequate [47].

According to Aldrich, lots of professional designers can work well with the rough forms as long as proportional associations are observed [48]. This observation especially applies to educational mannequins.

2.13.2 Regional Body Shape Considerations

In anthropometric research done in South Asia, it is apparent that the body proportions are significantly different in terms of the length of the torso and the ratio of hips to the waist [49]. This justifies the importance of mannequins that are locally developed and have improved regional body characteristics.

2.14 Sustainability and Material Selection

2.14.1 Sustainability in Fashion Tools

The issue of sustainability has turned into an issue of concern in fashion and textile engineering. Although the majority of the discussions involve clothing, objects like mannequins are also part of the material consumption and waste [50].

Manmade mannequins that are of low cost can help achieve the sustainability objectives by:

- Application of recycled or home based materials.
- Cutting down on the carbon emissions in transportation.
- Allowing repair and reuse

2.14.2 Material Selection Criteria

The material selection methodology presented by Ashby focuses on such aspects as performance, cost, availability, and environmental impact as the main ones [51]. Using this framework to the development of the mannequins can aid in choices of material that would be functional without being extremely expensive but at the same time being sustainable.

2.15 Educational Value of Prototype Development

2.15.1 Learning Outcomes in Engineering and Fashion Education

The prototype development projects have become well known in the engineering education as effective pedagogical tools. They encourage the skills of problem, interdisciplinary thinking and practical usage of theoretical knowledge [52].

Mannequins in the development projects of fashion technology programs combine:

- Anthropometry
- Material science
- Structural design
- User-centered design

This integration is consistent with the outcome-based education models.

2.15.2 Skill Development and Innovation

Students who have engaged in the practical building of tools have been found to be more creative, have a sense of technical confidence, and are more able to be innovative [53]. Thus, the creation of a mannequin made by hand has the functional and didactic significance.

2.16 Technological Alternatives and Their Limitations

2.16.1 Digital and Virtual Mannequins

The next-generation technologies in 3D body scanning and virtual prototyping have introduced the digital mannequins as the new alternative to the regular physical one. Although these technologies are very accurate, they are expensive to implement in terms of hardware, software as well as expertise [54].

In addition, digital mannequins cannot entirely substitute physical contact especially during draping and feeling fabric [55].

2.16.2 Hybrid Approaches

Hybrid Digital modeling and physical prototypes are suggested in some studies. These approaches are very promising but are mostly experimental and are still not available to majority of educational institutions [56].

2.17 Identification of Research Gap

Although the literature has reported a lot on the garment fit, anthropometry and high-end mannequins, it is evident that there is dearth of systemic scholarly research on the simple, handmade, low-cost mannequins that are currently being used in gathering, and in the low-end design practice.

Existing literature:

- Targets premium business solutions.
- Focuses on digital technologies on the expense of physical accessibility.
- Lacks standardized the instructions in the low cost mannequins.

This brevity is a solid academic rationale of the current project that seeks to design and test a practical, low cost mannequin based on local materials and engineering design principles.

2.18 Research Gap

The paper has reviewed literature on the developments, typology, functional needs, anthropometric specifications, material choice, and pedagogical relevance of mannequins and dress forms. It has pointed out the shortcomings of the available commercial and low-end solutions, and shown that there is a distinct necessity in the systematic elaboration of low-cost and functional mannequins.

3. METHODOLOGY

3.1 Research Design

3.1.1 Type of Research

This is an applied research, because this study is supposed to come up with a viable solution to the issue that already exists in the fashion and apparel industry. It is also an experimental and developmental research as the research is conducted through the creation of the tangible prototype and testing of its workability as opposed to the analysis of only theoretical aspects.

3.1.2 Research Approach

A mixed research design was taken:

- Qualitative approach: Used to get to know the needs, tastes, and problems of fashion designers, tailors, and students in terms of mannequins.
- Experimental approach: Mannequins were used in the selection of materials, construction of the mannequins, shape formulations as well as in the testing of functionality.
- Comparative approach: Was used to compare the developed prototype to commercially available mannequins on the basis of cost, functionality, durability, and usability.

