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Design and Development of Feminine Re-usable Maxi Pads for Economically Challenged People

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ABSTRACT

Menstruation is one thing which almost every woman has to deal with every month. To manage menstruation hygienically and with dignity, it is essential that women and girls have access to water and sanitation. They need private place to change sanitary cloths or pads; clean water and soap for washing their hands, bodies and reusable cloths; and facilities for safely disposing of used materials or a clean place to dry them if reusable. Considering above issues for women, this research mainly focused on designing and developing feminine reusable maxi pads for economically challenged peoples, the product is created with different styles, well supported by the line survey and also with different technical tests of fabric and product in order to take extra care for women's health related problems. The product is developed with three different types of fabrics, forming three different layers of the product, such as 100% bleached knitted cotton, which is used as a top layer attached to the skin ,which acts as an absorbing fluid and create comfort to the wearer, poly wadding (non-woven) used at the middle layer , which is mainly used for absorbent purpose, easily washable, retain cotton shapes and water resistance fabric is used as lower layer , which acts as further resistant for the fluid to prevent from the leakage. The aim of the study is to protect women's health, especially belongs rural area living women and girls from different health related issues caused due to menstruation, such as irritation, burning, attending class and works, cancer, infections which occur in the case of using normal cloths/ some disposable pads. The unique features of this product is that , this is made from materials which is easily available in market, cost affordable, environmental friendly, good absorbent, comfort, fluid resistant, high durability, has good tear and tensile strength.

Keywords : Menstruation, reusable maxi pad, disposable pad, environmental friendly, cost affordability, healthy, economical challenge, Menstrual Hygiene management.

I. INTRODUCTION

Menstruation is one thing which almost every woman has to deal with every month. Natural women have menstruation cycle in permanent time that is once in a month, destroyed eggs leave the body in the form of bad blood. Girls begin their periods between the ages of 10 to 18. The average age is 13. Women will continue to menstruate until the age of 45 to 55, when menopause begins. A woman will have approximately 500 periods in her lifetime.

Through the ages women have used different forms of menstrual protection. Women often used strips of folded old cloth (rags) to catch their menstrual blood, which is why the term "on the rag" was used to refer to menstruation. This old cloth is not recommended for health that cases infection in the body not friendly with environment. A maxi pad is needed to hold off the blood and it is necessary to change the maxi pad or towel regularly, at least three times a day in order to maintain proper hygiene.

Normal or regular menstruation lasts for a few days (usually 3-7 days) and the average blood loss during menstruation is 35 ml with 10-80ml considered normal (A. B Nyoni, 2014 , Wafawarova, P.., 2003). Menstruation Hygiene Management (MHM) in sub-Saharan Africa is a topic that has gained increasing attention in recent years from various factors, including the water and sanitation, education, anthropology and health communities, because of its potential impact on school attendance and employment (Emily Wilson,

Josie Reeve, Alice Pitt, Ben Sully & Steven Julious, 2012).

In Ethiopia, menstrual hygiene is one of the critical challenges for adolescent girls. Menstruation is seen as taboo by many communities, majority of families in rural Ethiopia is too poor to buy disposable pads.

Ethiopian girls miss 3-7 days of school per month, average -5 days– 50 days per school year frequently causing them to drop out of high school. Because, they lack adequate supplies related to menstruation. In 2005, United Nations International Children's Emergency Fund (UNICEF) estimated that 1 in 10 school-age African girls do not attend school during menstruation or they drop out at the onset of puberty (Kirk and Sommer, 2006).

Poor protection and inadequate washing facilities may increase susceptibility to infection, with the odor of menstrual blood putting girls at risk of being stigmatized, see also water sanitation and health (KIRK and SOMMER, 2006).

Menstrual hygiene is a largely overlooked issue in the WASH sector. Every day, an estimated 200 million menstruating girls and women in low-income countries struggle to find clean water for washing, private places for changing and adequate blood absorbing materials (CROFTS, T and FISHER, J, 2012).

