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Redesigning Reusable Sanitary Pads Using The Human-Centered Design Model and Triple Bottom Line Strategy

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Abstract

Introduction: *In Sub-Saharan Africa, many women and girls lack access to adequate menstrual hygiene management (MHM) products, which negatively affects their participation in education, employment, and community development. Additionally, limited access to MHM products leads to diminished dignity and respect and increased discrimination and stigma.* **Objectives and Methodology:** *The Specific Objectives were to 1) Produce an improved, cost-effective reusable sanitary pad (HERS pad) using the Human-Centered Design (HCD) model, 2) Train women and girls in the production of the HERS pad as a sustainable social enterprise, using the Triple Bottom Line (Profit, People, Planet) Strategy, and 3) Evaluate the quality, cost and affordability, performance, and adoption of the HERS pad by target end-users. The study was conducted in two districts (Bulambuli and Butaleja) of Eastern Uganda. Four women groups were trained to produce the HERS pad, and 46 secondary schoolgirls assessed the quality, performance, and adoption of the HERS pad.* **Results:** *The HERS pad was developed from mostly sustainable, locally available, and affordable materials. This pad was cheaper, and it exhibited better properties in relation to comparable pads on the market in Uganda. Overall, there was a statistically significant difference in the favourable*

compared to the unfavourable rating of the quality and performance of the HERS pad. **Conclusion:** *The production of the HERS pad enabled participants to access an affordable, sustainable pad, to manage their menstrual hygiene with dignity in an environmentally friendly way. Despite the cultural barriers encountered in marketing the HERS pad, women were empowered to diversify into environmentally friendly production of an essential product and to reap some intangible social benefits.*

Key words: Human-centred design, menstrual hygiene management, reusable-pads, social entrepreneurship, triple bottom line, women empowerment

1.0 Introduction

In Sub-Saharan Africa (SSA), women and girls face challenges regarding their overall menstrual health and managing (MHM) their menstrual periods with dignity due to a lack of ready access to hygienic and cost-effective MHM products (Kuhlmann et al., 2017). Fundamental changes in access to menstrual hygiene management (MHM) products are needed to meet the needs of women and girls in this region. MHM products' key characteristics for women and girls include effectiveness, safety, discretion, sustainability, and affordability. Women and girls who use unhygienic alternatives for sanitary pads or tampons (such as newspapers, leaves, pieces of cloth, cow dung, and other materials) not only face health issues but also tend to miss work or school more frequently (World Bank Group, 2020).

Current literature suggests that women and girls in Low-and, Middle-Income Countries (LMIC), particularly in SSA, face significant MHM barriers (Bill and Melinda Gates, 2020). In Ethiopia, for example, only 28% of women and girls reported having "everything they need" to manage their menstruation. In 2020, data collected by Performance Monitoring for Action (PMA) from 8 countries estimated that 528 million women and girls lack what they need for basic MHM. Put differently, 72% of girls and women interviewed lacked basic needs for MHM. The physical, emotional, psychological, and socioeconomic impact of this problem on the advancement of girls and women who face this unavoidable cyclical plight is unimaginable. MHM challenges include but are not limited to social stigma, lack of clean water for basic hygiene, and ineffective, inadequate, or expensive products (Kuhlmann et al., 2017; Hennegan et al., 2019). Additionally, limited access to MHM products leads to diminished dignity

and respect and increased discrimination and stigma for many women and girls in LMIC throughout their reproductive life (Bill and Melinda Gates, 2020).

Previous faculty-led research in Uganda indicated that lack of access to MHM products negatively affected women and girls' ability to engage in educational, social, and economic activities (Lumutenga et al., 2017). Despite interventions applied through the low-skill production of reusable sanitary pads, MHM continued to negatively affect women and girls' participation in education and employment, community development, and, ultimately, society (World Bank Group, 2020; Tellier and Hyttel, 2018; Hennegan et al., 2021). Additionally, in 2019, the United Nations Population Fund (UNFPA) reported an association between inadequate access to MHM products and poorer physical and mental health outcomes. As a result, economic development in SSA countries where women are the primary producers lags far behind growth rates in other geographical regions (UNFPA, 2019). Therefore, placing women and girls at the centre of interventions for health and improved livelihoods significantly increases the chances of empowerment, with positive externalities and holistic socioeconomic development.

To mitigate the problem of access to MHM in East Africa, Higher Education Resource Services, East Africa (HERS-EA) (Khaitsa et al. 2017), a non-governmental organization advancing women in leadership and management, developed a reusable sanitary pad (Lumutenga et al., 2017). However, anecdotal data indicated that in comparison to existing products on the market, this pad was 1) more costly, 2) raised disposal challenges by filling up pit latrines, and 3) was stigmatized as being of a low quality. This study aimed to develop an appealing, affordable sanitary pad that is environmentally sustainable. **The specific objectives** were to: 1) Design an improved, ***cost-effective reusable sanitary pad*** (The HERS pad) using the Human-Centered Design (HCD), 2) Train women and girls in the production of the HERS pad as ***a sustainable social enterprise*** using the Triple Bottom Line Strategy and 3) Evaluate the *quality, affordability, performance, and adoption* of the HERS pad by target end-users.

Our conceptual framework was that the availability of a cost-effective reusable sanitary pad (the HERS pad) would increase access to pads for women and girls, thereby mitigating existing MHM problems. Additionally, training women and girls to produce sanitary pads as *a sustainable social enterprise* would improve their livelihood through increased income and other intangible benefits such as access to a social support system; and the *cost, quality, and performance* of the HERS pad would be comparable to existing pads in the market. The

Research questions were: 1) What is the role of HCD in establishing features of a profitable, sustainable, and scalable HERS pad? 2) What are the financial and social costs of producing a profitable HERS pad? and 3) Was the HERS pad cost, quality, and performance comparable to the alternative pads on the market?

1.1 Literature Review

1.1.1 Access to Menstrual Hygiene Management (MHM)

Studies among far-to-reach rural communities where girls and women are isolated (for example, in pastoral homesteads, homeless women, and women and girls who are internally displaced) have shown that these women not only lack access to sanitary napkins and underwear but do not have access to water (Muyaka, 2018; Goodson, 2020; Ayanda, 2021). Limited access to `menstrual health and managing (MHM) products leads to diminished dignity and respect and increased discrimination and social stigma for many women and girls living in low-and middle-income countries (LMIC) throughout their reproductive life (Bill and Melinda Gates, 2020). In addition to the lack of clean water for basic hygiene, there are ineffective, inadequate, or expensive MHM products (Kuhlmann et al., 2017; Hennegan et al., 2019; & Jones, 2016). Furthermore, this lack of access to MHM negatively affects their participation in education and employment and, ultimately, society (World Bank Group, 2020; Tellier and Hyttel, 2018). For example, a study conducted in 2012 estimated that girls miss up to 13% of school time due to a lack of MHM products and eventually may drop out of school (Tamiru, 2021).

1.1.2 Human-Centred Design (HCD) Model

The human-centered design (HCD) model is a creative approach to problem solving. The process begins with the people affected and results in new solutions that best suit their needs (IDEO, 2017). HCD seeks to understand humans through a conceptual framework to meet the end-user's needs, desires, and aspirations (Uebernickel et al., 2019). HCD starts with building a deep empathy for the end-users of the product or service to find new tailor-made solutions to suit their needs (IDEO, 2017).

HCD locates the human at the centre of the design decisions and involves all stakeholders to understand human-system interactions around new product ideas (Nhinda, 2014). HCD aims to stimulate the people working on a problem to seek solutions through techniques to communicate, interact, and empathize (Giacomin, 2014). HCD is part of a growing body of knowledge known as design

thinking, design-led innovation, or design-driven innovation (Giacomin, 2014). It has been used to define problems, generate solutions, and test them to improve the services and products.

The Human-Centered Design idea is that the researcher will better understand the needs of end-users by engaging them, beginning with open communication, and producing more innovative solutions to issues. This aspect further enables the HCD model to gain traction as one that *'humanizes'* the innovation process. Additionally, when users are involved in the process, they are more likely to embrace the results (IDEO, 2017). It is a framework that situates challenges and then creates novel solutions to address them (Baker & Moukhliss, 2020). It seeks to understand humans through a conceptual framework to meet further the end-user's needs, desires, and aspirations (Uebernickel et al., 2019). The HCD approach also aims to stimulate the people working on a problem to seek solutions through techniques to communicate, interact, and empathize (Giacomin, 2014).

