Menstrual (Im)Mobilities and Safe Spaces

Anupriya Tuli
IIIT-Delhi
Delhi, India
anupriyat@iiitd.ac.in

Shaan Chopra
University of Maryland
College Park, MD, USA
schopra7@umd.edu

Pushpendra Singh
IIIT-Delhi
Delhi, India
psingh@iiitd.ac.in

Neha Kumar
Georgia Tech
Atlanta, Georgia, USA
neha.kumar@gatech.edu

ABSTRACT

In cultural contexts where menstruation is a stigmatized health topic, daily management of menstrual hygiene comes with its set of challenges. Our research aims to identify and examine such challenges faced during menstruation in the urban environs of Delhi, India. Through participatory design activities and interviews conducted with 35 participants who identified as menstruating and female, and a survey with 139 responses, we investigate how participants deal with their periods *on the go*. We also examine participants' conceptualizations of *safe spaces*, where they are able to deal with their period on their own terms. Finally, we discuss how *menstrual mobilities* are being, and might be, supported through technology-based interventions for a *third space*, targeting the *legibility*, *literacy*, and *legitimacy* of surrounding environments.

Author Keywords

Menstruation; menstrual health; menstrual hygiene; safe spaces; mobilities; India; HCI4D

CCS Concepts

•**Human-centered computing** → **Empirical studies in HCI**;

INTRODUCTION

In 1980, Dolores Hayden—an urban planning historian—asked, "what would a non-sexist city be like?", asserting that a woman's place was no longer in her home [51]. Highlighting the sexist origins of many metropolises of today, Rao asserts that most cities were designed around men and their work, but it is time for urban design to include "the other half of the population" [78]. Fox brings the conversation around feminism and design of public infrastructures to human-computer interaction (HCI) with her research on public restroom infrastructures and the distribution of hygiene resources [41, 43]. Like Fox, we see menstruation as a site "of and for political action and technological intervention" [41], situating our research in an environment impacted by acute menstrual stigma [13, 91] alongside unfulfilled aspirations for safe spaces.

In Delhi, India, where we situate our research, gendered mobilities [94] have only recently been made the object of

scrutiny by the government [73]. Public infrastructure initiatives, including introduction of more public toilets, aim to make the city more citizen-friendly and sustainable, duly aligning with campaigns such as *Digital India* [72] and *Swachh Bharat* (Clean India) [74], to "digitally empower" citizens and strengthen urban design. In 2017, the Indian government also introduced *pink toilets* to address the needs of "women, adolescent girls, and children" [95], and launched the *Swachh Bharat Toilet Locator* [34] and *Swachhta@PetrolPump* [65]. However, the toilet locator app only shows the geo-tagged location of (not directions for) nearby toilets, and the latter only collects feedback on toilets at gas stations across the city. In the same year, Google joined this endeavor by hiring Local Guides (local citizens) to geo-tag toilets, upload pictures, write reviews, and provide ratings on Google Maps [29, 30]; these maps currently represent 45,000 public toilets across the country [83], including the *pink toilets* in Delhi. The drive for pink toilets is well-intentioned; access to proper sanitation in India remains an untenable problem for women [28]. As these toilets (and their tracking mechanisms [29, 39, 83]) become pervasive, our research investigates whether and to what extent they are poised to address a key need and source of stigma for a sizeable chunk of Delhi's population—of menstrual hygiene management (MHM) [13, 24, 46, 90, 91].

Our research focuses on attaining a deeper understanding of *menstrual (im)mobilities*, or the challenges and limitations that menstruating individuals face when they must contend with MHM and its associated stigma in a state of transit. For this, we engaged with the culture of MHM in Delhi. Using qualitative and design inquiry, we investigated current management needs and practices of menstruating individuals, focusing on their MHM practices in transit, and their experiences around the lack of toilets or other spaces they could use. We also examined their aspirations around safe spaces, or spaces where they felt that they could freely recognise, express, and address their MHM needs. We then analysed the insights gained using Brewer and Dourish's examination of *storied spaces*, targeting the *legibility*, *literacy*, and *legitimacy* of surrounding environments [26]. This lens fittingly and generatively allows us to illustrate how menstrual mobilities are currently negotiated, and how existing mobile technology support falls short of meeting target users' needs. We conclude by discussing how technology design might better support menstrual mobilities by offering a *third space* for MHM [21, 69].

RELATED WORK

We begin by situating our research at the intersection of HCI literature on gendered mobilities, and safe spaces, before articulating our contributions to women's health within HCI.

Gendered Mobilities and Safe Spaces

Cresswell and Uteng define mobility by "not only geographical movement but also the potential for undertaking movements (motility) as it is lived and experienced—movement and motility plus meaning plus power" [94]. They add, "Each of these aspects of mobility—movement, meaning, practice and potential—has histories and geographies of gendered difference." Rao reflects that she felt safer in "Mumbai and New York than Delhi and DC", and that her "instinct was grounded in a long history of urban planning, and how most cities never accounted for women in their design", highlighting how mobilities and access have been and remain gendered [78]. Building on these writings, we investigate how gendered mobilities are sought and negotiated in a localized yet pervasive scenario—that of MHM in conditions of transit. We examine the case of Delhi in particular, amid a strong popular sentiment that finds the city seriously unsafe for women [96].

Our conceptual understanding of mobilities is shaped by how we understand *space*. Dourish and colleagues [36, 50] have differentiated between, and drawn connections across, the concepts of *space*—as geographic location—and *place*—as lived or experienced environment. They assert, "We are located in *space* but we act in *place*" [50]. Along similar lines, Tuan defines place as "more than a location, while that *more* is related to the personal experiences of places" [89]. On the topic of designing technology-based interventions for mobility, Brewer and Dourish [26] propose grounding such designs in the "experienced place" or cultural context of the users. They argue that "mobile information technologies [...] are tools that serve to structure the spaces through which they move" [26].