In rural western Kenya, a ''menstrual feasibility study'' tested the acceptability, use, and safety of menstrual cups and sanitary pads against ''traditional practice'' among primary school girls. (**Mason L,** Nyothach E , et al. 2013)

Cultural beliefs, social norms and myths

Many cultures have beliefs, myths and taboos relating to menstruation. Almost always, there are social norms or unwritten rules and practices about managing menstruation and interacting with menstruating women. For example, the concept of pollution was strongly associated with menstruation and was described by one girl in Nepal: 'A woman is ritually impure during menstruation and anyone or anything she touches becomes impure as well. It is usually the mothers who enforce these restrictions.' (Water Aid in Nepal 2009a, 10), (Dasgupta, A. and M. Sarkar, 2008). Another girl reported that, due to the polluting touch, during winter she is not provided with sufficient warm clothes during menstruation, as the clothes would become polluted (Dasgupta, A. and M. Sarkar, 2008).

These reusable pads are usually washed and re-used. Other blood absorbing materials include toilet paper, leaves, newspaper, cotton wool and extra layers of clothing. Commercially produced disposable sanitary pads are too expensive for most African schoolgirls (CROFTS, T and FISHER, J, 2012, sited in Kinoti, 2008).

Facilities for changing pads

Sanitary protection materials were usually changed at least once a day in school. A few girls avoided changing due to poor hygiene conditions and lack of privacy. Whether at home or at school, 54% of students usually changed in latrines, 27% changed in dormitories or bedrooms and 19% changed in bathing places (CROFTS, T and FISHER, J, 2012).

II. Justifications of the research

This research mainly focused on producing a reusable maxi pad products and supplying those product to the customer with low cost for all ages between 15 and 59 years, to address to the customer in order to achieve their needs by creating awareness to the customer about using, washing, packing, drying, storing and wearing systems of the reusable pads.

This research mainly focus on the design and developments of the reusable sanitary pad for economically challenged population in developing countries (especially Ethiopia) by producing cost affordable, health, comfort, easy to use, washable/ reusable, minimizing student absenteeism in school, environmental friendly, durable, wears to long times, prevent body from infection and cancers products. The project supported by different test (i.e. absorbency, durability, wash fastness, water repellent test, air permeability, tensile strength, seam slippage etc.) in order to enhance the customer safety and healthy from different infection and disease, like disposable pads.

Development of a reusable maxi pad is easy to make, affordable, and that utilizes locally available natural fibers such as cotton, or bamboo, poly wadding and water repellent is described in this paper.

III. Objectives

The objectives of this research are to take care of women's health, economy and preventing from discomfort environments by design and development of eco-friendly product with different styles of reusable maxi pads for economically challenged populations. When come to detail, it used for understand the current status of affairs between the sanitary and disposable pads then, carried out raw material and product tests in order to developing the reusable maxi pad. Make analysis the cost benefits of reusable rather than disposable pads and develop customer fit reusable maxi pads design then, address cost affordable and comfort product to the customer. Finally ensure that every Ethiopian girl will have protection to attend school during menses by creating awareness on the benefit of the reusable maxi pad and implement the product.

IV. Materials and Methods

4.1. Materials and equipment

Raw materials and equipment are required designing reusable feminine maxi pads are:

- ✓ Cotton fabric at top, poly wedding at middle and at bottom with water repellent materials like Polyester/Nyon plain weave fabric.
- ✓ Plain 100% knitted cotton fabric may be made with Bamboo fabric, since it has natural absorbency.
- ✓ Testing equipment's, materials and machines (e.g. absorbent, durable, washable, air permeability, water-repellent, tensile strength, etc.)
- ✓ Auto-CAD or Archi-CAD for -3D designs of the product
- ✓ Snaps buttons or Velcro

4.2. Methods

4.2.1. Data collection

The methodologies used to collect quantitative and qualitative information included: observation, interview and questioners in both primary and secondary data for baseline survey study.

