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Developing a conceptual framework for maternity apparel manufacturing in Kenya

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Abstract
This study explores the need for appropriately fitted maternity clothing for pregnant women, emphasizing the significant physical changes they experience. Regular clothing becomes unsuitable due to varying anthropometric changes across trimesters, necessitating maternity apparel that accommodates the changes. Previous research highlights the challenges in accommodating diverse body morphologies and stresses the importance of anthropometric data in creating effective size charts. This study aims to develop a conceptual framework for maternity apparel manufacturing in Kenya, utilizing localized anthropometric data to ensure well-fitted garments. Through a mixed-methods approach, the research collects and analyzes detailed body measurements from Kenyan pregnant women and integrates insights from local apparel manufacturers. The findings underscore the necessity of trimester-specific size charts and advocate for a structured manufacturing process that enhances garment fit and consumer satisfaction. The proposed framework promises to standardize production, support a competitive local industry, and improve the overall maternity clothing experience for Kenyan women.

Keywords: Pregnancy, anthropometric changes, anthropometric measurements, size chart creation, maternity apparel manufacturing

Introduction
Pregnant women experience various physical changes that necessitate appropriate clothing to accommodate their evolving bodies (Barasa, 2016) [9]. Each trimester of pregnancy brings distinct anthropometric changes, which significantly impact the suitability of regular clothing and compel women to purchase maternity apparel (Sohn & Bye, 2012; Noopur, 2012) [24, 25]. Maternity clothes are designed to fit a pregnant woman's body without compromising health or style, offering both functionality and aesthetic appeal. As maternity fashion has evolved from oversized, unfashionable garments to stylish apparel that maintains a woman's pre-pregnancy body image (Weigle & McAndrews, 2021) [35], the importance of size and fit has become paramount.

Clothing manufacturers recognize the challenge of varying body morphology among women, acknowledging that standard sizes often fall short (Faust, 2013) [14]. Research by Faust and Carrier (2009) [16] underscores the impact of factors such as ethnicity, race, and geographical location on body shape. Consequently, there is a growing appeal within the apparel industry for countries to develop anthropometric data databases and sizing systems tailored to their populations. For maternity wear, incorporating anthropometric changes at each trimester is crucial, as body shape, measurement, posture, and size vary significantly throughout pregnancy. Therefore, the use of anthropometric data in manufacturing maternity clothing is essential. A pivotal study by Barasa *et al*. (2024) [8] utilized anthropometric data to create size charts specifically for Kenyan women, providing a foundational framework for this research. Barasa's study collected and analyzed body measurements from a diverse group of Kenyan women, resulting in a comprehensive set of size charts that reflect the unique body shapes and sizes prevalent in the country. These size charts are critical for designing well-fitting, comfortable maternity apparel tailored to the Kenyan market, thereby enhancing marketability and consumer satisfaction. Balasubramanian and Robinette (2020) [7] advocate for the integration of anthropometric data in the maternity apparel manufacturing process to ensure proper garment fit. When sizing systems developed from specific population data are utilized alongside precise pattern-making and fit trials, the resultant garments meet the desired fit

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standards (Adu-Boakye, 2012; Chun, 2014) [2, 13]. However, a well-documented framework for maternity wear manufacturing is still lacking. Different populations undergo unique physical changes during pregnancy, necessitating garments that accommodate these changes (Oluwaleyimu, 2020; Barasa, 2024) [27, 8]. Designing maternity apparel requires distinct parameters compared to other types of clothing to ensure the fit and aesthetics align with the pregnant body.

Given the significant influence of anthropometric changes on garment fit during pregnancy, it is imperative to consider these factors in maternity apparel manufacturing (Barasa, 2016) [9]. Systematic consideration of these changes, aligned with procedures for pattern development, fit testing, and garment production, is crucial (Balasubramanian & Robinette, 2020) [7]. Collecting body measurement changes at different pregnancy stages and using them to create trimester-specific size charts is essential (Oluwaleyimu, 2020) [27]. Such a database can aid designers and manufacturers in generating accurate patterns for maternity wear production.

This study aims to develop a conceptual framework for maternity apparel manufacturing in Kenya, building on Barasa's (2024) [8] findings regarding the use of anthropometric data to create maternity wear size charts. By integrating localized anthropometric data, this framework will guide the production of maternity apparel that fits well and meets the unique needs of Kenyan women, thereby supporting the growth of a sustainable and competitive local industry.