We draw on Brewer and Dourish's examination of *storied spaces* [26] to explore the relationship between mobile information technologies and *safe spaces*. Prior HCI research has engaged with technology interventions such as panic buttons, online storytelling, and a breastfeeding-friendly tool that aim to address everyday mobility challenges [2, 15, 32, 58]. Definitions of safe spaces in HCI have been shaped by research in both online and offline environments. Scheuermann et al., among the first to document transgender individuals' experiences of technology-mediated safety and harm, elaborate: "While safe spaces emerged as a conceptual space of resistance to violence and freedom to organize, the term has become commonly used to denote safety from any emotional harm or othering" [79]. Their work and others' (*e.g.,* [23]) highlights the importance of safe spaces for affording the mobility of information around a range of stigmatized topics, such as mental health [11, 22, 54, 64, 80], HIV/AIDS [62], sexual abuse [8], pregnancy loss [9, 10], among others. We extend this research by investigating *menstrual (im)mobilities*, studying the challenges individuals face in dealing with their periods on the go, and their aspirational safe spaces in this context. The notion of a *third space* [21, 69] also inspires us to consider ways in which we might foster liminal spaces for culturally situated knowledges and representation in our context (*e.g.,* [84]).

Women's Health, Wellbeing, and HCI

We build on and extend a rich and growing literature within HCI on women's health. At CHI 2017, Balaam et al. organized

a workshop around hacking women's health [17] and the area has since expanded to touch upon a range of related topics [3, 5, 16, 31, 97], leading to various design tools (*e.g.,* [19, 53]) and interventions (*e.g.,* [6, 16, 68]). Recent research has conveyed how HCI must also address the social impact of women's health issues [4, 57]. This has led to more work being done on a wider array of topics such as intimate care [4, 7, 100], sexual wellness [37, 57], pregnancy loss [9, 10], motherhood [77, 86], mental health [35], intimate partner violence [44, 45], and more. In particular, studies from the Global South have mainly focused on maternal and child health (*e.g.,* [14, 55, 76, 85, 99]) and sexual and menstrual health (*e.g.,* [56, 70, 90, 91]).

Topics related to menstrual health, in particular, have received increased attention in recent HCI research. To encourage early discussions between children and parents about menstruation, Tran et al. [88] created an interactive model of the uterus. Also to impart menstrual health education (MHE), Jain et al. [56] created a support-seeking tablet-based game for adolescent girls in Assam, India. Tuli and colleagues [90, 91] have examined culturally responsive design for imparting MHE, also offering a study of *Menstrupedia*—a digital platform aimed at providing MHE to an Indian audience.

In work on analysing menstrual health tracking practices, Epstein et al. did an extensive study of the use of tracking applications across the United States [38]. Recent studies have also shown how ambient light and colour-emitting smart mirrors can be leveraged for menstrual tracking [40, 52]. Sondergaard and Hansen encouraged researchers to reflect on the "politics and culture of self-tracking, sharing, and intimate data" through speculative design of a smart menstrual cup [81]. Along similar lines, Fox et al. designed a product catalogue to provoke reflections on the intimate data collection and privacy regulations around existing tracking applications [42]. In other recent work, Woytuk et al., emphasised a "period-positive" approach that does not view menstruation as a "problem" [27]. Researchers have also explored the intersection of MHM and supporting public infrastructures, extending conversations around the challenges of combating stigma associated with MHM [18, 43, 66]. This is the perspective we extend, as we examine the construction of safe spaces around MHM.

There has also been a growing interest towards investigating menopause in particular. Lazar et al. [63] studied a subreddit forum to understand lived experiences of women with menopause; they found that the social context it occurs in plays a significant role in defining the meaningfulness of bodily experiences. Bardzell et al. [19] draw from their previous research to produce multiple menopause experience design frames—including concepts for new products, services, and environments—with the aim of developing a design theory for women's health. Finally, Tutia et al. [92] designed a personalized tracking and evaluation mobile application for menopause called *Vera*.

Increasingly, we see connections being drawn in HCI literature between women's health topics and the need for a more holistic approach to wellbeing. Research on topics such as menstruation is inherently feminist, invariably invoking Bardzell's Feminist HCI principles of pluralism, advocacy, and embod-

iment, among others [20]. Kumar et al.'s panel at CSCW 2019 [60] also aspires to make connections between "women's health, wellbeing, and empowerment" more explicit, drawing on Nussbaum's feminist definition of wellbeing based on the Capabilities Approach [71]. These are the conversations we seek to align with and advance with our research.

METHODOLOGY
Our IRB-approved research took place in Delhi's National Capital Region (Delhi-NCR), India, from February 2019 to July 2019. Our goal was to attain a deeper understanding of the challenges and limitations that face menstruating individuals when they experience periods in transit. To do this, we collected data using participatory design exercises (alongside interviews), and an online survey to corroborate our findings.

Participatory Design
We engaged in participatory design, aligning with Spinuzzi's recommendation of using participatory design as a methodology [82], to develop an in-depth understanding of participants' current practices around managing periods on the go, factors that shape these choices, and participants' aspirations of a public safe space while on their period. We conducted two activities with 35 participants (see Table 1). Each session included a participant and two researchers (the first and second authors), where one moderated the session while the other took notes. Sessions were at locations convenient to the participants. At the start of each session, we explained the study protocol to the participant, and obtained written consent. Participants were recruited through the authors' social networks using purposive [87] and snowball sampling [47]. All data was collected in both English and Hindi field notes, audio recordings, and photographs. Audio recordings were transcribed—and translated to English as necessary—for analysis.
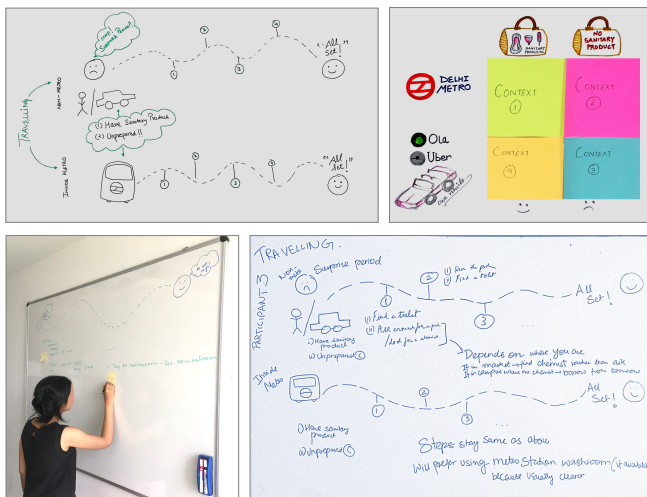