4.2.2. Working Methods

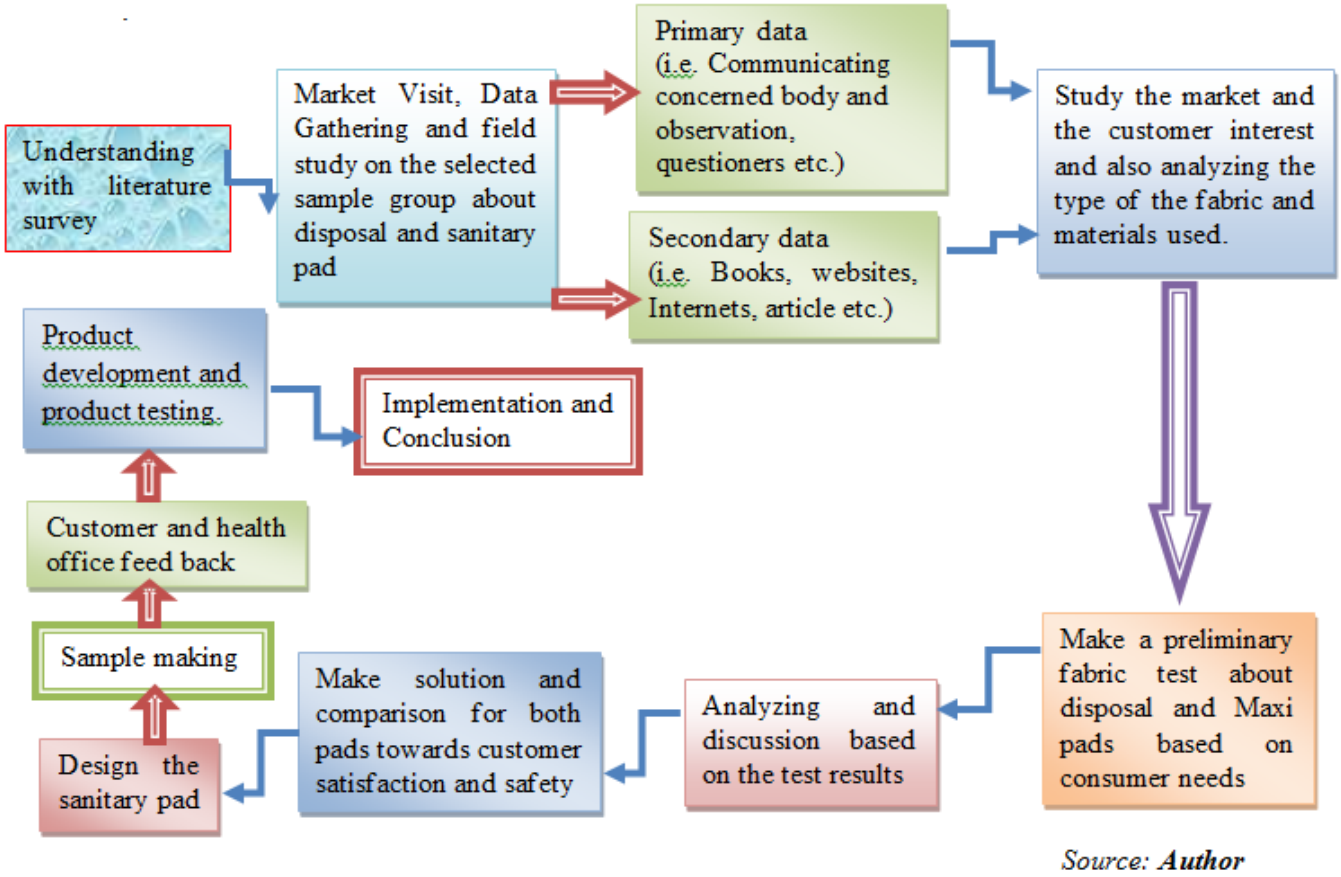


Figure 1: working methods

V. RESULTS AND DISCUSSION

5.1 Baseline survey

The baseline survey feedback collected from 420 sample size of target populations are by interview, observation and questionnaires are seen as follow; the customer currently used type of product to preventing menses are disposable pads is (74.3%) and 14.8% is old cloth, they also used disperse system is throwaway in lavatory (40.2%) and put in dust bin (32.1%), they said that, the product by itself has a bad feeling (i.e. irritate, burn, discomfort etc.) is (25.5%) and good feeling (19.5%). The mean waiting time of their menses is between 1-3 days are 147 (35%), 4-5 days are 245 (58.3%) and 6-7 days are 28 (6.7%). They also spent their time in case of menses by work in home are 124 (29.5%), sleeping in home are 112 (26.7%) and by work out of home are 108 (25.7%). When asking about cost affordability of disposable pad, they are said cheap in price 7(1.7%), cost affordable 112 (26.7%), expensive 87 (20.7%) and very expensive 102 (24.3%), based on this cost expense during one menses is 5-15 birr are 116 (27.6%), 25 – 35 Birr are 79 (18.8%), 35-45 birr are 66 (15.7%) and 45-55 birr are 54 (12.9%). Due to the above discussed problem, by asking the question which regarded to new reusable pad design about their willingness to develop the product. For this case the options are, yes or used are **331** (78.8%), No or not used are 10 (2.4%) and I am not decide now are 76 (18.1%). So, from this feedback customers are voluntary to use these types of new product. Based on this, need assessment almost they are accept this product, so start to develop the product as per their interest.