Literature Review
Anthropometric Data and Apparel Manufacturing
Anthropometric data, which involves the systematic measurement of the human body, is crucial for the apparel manufacturing industry (Barasa *et al* (2024) [8]. In the context of maternity wear, the need for precise fit and comfort is paramount due to the significant physical changes women experience during pregnancy. Balasubramanian and Robinette (2020) [7] highlight that accurate anthropometric measurements are essential for creating garments that accommodate these changes, ensuring both support and comfort for expectant mothers. The application of anthropometric data enables designers to tailor maternity clothing to the evolving body shapes of pregnant women, enhancing their overall well-being and satisfaction with the garments.

In apparel design, anthropometric data is the foundation for developing size charts that reflect the actual body dimensions of the target population. Gupta (2014) [17] emphasizes that anthropometry is critical for determining size charts, which serve as the basis for garment construction. Bari *et al.* (2015) [10] also note that these measurements allow manufacturers to produce clothing that fits well and meets consumer needs. For maternity wear, fit is particularly dependent on both vertical and horizontal body measurements. Noopur (2012) [25] demonstrates that pregnancy significantly alters these dimensions, affecting how garments drape and fit the body. Barasa (2016) [9] further supports this, indicating that pregnant women's bodies undergo changes that alter their vertical and horizontal measurements, thus impacting the fit of maternity clothing. Key measurements for maternity wear include height, waist and hip widths, and various girths, which must be accurately captured to ensure proper fit. These measurements are often taken following ISO standards to maintain consistency and reliability.

The process of collecting these measurements typically involves an anthropometric survey, which includes measuring a sample population, analyzing the data, and grouping individuals with similar body dimensions to create standardized size charts (Kouchi, 2020) [21]. Capelassi *et al.* (2017) [12] highlight the importance of categorizing the population into size groups, which facilitates the production of garments that fit well across a diverse range of body types. Traditional methods, such as using a tape measure, and modern techniques, like three-dimensional body scanning, are commonly employed to obtain body measurements (Ashdown, 2007; Brownbridge & Power, 2010; Otieno, 2013; Lee, 2013) [4, 11, 30, 22]. For a population that is both small and widely dispersed, such as pregnant women in Kenya, the traditional method is often more practical due to its accessibility and cost-effectiveness.

Balasubramanian and Robinette (2020) [7] stress the importance of preparing the body properly for measurement to ensure accuracy. This involves careful identification and marking of body landmarks, as suggested by Gupta (2014) [17], ensuring all key areas are correctly measured. Pregnant women must also understand and be prepared for the measurement process, which can affect the accuracy of the data collected. After the anthropometric data is collected, it can be analyzed to create size charts. Otieno (1999; 2008) [28, 29] outlines the process of developing size charts, which includes body measurement, data entry and cleaning using software like SPSS, generating descriptive statistics, establishing midpoints and endpoints for sizes, determining key dimensions, building body measurement tables with size codes, developing test garments, conducting fit trials, and finally confirming the size chart. These steps ensure that maternity wear size charts are accurate and reliable.

The diversity in a population can greatly benefit the development of size charts and apparel manufacturing. Diverse populations provide a broad range of body types and sizes, which can help create more inclusive and representative size charts. This inclusivity ensures that garments fit a wider range of individuals, improving overall consumer satisfaction. Faust and Carrier (2009) [16] argue that factors such as ethnicity, race, and geographical location impact body shape, and understanding these variations is crucial for developing accurate size charts. In the context of Kenya, which is ethnically and culturally diverse, incorporating anthropometric data from various groups can lead to the production of maternity wear that caters to the unique body shapes and sizes prevalent in the country. This approach not only enhances the fit and comfort of the garments but also promotes inclusivity in the apparel industry.

In conclusion, integrating anthropometric data into the apparel manufacturing process, particularly for maternity wear, is essential for producing garments that provide the necessary fit and comfort. The scientific approach ensures that maternity clothing meets the specific needs of pregnant women, improving their overall comfort and satisfaction. Additionally, leveraging the diversity in the population can lead to more inclusive and representative size charts, enhancing the fit and marketability of maternity garments. This study aims to develop a conceptual framework for maternity apparel manufacturing in Kenya by incorporating these principles and findings from relevant research.