Figure 1. In Activity 1, the participants were asked to complete a bare-bones diagram (top left) for four scenarios (top right) using markers and sticky notes to illustrate *"the steps they would take in each situation."* **Throughout the process, researcher queried them with varying scenarios:** *"what if the washroom is dirty?", "what if you are short on time?", "what if you are just 5 minutes away from your destination?"*

Activity 1: Identifying the Building Blocks of Safe Spaces
In the first activity, we focused on identifying both tangible and intangible components that participants associated with safe spaces in the process of MHM. We conducted individual sessions with 10 participants who identified as female and menstruating. First, we collected information about participants' daily commuting practices and modes of transportation. We then asked them to share their experiences (if any) of dealing with surprise periods on the go. Next, we asked the participants to complete a bare-bones diagram of their *journey* from having a *surprise period* while travelling to being *all set!* (see figure 1). Here, we gave our participants four scenarios to complete the diagram—traveling in the Metro while carrying or not carrying a sanitary product, and similar for transit via road. Finally, we gauged perceived usefulness of the information regarding the availability and access of "safe spaces for bleeding." For example, going by the experiences and responses shared, we asked, *"If you have the information about the nearest washrooms, will it be helpful?", "Will knowing about the condition of washrooms like availability of soap, water, and more make a difference?",* and *"How will the information about the availability and status of a sanitary napkin-vending machine impact your decision?"*

We collated our findings from Activity 1 and consulted the data from national and international guidelines on designing menstruation-friendly public toilets [95, 98], to come up with 52 unique elements (building blocks) of safe spaces for our case. Examples of elements included *access to sanitary products, safe location, toiletries like water, soap, tissue paper, lady attendants,* etc. Finally, all researchers collectively conducted affinity mapping [48] on this data to arrive at a consolidated understanding of aspirational safe spaces based on these identified themes: *privacy, safety, accessibility, availability, cater to MHM requirements,* and *well-maintained.* The lessons learned from this activity, including the building blocks we identified, formed the basis of our next activity.

Activity 2: Constructing Safe Spaces
The second activity was designed as an open interactive session, conducted with 25 adult women, and lasted 30-40 minutes. Here each participant was asked to visualise their aspirational (public) safe space(s) for a positive MHM experience, through sketching and/or using wooden building blocks (see figure 2). Each block represented an element identified in Activity 1. The white background represented the physical space where participants were asked to construct their safe space, using blocks or by creating new elements (using empty blocks and post-it notes). To understand the role that crowds played in the construction of these spaces, participants were asked to place chess pieces in their space. Black pieces represented male presence, while white represented all other company. Participants from Activity 1 did not participate in this activity; this was so we could validate our findings from Activity 1 and allow for other perspectives to emerge until we had achieved data saturation.

Each session began with participants building their space(s) using the blocks. Once the participant had finished designing their space, the moderator explicitly asked the participant to

	Activity 1 (10)	Activity 2 (25)	Survey (139)
Gender	Female (10)	Female (25)	Female (138), Genderqueer (1)
Age	Min 20, Max 36, Median 24	Min 20, Max 48, Median 27	18 to 35 (123), 35 to 50 (13), 50 & above (3)
Occupation	Student (6), Professional (4)	Student (15), Professional (6), Homemaker (4)	Student (84), Professional (48), Homemaker (6), No response (1)
Annual family income	Low: <$11K (2), Middle: $11K-$26K (3), >$26K (5)	Low: <$11K (8), Middle: $11K-$26K (8), >$26K (8), No response (1)	Low: <$11K (22), Middle: $11K-$26K (62), >$26K (41), No response (14)
Religion	Hindu (7), Sikh (1), No particular religion (2)	Hindu (17), Muslim (2), Sikh (1), Other (1), No particular religion (4)	Atheist (4), Hindu (100), Muslim (2), Sikh (5), Other (4), No response (5), No particular religion (19)
Daily transport	Own vehicle (1), Auto rickshaw (4), Buses (1), Metro (10), Ola/Uber (4)	Own vehicle (11), Auto rickshaw (5), Buses (4), Metro (15), Ola/Uber (16)	Own vehicle (44), Auto rickshaw (27), Buses (12), Metro (93), Ola/Uber (59)

Table 1. We conducted two participatory design activities with 35 women (labeled P#). Participants P1-P10 participated in Activity 1, and P11-P35 in Activity 2. We also did an online survey (labeled S#) to corroborate our findings from the first two activities and accompanying interviews.
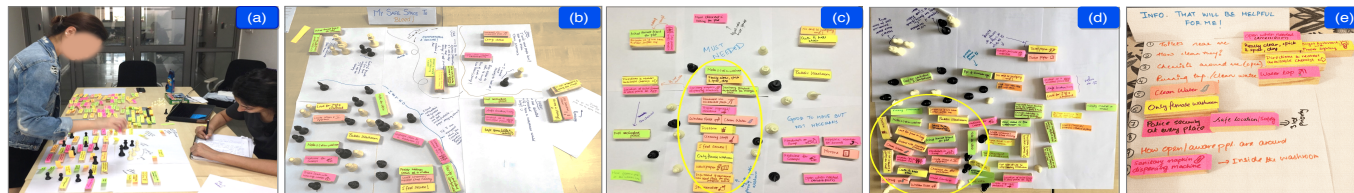

Figure 2. In Activity 2, participants were asked to visualise public safe spaces for a positive MHM experience, through sketching and/or using the blocks visible above. Here, the white background represents the physical space, and each block represented an element identified in Activity 1. For studying the role of the crowd, we asked the participants to place chess pieces in their space. Black pieces represented male presence, while white represented other genders. Most participants placed blocks in a radial arrangement (c, d) with the washroom and its facilities at the fulcrum of their space.

position the black and white pieces in the context of their safe spaces. Finally, participants were asked to prioritize the elements in descending order of relevance. Throughout the session, the moderator gave different scenarios and asked unstructured questions to probe the choices and placements of the elements in the space: *"What if you are running late for a meeting?", "Imagine you are traveling in the women's coach versus the general coach (of the Metro)",* and *"When caught by surprise by your period, do you prefer to be alone or in a group?"*. Participants were also given various scenarios to further gauge their comfort around people across genders in their space. For example, *"Would you feel comfortable if you were traveling with male members of your family?"*. Towards the end, participants filled out a survey with eight questions about demographics, three about commuting practices, and one about their experience using mobile applications (such as Google Maps or a toilet locator application) when dealing with periods in transit.