5.2. Discussion based on fabric and product test results

5.2.1 Fabric property tests

Fiber Content Test

The fiber contents of the new product are compared with disposable pad in the following table.

Table 1: Fiber content identification for reusable and disposable pad fabric

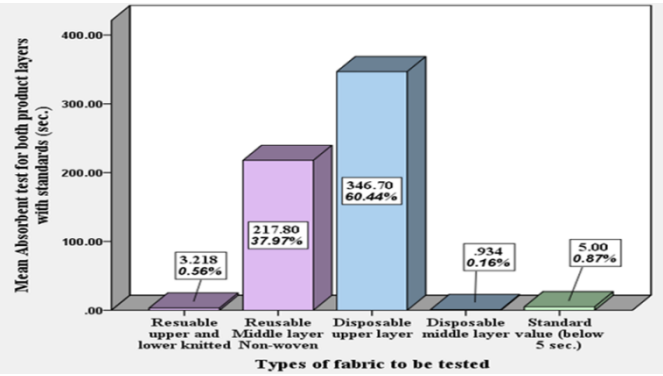
No.	Types of product	Location/layer	Method to be used	Fiber content
1	Reusable Maxi pad	Upper and middle of Knitted cotton	Burning and solubility	100% cotton
2		Middle of Non-woven	Solubility	98.08% polyester 1.92 % cotton
3		Lower layer water repellent	Solubility	93.26% is polyester 6.74 % color lose
4	Disposable pad	Upper layer	Burning and solubility	58.96% polyester 41.04% cotton/cellulosic
5		Middle layer -cotton	Burning and solubility	100% cotton
6		Lower layer	Burning and solubility	70.53% Polyethylene terephthalate 29.47% cellulosic

*Source: **Author***

From above table 1, the fiber content identification by using burning and solubility test of 25% of water and 75% of H_2SO4 or pure H2SO4 recipe on weight by weight (W/W) concentration solution.

Absorbance testing

The absorbent test is done according to ASTM D 4772-97 by using droplet test method. The test results are recorded for ten specimens were taken from each fabric types randomly. [Result is generated by SPSS -One-Way ANOVA analysis system (One-sample T-Test] methods.



Source: ***Author***

Figure 2: Graphical compression of absorbent test value for reusable and disposable pad materials with standard allowable absorbent values

From figure-2-, the value of absorbent test for each fabric type comparison with each other and standard values (below 5 sec.), the compression is based on mean value and statistically p-value of the different fabric with standard set time values. The best absorbent values of the test must be below five (< 5 sec.).

From figure 2, the best absorbent values of the tested fabric are disposable middle layer and reusable knitted cotton upper and middle layer, the middle layers of non-woven fabrics are slightly absorbent. But the upper layer of the middle fabric of disposable pads is poor absorbent types of fabric which is coated by plastic materials. So it is not recommended to wear. The average time values of upper layer knitted fabric is less than standard five second (<5 sec), so it is good absorbent. Whereas the average time values of poly wadding (Non-woven fabric) is greater than five second (>5 sec), so it is slightly absorbent and more durable to retain shape of product.

