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Integrating poverty alleviation and environmental protection efforts: A socio-ecological perspective on menstrual health management

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ABSTRACT

Apt menstrual health management is crucial to the livelihood of low-income, bottom of the pyramid (BOP) women as well as to environmental conservation. However, knowledge is still scant about the factors underpinning women's preferences towards menstrual products, and whether and how the environmental impact of different solutions matter to women's choices. We address this gap by proposing a socio-ecological perspective to understand whether a product's low environmental impact enhances low-income women's uptake of sanitary napkins, thereby supporting poverty alleviation objectives but also efforts geared towards environmental protection. Results from a discrete-choice experiment involving 164 women (n = 1148) in two Indian slums in Delhi and Ahmedabad show that sanitary products' biodegradability is the most important attribute affecting women's preferences towards menstrual hygiene management solutions, which also significantly interacts with women's socio-economic and socio-cultural characteristics. Our findings highlight the potential for business models to find positive synergies between environmental protection and poverty alleviation goals and to situate solutions within the larger socio-ecological context of receiving communities.

1. Introduction

The use of disposable sanitary pads among disadvantaged women has been at the center of public policy debates as a viable alternative to improve menstrual hygiene at the bottom of the (income) pyramid (BOP hereafter) (UNICEF, 2019). Menstrual hygiene management is an under-looked yet growing health challenge, because of its impact on women's physical health, psychological well-being, and income-generation opportunities (World Bank, 2018), and because of the catastrophic environmental implications of sanitary products associated with female menstrual cycle (Elledge et al., 2018; George, 2016). Advocacy in the public policy field around improvement of menstrual health has been supported by an increasing body of literature highlighting the strong relationship between menstrual health and socio-economic outcomes (Rossouw and Ross, 2021; van Eijk et al., 2016). UNICEF statistics show that, due to poor sanitation products, more than 50% of women in Bangladesh and more than 66% in Nepal miss out on everyday activities - such as school or work – while on their menstrual cycle. In Chad and the Central African Republic, the percentage is one in three women (UNICEF, 2022). Lack of awareness, poor health literacy and unavailability of hygienic menstrual products lead to a higher risk of reproductive tract infections (Das et al., 2015; Majeed et al., 2022), with an estimated 70% of them being associated with poor menstrual health management (Venema, 2014). Infection deriving from improper use of cloth leads to a high likelihood of missing working days, with heavy repercussions on women's livelihood (Garikipati and Boudot, 2017). Misinformation around menstrual health is also widespread, as only 3.1% and 1.5% of women received information on menstruation from teachers and health workers respectively (Afiaz and Biswas, 2021; Misra et al., 2013). Various factors such as schooling, place of stay (rural vs urban), profession of the father, age of marriage, caste and access to media affect the adoption of safe menstrual practices among teenage girls (Afiaz and Biswas, 2021; Khanna et al., 2005; Lohani, 2019).

The campaigns aiming at promoting fast uptake of disposable sanitary pads in India and in several developing countries have been met with strong criticism, because of their impact on local waste disposal systems and environment (Garikipati and Boudot, 2017). Multinational corporations in countries such as India have traditionally advertised Western, plastic-based disposable sanitary products as hygienically superior to traditional methods. However, this solution has dramatic environmental consequences, in India and worldwide (National Geographic, 2019). Sanitary napkins contain about 20 g of plastic (up to

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90% of their weight). Considering that women menstruate around 1400 days from menarche to menopause (Sumpter and Torondel, 2013), and use about five sanitary items per day (including tampons, their applicators and their plastic packaging), this will result in 125-150 kg of plastic waste in a woman's lifetime (Bharadwaj and Patkar, 2004). Only in the UK, 200,000 tons of menstrual waste are disposed of every year through sewage and landfills (London Assembly - Environment Committee, 2018). The use of sanitary pads is still confined only to urban areas and among higher educated women in India, where only 12% of overall women population use sanitary pads (Venema, 2014). The remaining 88% mostly rely on cloth and in some cases on hay, ash, wood shavings, newspapers, dried leaves, or plastic (Sinha, 2011; The New Indian Express, 2018). Still, about 113,000 tons of menstrual products (around 12.3 billions sanitary napkins) are disposed of every year in India (Path, 2017), with Bengaluru, a large city in the southern part of the country, alone generating 90 tons of menstrual waste per day (George, 2016). This poses critical issues for the waste disposal system. Incinerators are rare and can have unpleasant environmental impacts if used at scale. Sanitary pads are often disposed in fields. India's waste disposal infrastructure is already overloaded. Moreover, a large share of garbage disposal is taken care of by low-caste waste-pickers. If the use of sanitary pads scales up to large mass use, it will translate to both an extraordinary burden on the fragile waste infrastructure and a biohazard for the humans who deal with them. Even when sewers do work, they can be easily clogged by sanitary pads, designed to absorb liquid and expand (Gould, 2016; National Geographic, 2019).

The case is compelling for new (business model) innovation efforts in the domain of menstrual health, to improve women's livelihood and reduce the ecological impact of current solutions. However, initiatives are hindered by taboos surrounding menstrual products in developing countries. The 2020 Academy-award nominated documentary produced and streamed by Netflix titled "Period. End of sentence" reports the taboos surrounding menstrual health in India, which lead to widespread ignorance surrounding menstruations, young girls contracting infections and dropping out of school for lack of availability of, and awareness towards, adequate sanitary products (Zehtabchi, 2018). Lately, grassroots enterprises have emerged that locally produce environment-friendly, socio-culturally acceptable napkins to replace the use of cloth. However, product affordability and availability impair scaling up, and these initiatives remain limited (Musaazi et al., 2015; Pansera et al., 2016; Venema, 2014). Their penetration in the market is small, with the majority of urban middle- and upper-income women opting for Western non-biodegradable and disposable products. At the same time, theory and practice related BOP business initiatives – hence, business models that aim to serve low-income populations and communities through specifically designed products and services (Angeli, 2021; Prahalad and Hart, 2002) – have been mostly focused on poverty alleviation efforts, while devoting much less attention to environmental issues and to the tight linkages between poverty alleviation and environmental conservation.