Those who create, inform, and influence policies are often not the same people whose lives will be most affected by the policy, hence the suitability of applying the HCD approach for this study. HCD has been used to define problems, generate solutions, and test them to improve the services and products. Specifically, HCD has been used:

- to develop tools and strategies to optimize the implementation of a sexual and reproductive health intervention for young women with depression (Shrier, L. A. et al., 2020);
- as a lead to innovative education policies that are more effective, efficient, and equitable (Weeby, 2018),
- as a flexible yet disciplined approach to global health equity (Holeman, I., & Kane, D., 2020);
- to address complex and recalcitrant social and organizational challenges (Nandan et al., 2020); promote malaria testing and treatment (Yan et al., 2021); and
- to co-design comprehensive women's health screening tool with community partners (Foley et al., 2019).

The HCD model comprises three phases: Inspiration, Ideation, and Implementation.

1.1.3 Triple Bottom Line (TBL) (Profit, People, Planet) Strategy

The Triple Bottom Line (TBL) (Profit, People, Planet) Strategy was introduced by Elkington (1997), focusing on three performance indicators: economic (*profit)*, environmental (*planet*), and social (*people*). Elkington embedded intangible environmental and social costs into a product or a service's production process. The environmental cost refers to the use of natural resources, such as water and vegetation, with long-term impacts on people's livelihoods. This avoids negative impacts like pollution that can lead to diseases and reduce the well-being of communities.

Planet/Environmental: Research indicates that the textile and apparel industry is responsible for significant amounts of environmental hazards. Some researchers cite the textile and apparel industry as the greatest contributor to ecological harm, an estimated 80%-85% of textiles will end up in landfills (Kelley, 2017). It is estimated that the typical woman uses more than 11,000 feminine hygiene products in her lifetime (Global Health & Pharma, 2019). With increased global awareness of the production process's impacts, reusable pads keep many disposable products out of landfills. In a study by Van. et al. (2021) 4 to 25 reusable menstrual pads per period would be cheaper (170–417 US$) than 9–25 disposable pads, with waste savings of ~600–1600 single-use pads. Also, reusable pads do not contain the toxic chemicals that disposable pads seem to have that are not good for the body or the environment (Tiku, 2020).

Profit/Economic: The market for menstrual products was expected to be worth $42.7 billion by 2022 (Allied Market Research, 2016). It is expected that the women who make sanitary pads will continue to develop HERS pad as a social enterprise product with a sustainable financial profit. Their business and leadership skills, and financial literacy, are also expected to increase, supported by ongoing research in new areas, led by faculty in linked Higher Education Institutions and other collaborating partners.

People/Social: Social dimensions include equity, opportunity, and diversity and analyse how proceeds from a product or service are shared (Chaves et al., 2020). TBL offers a framework for organizations to develop their sustainable goals, which is critical in the textile industry. For instance, the UN’s 17 Sustainable Development Goals (SDGs) (Stone, 2017) can fall under the 3P's. An organization may not meet all SDGs but can create a competitive advantage by leveraging what works for them.

1.2 Methodology

The study utilized a mixed-methods approach, which involved the collection of both qualitative and quantitative data that was integrated to gain a deeper understanding of the research questions. The quantitative and qualitative data were combined in order to gain a richer understanding of the phenomenon being studied, as eluded by Thomson & Zhang (2020). Purposive sampling was used. This technique involves the researcher deliberately and purposefully selecting the study sample that they believe can be the most fruitful in answering the research question (Farrugia, 2019). Participants for this study lived nearby, so they were accessible and within the menstruation age group of (15-24) and willing to participate.

1.2.1 Study Area

The study area was Eastern Uganda, described in detail elsewhere (Lumutenga et al., 2017). Four women groups were trained to produce the HERS pad, and 46 secondary schoolgirls assessed the quality, performance, and adoption of the HERS pad.

1.2.2 Objectives of the Study

The study aimed to achieve three specific objectives:

- Objective 1: Design an improved, cost-effective reusable sanitary pad (The HERS pad), using the Human-Centred Design (HCD);
- Objective 2: Train women and girls in the production of the HERS pad as a sustainable social enterprise using the Triple Bottom Line Strategy (TBL);
- Objective 3: Evaluate the quality, performance, and adoption of the HERS pad by target end-users.

Objective 1: Design an improved, cost-effective reusable sanitary pad (The HERS pad) using the Human-Centered Design (HCD)

Objective 1 was addressed using the Human-Centered Design (HCD) framework, a creative approach to problem solving. The HCD was appropriate for this project because it engaged participants through four previously organized focus groups of women who served as co-creators of the sanitary pad. The study followed the three main phases of HCD: (a) Inspiration, (b) Ideation, and (c) Implementation (Figure 1).

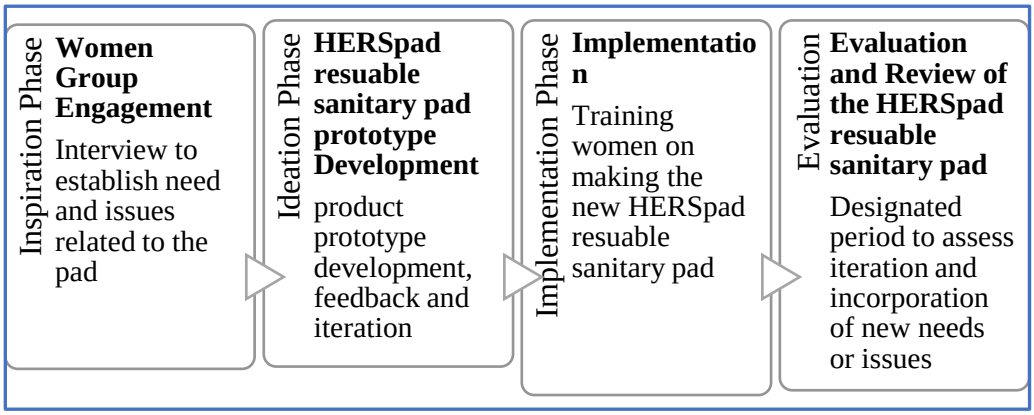

Figure 1: Human-Centered Design (HCD) Framework Adapted from the Human-Centered Design (HCD) available at www.designkit.org, n.d.

Inspiration phase*:* The Needs Assessment conducted previously by Lumutenga et al. (2017) had established that a group of women trained by a UK-based charity [African Village Support] had acquired skills in making affordable reusable sanitary pads. The women had also received organizational leadership training and seed money for initial equipment. However, there was a need to redesign and improve the pad's quality, performance, and packaging.

During the Inspiration phase, focus group interviews were conducted with the four women groups to identify the original pad's needs and issues. The interviews also evaluated other factors, including but not limited to family support and community support, that impacted the pad's use and sale.

Ideation phase: During the ideation phase a prototype of the HERS pad was developed based on results from the inspiration phase and available resources. The prototype was tested, revised, and refined through multiple iterations. Each of the four women groups had their leader trained on how to make the improved HERS pad. These trainers then trained the women in their groups on how to make the HERS pad.

Implementation phase: During the implementation phase, the prototype was provided to the women groups for mass production with technical oversight.

Objective 2: Train women and girls in the production of the HERS pad as a sustainable social enterprise using the Triple Bottom Line Strategy (TBL)

The Triple Bottom Line (TBL) strategy is a sustainability construct that uses 3Ps (Profit, People, and the Planet) to measure an enterprise's economic, social, and environmental impact (Figure 2). The approach involved educating women and girls on framing HERS pad social enterprise around the 3P's (Profit, People, and the Planet). In the HERS pad case, designing a reusable sanitary pad

addressed not only MHM issues (social/people) but also planet (environmental) and economic (profit). The women and girls were educated to frame HERS pad as a social enterprise to provide a sustainable source of income. The social entrepreneurial skills acquired could be transferred to other activities or products.

Profit/Economic: Women were trained in record keeping and a simplified product development costing model to ensure profitability, sustainability, and scalability of the HERS pad as a social enterprise (Figure 2). This training was expected to provide transferable financial literacy, build livelihoods, and provide job opportunities for women, enabling them to contribute meaningfully to social change in their communities. The women were expected to use and sell the pads, thereby increasing income and empowering themselves financially.