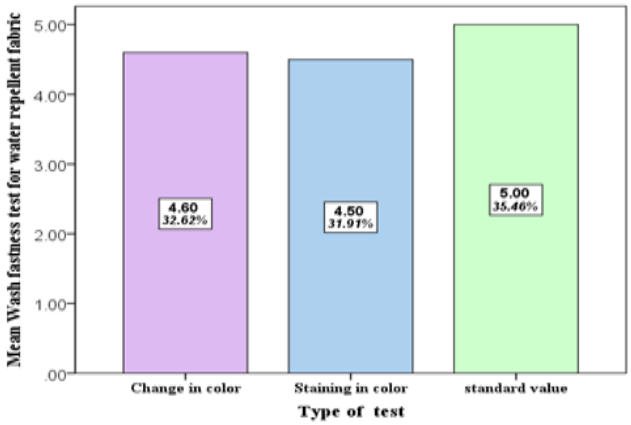
Washable test

The Washable test value of made by using ISO-105A test method. The test results are recorded for five specimens for water repellent fabric. [Result is generated by SPSS –Compare mean-one sample T-test analysis (One-sample T-Test] methods.

Table 2: Wash fastness test for water repellent fabric by one-sample T- test

Types of test		Test Value = 5					
		T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Change in color	Wash fastens test for water repellent fabric	-4.000	4	.016	-.40000	-.6776	-.1224
Staining in color	Wash fastens test for water repellent fabric	-3.162	4	.034	-.50000	-.9390	-.0610

Source: ***Author***



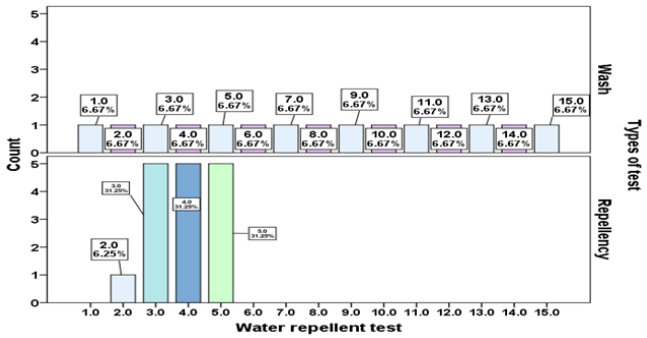
Source: Author

Figure 3: Graphical compression of wash fastness test values of water repellent fabric with standard best value

From the table 2 and figure 3, the wash fastness values of the water repellent fabric for reusable pad, for change in color and staining in color of water repellent fabric with standard test value of the fabric have p-value is 0.016and 0.034 for both case it is less than standard p-value = 0.05 and also the lower and upper bound not contains zero value in their boundary. So it is significant. The standard best values is (i.e. Class 5 = No color transfer and staining). From figure-3 change in color and staining in color value 4.6 and 4.5 respectively this is near to standard test values (i.e. 5). Generally as the regard value shows that to color fastness it has a very good color transfer and staining resistance for repeated washing of water repellent fabric.

Water repellent

The water repellent of the fabric was determined by using by frequently washing for water repellent fabric by using ASTM D 3779 or using AATCC test method 22, standard spray testing machine for repellent and Auto-wash or launder meter for wash machine. The test results are recorded for 15 wash and 16 repellence tests were done. (Result is generated by SPSS –ANOVA table analysis methods).



Source: ***Author***

Figure 4: Repeated wash test mean value of water repellent fabric

From figure 4, the water repellent test type fabric was tested by using repeated washing and checking the fabric its repellency within each washing interval by using spray test and compare the result with internationally AATCC set photographic image value.

Internationally for water repellent types of fabric repellency test is enough four (4) laundry and five (5) repellent tests. In this case, if the product has results between ISO 3.5 to ISO 5 is best repellent.

Due to this, the mean value of water repellent test for 15 repeated wash and 16 spray test recorded values are (i.e. 5-ISO 5, 5-ISO 4, 5-ISO 3 and 1-ISO 2) is 3.875. It is approximately near to ISO 4. It indicates that when compare to internationally allowed range, it has 3 time resistance than allowed wash and repellency of the fabric. So it is excellent types of fabric to repellent water within 15 repeated laundries and 16 repellent.

Generally this types of fabric is most selective for reusable maxi pad, since it is slightly circulate air and reusable types of product is needs frequently wash in order to hygiene the menses and it has best resistance to hold the blood from leak for a long time.