3.2 Problem Identification and Need Assessment

3.2.1 Identification of Existing Problems

An analysis of the key issues related to commercially available mannequins was carried out before the development of the prototype occurred. The issues that were identified were as follows:

- Expensive cost of standard mannequins.
- Lack of affordability among students and small fashion start-ups.
- Low adjustability of body size.
- Delicate substances that are easily destroyed.
- Large replacement cost and maintenance cost.
- Problem with the insertion of pins during draping.
- Poor portability and heavy weight.

These issues pose serious limitations to other upcoming fashion designers, tailoring stores and learning institutions, especially in developing economies.

3.2.2 Target Users

- The main target users discovered on this prototype are:
- Fashion designers
- Tailoring shop owners
- Students of the merchandising of the apparel.
- Fashion design institutes

3.3 Data Collection Methods

3.3.1 Tensile Strength Test:

EN ISO 3303-1

Date: 2020

Rubber- or plastics-coated fabrics - determination of bursting strength - Steel-ball method

Test Details

Test Name:	Ball Bursting	Print Date:	6/21/2025
Fabric Type:	Knitted	Force Control Gain:	100
Fabric Composition:	100% cotton	Jaw Pressure:	100
Specimens:	3	Load Cell:	5000 N
Required Directions:	Dry	Load Cell SN:	1126095
Test Time:	9:57 AM	Version:	11.0.3.0
Test Date:	6/21/2025	Firmware:	v1.00p36
Jaw Scheme:	T20A	Titan SN:	1710/05/21/1197
Jaw Separation(s):	100.00	Tested by:	Administrator

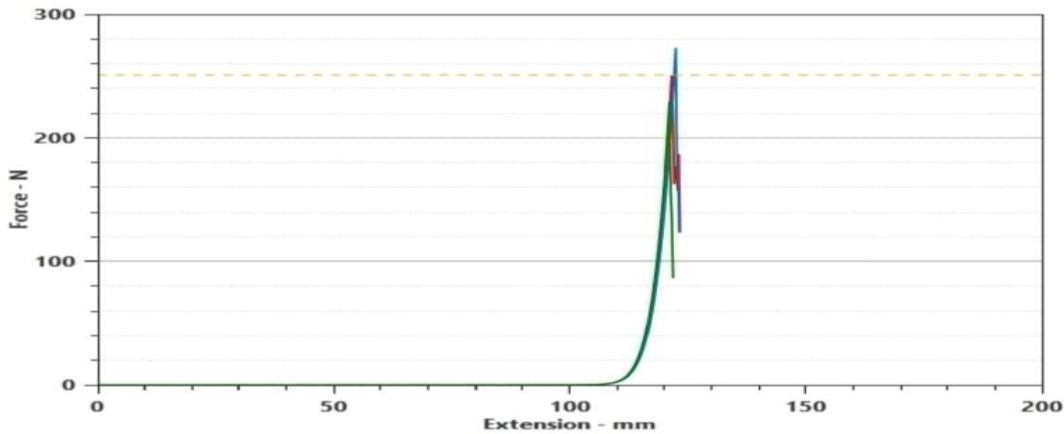
Procedure Settings

Break Detection:	50 %
Pretension:	ON
Pull To Load Cell Maximum Speed:	300.00 mm/min

Dry Results

Specimen	Rupturing Force (N)	Extension at Break (mm)	Observations
1	250.59	121.58	-
2	272.81	122.42	-
3	229.27	121.16	-
Mean	250.89	121.72	
Min	229.27	121.16	
Max	272.81	122.42	
Median	250.59	121.58	
Std Dev	21.77	0.641	

Dry Graph



3.3.2 Pilling Test:

Sample No	No. of Rub Cycle	Pilling Grade (1-5)	Surface Appearance After test	Performance Evaluation
01	500	4	Very slight fuzz	Very good
02	1000	3-4	Slight pilling observed	Good

3.3.3 GSM Test:

Sample No	Sample Weight (gm)	Sample Area (cm ²)	Calculated GSM (g/m ²)	Average GSM (g/m ²)
01	1.33	100	133	134
02	1.35	100	135	

3.4 Design Requirements and Specifications

The main target users discovered on this prototype are:

- Fashion designers
- Tailoring shop owners
- Students of the merchandising of the apparel.
- Fashion design institutes
- Small and medium clothing companies.
- Home based garment entrepreneurs.