The Concept of Maternity Apparel Manufacturing
During pregnancy, women require special clothing designed to accommodate rapid physical changes. Typically, these garments are worn during the second and third trimesters

when the body undergoes significant transformations. Shang and Hu (2015) [31] note that maternity garments should not only accommodate these physical changes but also ensure the health of the developing fetus. With changing fashion trends, maternity apparel is now designed to be both comfortable and stylish, meeting the needs for correct fit and size. Shamsaei *et al*. (2022) [32] emphasize that pregnant women need clothing that bridges the gap between their changing body shape and their ideal body image.

Balasubramanian and Robinette (2020) [7] suggest that achieving comfort, style, beauty, size, and fit in maternity clothing requires considering the anthropometric changes that occur throughout pregnancy. Researchers recommend that maternity wear manufacturers utilize anthropometric data from pregnant women to determine appropriate sizes and fits for their clothing. Additionally, each country should develop size charts tailored to its specific population, recognizing that body morphology varies greatly and affects standard sizes (Faust, 2013) [14].

Faust (2013) [14] found that size, shape, and fit are key considerations when choosing clothing for pregnant women. The researcher recommends scientifically collecting anthropometric data on pregnant women to improve maternity wear size systems and garment fittings. Considering the differences in body sizes among individuals, Oluwaleyimu (2020) [27] highlighted the need for gathering anthropometric data to produce functional apparel for pregnant women. Oluwaleyimu measured 384 pregnant women to develop patterns for producing functional maternity apparel in small, medium, and large sizes based on the mean body measurements.

In conclusion, integrating anthropometric data into the apparel manufacturing process, particularly for maternity wear, is essential for producing garments that provide the necessary fit and comfort. The scientific approach ensures that maternity clothing meets the specific needs of pregnant women, improving their overall comfort and satisfaction. Additionally, leveraging the diversity in the population can lead to more inclusive and representative size charts, enhancing the fit and marketability of maternity garments. This study aims to develop a conceptual framework for maternity apparel manufacturing in Kenya by incorporating these principles and findings from relevant research.

Maternity Apparel Manufacturing in Kenya.
The Kenyan apparel manufacturing industry has seen significant growth due to the opening of the global market economy. The sector is composed of three levels: 21 large companies located inside the Export Processing Zone (EPZ), 170 medium and large enterprises outside the EPZ, and over 70,000 micro and small enterprises operating outside the EPZ. According to a report by Kohantextiljournal.com (2021), Kenya exported nearly half of its apparel to the United States, primarily in the form of cotton trousers and slacks for women and girls, as well as man-made fibre trousers, shorts, breeches, blouses, and knit shirts. These garments are mass-produced using the principle of one pattern fits all.

However, small and privately owned maternity apparel manufacturers in Kenya often employ the fit-to-measure principle and the trial-and-error method, using international size charts. Despite these efforts, changing fashion trends and the influence of social media have created a demand for functional and fashionable maternity apparel that helps create a satisfying body image for pregnant women globally (Weigle & McAndrews, 2021) [35]. Liu *et al*. (2022) [23] highlight that

women who dress fashionably when not pregnant desire the same experience during pregnancy. This puts pressure on Kenyan maternity wear manufacturers to adopt production techniques that ensure their products are not only functional and stylish but also tailored to fit the unique body shapes of Kenyan pregnant women.

Abdukhashimovnal (2022) [1] emphasizes the importance of considering anthropometric changes during pregnancy when designing clothing for pregnant women. Hurst (2013) [18] suggests that retailers and manufacturers need to target specific demographics with precise anthropometric measurements and preferences to produce well-fitting maternity garments. This information is critical for creating maternity clothing that fits the Kenyan population accurately.

The Kenyan market is currently flooded with imported maternity wear, both new and second-hand, leading to stiff competition between locally manufactured and imported clothes. As a result, maternity clothing manufacturing in Kenya is predominantly conducted on a small scale by fashion designers and tailors. The absence of an anthropometric database or sizing system specifically for Kenyan pregnant women forces designers to rely on a trial-and-error approach when producing maternity wear. This method requires designers to adjust international size charts to better fit Kenyan women, which is both time-consuming and results in inconsistencies in size and fit.