5.2.2. Product tests include as per includes different international standard

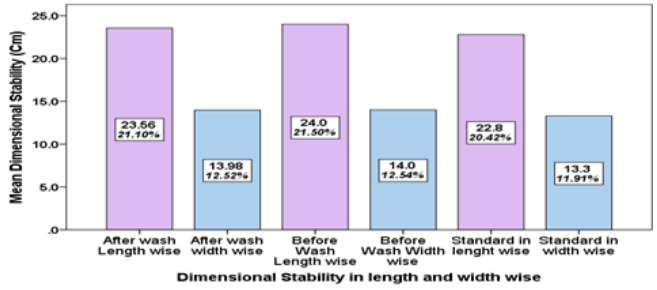
Dimensional stability and wash care

The Dimensional stability of the fabric was determined by using "Auto wash or laundro meter machine to wash the product" and was tested according to by ASTM Standards-D 2102, 1996. The test results are recorded for five specimens were taken. (Result is generated by SPSS –compare mean with graphical analysis] methods.

Table 3: Descriptive one-sample statistics mean of dimensional stability test for reusable pads product

Dimensional Stability in length and width wise	N	Mean	Std. Deviation	Std. Error Mean
After wash Length wise	5	23.560	.1949	.0872
After wash width wise	5	13.980	.0447	.0200
Before Wash Length wise	1	24.000	.	.
Before Wash Width wise	1	14.000	.	.
Standard Value (5% of Original result -is allowed) in length wise	1	22.800	.	.
Standard Value (5% of Original result -is allowed) in width wise	1	13.300	.	.

Source: ***Author***



Source: ***Author***

Figure 5: Graphical dimensional stability test mean compression of reusable pad materials

The dimension stability of the product before wash in length and width wise directions are 24cm and 14cm respectively, while table 3, the dimensional stability mean value of the reusable pad after wash in length wise and width wise values are 23.56cm and 13.98cm respectively, and the dimensional change in percentage is 1.833% in length wise and 0.143% in width wise direction, the allowable 5% tolerance of before wash in length wise and width wise are 22.8cm and 13.3cm respectively. This value was mean value of five wash of the product in length and width direction. From this observe, the product which changes in their dimensions are within five consequence machine wash has best resistance to change their shape. Since they have a difference five wash change mean with allowable standard value (i.e. 23.56-22.8 = 0.76cm) in length wise and (i.e. 13.98-13.3 = 0.68cm) in width wise direction is very small change especially in width wise it is very small (see table 3). Based on this result, the product has a good resistance to retain their shape from different repeated wash and it has good dimensional change, since it wears long time without changing this original shape.

Important specifications of a product (water carrying capacity)

- ✓ It carries 100ml of water for a longer time without any droplet.
- ✓ Form this study, Average blood loss during menstruation is 35 ml with 10-80ml considered normal (A. B Nyoni, 2014 sited in Wafawarova, P.., 2003).
- ✓ Natural women have menstruation cycle in permanent time that is once in a month is lasts for 3-7 day, average 5 day.
- ✓ To know daily blood flow, divided 35ml to five (35ml/5 = **7ml** per day),
- ✓ So the reusable pad carries capacity 100ml in average we can take 80ml.
- ✓ Due to this, it is not recommended, but even thought-out the day she use the pad, it has a capacity to carry the fluid without leak.

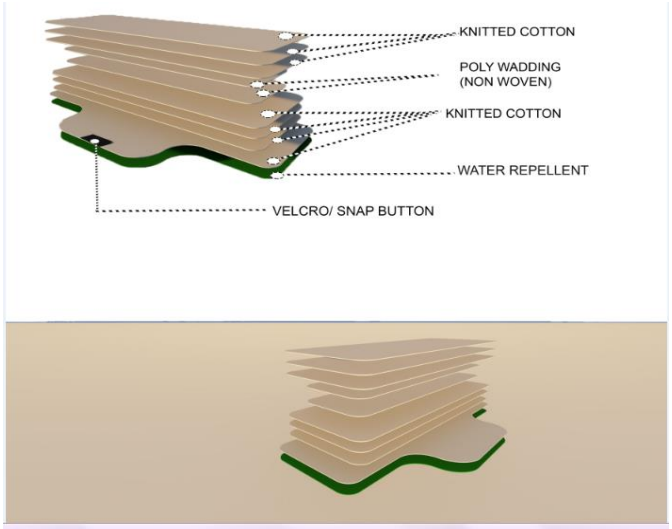
5.2.3. Re-usable maxi product design and developments

As mention in the previous explanation and based on need assessment survey the target of project mainly focused on design and development of pad with pad holder re-usable maxi pads for economical challenged peoples.