3.5 Material Selection

3.5.1 Criteria for Material Selection

The choice of materials was determined according to:

- Cost efficiency
- Local availability
- Ease of shaping
- Structural strength
- Weight
- Durability
- Safety

3.5.2 Materials Used

The mannequins were developed using the following materials:

- Structural materials: Net
- Body forming materials: Straw,
- Covering on the surface: cotton cover, knit cover.

- Adhesive: glue, gum, both side tape.
- Fasteners: Yarn
- Tools: cutter, measuring tape, needle, thread, hammer.

Recycles and cheap materials used contributed greatly to the cost of production.

3.6 Anthropometric Measurement and Sizing

3.6.1 Selection of Body Size

The measurement of the male body was chosen according to the popular apparel sizing charts. The sample sizes were selected based on mean proportions fit in a normal fashion design practice.

3.6.2 Key Measurements Considered

Important Measures to be considered are as follows:

- Bust circumference
- Waist circumference
- Hip circumference
- Shoulder width
- Neck circumference
- Bust point height
- Waist to hip length
- Total mannequin height

These were measurements that provided real garment fit and draping.

3.7 Design Planning and Concept Development

3.7.1 Sketching and Structural Planning

To visualize mannequin support, shape and structure, initial sketches were made to visualize base support. The methods of body shaping were tested prior to the completion of the construction method.

3.7.2 Structural Design Concept

The mannequin was split into the following parts of structure:

- Head and neck
- Upper torso
- Bust area
- Waist section
- Hip section
- Support rod

- Base stand

The design process was performed separately and assembled.

3.8 Prototype Development Process

3.8.1 Frame Construction

A horizontal support rod was placed in the middle vertically to ensure that the mannequins were stable. To avoid tipping of the base, weighted material was used to construct the base.

3.8.2 Body Shape Formation

The formation of body shape was carried out on the layered materials, which were molded to obtain the right body shapes. Shaping was done by doing continuous measurement verification.

3.8.3 Surface Finishing

The exterior was coated in fabric to give the pin friendly surface of smoothness that was amenable in draping and pinning patterns.

3.8.4 Assembly

The assembly of all sections was done in a secure manner so as to have good alignment and balance.

3.9 Cost Analysis

An extensive budget was made to present a comparison between the prototype and the commercial mannequins.

3.9.1 Cost Components

- Raw materials = 500 BDT
- Tools and accessories = 400 BDT

The overall price of the prototype that was developed was established to be much cheaper than the ones in the market.

3.10 Comparative Analysis

The prototype was in comparison with commercially available mannequins on the basis of:

- Price
- Durability
- Functionality
- Weight
- Ease of use
- Repairability

The findings showed great benefits of low cost and personalization.

3.11 Validation of the Prototype

The prototype was tested on the following basis:

- Achievement of original design targets.
- Positive user feedback
- Functional performance
- Cost efficiency

This had some minor restrictions which were observed but had no impact on core usability.

3.12 Ethical Considerations

- No harm was caused to any human being.
- Ethical measurements were done.
- The use of recycled materials was responsible.

4. FINDINGS

4.1 Achievement of Project Objectives

Achievement of Project Objectives: Achievement of project objectives is a key section of the entire project report. Among the main conclusions of the given research, the fact that the essence goals of the project were mostly met should be mentioned. The project was aimed at designing and developing a mannequin, which is affordable, home-crafted, practical, and can be used by fashion designers, in particular, students and those working at small-scale levels.