Addressing this gap, this paper aims to understand BOP women's preferences for menstrual health products through a socio-ecological lens (Mcleroy et al., 1988; Moore et al., 2013). This view highlights how health-enhancing individual behaviors – including the adoption of health-enhancing products or technologies - can be explained through the interplay of multiple interdependent factors at individual, interpersonal, community, organizational and policy levels (Mcleroy et al., 1988; Sword, 1999). We employ this theoretical lens to examine to what extent a product's environmental sustainability aspects (such as reusability and biodegradability) influence BOP women's product choices, directly and through the interplay with other factors at different levels of analysis. We thus aim to create a new, in-depth "understanding of the needs and specific cultural context of low-income consumers in their target market" (Ratcliff and Doshi, 2016: 272), by embedding people's views in a process of business model co-creation (Gardetti & DAndrea, 2014).

2. Theoretical background

2.1. The evolution of the BOP business approach

The conceptualization, implementation and empirical investigation surrounding BOPbusiness models for poverty alleviation have dramatically evolved since Prahalad's and colleagues' seminal studies (Prahalad, 2006; Prahalad and Hammond, 2002; Prahalad and Hart, 2002). While initially the focus of this body of work was on the participation of large multinational corporations in the BOP markets, over the years the importance of locally grown social enterprises has increased substantially (Webb et al., 2010). BOP communities have evolved from mere consumers of goods and services to suppliers, entrepreneurs, producers, distributors and co-inventors of solutions (Simanis et al., 2008). Value proposition and value creation have spun out into a process of value discovery, which involves close dialogue with communities and an in-depth understanding of their needs, fostered through a process of co-creation of both needs and solutions (Angeli et al., 2018; Angeli and Jaiswal, 2016; Nahi, 2016; Yunus et al., 2010). The need for embeddedness into the local environment has come to the fore, along with the necessity to promote long-term, trust-based relationship with a multitude of stakeholders, from communities, to local NGOs, to governments, to other private businesses with complementary competencies and assets (Duke, 2016).

One common element that has remained unquestioned across the wide variety of BOP theoretical approaches and empirical practice over time is their focus on poverty alleviation, with far less attention devoted to environmental concerns (Kolk et al., 2014; Nahi, 2016; Zhao et al., 2016), which extends also to business models addressing global health issues (Angeli and Jaiswal, 2016). Understanding environmental sustainability of BOP initiatives is, however, crucial to the development of successful and sustainable business models (Arnold and Williams, 2012), particularly as environmental protection is closely linked to poverty alleviation in non-trivial ways (Hahn, 2009). Current consumption patterns at the BOP are typically more eco-friendly and in harmony with the natural environment, as they favor products reuse, vegetarian diet, use of public transportation and less energy consumption (Zhao et al., 2016). Introducing new, Western-inspired products and services in disenfranchised settings also means promoting consumeristic models and lifestyles, which will not be sustainable if adopted at scale by the BOP population. As human life relies on natural resources for food, shelter, energy, and water, lifting BOP masses from poverty through enhanced access to satisfy unmet primary needs will be ecologically challenging. At the same time, poverty alleviation and environmental sustainability can produce synergies (York and Dembek, 2021). Scholars (e.g. Hahn and Gold, 2014) underline that, because BOP lifestyle, norms and values are very reliant and in co-evolution with the natural environment, interventions to preserve ecological resources will spill over into enhanced well-being. Moreover, because poverty often leads to environmental degradation, alleviating poverty will also improve the protection of natural resources.

2.2. Incorporating environmental sustainability in BOP co-creation initiatives: A socio-ecological perspective

Despite the large emphasis of BOP literature on users' values and needs as an important starting point to designing business models (Angeli et al., 2018; Angeli and Jaiswal, 2016; Nahi, 2016), particularly when addressing global health concerns (Angeli and Jaiswal, 2016), knowledge of whether environmental impact plays a role in BOP individuals' choice of products and services is still entirely missing. As noted by some authors, the lack of this perspective is surprising and concerning (Arnold and Williams, 2012; Kolk et al., 2014; Zhao et al., 2016), as scant knowledge about environmental implications of BOP strategies hinders the development of BOP business models that can contribute to alleviate poverty *and* promote environmental

sustainability, with an integrative view (Pinkse and Kolk, 2012; York and Dembek, 2021).

Advancing this stream of literature, this study is the first to investigate how environmental concerns influence BOP consumers' product choices. We do so by adopting a socio-ecological perspective to understand individual behavior and consumer preferences. The socio-ecological view has its roots in the ecological perspective advanced by the work of Brofenbrenner (1979), which aimed at explaining individual behavior as influencing and being influenced by multiple environmental factors, at micro-level (i.e. face-to-face interactions with family and informal social groups), meso-level (i.e. interrelations between the various settings an individual is embedded into, such as family, school, sports club or church) and the macro-level (i.e. policies as well cultural beliefs and values shared by the community or country). This model has been then extended and refined to a more encompassing socio-ecological perspective through its application in the domain of health promotion initiatives (Golden and Earp, 2012; Mcleroy et al., 1988), to explain health-seeking behavior for prenatal care (Sword, 1999), to study food choice in schools (Moore et al., 2013), the interventions to tackle social inequality or to examine comprehensive social change dynamics (Costanza, 2014). In its most common formulation (Mcleroy et al., 1988), individual behavior is explained by the dynamic interaction of different sub-systems, namely intrapersonal attributes (i.e. characteristics of the individual, including education, employment, skillset, attitudes), interpersonal processes (i.e. interactions within formal and informal social networks and groups), institutional factors (i.e. social institutions and organizations that define formal and informal rules and norms), community factors (i.e. relationships among institutions and informal networks), public policy (macro laws and policies).

We argue that an adapted version of the socio-ecological lens could provide an effective theoretical lens to understand products' preferences at the BOP, by considering the interactions of determinants at multiple levels and systems, and including the impact of environmental degradation. Prior research widely documents the influence of social networks and family consultations in defining healthcare utilization decisions for low-income patients (Das et al., 2020) and in the adoption of health-enhancing products (Angeli and Jaiswal, 2016). Socio-cultural acceptability of product and services emerges inherently as the outcome of decisions at family and community levels (Angeli et al., 2018). Affordability with respect to product price points is also understood and assessed within the broader resource prioritization decisions agreed within families, and aspects of product availability, awareness and acceptability largely rely on community-based processes and channels. For example, product awareness tends to be enhanced by word-of-mouth or door-to-door advertising (Angeli and Jaiswal, 2015), while product and service availability – especially for health-related goods and services that might be sensitive or lead to stigma – is influenced by the possibility to rely on channels that are discreet or familiar. In addition to intrapersonal, interpersonal (family) and community factors, we argue that the natural resource environment will also influence product preferences in the form of environmental impact.