Product design and specification

- **Pad holder**
  - Dimension (24cm X 15.5cm), add 1cm allowance. It has two wings with snap button or Velcro. Two belts or a holder which is attached in both ends below 2cm from edge in order to hold the inserted absorbent pads. It has also two layers upper (white Knitted plain cotton) and lower (white water repellent fabric) layers.
- **Inserted absorbent Pad**
  - Dimension (22cm X 7.5cm). It has two white plain knitted cotton and sandwich two layer of poly wadding fabric at middle of knitted materials, finally insert to both belts in the pad holder parts.

3D model of pad with pad holder



Source: ***Author***

Figure 2: 3D model of pad with pad holder in different view

Actual products of reusable maxi pad with pad holder

Source: **Author**

Figure 3: Actual products of reusable maxi pad with pad holder in different view

Zip-lock (Ziploc) bag

When changing cloth menstrual pads away from home, some women place the soiled pads into a waterproof or Zip-lock bag to keep them from drying out and to contain or prevent odor and then wash the pads when convenient.

Source: **Author**

Figure 4: Zip-lock bag

Re-usable maxi pad product composition

Basically the final product has three basic different layers.

1. Upper layer: it is absorbent, comfort and it puts towards skin (i.e. white 100% knitted cotton)

2. Middle layer: using 100% knitted cotton fabric which used for mostly absorbent the blood and poly wadding fabrics, which used for resist stain than cotton and retain shape.

3. Lower layer: it is a lower layer of the pad which used for preventing the blood from leak; it is called water repellent fabrics.

-Snap Button: applied buttons in the pad wing free from zinc substance, since it is a harmful to the wearer.

Washing, care and sterilizations of the a re-usable maxi pad

1. After use the pad, rinse/ immerse and soak soiled pads in cold water before wash, with natural lemon juice for one hour. At this time the blood in the pad becomes sterilize and also desterilizing
2. Remove the soiled water and also use cold bleaching methods by using H_2O_2 (hydrogen peroxide).
3. Probability, use boiling water if it needs.
4. Wash by using detergent which has lemon- available in market.
5. Wash with clean cold water by regular hand washing to remove detergents and other impurities.
6. Wring and dry by using sunlight. The sun is also very effective at killing germs- hang your pads out in the sunlight for the day if you're worried about germs.
7. Properly fold the product and put it into Ziploc bags separately from other cloths.
8. After dry it, properly fold the product, use a zip-lock bag to carry pads when away from home in order to prevents from dirty, wet and infections and put it separately from other cloths.

VI. CONCLUSION

Considering the women's menstruation challenges, this research mainly focused on designing and developing feminine reusable maxi pads for economically challenged peoples, well supported by the line survey and also with different technical

tests of fabric and product in order to take extra care for women's health related problems. The product is developed with three different types of fabrics, forming three different layers of the product, which helps in the fulfillment of the objective of the women during menstruation cycle. The aim of the study is protecting rural area living women and girls from different health related issues, such as irritation, burning, attending class and works, cancer, infections which occur in the case of using normal cloths/ some disposable pads.

The unique features of this product is that, this is made from materials which is easily market available, cost affordable, environmental friendly, good absorbent, comfort, good water resistance/ repellence, high durability, has good tear strength, bursting strength, tensile strength, air permeability, dimensional stability, pH-value, washfastenes, carry lot of fluid capacity for long time etc. and many more features. And also it helps in minimize the absenteeism from education and working areas, will tend to increase women's competitiveness.

Deposable pad outer layers are plastic coated air circulation is completely zero, upper layer of the absorbent materials also has poor absorbent since, it is coated, so it creates suffocation, infection, cancer, irritations, and any hearth related problems. To reduce the above mention problems, use reusable maxi pad to reduce this severe pain and infections during menses.

Granted, reusable has a larger initial cost, but they last much, much longer. With proper care, cloth pads can last for years. Compare this to the disposable that has a lifespan of a few hours before it's thrown away, forcing you to buy more and more all of them ending up in a landfill. It saves 1,600 ETB in one year than disposable pads.

With the help of this new product, which is aimed at the middle class people/lower middle class people, gives a lot of benefits with respect to the cost and also takes care of the women's health with all the unique features.

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