Therefore, developing a conceptual framework for maternity apparel manufacturing in Kenya is essential to guide the production of well-fitted maternity wear. This framework will provide standardized procedures for collecting and utilizing anthropometric data, ensuring that the resulting garments meet the specific needs of Kenyan pregnant women, thereby improving their comfort, satisfaction, and overall well-being.

Methodology
Research Design
This study employs a mixed-methods approach to develop a conceptual framework for maternity apparel in Kenya. The research design integrates quantitative data from anthropometric measurements and qualitative insights from interviews with apparel manufacturers. The methodology is based on the procedures undertaken in a study by Barasa (2024) [8] where anthropometric data was collected and utilized to create maternity wear size charts for Kenyan pregnant women.

Data Collection Procedures
Anthropometric Data Collection and Maternity Wear Size Charts Creation
In a 2024 study by Barasa *et al*, researchers aimed to address the gap in maternity wear fit and sizing by developing size charts tailored specifically for Kenyan pregnant women. They employed a longitudinal research design to track body changes across the second and third trimesters, traditionally collecting anthropometric data from pregnant women in Nairobi County, Kenya. The study selected a sample of 600 pregnant women from public health facilities across eight constituencies using purposive sampling to choose 63 facilities offering antenatal services. These women were evenly divided between the second and third trimesters and were selected through convenient sampling at antenatal clinics. Data collection instruments included measurement lists and a questionnaire validated by experts. The study developed trimester-specific size charts using the five-size-step approach employing statistical size grading techniques,

emphasizing the importance of key dimensions like bust, waist, hip, and the girth of the biggest protrusion. Fitting trials confirmed the charts' effectiveness, yielding satisfactory fit ratings across different body sizes.

Interview with Apparel Manufacturers
Using the snowball sampling technique facilitated by the Association of Fashion Designers (AFAD), 30 fashion designers manufacturing maternity wear in Nairobi County, Kenya, were selected. The researcher contacted the manufacturers through email to schedule interviews. Interview schedules were developed to gather information on maternity apparel manufacturers' opinions regarding the use of maternity wear size charts in maternity clothing manufacturing. Interviews were conducted between the researcher and the chief technical designers of each manufacturer of maternity apparel. Interviews took place over five weeks, with six firms being interviewed each week. Each interview lasted approximately 20 minutes and was conducted in the chief technical designers' office.

Data Analysis
Quantitative data analysis involved statistical techniques such as SPSS and Pearson's correlation coefficient analysis to identify key dimensions for maternity wear size chart development. Qualitative data from interviews were thematically analyzed to extract insights on size chart usage and industry perspectives. The analysis process was guided by the objectives of the study and aimed to inform the development of the conceptual framework.

Integration of Findings
The findings from anthropometric data collection and interviews with apparel manufacturers were integrated to develop the conceptual framework. The framework incorporates insights on body measurement data, size chart utilization, and industry practices to provide a structured approach for maternity apparel manufacturing in Kenya.

Ethical Considerations
Ethical approval was obtained from the relevant institutional review board prior to data collection. Informed consent was obtained from all participants, and measures were taken to ensure confidentiality and anonymity throughout the research process.

Results and Discussions
Findings from Anthropometric Data Collection and Size Charts Creation
The utilizing of anthropometric data to create trimester-specific size charts for Kenyan pregnant women has laid the groundwork for developing a conceptual framework for maternity apparel manufacturing in Kenya. Through a longitudinal design, the study tracked body changes across the second and third trimesters, involving 600 pregnant women from various public health facilities in Nairobi County. Descriptive statistics revealed significant weight increases and diverse body shape changes, emphasizing the need for customized maternity wear. Comparative analysis with studies from Nigeria, the United States, and China highlighted cultural and regional differences in body measurements, underscoring the importance of population-specific size charts. Key dimensions such as bust, waist, and hip girths showed strong correlations with weight, guiding the creation of well-fitting maternity wear. The study's size charts

demonstrated progressive measurement increases across sizes, accommodating the dynamic nature of pregnancy. Practical garment production and fitting trials confirmed the size charts' effectiveness, providing a reliable foundation for the design and manufacture of maternity clothing tailored to Kenyan women. This approach aligns with previous research emphasizing the need to consider diverse body types in maternity wear design, ensuring comfort and proper fit.