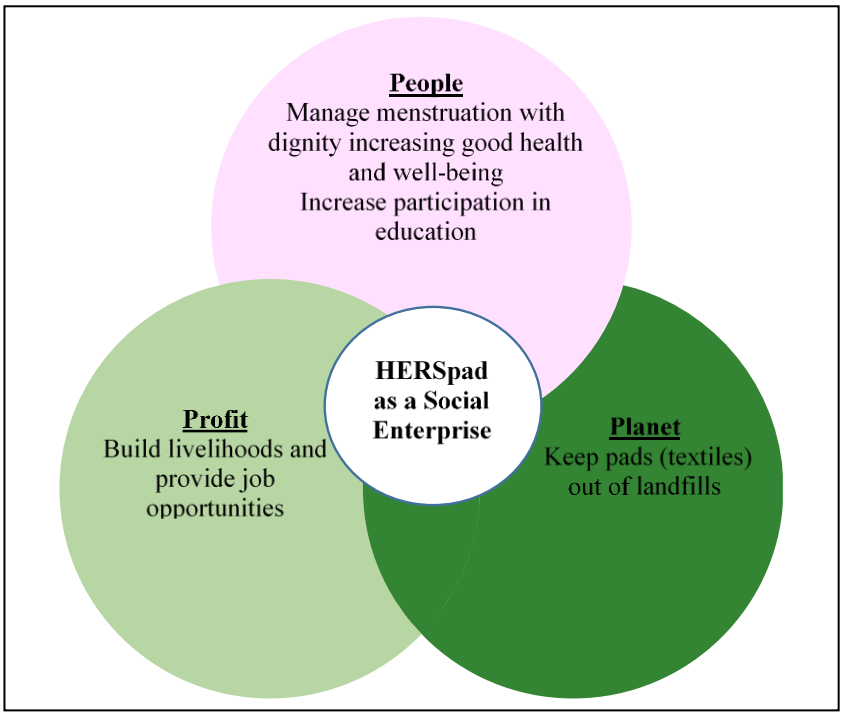

Figure 2: Triple Bottom Line (TBL) strategy

Source: Adapted from Triple Bottom Line Strategy

People/Social: The people in this study were the grassroots women and girls in rural communities that developed a reusable sanitary pad to manage their menstruation with dignity and in an affordable, sustainable, and environmentally friendly way. The HCD model provided a framework to redesign HERS pad with the women and girls in the communities and to understand deeply the actual rather than presumed needs as mentioned in the inspiration phase. Access to reusable sanitary pads was expected to contribute to keeping girls in school during

menstruation and enable women who were previously outside the market for unaffordable disposable pads to manage their menstrual periods with dignity.

Planet/Environmental: Women produced reusable pads from mainly cotton fabrics (washable up to one year), which helped keep the pads (textiles) from filling the pit latrines and landfills. Also, the HERS pad did not contain toxic chemicals that disposable pads have been reported to have (Tiku, 2020). By incorporating the planet/environmental initiatives into the production process, the women and girls thoughtfully considered the HERS pad product's life cycle, focusing on use and post-consumption (Aakko & Koskennurmi-Sivonen, 2013; Goworek et al., 2020). Waste disposal policies and guidelines for MHM products are limited in Low-and-Middle-income countries (LMIC) (Elledge et al., 2018). Disposal of pads in pit latrines causes the pit to fill up rapidly, exacerbating existing disposal challenges. Clogging pit latrines was a factor in resisting the use of some sanitary products. MHM products that are not biodegradable block drains and fill pit latrines. HERS pad is an ethical alternative that is reusable and that will evolve to keep textiles out of the landfill.

Objective 3: Evaluate the quality, performance, and adoption of the HERS pad by target end-users.

Questionnaire Development: A comprehensive review of literature provided information pertaining to the variables being studied. This information was used to develop a survey. A pilot study was conducted to ensure questions would better relate to HERS pad evaluation. The questions were grouped into five categories: Biographic data, Pad Quality, Reusability of the Pad, Cost of the Pad, and Comparison with current pads available on the market. An Institutional Review Board (IRB) approved the study.

Data Collection: A questionnaire was administered to 46 volunteer girls who were residents of a high school hostel located near one of the women groups making the HERS pad. These girls were selected based on the participant's proximity to their menstrual cycle and represented one category of HERS pad end-users. The leader (matron to the girls) administered the questionnaires to minimize bias. The inclusion criteria comprised any girl/woman at the target school who had started her menstrual cycle and was willing to participate in the study. Also, most of the girls had used the original HERS pad (donated to them by the matron) before it was refined.

Data Analysis: Data were transferred from questionnaires to an excel spreadsheet. Descriptive statistics of respondents and pad information were computed using SAS® 9.4. A Chi-square test of proportions was used to evaluate

if there was a significant difference in the proportion of girls who responded favourably compared to those who did not respond favourably to questions evaluating the HERS pad on quality, cost, performance, and comparison of the HERS pad to alternative pads available on the market.

1.2.3 Limitations of the Study

Whilst acknowledging the strides made by this study in developing a quality MHM product (the HERS pad) with good performance ratings, there were limitations. Firstly, a purposive sample was used to assess the quality performance and adoption of the HERS pad. Therefore, the study results should be interpreted with caution as they may not be generalized to all target end-users. Also, cultural taboos associated with menstruation, such as the stigma around promoting the pad were a limitation to developing the HERS pad as a profitable enterprise. It is necessary to address these cultural taboos to ensure broader adoption as the HERS pad offers a cost-effective, good quality, and environmentally friendly MHM option.

2.0 Results and Discussion

Data was obtained and collated for each stage in the achievement of the three objectives, which will be presented and discussed next.

2.1 Objective 1: Redesign an Improved Reusable Sanitary Pad (The HERS pad) Using the Human-Centered Design (HCD)

2.1.1 The Inspiration Phase

Results of the focus group interviews identified the following needs and issues of the original pad: 1) the pad was too short, less than eight inches long hence prone to leaks; 2) the pads were not thick enough, exacerbating leaking; 3) the pads used Velcro as a fastener, which picked lint and other particles risking lint build-up; 4) the pad had two parts, the pad and pad holder, which was inconvenient in terms of usability; 5) the waterproof material was weak hence it would tear after few washes; 6) the packaging was unattractive; 7) there were no use and care instructions; and, 8) the pad did not have a brand name hence it was difficult to market the product.

2.1.2 Ideation Phase

To develop understanding beyond statistical data, the women groups were engaged in a focus group discussion about the properties of the new HERS pad. Based on feedback from the inspiration phase, the HERS pad was developed with

the following features: 1) a longer size of 10 inches; 2) increased thickness by adding absorbent fabric; 3) snaps were used as fasteners instead of Velcro; 4) a single pad instead of the two-part pad that required a holder, was created; 5) a stronger waterproof material replaced the weaker material; 6) a more durable and aesthetically pleasing bag was developed for packaging; 7) A *Use and Care Instructions* sheet was created and added to every bag thereby also complying with The Uganda Bureau of Standards rule and the Federal Trade Commission (FTC) Care Labelling Rule and 8) The HERS pad brand name was created. Figure 3 illustrates the pad and bag.

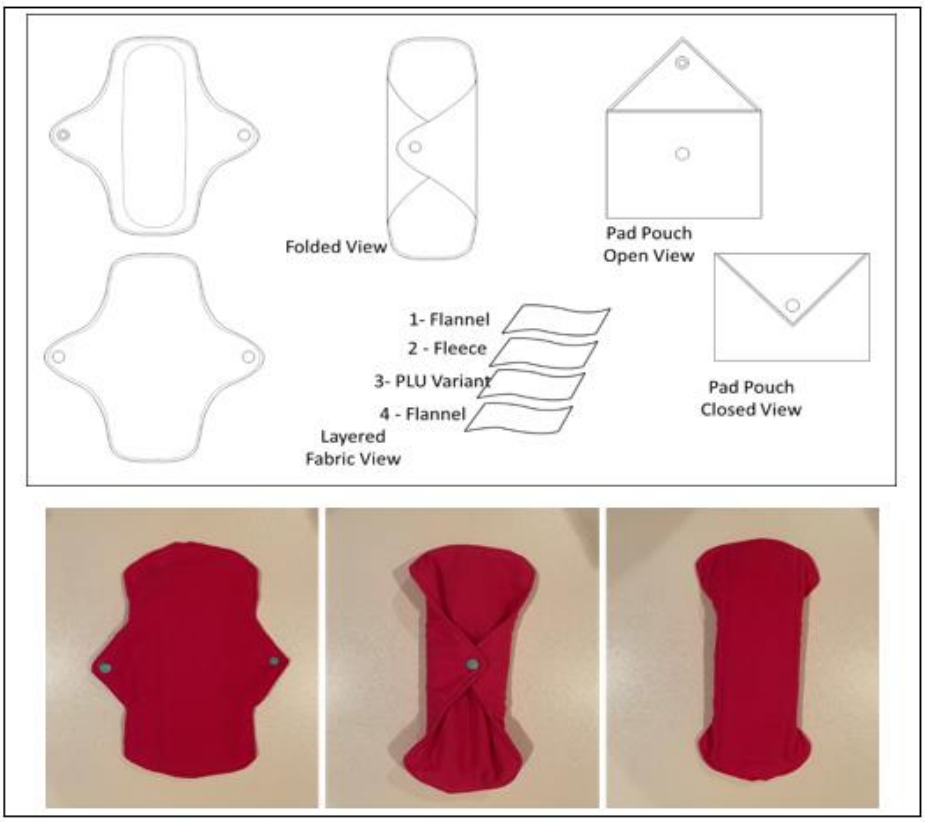

Figure 3: Photos of the HERS pad (Illustrated by Rachel Woodward, Mississippi State University)