We analysed all the data collected—audio recordings, field notes, and photographs—using inductive thematic analysis [25], where we observed repeating themes from our first activity. Examples of codes included *experiential information, safety, time matters, aspirations, technology support, crowd effect, comfort of a companion, preparedness, temporary hacks, poor infrastructure, solidarity,* and *fear of stain.*

Online Survey
To understand how women manage menstruation while in transit, we co-designed and distributed a survey in collaboration with Haiyya Foundation [1]. Haiyya has extensive experience in working towards providing safe spaces for women in Delhi NCR to access sexual and reproductive health services. Our

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[1] https://www.haiyya.in/

survey included 13 questions, with 2 filter questions and 6 on demographics. All but one questions were multiple-choice, and asked about participants' approach to period preparedness, that is, whether they carried a sanitary product with them, what happened when they did not, etc. The single open-ended question was aimed at offering respondents the space to share their experiences while having to deal with periods on the go.

We developed and administered the survey in English using the SurveyMonkey platform, and recruited respondents through email, WhatsApp, LinkedIn, and Facebook. A note at the beginning of the survey explained the objective of our study, also seeking written consent. Our survey received 361 hits over one month; of these, 106 participants only filled out the filter questions, 11 did not attempt the survey, leaving us with 244 responses, including 139 from Delhi NCR. Since Delhi NCR is our geographic focus, we only analysed these 139 responses for our paper (see Table 1).

We analysed the open-ended questions using thematic analysis [25]. Examples of codes included *preparedness, temporary hacks, poor infrastructure, solidarity,* and *fear of stain.* The remaining responses were analysed by calculating percentages and cross-tabulation [59]. An example of cross-tabulation included comparing answers to *"Have you ever been in a situation wherein you had surprise periods while in transit?"* and *"How do you prepare for dealing with surprise periods in transit?"* Our analysis of survey responses was mainly helpful in corroborating our findings from the methods listed above.

Positionality
All four authors are of Indian origin and have conducted fieldwork across different regions and with diverse marginalized groups in India, including on global health topics. Three authors identify as female and one as male. Each of the authors

has lived in Delhi for 10+ years and been intimately familiar with the public infrastructure challenges that this paper delves into. Menstrual health and hygiene management is an area of study for all authors, including a more general focus on women's health, wellbeing, and empowerment. We all view HCI research from a feminist and emancipatory action research mindset, aiming to explore how technology design, adoption, and use might prioritize the needs and interests of women and other underrepresented groups.

FINDINGS

Menstruation is a highly stigmatized topic in the urban Indian context of our study, as recent HCI research has documented in depth [13, 90, 91]. Tuli et al.'s study, which examines design opportunities for menstrual health education in India [91], highlights the deep-rooted stigma and its impact on everyday lives of menstruating individuals. As one of their research participants shared, *"So I got a stain on my school uniform...I observed few boys laughing and making fun of that thing. So that was very embarrassing for me."*These findings were echoed by our participants, who shared that they felt *"anxious,"* *"panicked,"* *"horrible,"* and *"scared"* when caught by surprise on account of their menstrual period while traveling. Focusing on the management of periods in transit, we detail below how our participants navigate public spaces while actively labouring to avoid facing menstrual stigma in such scenarios. We also discuss how they seek and construct a suitable version of the safe spaces they aspire for.

Dealing with Periods on the Go

In this section, we present our findings on how contemporary public places shape strategies for MHM while navigating through them. Our participants practiced preparedness as well as various *"temporary hacks"* to minimize the challenges faced on account of their periods while in transit. We describe below how they ensured preparedness, sought support from other women, and located or constructed safe spaces on the go.

Prioritising Preparedness

Menstrual products are not typically available in public washrooms in India, although there have been a few initiatives in some educational institutions (*e.g.,* [1, 75, 93]). Participants shared that they thus needed to remain equipped with sanitary products, hand sanitisers, tissues, wet wipes, and/or Pee Safe sanitiser sprays in their handbags, in the event that their period caught them by surprise.

> *"I am generally prepared. So I have my handbags and every handbag has one or two products always. Finding a particular product also becomes imperative in certain demographics as such. I carry hand sanitiser with me all the time now." (P27)*

Most interview participants and 60% of our survey respondents said that they were always equipped with sanitary pads, to avoid the hassle of having to procure them on the go; S57 shared, *"I get anxious if I don't have a pad, and if I can't buy a pad anywhere nearby then I go home"*.

Almost a third of our survey respondents believed in being prepared particularly when they were expecting their periods: *"once I know that I [have] started ovulating, I wear pantyliner as it is more hygienic. Especially since the time I have begun travelling like college and work"* (P28). However, 12% of survey respondents said that they did not feel the need to prepare for managing periods on the go—*"Surprise periods occur rarely. There is no need of being prepared every time"* (S3)—and preferred to *"arrange something on the go"* (S56).

When participants found themselves unprepared, they depended on *"temporary hacks"* such as tissues, toilet paper, handkerchiefs, or cotton to avoid getting stained, until they could get access to a sanitary product. The fear of a period stain surfaced repeatedly across our findings. For example, one survey respondent shared, *"I had nothing. Ultimately I used my hanky for, but that was horrible because I was going to washroom very frequently to check if I am stained or not"* (S38). When stained, participants' priority shifted to hiding or covering the stain using any available piece of clothing, like a scarf or jacket, as expressed by one interview participant (P29), *"So, if I have a coat or something to hide it then I am self-sufficient but if not then I need something to hide the stain. I don't know, maybe I will look and buy something from mall."*

Prioritising preparedness was critical to avoid being subject to the stigma of being caught with a stain, and participants shared that this was constantly on their mind as a scenario to be avoided at all costs. They avoided relying on their extrinsic environments to the degree that they could, and had personalized workarounds ready if the worst were to happen.

Relying on Solidarity from Women in the Vicinity

Three-fourths of our survey respondents shared that, when they found themselves unprepared, they relied on solidarity from women around them. This sense of solidarity was expressed by a survey respondent (S11) thus: *"There is always this understanding between two women I suppose, when it comes to period."* Research participants commonly relied on women in their vicinity for borrowing sanitary products, as S35 shared: *"Women around will always offer help by offering their back-up products. I've done it for others and vice versa. Plenty of times."* Notably, approaching women in public spaces (such as the bookstore at the airport in S28's response) when one was out of sanitary products was not seen as unsafe or challenging, although this was less desirable when there was male presence.