Fig. 1 highlights how individual product choices are shaped by a set of multilevel factors according to the proposed socio-ecological theory, and how such factors can be operationalized within product characteristics. The individual's age, education and income level – namely the intrapersonal, micro-level attributes of potential consumers – are likely to shape the perceived benefits of products. At interpersonal level, family circumstances – such as household size and marital status – are likely to be drivers of resource prioritization decisions within the household and hence influence the perceived affordability of the product. At community level, social networks facilitating word-of-mouth and widespread product or service adoption will likely influence the degree of familiarity with the product/service. The individual's dependence and awareness of the natural resource environment will emphasize the environmental impact of the product and its weight in defining individuals' product preferences. Finally, societal norms and values, as shaped by public policies but also by market actors – such as multinational corporations – will enhance the legitimacy and acceptance of some products over others. These multilevel factors will jointly influence individuals' product preferences, both directly and in interaction, as predicted by the socio-ecological model.

3. Methods

3.1. Empirical setting

This study is set in India, one of the countries in the world with the highest percentage of individuals living in slum settlements. A rough estimate based on the 2011 Census indicates as many as 64 million people living in slums, defined as 'settlements of at least 60 households deemed unfit for human habitation' (Rahman, 2013). Data collection has been conducted in two randomly selected slums in the metropolitan areas of Ahmedabad, the capital city of the state of Gujarat, India and

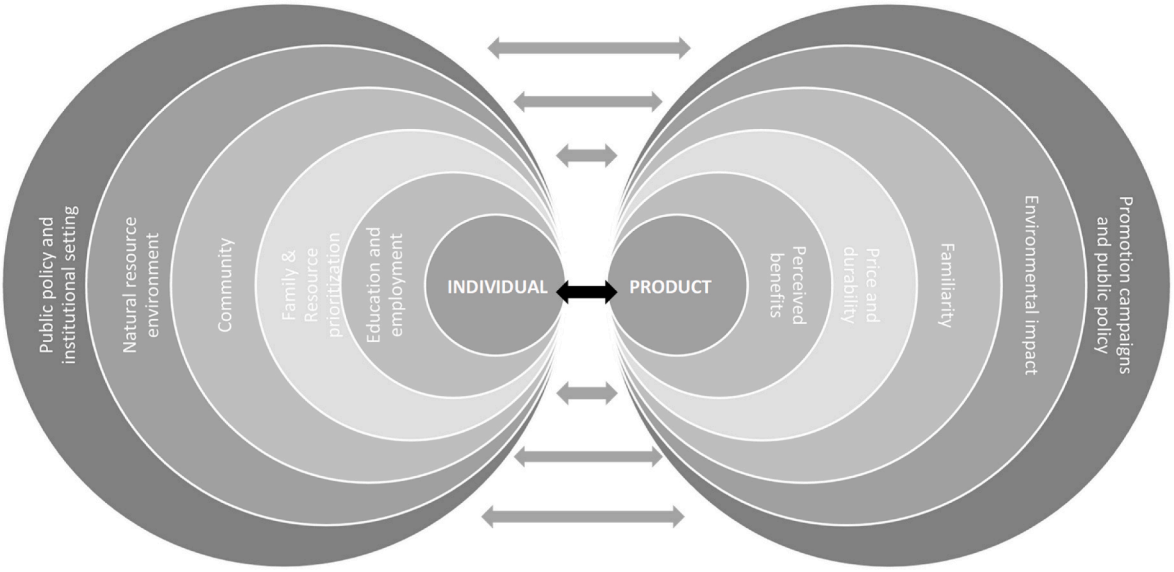

Fig. 1. Socio-ecological model of product preferences.

New Delhi, the country capital. Ahmedabad has over 1 million slum dwellers (part of 229 thousand families) who reside in 739 designated slums in different parts of the city (Urban Management Centre, 2013) and attracts migrants from rural areas. The capital city of New Delhi has an ever-growing population of slum-dwellers, and the latest estimate counts 1.8 million residents living in 22 slums (Kaiser, 2017). Ahmedabad and New Delhi present a comparable percentage of people residing in slum settlements, calculated at 13.7 and 18.7 respectively (Sawhney, 2013). Slums present unique health challenges as overcrowded human settlements with poor clean water and sanitation, severely limited availability of high-quality health facilities, and with highly idiosyncratic socio-cultural and socio-economic impediments to health-seeking behavior and health access (Das et al., 2020).

As a precursor to our quantitative analysis and to gauge an understanding of the values and beliefs surrounding menstrual health management in urban slums, we consulted a variety of published sources specifically addressing the use of sanitary products in India. We identified a total of 57 sources published between 2010 and 2018, namely 30 press releases, 1 case study, 7 blog posts, 4 policy reports, 7 scientific articles and 8 organizations' websites, with the purpose to grasp how the public opinion – also shaped by public policies and marketing campaigns – perceives the use of menstrual health products in India and in the urban slums particularly. We then analyzed the sources through a semantic analysis and derived word frequencies through a qualitative analysis software (MaxQDA). The relative word frequencies were plotted into a word cloud using Wordart.com, which aimed to visually represent the public narratives surrounding menstrual hygiene management. This search and related findings are deemed particularly relevant to operationalize the outer layer of our socio-ecological model, namely the institutional setting.

As a second stage in our preparatory work leading up to the DCE design and implementation, we conducted a total of seven semi-structured interviews in order to gain initial understanding of the women's perception of sanitary pads and various factors affecting their choices of sanitary products. Three interviews were aimed to understand the urban poor women's choice of traditional methods (such as cloth) over disposable sanitary napkins. Our sample included both old and young women. It was also important to gauge the perceptions of women who had been using these old traditional products earlier but have now 'moved up' to start using disposable sanitary napkins. Hence, three urban middle-class women were interviewed for the same. Since this research involves a sensitive topic that is typically subject to taboos and stigma (Joshi and Fawcett, 2001), there was a concern that women, especially those belonging to a low-income background, might abstain from providing accurate information and focus more on delivering a positive image about themselves. In order to overcome this issue, a third-party interview approach was utilized. The interviewee was therefore asked questions as though they were required to represent a third party, be it a relative or a friend, which in turn reduced the social desirability bias (Fisher, 1993). Finally, a gynecologist who specifically deals with rural women was also interviewed, to gain insight into the methods of using a cloth and how effective it is over a sanitary napkin, while considering safety and the product's environmental impact.