Figure 3: Photos of the HERS pad

2.1.3 Implementation Phase

Four women leaders were selected from each group and trained to make the improved reusable HERS pad (Figure 4). These women trainers trained the rest of the women in their groups. Additionally, technical explanation was provided

to help the women to understand why each fabric was used. Research was conducted on available reusable pads on the market, such as *Afripads, Cozy Cloth, SoSure,* and *Mariam Seba,* to assess competitiveness. Based on this research and the ideation phase, the pad design and components were adapted to make the improved pad, using locally sourced materials:

1) *Topper Fabric:* This fabric goes against the skin. ***Flannel*** made out of cotton was used as it is soft, absorbent, cheap, and biodegradable;
2) *Core fabric:* This fabric provides the main absorbency of the pad. ***Fleece*** made from cotton was used as it is absorbent, cheap, and biodegradable;
3) *Waterproof fabric:* A variant ***PUL fabric*** available locally was used. Previously, a baby mat fabric had been used, however, it was much weaker and had fallen apart with a few washes;
4) *Backing fabric:* This fabric touches the underpants. ***Flannel,*** same as the topper fabric, was used;
5) *Fastening:* **Snaps** were used as they were easy to attach and more hygienic than Velcro.

Table 1: Care and Use Instructions for the HERS pad

Care and Use Instructions for the HERS pad	
Dos	**Don'ts**
Wear: Place the pad into the underwear and snap the wings around the pant. The stitched side should face up.	Don't **bleach** to clean the pads.
Soak: After using the pads, soak in cold water with soap or detergent for 10 minutes.	Don't use **hot water** as it will set stains.
Wash: After soaking, pour the dirty water and wash the pad in clean water with soap or detergent. Rinse with clean water. If you cannot wash the pad immediately, put it in the leak-proof bag.	Don't **iron** since this will harm the layers inside the pad.
Dry: Dry the pad in direct sunlight for about 2 hours, this will help sterilize and remove stains. Allow to dry completely before reusing.	Don't **share** your pad with anyone.

Figure 4: Photos of Women making the HERS pad

2.2 Objective 2: Train Women and Girls in the Production of the HERS pad as a Sustainable Social Enterprise Using the Triple Bottom Line (TBL) Strategy

2.2.1 Profit/Economic

The women received two substantial orders for their pads. The first order, for 500 packets of sanitary pads, was made by the Uganda National Medical Stores for distribution to girls and women living in Internally Displaced Persons (IDP) camps. Landslides in the neighbouring district displaced these women. The second one was the sale of 200 packets distributed to women and girls during the International Women's Day celebration. However, in general, the women experienced difficulty selling pads, increasing their income, and running HERS pad as a profitable, sustainable enterprise, despite the training they had received.

The challenges experienced included: cultural taboos of discussing the need for pads and general MHM freely between women and male counterparts who hold the financial and decision-making power, lack of a marketing strategy, lack of scaling beyond personal use, and competing family priorities and demands on women's time. Some of the groups were stuck with an unsold stock of sanitary

pads, so they needed to become more versatile with their newly learned sewing skill.

Two groups diversified their products to include additional tailoring activities such as bags, bitengi (dresses), gomesi (traditional Ugandan dress), and school uniforms. New crafts were introduced to include weaving mats and crocheting tablecloths. They also engaged in rearing poultry and rabbits for food and income generation. Regardless of the challenges encountered in selling sanitary pads, the women felt empowered and energized by their achievements. Additionally, they were able to use the HERS pad for their MHM as indicated by the following testimonies: *(transcripts from video recording),*

1) ***Student aged 16,*** *'I used to really worry about getting to school when my periods were approaching, now it is nice to know that I can buy cheaper reusable pads (and some of my friends), which last a long time*.'

2) ***Student aged 17,*** *'These new pads are nice, I can wash and hang them outside to dry, and no one knows what they are; even the bag is nice, I can use it as a toilet bag*.'

2.2.2 Pad Production

Cost Analysis*:* The total cost of production for one HERS pad was approximately $1.00, and the bag was approximately $.40, as shown in Table1. The pads were sold as a pack of three to enable one to wear one pad while the second one was drying and the third serving as a spare, and the bag was reusable. The three pads' total cost was approximately $3.00, and they lasted at least a year. Generally, most women spent $3.50/ month for commercially available disposable pads, which amounted to about $42 per year. In comparison, the HERS pad was much cheaper than the cheapest disposable sanitary pads sold on the market.

People/Social: Results indicated that the HERS pad enterprise led to positive externalities by contributing to the empowerment of women belonging to these groups in other unanticipated social ways. For instance, participants in the HERS pad project supported each other in discussing and raising awareness of gender-based violence and emotional support during bereavement.

Planet/Environmental: Women used locally sourced materials to produce reusable pads (washable for up to one year), which helped keep the pads (textiles) from filling pit latrines and the landfills.

Table 2: Production Costs for One HERS pad and Packaging Bag

Details **Fabrics per meter (39.37 inches)**	**UGX**	**US $: $1US ~ UGX 3654**
HERS pad		
Fleece	14,000.00	3.83
Flannel	8,000.00	2.19
Waterproof PUL variant fabric locally available	16,000.00	4.38
Snaps	200.00	0.05
Total per meter	38,200.00	10.45
~ cost per pad (One meter makes ~13)	2,938.46	0.80
Labor at 20% of total cost	587.69	0.16
Total per pad	**3,526.15**	**0.97**
Bag		
Cotton	6,000.00	1.64
waterproof (light also referred to as baby mat)	5,000.00	1.37
Snaps	100.00	0.03
Total per meter	11,100.00	3.04
~ cost per bag (One meter makes ~10)	1,110.00	0.30
Labor at 20% of total cost	333.00	0.09
Total per bag	**1,443.00**	**0.39**

2.3 Objective 3: Evaluate the Quality, Performance and Adoption of the HERS pad by Target End-Users

2.3.1 Demographic Characteristics of Respondents

A total of 46 secondary schoolgirls in a residential high school participated in the survey to assess the quality, performance, and adoption of the HERS pad. Most of the girls, 34/46 (73.9%), were from Bulambuli district, while the rest 12/46 (26.1%) girls came from 5 neighbouring districts. One girl (1; 2.2%) did not indicate her district of origin. Most girls were aged between 15 and 18 years (32; 69.7%) while (13; 28.3%) were between 18 and 24. Most girls started their first menstrual periods (menarche), at 15 (21; 45.6%) and 14 (12; 26.1%). The rest started at 11 at 11 (1; 2.2%), 13 (4; 8.7%) and 16 (4; 8.7%). Four girls (4; 8.7%) did not respond.

2.3.2 Quality, Performance, and Adoption of the HERS pad

Quantitative responses about the pad characteristics (quality, cost, reusability, and comparison with pads on the market) are summarized in Table 3. Additionally, in response to the question of whether to recommend the pad or not (36; that is 78%

of the girls) gave a positive response; the reasons to recommend it included: "Comfort", "More secure, strong", "Safer", "Don't cause symptoms", "Soft", "long time use", "Leak proof", "Takes shorter time to dry", "Reusable", "Easy to use", "Easy to maintain", "They are good", "Easy to wash", "Alternative to expensive one", "Cheap, affordable", "They keep blood for a long time", "They are durable", "Saves money", "They are cheap", "They don't itch", "They don't cause rash", "Easy to handle", "You can play with friends", "Easy to change", "Good quantity in the package", "They are easy to fasten with snaps", "Good absorbance", "Heat free", "Fits". One participant stated, “you could play with a friend,” This indicated that they were comfortable enough to have the freedom to go about their business. Only 7 (15%) of the girls provided the reasons for not recommending the pad, and they ranged from: "Everyone had the same pad", "They cause rashes", "They cause itch" and are "Too big". A total of 31 girls (67%) provided advice on how to make the pad better; they include: "Improve on its absorbency", "Make pads of different sizes", "Increase the number", "Change the colour e.g., red", "Make them soft", and "Improve fastening".

A total of 31 girls (67%) said they could afford the pad while 11 (24%) said they could not. Nine of the 11 girls provided the following reasons why they could not afford the pads: "I am still a student", "It is a bit expensive", "I don't have a lot of money", "Low cost of living", "Conditions at home". Thirty-one girls (69%) of the girls did not feel disgusted washing the pad. However, the 9 girls (20%) reported disgust washing the pad due to the following reasons: "Takes time to clean", "Stains do not get off completely", "It smells", "It does not dry faster", "It takes a lot of soap", "It leads to vomiting", "I fear touching blood", "It needs a lot of water to clean", "It needs attention when drying", "Looks dirty".