While traveling in the Delhi Metro, the women's coach was viewed as a *"personal space"* and the *"go-to place"* for support in the given scenario: *"In general coach I visualize more of males. So if you are in ladies' coach and you ask for pad, there will be like 3 or 4 people more listening to you, so basically there is high probability of finding the pad/product. Yes, [women's coach] makes a difference! I will be more at ease in women's coach "* (P15).

Participants also turned to women nearby as they sought comfort and help towards hiding period stains: *"They [the women around me] will somehow be able to hide it [stain] and help me to go to place where I might find amenities. They can also cover it by standing in front of me"* (P31). One survey

respondent (S7) also shared that when a girl in her class got her period, teachers helped out by *"covering her skirt."*

This solidarity extended beyond offering sanitary products and hiding period stains as well. In the words of one interview participant, a period stain was not the end of the world, but a potential call for empathy and/or concern.

> *"If I see a woman with a stain I would be concerned like are you okay? Do you need medicine or hot water bag but not create a hoopla around it! I will not be 'Oh my god, it's a stain', that would be my last concern, it's just like any other blood stain. I would be concerned if the other person needs anything, as basic as chai or warm water, but not be concerned that they have stain"* (P28).

Safe spaces for MHM then did not translate to a particular physical location, such as a handbag, washroom, or a coach in the Metro, as in the subsection above. They included many locations where one could expect to find the company of other women that one could derive solidarity from (even if there was not a one-to-one mapping between women and menstruating individuals). Protection from stigma was key.

Locating (and Appropriating) Changing Rooms
Although safe spaces were not all about washrooms or changing rooms, they *were* in large part about them. Once participants had obtained access to a sanitary product, they needed to locate a place where they could change, at a minimum. As one survey respondent expressed, *"the problem was not of the availability of sanitary products but the availability of toilets"* (S27). Government and industry initiatives have been taking active measures to provide information about public washrooms online [29, 34, 39, 83], but most participants did not seem to be aware of these efforts. All research participants admitted to using Google Maps whenever they traveled, even when they were familiar with their routes, but *"it never occurred"* to them to use these maps for locating public washrooms or to *"look up for such [toilet locator] app"* online. Fewer than a handful interview participants had used Google Maps to *indirectly* locate washrooms by looking up the nearest mall, marketplace, or petrol pumps, as they *"did not know whether it could do that (look up washrooms) or not!"*

The exercise of locating safe spaces (such as public washrooms) for changing was shaped by women's mode of transportation. When using public transport, women preferred to locate washrooms manually or by asking around for directions, as shared by one participant:

> *"I will prefer to walk out and manually hunt for washroom because there are lot of places which are not on Google map... So I would instead look for them physically rather than searching on Google map." (P12)*

For women who could afford it, travel by cab or personal vehicles offered them the *"freedom"* to reroute to specific locations (*e.g.,* pharmacies, public washrooms, their homes) without worrying about being judged by crowds. As expressed by one of our participants, this was especially the case if they had a period stain:

> *"This gives a lot of freedom right! I can stop anywhere, buy anything. Also there are so many malls in the city. I think cab is really not an issue though. I will go to the nearest chemist and then search for toilet."* (P32)

Additionally, a private vehicle was viewed as a safe changing space, in the case that a washroom was inaccessible. An interview participant shared that she would *"just kick out the person for some time and you know change or put pad"* (P17). One survey respondent (S14) also shared:

> *"I realised my periods started in the back of the car, with my friends sitting in front (1 female and 1 male). Even though I wasn't that comfortable with that male friend, I immediately told him to look for a chemist shop. Without me putting much emphasis on it they both understood and the guy started looking for one immediately. I gradually started building the urgency and why I need it. Luckily after like 10-15 minutes, we spotted a chemist. Then the issue was where [space] to put it (the pad) on. Chemist didn't have a space I could go and do that. Car? A sad alternative but possible if we get nowhere else."* (S14)

From the participatory design exercises as well, it was clear that the definition of a safe space was conditional on the mode of transport participants were using, and the public infrastructures available nearby—of a mall, public washroom, or a pharmacy. The burden of reasoning through a given scenario to locate a safe space rested with our participants at all times that they were outside their homes and on their period.

Going the Extra Distance for "Love and Care"
Participants turned to what was familiar in their quest for safety, and opted for visiting friends or relatives nearby, rather than locating public washrooms, even when the latter might have technically taken less time.

> *"If my home is 40 minutes away and this safe space is 30 minutes away, then I will prefer going home or probably my friend's home because at home or even if it's my friend's place, the people will be understanding and there is extra love and care we get! So basically, you are not being treated as just one another person in the mall. They understand you!"* (P12)

Company and empathy mattered to participants, but if they could not find such a place nearby, participants preferred using public washrooms (at the Metro station, a restaurant, or a mall) where they had been before and could recall having a good experience, even when they were not the closest. For example, P4 shared, *" If I really have to go to the washroom and I am in the Metro, then I get down at Rajiv Chowk and use the Starbucks washroom because I find that fairly clean."* Participants were open to using a washroom in a mall or restaurant if it had been recommended by other friends, relatives, or women nearby as clean and safe: *"It would be nice to know if people have used a place for such kind of purpose. So if I see that someone has used this place that will increase my trust for that place."* (P35). This trust that P35 mentioned was evidently challenging to build; participants were not in the habit of trusting public infrastructures to be tailored to their needs.

Developing a "Period Vocabulary", or Not

In locating safe spaces and/or friendly faces, participants seldom expressed themselves using terms or phrases that precisely communicated their situation. They had their own *period vocabulary,* which they used to signal their needs. For example, one participant (P35) consistently used the word *"things"* to refer to sanitary products. For example, she said, *"If the person is having the regular cycle and know that it is about time then people will be having the things [sanitary pads], at least I will be having the things."* Words like *"tension," "pressure," "discomfort,"* and *"emergency,"* were commonly used by participants to refer to the condition of having one's period. Further, for most participants, the term *"safe space"* immediately led them to thinking about washrooms.