3.2. Data collection and analysis

We then conducted a quantitative study using a discrete-choice experiment (DCE) method to estimate the importance of different attributes in a sanitary product in driving the adoption behavior amongst low-income women. DCE is used to understand consumers' preferences for a given product or service (Černauskas et al., 2018), and it assumes that the degree to which a consumer prefers a service or an intervention varies with the value or level of specific product attributes (Ahmed et al., 2003). Taking a car as an example, relevant attributes could be the engine power, the price range or its level of CO2 emissions. The DCE was designed and completed in four stages - identification of attributes and levels, experimental design, data collection, data interpretation and analysis (Lancsar and Louviere, 2008; Ryan et al., 2008).

3.2.1. Identification of attributes and levels

This type of DCE requires participants to choose one product profile over another (choice between two alternatives), multiple times. The product profiles (or choice sets) are composed by the same combination of attributes, with different levels. Hence, the choice sets are distinct because of the variation of one or more attributes across their specified levels (Mangham et al., 2009). Our socio-ecological model depicted in Fig. 1 provided a general framework to identify attributes that could reflect the influence of inter-personal, community, environmental and policy factors on products' preferences. Results from our seven qualitative interviews and general literature were used to identify such attributes, following recommended guidelines for designing DCEs in low-income settings (Černauskas et al., 2018; Lancsar and Louviere, 2008; Mangham et al., 2009).

The final chosen attributes covered all aspects of the socio-ecologic model, whilst being parsimonious and validated through the qualitative interviews. Product affordability is linked to family circumstances and resource prioritization choices and has been operationalized through different price points. Absorption power and reusability were used to operationalize perceived benefits (linked to individual educational background and employment characteristics, but also to the possibility of reducing disposal occurrences that could be associated with safety or stigma concerns). Product biodegradability was explained to the respondents as the product's capability to dissolve completely in nature without any adverse effects, while reusability was used to indicate the product's ability to be repeatedly used, such as clothes after wash. Both attributes of biodegradability and reusability reflected the product's positive environmental impact (linked to sensitivity to the natural resource environment). Finally, familiarity with the seller emerged in the qualitative interviews as the most prominent factor that could reflect the community-level influences towards the product purchase. Four of the final five attributes were dichotomous, while the price of the product consisted of three levels to differentiate between products that were entirely free from cheap (50 INR) or more expensive products (100 INR). 'Absorption Power' was chosen as a quantitative attribute, while 'Reusability', 'Environmental Factor' and 'Seller' were chosen as qualitative attributes. While public policy and higher-level institutional influences were difficult to embed among product characteristics, these have been investigated through the preliminary search and analysis of press and social media sources. The final list of attributes and levels chosen are indicated in Table 1.

As the socio-ecological model theorizes co-dependencies between individual and environmental factors, individual characteristics such as respondents' age, education, income, household size and marital status have been analysed in interaction with product attributes to determine consumers' product preferences. These characteristics are important as they reflect other aspects that could not be directly captured because of parsimony and variance considerations. For example, women's financial

Table 1
List of attributes and respective levels.

Attributes	Attribute Levels and Regression Coding
Price of Product	1. Rs 50 per month - 50 2. Rs 100 per month - 100 3. Does not cost - 0
Absorption power	1.4–5 h - 0 2.6-10 h - 1
Reusability	1. Cannot be reused - 0 2. Can be reused - 1
Environmental Impact	1. Non – biodegradable – 0 2. Biodegradable - 1
Seller	1. Unknown - 0 2. Known - 1

independence is likely to play an important role in their product choices. Owing to the sensitive nature of this aspect, whether women have the latitude to make their own financial choices is reflected directly in the use of price as an attribute (and the possibility to select free products only) and indirectly with the household's monthly income (assuming that a higher income, probably because of their own independent salary, gives them more financial discretion), with the marital status (assuming that being married may affect the independence on purchasing decisions) and with the household size (assuming that the larger the household, the tighter and more complex are the budget considerations). Other relevant considerations, such as the availability of water to wash sanitary products or space to dry them, are instead likely to constitute widespread issues that apply to most women living in slums, thereby generating little variance for quantitative purposes.

3.2.2. Experimental design

Although various methods of designing a DCE experiment were used in previous studies (Clark et al., 2014; Lancsar and Louviere, 2008), the "Constant Comparator" type of DCE approach was chosen for this experiment, because it generates minimum number of comparisons and allows "meaningful estimation of the main attribute effect using a minimum number of comparisons" (Baji et al., 2012; van de Schoot et al., 2017). The given number of attributes and levels generated $3^1 \times 2^4$ (One attribute with three levels and four attributes with two levels) equal 48 choice scenarios and is termed as Full Factorial Design. An orthogonal design comprising of the given attributes and their respective levels was created in IBM SPSS (Version 23) software, which generated 8 profiles that satisfied the criteria of orthogonality and proper overlap. It was not possible to achieve a perfect level balance due to the presence of one attribute with three levels. In order to make the questionnaire realistic, one profile that comprised of the most realistic levels of each attribute was chosen and named as Base Profile. The remaining seven profiles were named as Alternative profiles. The base profile and alternative profiles are provided in Table 2. Because the study is specifically interested in understanding how attributes influence product choice, rather than the intention to purchase as in other methodological approaches (for example, willingness-to-pay studies), we preferred a 'forced adoption' scenario, in which the respondent has no 'do not buy/adopt' option (Abuya et al., 2021). This design choice simplifies the questionnaire and focuses the enquiry, as it allows for singling out which attributes are relevant when the target woman is confronted with a forced choice of a sanitary product for her menstrual hygiene management. This 'forced choice' choice is also deemed in line with the real-life decision-making processes that women face during their menstrual cycle: whilst they can prefer a product over another, they cannot altogether opt out from using any menstrual health management solution.