A total of 30 girls (65%) provided advice on improving the packaging of the HERS pad; these included: "Use somehow bigger packages", "Change the colour e.g., pink", "Put handles", "Use perfumes in packaging", and "Pack in non-cloth material". The most important factors to consider when choosing a sanitary pad were quality (22; 48%), price (21; 46%), packaging (9; 20%), availability (6; 13%), brand (6; 13%) and friend’s recommendation (5; 11%).

Table 3: Development of HERS pad: Pad characteristics

QUALITY OF THE PAD			
Variable	Frequency % (N)	Variable	Frequency % (N)
Length of Time Pad worn before changing		*Pad Leakage*	
1. ≤ 2 hours	28.3 (13)	1. Yes	34.8 (16)
2. 2-4 hours	41.3 (19)	2. No	63.0 (29)
3. 4-6 hours	23.9 (11)	3. No Response	2.2 (1)
4. 6-8 hours	4.4 (2)		
5. No Response	2.2 (1)		
Recommend Pad to Friend		*Pad Change at Night*	
1. Yes	80.4 (37)	1. None	47.8 (22)
2. No	15.2 (7)	2. Once	43.5 (20)
3. No Response	1.4 (37)	3. Twice	4.4 (2)
		4. No Response	4.4 (2)
Pad Comfort		*Ease to Wash*	
1. Poor	6.5 (3)	1. Poor	19.6 (9)
2. Fair	23.9 (11)	2. Fair	15.2 (7)
3. Average/Good	34.8 (16)	3. Average/Good	41.3 (19)
4. Excellent	30.4 (14)	4. Excellent	10.9 (5)
5. No Response	4.4 (2)	5. No Response	13.0 (6)
Pad Absorbency		*Pad Width*	
1. Poor	4.35 (2)	1. Poor	13.0 (6)
2. Fair	15.2 (7)	2. Fair	13.0 (6)
3. Average/Good	32.6 (15)	3. Average/Good	41.2 (19)
4. Excellent	30.4 (14)	4. Excellent	21.7 (10)
5. No Response	17.4 (8)	5. No Response	10.9 (5)
Ease to Use		*Pad Length*	
1. Poor	4.35 (2)	1. Poor	8.7 (4)
2. Fair	15.2 (7)	2. Fair	13.0 (6)
3. Average/Good	43.5 (20)	3. Average/Good	47.7 (21)
4. Excellent	28.3 (13)	4. Excellent	19.6 (9)
5. No Response	8.7 (4)	5. No Response	13.0 (6)
Pad Fastening (Ease of Fastening)		Pad Look	
1. Poor	4.35 (2)	1. Poor	2.2 (1)
2. Fair	19.6 (9)	2. Fair	17.4 (8)
3. Average/Good	26.1 (12)	3. Average/Good	28.2 (13)
4. Excellent	43.8 (20)	4. Excellent	34.8 (16)
5. No Response	6.5 (3)	5. No Response	17.4 (8)
Leak-Proof		Packaging	
1. Poor	8.7 (4)	1. Poor	2.2 (1)
2. Fair	15.2 (7)	2. Fair	15.2 (7)

3. Average/Good	28.2 (13)	3. Average/Good	34.8 (16)
4. Excellent	24.0 (11)	4. Excellent	45.7 (21)
5. No Response	23.4 (11)	5. No Response	2.2 (1)
REUSABILITY OF THE PAD			
Water Source		*Where to Dry the Pad*	
1. The river/stream / spring	8.7 (4)	1. Outside in the sun	71.1 (32)
2. From rainwater	8.7 (4)	2. In the bathroom	13.3 (6)
3. Tap in the house/ yard	78.3 (36)	3. In the bedroom	15.6 (7)
4. No response	4.4 (2)	4. No response	2.2 (1)
Time to Dry the Pad		*Feel Disgusted Washing the Pad*	
1. 2 hours	30.4 (14)	1. Yes	28.9 (13)
2. Half a day	28.3 (13)	2. No	68.9 (31)
3. Full day	34.7(16)	3. No Response	4.4 (2)
4. More than a day	4.4 (2)		
5. No Response	2.2 (1)		
COST OF THE PAD			
Affordability of HERS pad		*Monthly Cost on Pads*	
1. Yes	67.4 (31)	1. UGX3500 and below	78.2 (36)
2. No	23.9 (11)	2. Above UGX3500	10.9 (5)
3. No Response	8.7 (4)	3. No response	10.9 (5)
ALTERNATIVE PAD OPTIONS			
What Do You Normally Use		*How Often You Switch*	
1. Cloth/Towel	23.9 (11)	Frequently	36.7 (17)
2. Purchased sanitary pad	67.4 (31)	Occasionally	26.0 (12)
3. No Response	8.7 (4)	Never	6.5 (3)
		No Response	30.4 (14)
Likelihood for Alternative Pads			
1. Likely	50.0 (23)		
2. Not very likely	41.3 (19)		
3. No Response	8.7 (4)		

2.3.3 Chi-square Test of Proportions

Results of the Chi-square test of proportions to evaluate if there was a significant difference in the proportion of girls and women who responded favourably compared to those who did not respond favourably to questions evaluating the HERS pad (quality, cost, performance, and comparison to alternatives on the market) are summarized in Table 4. Overall, there was a statistically significant difference (P<0.0001) in the proportion of girls who responded favourably compared to those who did not to the following qualities of the HERS pad (Comfort, absorbency, Easy to use, ease of fastening, leak-proof, length, width, look, and packaging quality).

Likewise, there was a statistically significant difference (P<0.0001) in the proportion of girls who said they would recommend the pad to a friend due to: *Easy to Use, Leak proof, and Secure* compared to those who did not (Table 4). Also, only 13; 28.3% of the girls said they felt disgusted using this pad compared to 31; 67.4% who said that they were not; and this difference was statistically significant (P<0.00015). The response to the following qualities of the pad were not favourable: Easy to wash; recommend the pad to a friend due to comfort, and long-term use. The difference in the proportion of girls who ranked the HERS pad as easy to wash (26; 65%) compared to those who did not (14; 35%) was not statistically significant (P= 0.0578). Likewise, the difference in the proportion of girls who said they'd recommend the HERS pad based on comfort (13; 28.3%) compared to those who did not (22; 47.8%) was not statistically significant (P=0.0159). Also, the difference in the proportion of girls who said they would recommend the HERS pad based on its long-term use (21; 45.7%) compared to those who did not (15; 32.6%) was not statistically significant (P = 0.1383) (Table 4).

Table 4: Characteristics of HERS pad: Chi-square Test of Proportions

Variable	Frequency % (N)	P-value
QUALITY OF THE PAD		
Length of Time Pad worn before changing		
≤ 4 hours	69.6 (32)	P<0.0001
≥ 4 hours	41.3(13)	
No Response	2.2 (1)	
Pad Leakage		
Yes	34.8 (16)	P<0.0001
No	63.0 (29)	
No Response	2.2 (1)	

Pad Change at Night		
None	47.8 (22)	P<0.0001
Once	43.5 (20)	
Twice	4.4 (2)	
No Response	4.4 (2)	
Recommend Pad to Friend		
Yes	80.4(37)	P<0.0001
No	15.2 (7)	
No Response	4.4 (2)	
Comfort listed as a reason to Recommend Pad		
Yes	28.3 (13)	P= 0.0876
No	47.8 (22)	
No Response	23.9 (11)	
Ease to Use listed as a reason to Recommend Pad		
Yes	23.9 (11)	P=0.0102
No	54.4 (25)	
No Response	21.7 (10)	
Ease to Wash listed as a reason to Recommend Pad		
Yes	15.2 (7))	P<0.0001
No	63.0 (29)	
No Response	21.7 (10)	
Leak Proof listed as a reason to Recommend Pad		
Yes	13.0 (6)	P<0.0001
No	65.2 (30)	
No Response	21.7 (10)	
Long-time Use listed as a reason to Recommend Pad		
Yes	45.7 (21)	P = 0.1383
No	32.6 (15)	
No Response	21.7 (10)	
'Secure' listed as a reason to Recommend Pad		
Yes	8.7 (4)	P< 0. 0001
No	69.6 (32)	
No Response	21.7 (10)	
Pad Comfort		
Poor/Fair	30.4 (14)	P=0.0159
Average/Good/Excellent	65.2 (30)	