Communicating about one's (or another's) period was also challenging for similar reasons. Participants stressed the importance of using the right language to indicate that they needed a sanitary product, or to inform someone else that they had a stain:

> *"Sometimes you don't know if you are stained. So if somebody notices my stain I expect them to tell me. So, that is a kind of experience I had, so I saw a girl with stain and I think she didn't know about it so I just went to her and informed her. That said, you should tell this decently!" (P34)*

Even when participants were okay talking freely about their own period, they were mindful of others' comfort levels—both around experiencing one's own period in public, or even seeing a stain on another. As P28 shared:

> *"See, I don't care but at the same time I can sense if other people are uncomfortable. I am comfortable anywhere in any public space even if I have stained my dress and people can see my stain. But then you know I can sense that everyone is getting uncomfortable by looking at me, and they are all the more weird that why am I not uncomfortable and walking so freely."*

Non-verbal communication around the stain also highlighted that even when there was a lack of precise vocabularies to describe the scenario participants found themselves in, the sense of alarm as well as solidarity that resulted from a stain were tacitly received and unanimously appreciated.

Securing Physical Safety First

Prior research has discussed challenges around women's safety in public spaces of Delhi [58]. Our participants also noted that concerns around physical safety were frequently present when thinking about identifying a safe space for changing, depending on the time of day.

> *"So only in night, searching for a safe location will be on top of my head otherwise [in day time] I would not worry much about safety or having experience of a place before or feel insecure or have preference for lighted place. These things matter to me only at night!" (P12)*

Although during the day crowds were a source of discomfort on account of the fear of being judged (such as for a period stain), they were seen as favorable at night by participants as it would make them *"feel more secure."* All participants stressed that having a companion (friend or relative), especially at night, would make them feel secure and at ease: *"See, if I don't have this safe space which I have just created, then having a companion creates a huge difference. If I am blessed with my safe space then I am completely fine on my own. You know this [constructed safe space] is a very ideal state where I can walk to a guard and ask for help. This is too safe!"* (P32). Participants knew to temper their expectations, given their knowledge of public spaces in Delhi.

When it was dark, physical safety was a bigger concern, but it was also a boon where stigma was concerned, as it was easier to hide stains and avoid attracting people's attention (P25): *"[At night] I will be needing all those things which I need in such situation, but the difference would be that tension in my mind will be less in night since there is darkness around, so maybe less number of people will be around who may concentrate on you, I think they will be less active which will help me in dealing with the thing in better way."*

Managing periods on the go thus entailed a multi-faceted adventure; participants described in depth how they carried their safe spaces with them in their handbags (as far as possible), drew on the support of women in the vicinity, and struggled to identify safe spaces for changing. These steps were essential not only for securing physical comfort, but also for protection from being subjected to stigma—as evident from the importance given by participants to hiding stains, or identifying ways of speaking about menstruation in imprecise terms.

Aspirations for Menstrual Mobility and Safe Spaces

We now detail the findings from our participatory design exercises, where we asked participants to construct the aspirational safe spaces they could turn to when dealing with periods on the go. Using wooden blocks, chess pieces, post-it notes, and markers, participants were asked to convey what a safe space meant to them—whether it was a washroom or more, what kinds of information they needed, and what they expected from their environments.

First, a Functional Washroom

On being asked to build a safe space for managing periods on the go, most of our participants started with building a washroom and used up most of their blocks and time in its construction. As discussed above, this connects back to women practising preparedness (P7): *"I am prepared enough. I carry my stuff with me. So the first step, if I am not wearing a pad, is finding a washroom."* Many participants mentioned that they would *"first check for false alarm"* (P31) or a stain in a washroom, then use *"toilet paper as temporary fix"* (P21).

The importance of the washroom was evident throughout the different structures of the safe spaces built by participants. Most participants placed blocks in a radial arrangement (figure 2) where the washroom and its facilities formed the fulcrum of their safe space, with surrounding blocks denoting pharmacies and other environmental needs. Participants also differentiated between public and private washrooms. While the former were often without basic amenities such as soap and water, the latter left participants feeling more assured:

"In general, public washrooms' conditions are very bad... So my basic expectation from public washroom is water and hand-wash. I am expected to carry my sanitary napkin because they will not have dispensing machines. So finding a decent washroom with soap and water is an ordeal. Also, I want to add [to my safe space] a lockable door to the toilet, which is also missing sometimes in public washrooms [. . .] So public places like markets where there is dearth of public washroom, and we look for cafes for using the washroom. Now the central government has made it that you can use any washroom in any restaurant. So now if the big cafes like Starbucks, CCDs, and all are little more considerate for women users, then it will be really nice safe place to use washrooms, which in any way we are looking for when we go for shopping." (P19)

Although a functional washroom was desired by most participants, that wasn't all they wanted. Cleanliness and hygiene were of high priority, followed by the availability of toilet paper, wash basin, running water, soap, garbage bin, lockable doors, mirror, etc.—either free of cost or at an affordable fee. Expectations around public washrooms were low, but most participants and 82% survey respondents preferred washrooms at Metro stations over other public toilets, since these were newly constructed, easily accessible, and relatively well-maintained.

While on the one hand, a washroom (with the above amenities) provided a safe space for participants to tend to their menstrual needs, on the other, it also allowed them to avoid dealing with any menstrual stigma they might have faced had there been a separate demarcated room for addressing MHM needs. As one participant (P24) acknowledged, *"I know there is a stigma around menstruation, but it would be just like using a washroom. People would not know the purpose, right?!"*

More than just a Washroom
Although participants used up most of their time in designing a washroom, they also voiced the desire for a changing space that was clean, hygienic, accessible, and private. Although this was generally a washroom, it could also be any closed and lockable space, such as a car or a private cubicle. As P23 said, *"I want a dedicated space like baby care rooms. I want them everywhere in addition to washrooms for menstruation, specifically dedicated for menstruation and changing sanitary product."* Participants also mentioned additional desires, such as access to food (and chocolates), herbal teas, energy drinks, and medicines for stomach cramps, an underwear-dispensing machine, a separate area for women's health products at the pharmacy, and even just comfortable cushioned chairs and hot-water bottles.