Each alternative profile was then consequently compared with the base profile to generate seven choices or questions (Appendix A provides a sample choice set) (Mangham et al., 2009). In order to generate a last (8th) question, the first choice set was replicated with the interchange of order of base and alternative profiles to establish consistency of responses (WHO, 2010). Each respondent was then presented with the 8 questions, and was required to make 7 choices between the base and the alternative profile. It was also very important for the participants not to know that a common base profile was present in all eight of the questions, hence, leaving out the specified order of the first and eighth questions, choice orders were shuffled in the remaining questions. To facilitate the respondents' understanding of the questionnaire, a hypothetical scenario was created, where the women were asked to imagine a situation in which someone they know was supposed to purchase a menstrual product from a hypothetical shopkeeper during their menstrual cycle.

Table 2
Comparison of base profile to alternate profiles in the form of regression coding.

Attributes	Base profile	Alternative Profiles						
		1	2	3	4	5	6	7
Price	50	50	50	50	100	0	0	100
Absorption Power	0	0	1	1	0	0	1	1
Reusability	1	1	0	0	0	0	1	1
Environmental impact	1	0	1	0	1	0	1	0
Seller	0	1	0	1	1	0	1	0

3.2.3. Sampling and data collection

The sample for the DCE consisted of 164 randomly selected low-income women, residing in two randomly chosen urban slum of Ahmedabad and New Delhi. Because in the experimental design each respondent provides 7 choices, the total number of observations is 1148 (164 × 7). The slum and respondent selection followed a multi-stage randomized sampling strategy, in line with previous work conducted in the same setting, with successive randomization being applied to city sections, wards, slums and households (Černauskas et al., 2018). Refusal to participate in the study was very marginal, and in the few cases, responses have been collected from the household immediately adjacent. Questionnaires have been administered face-to-face in the local languages Hindi and Gujarati by one of the authors or trained research associates with the support of two local guides. In terms of sample size, a rule of thumb produced by Orme (1998) and Johnson and Orme (2003) indicates that for this study, an acceptable sample should include at least 107 respondents[1], well below the 164 women included in our study, and in line with the threshold number of 100 used by prior work ((Lancsar and Louviere, 2008).

Table 3 shows the socio-economic characteristics of the respondents who have participated in the experiment, distinguishing between the Ahmedabad sample (80 women) and the New Delhi sample (84 women). The mean age of the participants was 28.3 years living in an average household of 5.2 members in Ahmedabad, while in Delhi the average was 26.5 years living in a household with on average 5.4 members. Out of the total number of participants, in Ahmedabad, 83.75% were married while the rest were single, against 56.57% in Delhi. The majority of women in Ahmedabad (68.75%) had only received primary level education, while in Delhi, a significant share had received secondary (30.95%) and high secondary education (15.48%). Only 6.25% of women had received college level education in Ahmedabad, comparable to 8.3% in Delhi. In both sites, a significant majority of participants fell in the category of families that earned between Rs 5000–15,000 each month. The below poverty line for an individual living in urban settings in India is given at Rs 47 a day, amounting to Rs 1410 monthly. For an average household of 5.2–5.4 members, this would amount to Rs 7000–8000 a month. Hence, hence most of the participants fell in the range or there were slightly above the poverty line.

3.2.4. Data analysis

Each response has first been analyzed to check for completeness and inserted in the database. Following prior work (Baji et al., 2012; Černauskas et al., 2018), we used random-effect logit regressions to model the choice of a profile. The choice was coded as '1' when the alternative profile was selected, and with '0' otherwise. Independent variables in this model were the difference between the levels of each attribute in each profile. As the product price attribute had three levels,

[1] Olme's formula is $n \geq 500c/ta$, *where:* n is the number of respondents, t is the number of is the number of tasks (so how many choices the respondent is required to produce) a is number of alternatives per task (so how many profiles the respondent is asked to evaluate per task) c is the number of analysis cells. When considering main effects, c is equal to the largest number of levels for any one attribute. Applying the above formula to our case, with 7 tasks involving 2 alternative profiles and 3 as the number of levels (since the price attribute has three levels), the minimum N is returned as 107.

Table 3
Socio-economic characteristics of all respondents and associated coding.

Ahmedabad sample			New Delhi sample		Coding
	Mean	SD	Mean	SD	
Age	28.36	8.89068	26.50	11.57	18–35 years = 0 36 and above = 1
Household Size	5.29	2.49655	5.43	2.23	1-4 members = 0 5 members and above = 1
Marital Status					
	N	%	N	%	
Married	67	83.75	45	53.57	0
Single	13	16.25	39	46.43	1
Education Level					
None	0	0	10	11.90	0
Primary (1–7)	55	68.75	27	32.14	0
Secondary (8–10)	18	22.5	26	30.95	1
Senior Secondary (11–12)	2	2.5	13	15.48	1
College	5	6.25	7	8.3	1
Household Monthly Income					
Rs 0-5000	3	3.75	5	5.95	0
Rs 5000–10,000	38	47.5	37	44.05	0
Rs 10,000–15,000	19	23.75	28	33.34	1
Rs 15,000–25,000	15	18.75	12	14.29	1
Rs 25,000–50,000	5	6.25	2	2.38	1

two dummy variables were created to track attribute differences, while the other attributes were coded with one dummy. In addition to the model containing the main effects of the independent variables, a second model was run to examine the influence of socio-economic characteristics on the product choice, in alignment with previous work and with the socio-ecological model underpinning this study. As product choices are theorized to be the outcome of an interplay between individual (intrapersonal) and higher-level factors, we expect significant interactions between respondents' individual attributes and product characteristics. Interaction terms between the respondents' socio-economic variables (indicated binarily) and the differences between the levels of each attribute were therefore included. Quantitative analyses were conducted with STATA 16.0.

Ethical approval for the study has been obtained by the Ethics Committee of the Higher Education Institution to which two authors are affiliated.

4. Results

4.1. Preliminary qualitative insights from published sources

Fig. 2 represents the word cloud resulting from a semantic analysis of word frequencies. The figure reveals that the problem is perceived mainly as a 'health' issue related to 'hygiene' and 'sanitation', among 'adolescent' 'girls' in 'school' age. The word 'pads' appeared three times more frequently than 'cloth' (201 times vs 68 times). No significant mention could be traced about the environmental implications of sanitary pads, and, while the need for 'awareness', 'education' and 'access' emerges quite strongly. There is no further elaboration on the role of males, infrastructure and socio-economic or socio-cultural determinants of poor menstrual health management.