No Response	4.4 (2)	
Pad Absorbency		
Poor/Fair	19.55 (9)	P< 0.0001
Average/Good/Excellent	63.0 (29)	
No Response	17.4 (8)	
Ease to Use		
Poor/Fair	19.55 (9)	P< 0.0001
Average/Good/Excellent	71.8 (33)	
No Response	8.7 (4)	
Ease to Wash		
Poor/Fair	34.8 (16)	P= 0.0578
Average/Good/Excellent	52.2 (24)	
No Response	13.0 (6)	
Pad Width		
Poor/Fair	26.0 (12)	P< 0.0001
Average/Good/Excellent	62.9 (29)	
No Response	10.9 (5)	
Pad Length		
Poor/Fair	21.7 (10)	P=0.0016
Average/Good/Excellent	67.3 (30)	
No Response	13.0 (6)	
Pad Fastening (Ease of Fastening)		
Poor/Fair	23.95 (11)	P=0.0014
Average/Good/Excellent	69.9 (32)	
No Response	6.5 (3)	
Pad Look		
Poor/Fair	19.6 (9)	P=0.0012
Average/Good/Excellent	63.0 (29)	
No Response	17.4 (8)	
Leak-Proof		
Poor/Fair	23.95 (11)	P=0.0164
Average/Good/Excellent	52.2 (24)	
No Response	23.95 (11)	
Packaging		
Poor/Fair	17.4 (8)	P< 0.0001
Average/Good/Excellent	63.0 (29)	
No Response	19.6 (9)	
REUSABILITY OF PAD		
Water Source		
River/stream/spring/rain	26.1 (12)	P< 0.0001
Tap water (in house/in yard)	78.3 (36)	

No response	4.4 (2)	
Time to Dry the Pad		
2 hours/ Half a day	58.7 (27)	P< 0.0001
Full day/ > a day	39.1 (18)	
No Response	2.2 (1)	
Where to Dry the Pad		
Outside house in the sun	71.1 (32)	P< 0.0001
In the bathroom/Bedroom	28.9 (13)	
No response	2.2 (1)	
Feel Disgusted Washing the Pad		
Yes	28.9 (13)	P< 0.0001
No	68.9 (31)	
No Response	4.4 (2)	
COST OF THE PAD		
Affordability of HERS pad		
Yes	67.4 (31)	P< 0.0001
No	23.9 (11)	
No Response	8.7 (4)	
ALTERNATIVE PAD OPTIONS		
What Do You Normally Use		
Cloth/Towel	23.9 (11)	P< 0.0001
Purchased sanitary pad	67.4 (31)	
No Response	8.7 (4)	
How Often You Switch Brands		
Frequently	30.4 (14)	P=0.0236
Occasionally /Never	62.7 (29)	
No Response	6.5 (3)	
Likelihood for Alternative Pads		
Likely	50.0 (23)	P=0.5371
Not very likely	41.3 (19)	
No Response	8.7 (4)	

2.4 Discussion of the Results

The HCD model provided a framework to redesign HERS pad with the women and girls in the communities and deeply to understand "actual" needs rather than their "assumed" needs. HCD has been gaining popularity as an approach towards tackling today's innovation challenges; it is part of a growing body of knowledge known as design thinking, design-led innovation, or design-driven innovation (Van der Bijl-Brouwer & Dorst, 2017). This project initially aimed at generating ideas to address reasons why the original pad had not progressed, with sales grounding to a halt and the group of women close to abandoning the project.

Mississippi State University (MSU) provided initial support through seed money for equipment and materials, since the women had prior sewing skills, supported by African Village Support (AVS). The HERS-EA team had been driven by the need to implement the multi-tier model (Khaitsa et al, 2017), in this case, by developing the leadership skills of women at grassroots level and intervening with returning learners, by addressing MHM to help keep girls in school. The HCD model was appropriate because, it engaged participants as co-creators of the product, an aspect that further enabled HCD to gain traction as a model that 'humanises' the innovation process (Van der Bijli-Brouwer & Dorst, 2017).

Data collected from participants suggest that their engagement helped generate and rate the product as more favourable. Overall, there was a statistically significant difference ($P<0.0001$) in the proportion of girls who responded favourably compared to those who did not, to the following qualities of the HERS pad (comfort, absorbency, easy to use, ease of fastening, leakproof; length, width look, and packaging quality) (Tables 2 and 3). Likewise, there was a statistically significant difference ($P<0.0001$) in the proportion of girls who said they would recommend the pad to a friend. Qualitative evaluation from testimonies further indicated that the women were empowered and felt valued, especially the group leaders who were subsequently trained to become trainers. The remainder became aspirational, with leaders to look up to.

The emerging organizational structures inspired shared responsibility for the production and sales processes, with record-keeping becoming the norm. Various members could talk about what they were making, and they developed the capacity to analyse what was working well (for example, sewing) and what needed better planning (for example, monitoring inputs and tracking sales by groups/individual schoolgirls and institutions with male compared to female leaders). HCD aims to produce useful, usable, pleasant, and meaningful products or services for people (Van der Bijl-Brouwer & Dorst, 2017). Participants spoke with pride about the new HERS pad, affirmed by the order received from a national institution, the Uganda Medical Stores. However, other problems emerged that required further design work. While the HERS pad was much improved, the women's skills remained rudimentary, thus unable to match the pristine products made by established companies like *Afripad*. There is a need to streamline the production process with embedded quality control to be consistent. The participants know what a pristine pad looks like, and they believe they have the skills to make them, but the cost of new equipment and sustained source of inputs remain a challenge.

The Triple Bottom Line (TBL) was adopted as a valuable social enterprise approach to alleviating women's poverty through the development of the HERS pad. In its most basic form, the term social enterprise reflects a model that is part *profit (economic)* and part *social (people)* (Alter, 2007). Elkington (1997) introduced the concept of TBL, focusing on three performance indicators: economic, environmental, and social. Building on traditional business models that focused on financial profitability, Elkington (1997) embedded intangible environmental and social costs into a product or a service's production process. The environmental cost refers to the use of natural resources, such as water and vegetation, with a long-term impact on other people's livelihoods, outside the business. Social costs include pollution that can lead to diseases and a reduction in the well-being of communities. Social dimensions include equity, opportunity, and diversity (Chaves et al., 2020). In 2018 Elkington revised his study and indicated that TBL could not be achieved without breakthrough change and disruption of existing models and scaling of next-generation markets. The HERS pad is evolving towards sustainability, applying the Triple Bottom Line (TBL) construct by exploring collaborative research with chemical engineers and companies that use large quantities of plant fibres to make textiles. Other avenues include research into using biodegradable papyrus and waste products from sugarcane and banana industries in East Africa. Inclusivity is catered for by employing women who are among the most marginalized groups in the community, especially those who head their households (Van de Walle et al., 2017).

A social enterprise is enveloped in ideas of innovation, creativity, and resourcefulness with the main objective to reduce poverty and social exclusion through the creation of jobs for those who are left out of the dominant economic system and by empowering marginalized people towards their own individual and community socioeconomic success (Noya & Clarence, 2007).

2.4.1 Profit/Economic

The market for menstrual products was expected to be worth $42.7 billion by 2022 (Allied Market Research, 2016). However, women who participated in this study experienced difficulty selling and distributing pads widely in their communities for various reasons. Although a pack of three HERS pads costs about $3 to produce, it is a sum that can be a choice between buying home basics like soap or kerosine for the lantern and buying sanitary pads. A recent study conducted in a neighbouring [district] (Kennedy & Severe, 2020) concluded that period poverty remains a key barrier to accessing sanitary pads for school-age

girls. Cultural barriers and taboos associated with menstruation, combined with an overall culture of silence around the topic, played a significant role, particularly regarding speaking openly about pads to men, many of whom dominated the local market. Gender inequality across developing and developed countries result in greater poverty among women, exacerbating rural SSA countries. When 2015 was crowned as "the year of the period," people started deeper conversations about gender equality and social change through women's periods (Jones, 2016). Also, challenging the harmful beliefs that menstruation is dirty and shameful will contribute towards eradicating "period poverty" (Weiss-Wolf, 2019; Mohammed & Larsen-Reindorf, 2020).

2.4.2 Planet/Environmental

By incorporating the planet/environmental initiatives into the production process, the women and girls thoughtfully considered the HERS pad product's life cycle, focusing on use and post-consumption (Aakko & Koskennurmi-Sivonen, 2013; Goworek et al., 2018). Waste disposal policies and guidelines for MHM products are quite limited in SSA (Kjellén et al., 2012).

2.4.3 People/Social

The production of HERS pad enabled these women to manage their menstrual hygiene with dignity and in an affordable, sustainable, and environmentally friendly way. Additionally, even if women encountered cultural barriers in selling the HERS pad, women were empowered to think outside the box and engage in diversified products.