Insights from Interviews with Apparel Manufacturers
The interviews with apparel manufacturers provided valuable insights into the usage and opinions regarding the use of size charts in maternity clothing manufacturing. The results were presented in relation to the themes created. They include the usage and origin of size charts, and their opinions regarding the use of size charts when manufacturing maternity wear.

Usage and origin of size charts
Regarding the usage and origin of size charts, respondents were first asked to comment on the size charts they use when manufacturing maternity clothing. The findings indicate most of the respondents (82%) modified the existing size charts from other countries or created their own size charts. The respondents further explained that they modified or created their size charts based on American, Mexican, British, and international standards. The respondents pointed out that the process of modifying the measurements to suit the Kenyan pregnant body is time-consuming and sometimes not accurate. Other respondents (18%) indicated that they did not utilize size charts in maternity production but instead, they measured their clients manually and used the measurements to draft patterns which are then used to produce the garments. The respondents explained that the size chart measurements did not relate to the Kenyan pregnant body. In their response, they stated,

"Most of our clients were not satisfied with the fit of maternity clothing, we produced using the size charts."

Based on this finding, it is noted that Kenyan pregnant women's body measurements differ from those on size charts from other countries. Despite the difference in size chart usage, all the respondents pointed out that due to the unique body shape of Kenyan pregnant women, total reliance on size charts from other countries doesn't provide Kenyan women with the expected size and fit of maternity wear. Most respondents expressed the need for an anthropometric database, geared specifically for Kenyan pregnant women, which can be used in conjunction with size charts from other countries when producing maternity clothing.

Balasubramanian and Robinette (2020) [7] show that pregnant women's anthropometric data and sizing systems are necessary for providing the required fit of maternity apparel. Previously, Balasubramanian and Robinette (2018) [6] suggested that anthropometric data must be incorporated into the maternity apparel manufacturing process for garments to fit properly. Additionally, when sizing systems developed using anthropometric data for a specific population are utilized, pattern-making processes followed, and fit trials performed, the garment's fit is determined (Adu-Boakye, 2012; Chun, 2014) [2, 13]. In the manufacture of maternity wear, a framework that utilizes size charts developed based on anthropometric data from a specific population of pregnant women appears not well documented. It's evident from the findings that Kenya lacks an anthropometric database or sizing systems for Kenyan pregnant women. As a result, maternity wear manufacturers are left with the option of

employing the trial-and-error method by utilizing sizing standards from other countries to produce maternity wear. The adaptation or modification of these size charts is necessary so that they accommodate the Kenyan pregnant women's body shape. In line with previous studies on maternity apparel, these findings support the use of anthropometric data in order to develop size charts that can be utilized to manufacture maternity wear that fits correctly (Ola-Afolayan & Mastamet-Mason, 2013; Chun, 2014; Muthambi *et al*., 2015; Balasubramanian & Robinette, 2018) [26, 13, 24, 6].

Their opinions regarding the use of size charts when manufacturing maternity wear
Unexpectedly, the results indicate that most of the respondents were positive (73%) about the usage of size charts when manufacturing maternity clothing. As per the respondents, size charts can provide a proper fit for maternity clothing if one understands the changes in body measurements that occur during pregnancy in any population and can adapt or modify them in accordance with the appropriate sizing system. In concurring with this finding, Adu-Boakye (2012) [2]; Chun (2014) [13] indicated that when sizing systems developed using anthropometric data for a specific population are utilized, pattern-making processes followed, and fit trials performed, the garment's fit determined is appropriate. Consistent with the literature, the respondents also stated that maternity clothing size charts specifically developed using anthropometric measurements of Kenyan pregnant women would give a better fit of maternity wear. They explained that the lack of a size chart for Kenyan pregnant women has resulted in manufacturers employing different maternity apparel manufacturing methods that has resulted in a variation in sizes among the manufacturers. Adu-Boakye (2012) [2] have both indicated that manufacturers assess body dimensions differently according to their own standards and the goals they wish to achieve, resulting in differences in garment sizes. For this reason, the respondents unanimously stated the need for a standardized guideline that would guide the production of maternity apparel that fit the body size and shape of Kenyan pregnant women. They indicated the availability of a ready market that seems to be frustrated by what is available in the market.