4.2. Preliminary qualitative insights from semi-structured interviews

Our qualitative interviews were particularly enlightening in emphasizing the aspects that were deemed as important by women when choosing a sanitary product, and particularly in evaluating the traditional cloth over other solutions. When questioned about the usage of sanitary napkins in their regular months as compared to the usage of cloth, a middle-aged, urban low-income woman mentioned:

> "No, I have never made use of a sanitary napkin in my lifetime. Even during travelling, I make sure that the cloth I use is tightly fit and long lasting, otherwise I altogether avoid travelling during those days. The regular cloth that I use is very comfortable and I throw it away after use every month so overall, it works as a sanitary napkin for me."

Since she had been living in the slum for the last fifteen years, we questioned her about the views of the younger generation of women in the slums towards the use of sanitary napkins and whether they would

Fig. 2. Wordcloud representing a semantic analysis of 57 online sources addressing menstrual hygiene management in India.

adapt to them more easily as compared to the older generations of women. She responded that,

> 'Most of the young girls in our community started off with a cloth, tried sanitary napkins due to peer influence and moved back to using cloth again. The major reason for their preference towards cloth is the reason that girls have become used to it and find it comfortable and familiar. While talking to girls, you yourself will understand that they find clothes softer and better to use and the concept of using sanitary napkins and comfort it may give are still not very well established within their minds. The difference or similarity of perspectives does not exist because these girls did have the option of using sanitary napkins, yet their own decision was to go along with disposable cloth.'

In order to confirm our findings regarding the preference of young girls towards cloth in this specific community, we talked to a young girl who responded by saying,

> "We use sanitary napkins on rare occasions, while travelling or when the flow is really heavy. Otherwise, the cloth that we use is good to go, comfortable and obviously inexpensive.'

Perceptions among middle-class urban women instead highlight the potential benefit of sanitary napkins over cloth:

> 'Since I have been using sanitary napkins for about 16 years, I believe sanitary napkins are a better option any day. The maintenance of cloth was a tedious task. It was thick, we had to remain conscious at all times, prone to leaking and had to be washed on the same day or within a few days. With repeated washing, the cloth tend to become a bit rough, and my mother had strictly told me to keep my cloth pieces privately, which made the task of handling it more difficult. Sanitary napkin can be disposed of after usage and makes my periods tension free.'

On the advantages of cloth-based alternatives, a young low-income woman noted,

> 'A sanitary napkin is user friendly, but a piece of cloth is far more comfortable when it comes to rashes and itching that sanitary napkins usually lead to. Sanitary napkins have infiltrated our lives in such a profound manner that it is difficult to choose cloth over it, but there is no denying that cloth in fact is an amazing alternative.'

The middle-class informants felt that it would be very difficult to convince or even suggest to women using sanitary napkin to shift to cloth, but the change from their normal plastic based sanitary napkin to a biodegradable napkin one would not be that difficult. Most of the middle-class women are scarcely aware of the raw materials that go into the manufacture of a regular sanitary napkin and when informed about the environmental effect of an average branded pad, they start seeing things in a different light. One informant said,

> 'I don't think anybody in our locality does deep research on sanitary napkins before purchasing them, butafter listening to the amount of environmental waste that is being produced, a better alternative such as cotton sanitary napkins or cloth pads need to come back into the market. Although the usage of cloth would be very difficult, the environmental cause is more important.'

Another woman of the same locality was questioned about her awareness regarding the technology that goes into the making of a sanitary napkin, she responded that,

> 'I am remotely aware that a sanitary napkin consists of plastic as well as a gel to lock the blood for a longer duration of time, but the process that goes behind it is not known. If things such as the high amount of environmental waste and the chemicals involved in the production of sanitary napkins are made public, the way Patanjali [a company selling natural herbal products in India and known for successfully convincing a large masses of consumers to go back to natural products instead of using chemical based products] products exposed the chemicals in various well-known brands, I think a significant change would come into the minds of the women who are actively using plastic based sanitary napkins.'

On awareness level and usage of sanitary napkins among the urban and rural poor, a gynecologist who specifically deals with rural women stated,

> "If we talk about urban poor women, who reside in the slums of Ahmedabad, they have a pretty good knowledge regarding sanitary napkins through advertisements and various educational initiatives. NGOs conduct workshops in different places regarding the use of sanitary napkins and how they are a better option over a cloth. These exercises have instilled a fair sense of awareness amongst the Urban Poor, but a large percentage of rural women still remain unaware of sanitary napkins. The main reason why urban poor women do not use sanitary napkins is because either they cannot afford them, or they do not want to adapt to a new change and believe that cloth is a better option. The other reason that prevails amongst them is culture. For years they have been using cloth as a means to absorb their menstrual flow and suddenly switching to sanitary pads may be a bit shocking and culturally wrong in their thoughts, especially when it comes to purchasing them from an unfamiliar shop. The rural women neither have apt knowledge nor are ready to add sanitary napkins to their monthly expenditure."

4.3. Quantitative findings

Table 4 reports the results of the random effects logit model with main effects only, hence without the interaction with individual characteristics. It is worth noting that the effects are presented with a Δ in front to indicate that the model tests whether the *change* in that specific attribute (with respect to the alternative profile) leads to a choice preference. Environmental impact (ΔEnvironment) – operationalized as biodegradability – is the sanitary products' attribute that most influences slum-dwelling women's purchasing decision. Biodegradable products are 4 times more likely to be purchased than non-biodegradable ones (OR 4.096, β 1.393, $p < 0.01$). Absorption power (ΔAbsorption) is the second most valued attribute; products that offer high absorption and hence need to be changed less frequently are preferred by 2.3 times (OR 2.325, β 1.085, $p < 0.01$). Knowing the seller (ΔSeller) is perceived as the third most important attribute; arguably, familiarity during the act of purchasing prevents women from being exposed to social stigma or embarrassment. The possibility to purchase from a known seller enhances product preference by 38% (OR 1.378, β 0.321, $p < 0.05$). Finally, the negative sign in the price attribute for INR 100 (ΔCost – 100) indicates that women mildly prefer a lower-cost version of the product.