The data in this study suggested that the cost, quality, and performance of the HERS pad was comparable to existing pads in the market. Overall, there was a statistically significant difference in the rating of the quality and performance of the HERS pad with 84% of the girls saying that they'd recommend the pad to a friend compared to 16% who said they would not. Of the top reasons for recommending the pad, long-time use was the only variable with a higher percentage of girls (46%) that cited it than those who did not (33%). Although this difference was not statistically significant, this finding was notable because long term use was a critical variable for the HERS pad. It is probable that more girls would have responded positively had we not phrased this question in an open-ended manner. Despite the existing taboo or shaming surrounding the issue of washing sanitary pads 52% of the girls said that the HERS pad was average, good, or excellent regarding ease to wash. It is possible that this was because the majority (78%) of the girls had access to tap water (in house/in yard) at school.

Access to water could have explained why most girls (69%) said they were not disgusted with washing the HERS pad. It is important to note that access to tap water is not widespread in many rural areas, so this finding may not apply to other target end users.

It was notable that the majority (71%) of the girls dried the pads outside the house in the sun and that most girls (59%) reported that the pads dried within 2 hours to half a day. This is a significant finding given the taboo around display of pads in public (Crofts & Fisher, 2012) It is possible that this was due to the fact that all respondents were from an all-girls' residential school hence the stigma was minimal. Also, although 63% of the girls reported that they occasionally or never switch pad brands, 30% said they frequently switch brands with 50% open to alternative pads. This implies that the market for HERS pad exists if promoted appropriately, given that most girls (67%) said they could afford the redesigned HERS pad, and 67% purchased sanitary pads for their MHM.

The testimonials and quantitative data generated suggested that there was a significant difference in the proportion of girls and women who responded favourably to most of the qualities of the design of the HERS pad that we assessed (quality, cost, performance, and comparison to alternative pads on the market) compared to those who did not. However, some results (such as easy to use, recommendation of the pad due to comfort, and long-time use) revealed the continuous need for MHM product development. Despite some achieved strides in addressing MHM issues, these results support previous studies that indicate that MHM is a critical issue in LMICs that still needs researchers and practitioners to continuously work collaboratively, to provide holistic solutions. For instance, Hennegan et al. (2019) undertook systematic searching to identify qualitative studies of women's and girls' menstruation experiences in 35 LMICs; results indicated sociocultural economic environment, and resource limitations underlay inadequate access to affordable menstrual materials. Additionally, United Nations Children's Fund (UNICEF, 2019) suggests that millions of women and girls worldwide are denied the right to manage their monthly menstruation in a dignified, healthy way and suggests a holistic approach in the context of human rights and gender equality. Conclusions of this study, summed up in the next section suggest that being able to manage menstruation safely, hygienically, with confidence and dignity is critical not just for women and girls' health and education but for economic development and overall gender equality.

3.0 Conclusion

The pad's quality improved significantly, and most participants in the study valued the product quality. This research directly addressed the 3P's (People, Planet, and Profit). This addressed the first research question, what is the role of HCD in establishing features of a profitable, sustainable, and scalable HERS pad? In answering the question, what are the financial and social costs of producing a profitable HERS pad? More resources were needed to improve the enterprise's marketing and scaling up in more districts to produce and market the pad as a profitable, sustainable enterprise.

The majority of the girls rated the HERS pad performance as average, good, and excellent, and that they'd recommend the pad to a friend. Many girls liked the pad's several qualities, such as cost-effectiveness, reusability, and pad's longevity. However, several challenges remained including: 1) stigma from washing and drying of the pad, 2) affordability, and 3) versatility to address variable flows. This addressed the question, was the HERS pad cost, quality, and performance comparable to the alternative pads on the market?

HCD was critical in valuing and amplifying the voices, viewpoints, and varied backgrounds of the girls and women in the community. The HCD framework, in this case, aligned well with HERS-EA multi-tier model, that connects women researchers in the top tier, to their counterparts in other tiers. The researchers developed scholarly skills for teaching, and they produced publications to support their professional and institutional development. At the same time, women and girls in the community benefited from increased awareness of the plight of MHM.

4.0 Recommendations

- Further research into competitor products to understand their business models might provide some lessons for the HERS pad to be produced as a profitable social enterprise. Also, future research could be extended to include a wider age group and women and girls from other socioeconomic backgrounds.
- Future research could focus on developing an affordable MHH product that can be kept discreet in the absence of clean water supply and does not require immediate washing.
- Additionally, a wider network of fabric and trim manufacturers and vendors is needed for the HERS pad producer to source environmentally friendly

fabrics and trims. Currently, fabric manufacturers are trending toward producing environmentally friendly fabrics and trims (TEXFAD, 2021), increasing the supply of these fabrics for vendors to source.

- Future work could focus on developing a biodegradable pad made from mainly local cellulosic plants such as papyrus and waste products from sugarcane industries. This research could be conducted in collaboration with chemical engineers in partnership with private companies that use large quantities of plant fibres to make textiles. This adds to the dimension of engaged research and knowledge transfer, with reciprocal benefits. Companies will have a solution to waste disposal, while researchers will increase their scholarship in the development of a sustainable product. Eco-friendly MHM products are critical, hence the need for sustainability to meet innovation in MHM products.
- MHM is an under-researched issue in SSA and requires a commitment by Higher Education Institutions, to ongoing multidisciplinary research, to fully understand the extent of the issues and how they impact women and the wider community. Placing women and girls at the centre of interventions for health and improved livelihoods significantly increases the chances of empowerment, with positive externalities, and holistic socioeconomic development.

References

Aakko, M. and Koskennurmi-Sivonen, R. (2013). Designing Sustainable Fashion: Possibilities and Challenges. *Research Journal of Textile and Apparel*, 17 (1), 13-22. https://doi.org/10.1108/RJTA-17-01-2013-B002

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*. 50(2), 179–211.

Allied Market Research, (2016). Feminine Hygiene Products Market by Type and Distribution Channel: Global Opportunity Analysis and Industry Forecast, 2015–2022. https://www.alliedmarketresearch.com/feminine-hygiene-market.

Alter, K. (2007). Social Enterprise Typology. *Virtue Ventures LLC*, http://www.virtueventures.com/resources/setypology

Ayanda, M. (2021). A Capability Approach to Examining the Experiences and Perceptions of Menstrual Hygiene Management (MHM) among Homeless

Women in Cape Town. https://open.uct.ac.za/handle/11427/33809.

Baker, F. W., and Moukhliss S. (2020). Concretising Design Thinking: A Content Analysis of Systematic and Extended Literature Reviews on Design Thinking and Human-Centred Design. *Review of Education*; 8(1):305-333.

Beres, L. K., et al, (2019). Human-Centered Design Lessons for Implementation Science: Improving the Implementation of a Patient-Centered Care Intervention. *Journal of Acquired Immune Deficiency Syndromes,* 82, 230-243, doi:10.1097/QAI.0000000000002216, https://journals.lww.com/jaids/fulltext/2019/12003/Human_Centered_Design_Lessons_for_Implementation.10.aspx

Bill and Melinda Gates Foundation, (2020). Innovations in Materials Science for a Transformative Menstrual Health and Hygiene Product. https://gcgh.grandchallenges.org/challenge/innovations-materials-science-transformative-menstrual-health-and-hygiene-product-round

Chaves, L.S.M., Fry, J., Malik, A. et al. (2020). Global Consumption and International Trade in Deforestation-Associated Commodities could Influence Malaria Risk. *Nat Commun* 11, 1258 https://doi.org/10.1038/s41467-020-14954-1

Crofts, T., & Fisher, J. (2012). Menstrual hygiene in Ugandan schools: An investigation of low-cost sanitary pads. *Journal of Water, Sanitation and Hygiene for Development*, *2*(1), 50–58.

Elkington, J. (1997). *Cannibals with Forks: Triple Bottom Line of 21st-Century Business*. New Society Publishers

Elledge, M. F., Muralidharan, A., Parker, A., Ravndal, K. T., Siddiqui, M., Toolaram, A. P., & Woodward, K. P. (2018). Menstrual Hygiene Management and Waste Disposal in Low-and- Middle-Income Countries, A Review of the literature. *International Journal of Environmental Research and Public Health*, 15(11), 2562. https://doi.org/10.3390/ijerph15112562

Farrugia, B. (2019). WASP (write a scientific paper): Sampling in Qualitative Research. *Early Human Development.* 133, 69-71. https://doi.org/10.1016/j.earlhumdev.2019.03.016.

Foley, K. A., Shelton, J., Richardson, E., Smart, N., Smart-McMillan, C., Mustakem, O. S., Young, A., Davis, D., & Frayne, D. (2019). Primary Care

Women's Health Screening: A Case Study of a Community Engaged Human-Centered Design Approach to Enhancing the Screening Process. *Maternal and Child Health Journal*, *23*(11), 1446–1458.