Development of a framework for maternity clothing manufacturing
This section outlines the creation of a conceptual framework for maternity apparel production in Kenya, addressing the specific needs of pregnant women through a structured approach. Based on the work of Barasa *et al*. (2024) [8] and incorporating industry feedback, the framework integrates methods for collecting anthropometric data, generating sizing systems, and producing maternity wear. This process begins with traditional anthropometric data collection, including key body measurements such as bust, waist, and hip girth. These measurements inform the development of sizing systems, reflecting observed changes in size, shape, weight, and posture during pregnancy.
The framework systematically connects data collection, measurement table development, and size chart creation, ensuring a continuous feedback loop. Garment production stages, including pattern development and fit testing, are aligned with the sizing system, emphasizing the interdependence of these variables. This structured approach highlights the collaborative relationships among manufacturers, consumers, stakeholders, and academicians,

ensuring garments meet the unique body shapes and sizes of pregnant women in Kenya.
By addressing the inadequacy of existing size charts, this framework aims to enhance the quality and fit of maternity clothing, leading to improved customer satisfaction. It provides manufacturers with a comprehensive understanding of the specific needs of pregnant women, optimizing production strategies and effectively targeting the maternity wear market. For consumers, the framework promises better-fitting, more comfortable, and stylish maternity wear, enhancing their overall maternity experience. Stakeholders like the Kenya Association of Manufacturers (KAMs) and the Kenya Bureau of Standards (KEBS) benefit from the framework through improved industry standards and practices, promoting innovation and competitiveness. Academicians gain valuable insights for research and teaching, advancing the understanding of maternity apparel manufacturing.
Overall, this conceptual framework represents a significant advancement in the field, offering a comprehensive overview of key variables and their interrelationships. It serves as a foundation for future research, facilitating the development of well-fitting and stylish maternity clothing options for pregnant women.
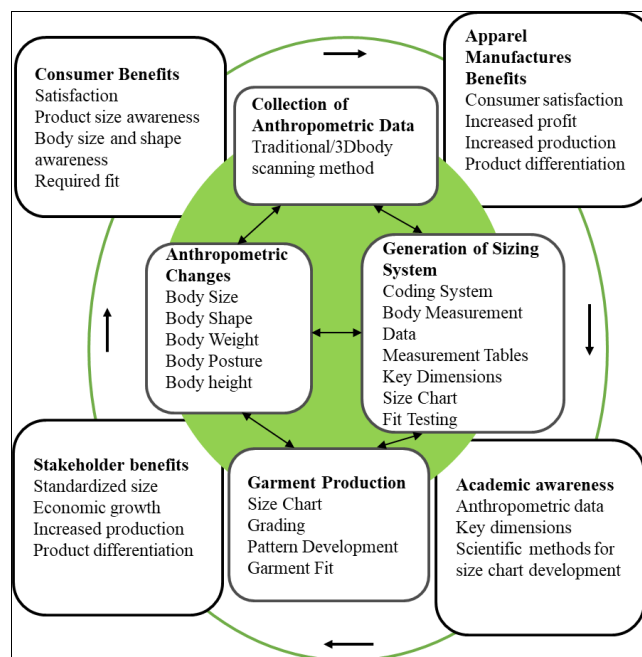
Fig 1: A conceptual framework for maternity apparel manufacturing in Kenya

5. Conclusion
The study successfully developed a conceptual framework for maternity apparel manufacturing in Kenya, rooted in the collection and application of localized anthropometric data. This framework addresses the critical need for accurate and well-fitting maternity garments tailored to the unique body changes experienced by Kenyan women during pregnancy. By utilizing trimester-specific size charts derived from comprehensive anthropometric measurements, the framework offers a systematic approach to enhance the fit and comfort of maternity wear. The insights from local manufacturers underscore the importance of this framework in standardizing production processes and improving garment consistency. The adoption of this framework promises significant benefits, including better consumer satisfaction, enhanced market competitiveness, and the growth of a sustainable local apparel

industry. This research contributes valuable knowledge to the field of maternity apparel manufacturing and provides a robust foundation for future studies and industry practices aimed at improving the quality and fit of maternity clothing for Kenyan women.

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