Table 5 provides the results of the random effects logit model with the interactions between main effect variables with individual characteristics. To be parsimonious, only the interactions as well as attributes found to be statistically significant have been included in the table. The reusability attribute (ΔReusability), which was statistically insignificant in the main effects model, becomes statistically significant in the interactions model. The results indicate that women are 60% more likely to choose the reusable versions of the product over the non-reusable ones (OR 1.632, β 0.490, $p < 0.01$). The interactions between individual characteristics and the product's main attributes reveal that older women (35 and above) are willing to pay more for a sanitary product (Age*ΔCost – 100), as compared to younger women, while they value reusability 55% less (Age*ΔReusability - OR 0.555, β −0.589, $p < 0.1$). Single (unmarried or divorced) prefer more expensive sanitary products over free ones by 16% and 18% for sanitary solutions costing Rs 50 (Single* ΔCost – 50) and Rs 100 (Single* ΔCost – 100) a month

Table 4
Random-effects logit model without socio-economic interactions.

Base Profile – 0 Alternative Profile – 1	Odds Ratio	Coefficient	St.Err.	p-value	[95% Confidence Interval]		Sig
ΔCost - 50	0.995	−0.005	0.003	0.122	−0.012	0.001	
ΔCost - 100	0.992	−0.008	0.002	0.001	−0.013	−0.004	***
ΔAbsorption	2.325	0.844	0.121	0.000	0.607	1.081	***
ΔReusability	1.085	0.081	0.131	0.533	−0.175	0.338	
ΔEnvironment	4.026	1.393	0.143	0.000	1.113	1.673	***
ΔSeller	1.378	0.321	0.125	0.010	0.077	0.565	**
Number of observations (respondents)		1148 (164)		Chi-square		109.508	
Prob > chi2		0.000		Akaike crit. (AIC)		1347.956	

***p < 0.01, **p < 0.05, *p < 0.1.*

Table 5
Random-effects logit model with socio-economic interaction.[a].

Base Profile – 0 Alternative Profile – 1	Odds Ratio	Coefficient	St. Err.	p-value	[95% Confidence Interval]		Sig
ΔCost - 50	0.989	−0.011	0.007	0.118	−0.024	0.003	
ΔCost - 100	0.989	−0.011	0.005	0.036	−0.021	−0.001	**
ΔAbsorption	2.042	0.714	0.232	0.002	0.260	1.168	***
ΔReusability	1.632	0.490	0.283	0.083	−0.064	1.045	*
ΔEnvironment	6.020	1.795	0.269	0.000	1.269	2.322	***
ΔSeller	1.738	0.553	0.244	0.023	0.075	1.030	**
Age*ΔCost - 50	1.015	0.016	0.009	0.070	−0.001	0.032	*
Age*ΔCost - 100	1.016	0.016	0.007	0.025	0.002	0.030	**
Age*ΔReusability	0.555	−0.589	0.353	0.095	−1.282	0.103	*
Single*ΔCost - 50	1.016	0.016	0.009	0.080	−0.002	0.034	*
Single*ΔCost - 100	1.018	0.018	0.006	0.005	0.005	0.030	***
Single*ΔAbsorption	0.429	−0.846	0.313	0.007	−1.460	−0.233	***
Single*ΔSeller	2.202	0.789	0.315	0.012	0.172	1.407	**
Education*ΔCost - 100	0.990	−0.010	0.006	0.082	−0.021	0.001	*
Income*ΔCost - 50	1.010	0.010	0.003	0.001	0.004	0.016	***
Income*ΔCost - 100	0.992	−0.008	0.004	0.050	−0.015	0.000	*
Household size*ΔAbsorption	1.662	0.508	0.265	0.055	−0.012	1.027	*
Household size*ΔSeller	0.527	−0.640	0.273	0.019	−1.174	−0.106	**
Number of observations (respondents)	1148 (164)		Chi-square				183.774
Prob > chi2	0.000		Akaike crit. (AIC)				1347.666

***p < 0.01, **p < 0.05, *p < 0.1.

[a] To simplify reading, only the significant effects are included in the table, even though the regression analysis included all the interaction effects.

respectively. Single women value 43% less absorption power of sanitary products (Single* ΔAbsorption - OR 0.429, β −0.846, p < 0.01), while they are 2.2 times more likely to purchase from a known seller (Single*ΔSeller - OR 2.202, β −0.789, p < 0.5). Higher-income women are mildly more likely to prefer sanitary products that cost up to Rs 50 per month over free ones (Income*ΔCost – 50 - OR 1.01, β −0.010, p < 0.01), while they would mildly – though significantly - prefer free solutions over very costly (Rs 100 per month) ones (Income*ΔCost – 100 - OR 0.991, β −0.008, p < 0.1). Women living in larger household value absorption power 66% more than women in smaller households (Household size*ΔAbsorption OR 1.662, β 0.508 p < 0.1) while they value a known seller over an unknown 53% less than women in smaller households (Household size*ΔSeller OR 0.527, β −0.640 p < 0.05).

5. Discussion

Our study indicates that environmental impact, in the form of product biodegradability, is a crucial factor affecting BOP women's choice of sanitary products. Secondly, BOP women prefer highly absorbing products – especially if they are not single and live in larger households - and prefer lower-priced sanitary products, in particular, if they are younger in age. Women also emerge to be more comfortable in buying sanitary products from known sellers, especially if they are single and in small-sized households. When living in large households, women are more comfortable in buying products from unknown sellers. Our findings indicate that, though BOP consumers prefer low priced products, affordability is not the most critical determinant of their choice. It is therefore important for organizational decision-makers and policy-makers to not only aim at product affordability but also – and most importantly - enhance product acceptability, awareness and availability (e.g. Angeli and Jaiswal, 2015, 2016). To do so, garnering a broader, multilevel understanding of product preferences at the BOP, as informed by the socio-ecological model proposed in this article, is salient. Biodegradable sanitary products emerge as being much more socially and culturally acceptable for BOP women, who have been used to employing cloth-based, reusable and biodegradable products for generations. This finding is somewhat in contrast with the more dominant narrative surrounding menstrual health management – as illustrated by our Wordcloud – where issues of environmental sustainability are largely ignored, and 'pads' are emphasized and marketed as a panacea-like solution. It should also be noted that BOP women prefer cloths or cloth-based products not only due to their environmental value but also owing to familiarity and traditions. Consumption patterns and habits at BOP settings are more tuned to nature and environmental protection, in a way that can be upset by large scales adoption of external westernized solutions.