Giacomin, J. (2014). What is Human-Centered Design? *The Design Journal*, 17 (4): 606-623. DOI: 10.2752/175630614X14056185480186

Global Health & Pharma (2019). The Effect of Periods on the Environment. https://www.ghp-news.com/2019-the-affect-of-periods-on-the-environment/.

Goodson, C. J. (2020). The Issue of Blood: Urban Ministry in a Rural Setting; New Brunswick Theological Seminary. *ProQuest Publishing*, 27955701.

Goworek, H., Oxborrow L., Claxton S., Cooper TH., Hill H., and A McLaren (2020). Managing sustainability in the fashion business: challenges in product development for clothing longevity in the UK. *Journal of Business Research*. 117, 629-641.

Hennegan, J., Shannon, A. K., Rubli, J., Schwab, K. J., & Melendez-Torres, G. J. (2019). Women's and girls' experiences of menstruation in low- and middle-income countries: A systematic review and qualitative meta synthesis. *PLoS medicine*, *16*(5), https://doi.org/10.1371/journal.pmed.1002803

Hennegan, J., Winkler, I. T., Bobel, C., Keiser, D., Hampton, J., Larsson, G., Chandra-Mouli, V., Plesons, M., & Mahon, T. (2021). Menstrual Health: A Definition for Policy, Practice, and Research. *Sexual & Reproductive Health Matters*, *29*(1), 31–38. https://doi.org/10.1080/26410397.2021.1911618

Holeman, I., & Kane, D. (2020). Human-Centered Design for Global Health Equity. *Information Technology for Development*, *26*(3), 477–505. https://doi.org/10.1080/02681102.2019.1667289

IDEO (2017). Design Kit, "What Is Human-Centered Design? https://www.designkit.org/human-centered-design.

Jones, A. (2016). The Fight to End Period Shaming Is Going Mainstream. *Newsweek* http://www.newsweek.com/2016/04/29/womens-periods-menstruation-tampons-pads-449833.html.

Kelley, S. (2017). Common Threads: U.S. Foundation Opportunities in Sustainable Fiber and Textiles. *Sustainable Agriculture & Food Systems*

Funders. https://www.agandfoodfunders.org/featured-work/sustainable-fibers-and-textiles/secure-resource-for-fibers/

Kennedy, C. and Severe. J (2020). Period Poverty in rural Uganda; an Exploration of the Challenges and the Need for Intervention. *European Journal of Public Health*, 30 (5), https://doi.org/10.1093/eurpub/ckaa166.335

Khaitsa, M.L., N.W. Lumutenga, R. Muwazi, F. Wakoko-Studstill, I. Naigaga, M. Sengendo, C. Kabonesa, W. M. Kabira, et al, (2017). Higher Education Resource Services, East Africa: A Women Leadership and Management Development Model. *Pan African Medical Journal*; 27 Supp (4:7).

Kjellén, M., Pensulo, C., Nordqvist, P., & Fogde, M. (2012). Global Review of Sanitation System Trends and Interactions with Menstrual Management Practices : Report for the Menstrual Management and Sanitation Systems Project. *Stockholm Environment Institute*. http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-84442

Kuhlmann et al. (2017). Menstrual Hygiene Management in Resource-Poor Countries. *Obstetrical & Gynecological Survey*, 72(6), 356–376. DOI: 10.1097/OGX.0000000000000443.

Lamont, J. M., Wagner, K. M., & Incorvati, C. G. (2019). The Relationship of Self-Objectification and Body Shame to Attitudes Toward and Willingness to Use Reusable Menstrual Products. *Women's Reproductive Health*, *6*(1), 1–16. Academic Search Complete.

Lumutenga, N.W., M.L. Khaitsa, R. Muwazi, F. S. Wakoko, I. Naigaga, L. Hossfeld, M. Ralston. (2017). Women Empowering Women through Reusable Sanitary Pads. Journal of Community Engagement and Scholarship, Vol.10, No.1, 2017, pp 141-151; Special Conference Issue.

Mohammed, S., & Larsen-Reindorf, R. E. (2020). Menstrual Knowledge, Sociocultural Restrictions, and Barriers to Menstrual Hygiene Management in Ghana: Evidence from a Multi-Method Survey among Adolescent Schoolgirls and Schoolboys. *PLoS ONE, 15*(10), 1–19. Academic Search Complete.

Muyaka, J. (2018). Community Environment and Education of Girls: The Case of Communities in Marsabit County, Kenya. *Universal Journal of Educational Research*, 6 (3), 430-439, https://files.eric.ed.gov/fulltext/EJ1171396.pdf

Nandan, M., Jaskyte, K., & Mandayam, G. (2020). Human Centered Design as a

New Approach to Creative Problem Solving: Its Usefulness and Applicability for Social Work Practice. *Human Service Organizations: Management, Leadership & Governance*.

Nhinda, G. (2014). Human-Centered Design (HCD) vs User-Centered Design (UCD) vs Customer Centered Design (CCD). Ishunga Inc. https://shingapi.blogspot.com/2014/06/hcd-vs-ucd-vs-ccd.html

Noya, A., & Clarence, E. (2007). *The Social Economy: Building Inclusive Economies*. Retrieved from http://www.oecd.org/regional/leed/thesocialeconomybuildinginclusiveeconomies.htm

Performance Monitoring for Action: https://www.gatesinstitute.org/performance-monitoring-action

Shrier, L. A., Burke, P. J., Jonestrask, C., & Katz-Wise, S. L. (2020). Applying Systems Thinking and Human-Centered Design to Development of Intervention Implementation Strategies: An Example from Adolescent Health Research. Journal of Public Health Research, 9(4), 376–380. https://doi.org/10.4081/jphr.2020.1746

Stone, A. (2017). These 17 Goals have a Triple Bottom Line. ecoViews. https://www.ecopreserve.net/sdg/

Tamiru, S. (2021). Girls in Control: Compiled Findings from Studies on Menstrual Hygiene Management of Schoolgirls. SNV Girls in Control Programme. https://snv.org/cms/sites/default/files/explore/download/snv_girls_in_control_baseline_report.pdf

Tellier, S., & Hyttel, M. (2018). Menstrual Health Management in East and Southern Africa: A Review Paper. Available at https://esaro.unfpa.org/sites/default/files/pub-pdf/UNFPA%20Review%20Menstrual%20Health%20Management%20Final%2004%20June%202018.pdfTEXFAD (2012). Banana Fiber Manufacture https://www.texfad.co.ug/index.php

Tiku, S. D. (2020). Design and Development of Feminine Reusable Pad without Pad Holder. *International Journal of Clothing Science & Technology*, *32*(2), 271–283. Business Source Complete.

Thompson, K & Zhang, W., (2020). Using Mixed Methods Research to Better Understand Pediatric Feeding Disorder

Uebernickel, F., Jiang, L., Brenner, W., Pukall, B., Naef, T., & Schindlholzer, B. (2019). *Design Thinking: The Handbook.*

UNICEF (United Nations Children's Fund) (2019). Guidance on Menstrual Health and Hygiene. Available at: https://www.unicef.org/wash/files/UNICEF-Guidance-menstrual-health-hygiene-2019.pdf

UNFPA (United Nations Population Fund) (2019). Menstruation is not a Girls' or Women's Issue – it's a Human Rights Issue. https://www.unfpa.org/news/menstruation-not-girls-or-womens-issue-%E2%80%93-its-human-rights-issue

Van der Bijl-Brouwer M, Dorst K. (2017). Advancing the Strategic Impact of Human-Centered Design. Design Studies53:1-23. doi:10.1016/j.destud.2017.06.003

Van, E. et al. (2021). Exploring Menstrual Products: A Systematic Review and Meta-Analysis of Reusable Menstrual Pads for Public Health Internationally

Weeby, J. (2018). Creating More Effective, Efficient, and Equitable Education Policies with Human-Centered Design. Bellwether Education Partners.

Weiss-Wolf, Jennifer. 2019. Periods Gone Public: Taking a Stand for Menstrual Equity. New York: Arcade Publishing.

World Bank Group (2020). Social Enterprises Innovation Program. Available at: http://www.innovationpolicyplatform.org/www.innovationpolicyplatform.org/sites/default/files/Health_Female%20Hygiene%202-pager_July11/index.pdf

Yan, S. D., Simpson, J., Mitchum, L., Orkis, J., Davis, T., Wilson, S., Trotman, N., Imhoff, H., Cox, H., Hunter, G., Olapeju, B., Adams, C., & Storey, J. D. (2021). Human-Centered Design Process and Solutions to Promote Malaria Testing and Treatment Seeking Behavior in Guyana Hinterlands. *BMC Public Health*, *21*(1), 1–19. https://doi.org/10.1186/s12889-021-12297-0