4.1.1 Development of a Functional Prototype

The most notable observation is that a full-fledged mannequin prototype can be developed that can be utilized in:

- Garment draping
- Pattern checking
- Fitting observation
- Design visualization
- Fashion training and education.

The prototype was in a stable development and the shape of a human body was realistic as was required of a fashion mannequin in terms of functionality.

4.1.2 Cost Reduction Achievement

The overall cost of the mannequins that was developed was established to be significantly less than the commercially offered mannequins. Locally sourced and recycled materials were used and this helped in reducing this cost.

This observation confirms that development of useful mannequins at a fraction of the market price without undermining key functionality is possible.

4.2 Findings Related to Material Performance

4.2.1 Structural Strength of Selected Materials

The materials used in the internal structure and body formation showed sufficient strength when used in fashion designs. During testing:

- The mannequin stood erect without stooping.
- There was no structural collapse when the weight was under the garment.
- The load bearing capacity was adequate as indicated by the support net and the base.

This shows that low-cost materials can be assembled to offer reliable performance in the structure when the right construction is done.

4.2.2 Durability of Handmade Construction

The mannequin was well-constructed although it appeared durable when used repeatedly even though it was a handmade product. Repetitive pin insertion, placing of garments and manipulations did not cause serious damage or deformation.

There was slight wear on the surface but this did not impact on the usability of the mannequin after prolonged use.

4.3 Surface Characteristics and Pin Holding Capability

4.3.1 Pin Penetration and Grip

Amongst the most significant of the findings are associated with pin holding capability, required in draping and pattern work.

- Observations revealed that:
- Pins were easily inserted on the mannequin surface.
- Pins were generally very fixed.
- The usage of pins repeatedly did not overly harm the surface.

This proves that there was an adequate surface material and internal padding thickness in the fashion design work.

4.3.2 Surface Smoothness and Fabric Compatibility

The outer fabric used was a non-slip and smooth covering and this meant that the garments could be worn in a natural manner. Movement of fabrics was at a minimum and thus the correct placement of garments became possible.

This observation shows that the finishing procedure on the surface was successful.

4.4 Anthropometric Accuracy and Shape Representation

4.4.1 Measurement Accuracy

The final prototype was measured against standard body measurements that are used in the sizing of apparel. Findings showed:

- The value of bust, waist, and hip were acceptable within the tolerance limits.
- Vertical proportions were in line with the standard sizing charts.
- Balance balancing was kept on both left and right sides.

There were small differences that were caused by manual shaping but these differences were not considerable to interfere with the fitting of the garments.

4.4.2 Body Shape Realism

The general shape of the mannequin was quite close to an actual torso of a woman. Design work could be done in terms of bust prominence, waist indentation and hip curvature which were visually and functionally acceptable.

This proves the idea that realistic body forms can be created by using handmade methods of shaping as long as these are done with care.

4.5 Stability and Balance Findings

4.5.1 Base Stability

The mannequins were sufficiently steady at the base to make their use during normal usage. Findings include:

- There was no tipping when draping the garments.
- When moderate force was exerted on the mannequin, the mannequin was firm.
- The distribution of weight was equal.
- This means that the base design was efficient.

4.5.2 Portability vs. Stability Trade-off

Although the mannequin was quite light and easy to transport, to some degree, this decreased resistance to the strong external force. Nevertheless, it was acceptable that this trade-off could be applied to indoor fashion design settings.

4.6 Usability Findings from Practical Application

4.6.1 Ease of Use

According to the users, the mannequin was simple to use and manipulate. Key observations include:

- Easy placement of garments
- Comfortable working height
- No sharp or unsafe edges
- This shows that the prototype is user friendly.

The educational use of the company's product is suitable.

4.6.2 Suitability for Educational Use

The mannequin was deemed to be especially suitable in:

- Fashion students
- Academic institutions
- Training centers

It is relatively inexpensive and therefore should be used in large quantities in classrooms and workshops.

4.7 Comparative Findings with Commercial Mannequins

4.7.1 Cost Comparison

A considerable difference in costs was one of the strongest findings. The prototype price was discovered to be about 70-85 percent less than mannequins in the market.