"[I will need] medicine and energy drinks. When I have pain, I really feel like lying down. So maybe in girls coach [in Metro] they can create few special seats with cushions. It would be great to have an underwear dispensing machine or cheap and temporary bottom wear dispensing machines." (P32)

Participants' needs were centered around a washroom, but did extend to other amenities such as medicines, energy drinks, and more (see above). We also found that participants fre-

quently seemed to think that they were aspiring for too much. One participant (P28) remarked, *" I would really want to know if there is tissue paper but then I guess it's very stupid!"* Another (P22) laughed and said, *"In the washroom I would like to know about running tap, but isn't this asking for too much?!"* Still another (P27) considered hot/lukewarm water a "luxury". As Kumar et al. discuss in their work on leveraging aspirations towards design, *"aspirations are embedded in larger sociotechnical assemblages that are not entirely intrinsic to the individual in question"* [61]. In tempering their expectations, participants were continually ensuring that they were not unreasonable in their aspirations, given their experience with their environments, adding: *"because as you know generally washrooms here do not provide all these facilities."*

Locations of Safe Spaces, Online and Offline
Although participants were mostly uninformed of existing information channels, such as Google Maps and various toilet-locator applications, and prioritized experiential information, they did express a desire to have information regarding the nearest chemist and washrooms with a detailed list of available facilities (P11):

"No, I am not aware of such applications. I think, even now, when I know something like this is available, I might not install it. As I mostly commute through Metro and I usually know where these washrooms are! But yes, if I am travelling to a new place then maybe I will. So if an app provides me in-depth information and not just about where are the toilets, then I will install and use it."

Participants were keen to know where the nearest washroom was, which existing applications could inform them about. P32 shared:

"In my case, I have this severe pain so I avoid stepping out of the house and even if I have to then I have to ensure that I am well prepared (carrying pad, food, and stuff). So if this [application] works out then I will not have to wait one or two days to go out! Yes, it will be amazing!"

However, participants also wanted to know if the washroom would be "safe" to use or not. Knowing that it was clean, hygienic, with running water, soap, etc. was the level of awareness they sought, adding that it would *"take a burden out"* and make them *"secure", "carefree", "less worried", "more prepared",* and *"end the crisis-ness of that moment."* One participant (P30) shared: *"Just like the things are on Google where you can actually see the places and everything that makes our life so easy, so similarly if we have that kind of information on our phone that how secure is this place, what are the amenities in the washroom, what kind of people are here and what time is it crowded or not crowded then that will be helpful."* Additionally, participants also valued receiving information about such facilities through posters, newspapers, and hoardings: *"If some hoarding or board could be placed that 'safe female washroom ahead,' something like that will be helpful"* (P19). Another way of getting at this information was through reviews or ratings indicating the experiences of other women (to the extent that this information could be deciphered). Participants expressed a willingness to

consider using a public washroom if there was information about its use. For example, information about the location of Metro washrooms was seen as desirable, since these were *"still relatively in better condition, and there is a staff which takes care of it, but the same can't be expected from a public toilet"* (P24).

Additional information that participants cared to have was whether public (or Metro) washrooms had women attendants or not. If so, this would add to their comfort levels. As S4 shared: *" So outside the public washroom usually, a guy sits over there charging you for it. So if there is a woman that will undoubtedly [bring a] change. It will be more comfortable"*. These attendants are typically male, and participants felt that if they were informed and empathetic, it could transform their experience of the washroom. As P32 expressed, *"I want this one thing. I don't know how overly ambitious I am being, but yes, the male guards of the Metro station washroom should not be unaware about the situation...they should be informed."*

A Period-Empathetic Environment
Participants revealed a continual awareness of who was around them (and their genders). They naturally preferred the company of a female friend or family member over being alone. When traveling alone, finding oneself surrounded by a crowd of women, even if they were strangers, was acceptable because they would "empathise and not judge", be "understanding", or "offer help" (perhaps in the form of a sanitary product). Amidst a predominantly male crowd, participants felt the fear of being judged, especially if they had a period stain.

> *"It becomes a hoopla right, if they see a stain. I don't want anyone to judge me. I want everyone around to do their jobs and not stare if they see a stain. They should be concerned at the most but not judgmental." (P28)*

With regards to male company, either family members or friends, participants shared mixed feelings. Many participants viewed them as part of their comfort zone, as shared by P25: *"It doesn't matter from which gender the person [companion] is because it will be my comfort zone as compared to everyone else in that situation or area around me."* This did not hold, however, when participants felt that their companions might have old-fashioned beliefs on the topic of menstruation. Age was seen as a factor here, as P30 shared:

> *"I will ask for help from people around me irrespective of their gender. In fact I have done this couple of times where I have approached people specifically males for help and I have seen that people from my age group, not too old people, are actually very understanding about it. As far as I have met them, I can't speak for general case."*

Underlying these attitudes was the aspiration for a safe space where individuals across gender and age could be seen as empathetic, not likely to judge or stare.

DISCUSSION
As in Brewer and Dourish's *storied spaces*, we found that our participants' encounters with space were framed by cultural logics, "a series of collective understandings through which space and spaces take on different kinds of meaning" [26].

By studying participants' responses to their surroundings during MHM, and contrasting these with the Delhi government's (and other) attempts to introduce toilet-locator applications, we imagine how technology design might support new forms of "environmental knowing" [26]. Brewer and Dourish posit that "information technologies are deeply implicated in the operation and emergence of these logics, and the forms of collective encounters in space", and we unpack these implications below. We do so by dwelling on the constructs of *legibility, literacy,* and *legitimacy* introduced by the authors [26].

Legibility: Panoptic, Local, and Personal
Brewer and Dourish discuss *panoptic* and *local* legibilities. They define panoptic legibility as a "centralized form of legibility, in which a standardized scheme can be applied across multiple settings and locales in order to measure and compare them" [26]. "It is almost by definition", they say, "a view from nowhere" [26]. By contrast, local legibility is defined to be the view "from within" or "on the ground" [26]. These references are reminiscent also of Haraway's notion of partial and *situated knowledges* [49], reminding us that there are not only panoptic and local legibilities at work, but also *personal* legibilities. The view is different per individual, based on diverse navigational experiences. Just as the authors find that the elements of the everyday world such as individuals, places, activities, etc., are "not elements of the physical world to be uncovered and recognized, but elements of the social world", it is the elements of the everyday world our participants encounter that make up their social worlds [26].