5.1. Theoretical contributions and practice implications

Our evidence advances existing literature on BOP business models and the current public policy debate on menstrual hygiene in particular on two main fronts. First, to our knowledge, this is the first study that proposes a socio-ecological view to examine low-income individuals' buying behavior and women's attitude towards menstrual hygiene management products. In doing so, this study extends the previous socio-ecological model (Golden and Earp, 2012; Mcleroy et al., 1988; Sword, 1999) by adding the natural resource system as an important domain, able to influence individual product adoption/service

utilization. This approach allowed for documenting BOP users' preference for adopting environmentally friendly products and services and the saliency of ecological impact in BOP consumers' product choice. Our findings pave the way to the opportunity to redefine BOP business models towards a more balanced triple bottom line that pursues social, economic and environmental goals on equal footing (Hussain et al., 2018; Ozanne et al., 2016; Schweikert et al., 2018). While most of the triple bottom line literature has highlighted tensions across the economic, social and environmental performance dimensions, and hence the need for difficult trade-offs (Hahn et al., 2018; Ozanne et al., 2016), our evidence suggests instead that synergies are possible, and that environmental and social value can – and should – reinforce one other. Our co-creation perspective, aimed at rethinking solutions based on communities' perceived needs and preferences along a socio-ecological perspective, highlights that explicitly incorporating environmental aspects in a product/service offer effectively creates value for BOP consumers and can lead to a product's competitive edge.

As a second line of contribution, our findings confirm the salience of co-creation approaches, crucial to craft products and services that are able to respond to needs and align with values as perceived and formulated by consumers (Angeli et al., 2018; Angeli and Jaiswal, 2016; Nahi, 2016). The case of sanitary napkins highlights a fundamental discrepancy between innovators and recipients. The market approach of MNCs and at times of NGOs strongly emphasized the use of Western-like, disposable sanitary napkins to improve menstrual health and reduce their negative impact on the education of young girls and the livelihood of women in fertile age. Although these solutions are certainly valuable in preventing reproductive tract infections and thus in enhancing health outcomes, they also prove to be both environmentally unsustainable and socio-culturally ill-designed for BOP women. Stigma related to purchase and disposal of sanitary napkins should be taken into account (Zehtabchi, 2018), in addition to the cultural shock that the use of sanitary napkins may bring to poorly educated women accustomed to use cloths during their menstrual cycle (Chinyama et al., 2019; Mahon and Fernandes, 2010). In addition to that, our study highlights that the environmental impact of plastic-based napkins, their high costs, their lack of durability, and the stigma related to purchase from an unknown seller hinder uptake. Rural women tend to avoid the use of sanitary napkins as they are not sure about the methods of disposal and believe that if any male member of the society sees them disposing of a sanitary napkin, it would bring shame to the woman concerned (Ray and Dasgupta, 2012). An institutional divide therefore emerges, which points to a mismatch between values, needs and beliefs of recipients as opposed to innovators, that has often been observed in BOP ventures (Angeli and Jaiswal, 2015; Rivera-Santos et al., 2012). Moreover, problems of awareness, acceptability and availability, rather than affordability only, make disposable sanitary napkins largely unsuitable in these contexts, which reconfirm the experiences of other BOP initiatives (Anderson and Markides, 2007; Angeli and Jaiswal, 2015).

This study therefore contributes empirical as well as theoretical advancement to the co-creation literature. From an empirical point of view, it documents the relevance of the DCE as an instrument to gauge women's preferences towards menstrual health management solutions, and to tease out how product attributes – alone and in interaction with a user's socio-cultural and socio-economic characteristics – affect product choices. In doing so, this work highlights the DCE as an inexpensive, easy-to-administer and well-received tool that can effectively document the users' perspectives, particularly valuable in the context of a vulnerable target population (women living in urban slums) and the sensitivity of the topic (menstrual hygiene management). This empirical strategy, therefore, paves the way for private businesses, third sector organizations and governmental bodies in adopting this and other similar tools to engage users and communities in effective service co-creation and product co-development endeavours. This methodological approach also provides an opportunity to overcome the limits and challenges identified by the literature in leveraging NGOs as intermediaries to represent communities' and beneficiaries' unmet demands and unheard voices (Arora and Romijn, 2012; Kolk et al., 2014). From a theoretical standpoint, this work highlights the salience of a socio-ecological perspective to understand product preferences, as determined by the complex interplay of factors at multiple levels and at the intersection between individuals' backgrounds, personal experiences and product characteristics. The socio-ecological view, therefore, allows for embracing the complexity of users' behavior and product preferences, rather than simplifying it. This provides a particularly important theoretical shift, given the highly heterogenous and context-specific BOP communities (Angeli and Jaiswal, 2015, 2016) and the complexity of health-seeking behavior in general and in slum communities in particular (Das et al., 2020).

5.2. Limitations and directions for future research

Efforts have been made to keep the research as rigorous as possible, yet a few limitations exist. To maintain parsimony, only five attributes were taken into consideration while preparing the questionnaire. Although this choice was informed by both a literature review and the qualitative evidence gathered in the first phase of the project, there is a possibility that some other attributes might have been left out. Considering women's traditional use of cloths for menstrual health management, there is the possibility that cultural norms might be confounded with preferences for environmental sustainability and that variables such as product familiarity and comfort might have a bearing on low-income women's choices. The current DCE, for its methodological nature and analytical structure, allows teasing out the differential effect of the product's environmental sustainability - encapsulated in reusability and biodegradability factors - from women's socio-cultural and socio-economic background - captured by individual level factors, such as their married status, age, household size, education, and income, and at product level, for example, the familiarity with the seller. Future research can however include more attributes related to product's comfort, such as the likelihood of skin irritation and familiarity of use.

The minimum sample size required for a DCE Experiment (de Bekker-Grob, Donkers, Jonker and Stolk, 2015) varies according to the kind of hypothesis investigated. Our sample consisting of 164 women from two cities largely meets the requirement, although a larger sample size from multiple locations may provide more robust results and higher generalizability. Another potential limitation was that the participants were not given the option of choosing neither of the two profiles, which, if included, can provide an idea about the difference between our hypothetical choices and more real-life situations (WHO, 2012). Although this design choice was justified for this specific study, future research can undertake SADR-based study which provides free choice questions (choice between the chosen product and the do not buy option) in a similar setting.

Credit author statement

Federica Angeli: Conceptualization, Methodology, Writing, Data Formal analysis; Anand Kumar Jaiswal: Conceptualization, Methodology, Writing; Saumya Shrivastava: Data Collection, Data Formal analysis.

Data availability

Data will be made available on request.

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