4.7.2 Functional Comparison

As compared to commercial mannequins:

- Higher durability
- Adjustable sizing
- Polished finishing
- The prototype created offers:
 - Similar fundamental functionality.
 - Adequate precision in the majority of design work.
 - Lower cost and serviceability.

This observation proves the prototype to be a feasible substitute to low-end users.

4.8 Repairability and Maintenance Findings

4.8.1 Ease of Repair

The mannequin proved convenient to fix with the help of not complicated tools and materials. Damages that are minor like tears on the surface or loosened joints may be repaired without any special skills.

4.8.2 Maintenance Requirements

There were very few needs in maintenance. Covering or tightening of joints occasionally on the surface was also enough to sustain usability.

4.9 Environmental and Sustainability Findings

4.9.1 Use of Recycled Materials

Recycled materials saved waste and enhanced sustainable practices. This observation underscores the environmental advantage of the development of mannequins made by hand.

4.9.2 Reduced Carbon Footprint

The use of local material and manual production minimized transportation and manufacturing emission in comparison to the industrial production.

4.10 Limitations Identified During Findings

Although successful in general, the following limitations were noted:

- Lack of size adjustability
- Poor aesthetic trimming in comparison to commercial models.
- Such restrictions do not imply an inability to function, but reflect the points of enhancement.

4.11 Economic Feasibility Findings

4.11.1 Suitability for Small Enterprises

The prototype is economically feasible for:

- Small tailoring businesses
- Home-based designers
- Start-up fashion brands

4.11.2 Potential for Local Production

The results imply a great opportunity of small scale localization and commercialization.

4.12 Safety Findings

Testing did not reveal any danger. The mannequin had:

- No sharp edges
- Stable structure
- Safe materials

This establishes educational environment appropriateness.

4.13 Final Outcome



Fig: Final outcome – usable hand-made low cost mannequin

5. CONCLUSION

This chapter has given the current study a solid theoretical and contextual background on developing a prototype low cost mannequin/dummy among the designers of fashion. The introduction and the widespread analysis of the literature related to the topic have effectively proven the importance of mannequins in fashion design and garment development, as well as in education within the field of textile engineering. The introductory part has made it clear that the nature of the process of fashion design and garment development is multidisciplinary and depends crucially on proper three-dimensional body representation. Dress forms and mannequins are important to the designing process, as well as to the design students, as they offer a way to visualize the fit of garments, their drape, proportion, and structural balance in a controlled and repeatable fashion. Compared to live models, mannequins can be used consistently, are available and practical, which further made them an invaluable resource in both professional and educational experiences but the discussion also showed that they have some challenges, especially in developing nations. They are expensive to purchase, difficult to obtain, not tailored to regional body types, and have problems with maintenance, which limits their use among students, self-designers, and small-scale garment makers. All these constraints generate a discrepancy between the educational requirements and the available resources, particularly in institutions with limited budgets. The literature review followed the path of mannequins development since early hand drawn body models to contemporary industrial and computerized solutions. Although with the emergence of new technologies (including adjustable dress models, 3D mannequins, etc.), the new technologies have become more accurate and flexible, they are not always accessible financially and technically to a user. In addition, the current research suggests that educational uses and small-scale design applications of anthropometry often do not require absolute anthropometric perfection, but functional adequacy, which is often inadequate to capture body dimensions of particular areas, especially in South Asian communities. These results support the usefulness of locally made mannequins that may be localized to proportions of population. The literature also suggested the use of hybrid and textile-based covers are very critical in pinnability and draping, whereas low-cost materials would be used in structural performance that is satisfactory with a solid engineering design understanding. One way in which these objectives can be met is through hand-made prototyping with locally available and recycled materials, which has both functional benefits as well as the educational value. Nevertheless, in spite of the scanty DIY solutions, the study of the available literature clearly places a knowledge gap in the creation of low cost, functional, and educationally appropriate manikins. This loophole gives a great rationale to the current research.

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