The Delhi government offers online maps that can be used to locate public washrooms, but even when participants were aware of these resources, and had affordable access to them, they chose not to utilise them. Although mapping such information seemed intuitive, we realised that participants desired a more relevant map to inform their mobility across these spaces. There is a tension between *panoptic* and *local* legibilities here. Each participant had a different *personal* compass for navigating to their safe spaces as they dealt with their periods in transit. Some were okay with male companions, others preferred the solidarity of women's presence, perceptions of crowds differed, and the desirability of washrooms, cars, homes, etc. was different across participants. These factors shaped the extent and nature of participants' mobilities, highlighting that although the physical public infrastructure of toilets was key, these made up the panoptic view. The local and personal layers were often different, and yet the ones that mattered for use.

Literacy, and the Vocabularies of Menstruation
According to Brewer and Dourish, literacy entails representational practices, or practices through which representations are brought into existence, used, shared, and manipulated [26]. In our context, these representations indicated the menstrual (im)mobilities of participants. Spaces acquired meaning once participants were able to annotate them appropriately to convey their preference, whether it was for a washroom in a public setting, a private vehicle, or the home of a relative. Digitisation of these annotations could make maps more legible and meaningful for individuals, but are only possible when individuals

indicate what they do or do not prefer in/as their safe spaces and why. As identified by Lazar et al. [63] in the context of describing menopausal experiences, a significant challenge in our case is also of *vocabularies*. Because menstruation is a stigmatised topic, participants remained generally reticent, avoiding using terms that would make them or others feel uncomfortable. Thus, *period vocabularies* can help towards defining the scope of menstrual mobilities, but are generally imprecise and unlikely to convey sufficient detail; for example, pads or tampons were frequently referred to in vague terms as "things." The language of stains was generally not even talked about, but tacitly understood.

Legitimacy, Across Social Groups
Brewer and Dourish note that an environment can be viewed differently by different people from different vantage points, shaped by diverse backgrounds [26]. They also recognise that "these different epistemologies do not always sit comfortably side by side, but are frequently in tension with each other" [26]. The gendered context of MHM was expected and evident, and highlighted that many spaces—not only washrooms—were viewed by participants through the lens of whether they were safe spaces for MHM, during their periods. This difference is seemingly recognised by the Delhi government, based on the design of *pink toilets* that make special allowances for women and adolescents in this regard. However, such existing infrastructures must convey a culturally situated understanding of safe spaces, at least from the perspectives of those intended to use these facilities. Participants clearly indicated not wanting to draw particular attention to their sanitation needs, but the *pink toilets* explicitly draw attention to their presence and purpose. Similar tensions were observed by Bardzell et al. [19] while discussing design frames for a positive menopause experience. Participants' safe spaces did not favour male presence, or if they did, then the male company was explicitly young and non-judging. Participants also wanted many women around whom they could derive solidarity (and sanitary products) from, like in the women's coach in the Metro. These are indicators of the stigma that must be neutralised for menstrual mobilities to be preserved, for more spaces to be seen as safe, and for individuals' menstrual needs to be legitimised. This will ensure that individuals are able to *recognise, express,* and *address* their MHM needs.

Towards a Third Space for Menstrual Mobilities
As per Brewer and Dourish, technology is a site where social and cultural categories are put into practice [26]. We now make design recommendations for a representational analogue of safe spaces to support and enhance menstrual mobilities.

It is first crucial to assure *legitimacy* from the vantage points of different social groups—those who menstruate but belong to different economic backgrounds, or are differently affected by stigma, as well as other individuals who are seen as judging or disapproving, but could potentially be more empathetic so as not to hurt the perceived safety of others' spaces. Prior work on online information sources such as Menstrupedia [90] have highlighted that there are often friends and family who may not menstruate, but are keen to provide support. Further, the use of mobile apps is heavily gendered across India [12],

and targeting male audiences to solicit their engagement could widen reach for target users as well through intermediated access. For example, in cases where a phone is shared with a male spouse, intermediated access could be leveraged, and apps could be designed to cultivate allyship and convey information discreetly, which could be of value to other users as well. Toilet locator apps could thus explicitly be designed to *(1)* reach such individuals, with a view to engage them in *period empathy*, and *(2)* possibly linking to Menstrupedia as appropriate. The content could also be designed to combat taboos by drawing inspiration from Menstrupedia's site [67].

As the use of washrooms (and other static and dynamic safe spaces constructed by participants) is gradually legitimised for MHM needs, barriers to *literacy* would be reduced. The design of mobile apps could be culturally situated by drawing on the *period vocabularies* that we found our participants to use (or not use), also making allowances for non-verbal cues—such as appropriate emojis—that individuals could use to annotate spaces. These apps could additionally aim to *enhance* the vocabularies of those who are not currently comfortable using any. This could help with combating stigma as well.

Finally, the *legibility* of existing infrastructures can be augmented based on the insights gained through our research. Here we prioritise *personal* legibility, so that women can easily access data meaningful to them, regarding spaces that they have historically considered safe—such as a friend's home, or a washroom in a bookshop they have visited. Annotations thus expressed could enhance *local* legibility via toilet locator applications, to incentivise and make it easier for users to communicate their reviews of spaces with others, expressing solidarity digitally not only in person. The *local* legibility must also fed into *panoptic* legibility, however, so that both state authorities and private establishments can be informed and held accountable for the state of their washrooms.

It is not the provision or operation of physical infrastructures that we are after, *i.e.,* additional public washrooms or pervasive pink toilets, but recommendations for technologies that facilitate mobilities across existing infrastructures. We view toilet locator apps thus as a potential *third space*, a "fertile environment" where individuals can bring diverse, culturally situated knowledges towards new insights and plans for action [21, 69], *i.e.,* where users can recognise, express, and address their MHM needs safely. We focus therefore on the potential for the existing information infrastructure of toilet locator apps to address a larger set of scenarios than it is currently addressing. This is not only to make them achieve their goals of making washrooms easier to track around the city, but also to target a more holistic approach to supporting menstrual mobilities of (many of) their target users. Prior HCI research on systems in this vein, such as Protibadi and Hollaback! [2, 33], have emphasised the need to ensure that these systems are not appropriated to serve perilous purposes. This is also of critical importance in our context, given that Delhi is popularly held to be unsafe for women. However, combating this lack of safety, particularly when viewed through the lens of menstrual mobilities, is also the driving force of our research.

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