# Domestic Artefacts: Sustainability in the context of Indian Middle Class

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**ABSTRACT**
Sustainability has become one of the important research topics in the field of Human Computer Interaction (HCI). However, the majority of work has focused on the Western culture. In this paper, we explore sustainable household practices in the developing world. Our research draws on the results from an ethnographic field study of household women belonging to the so-called *middle class* in India. We analyze our results in the context of Blevis' [4] principles of sustainable interaction design (established within the Western culture), to extract the intercultural aspects that need to be considered for designing technologies. We present examples from the field that we term "domestic artefacts". Domestic artefacts represent creative and sustainable ways household women appropriate and adapt used objects to create more useful and enriching objects that support household members' everyday activities. Our results show that the rationale behind creating domestic artefacts is not limited to the practicality and usefulness, but it shows how religious beliefs, traditions, family intimacy, personal interests and health issues are incorporated into them.

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Design, domestic settings, sustainability, developing countries

**ACM Classification Keywords**
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**INTRODUCTION**
In the past decade, considerable efforts have been made to carry forward the 'green' agenda in the HCI research. For example, new paradigms and guidelines are developed for applying sustainability in interaction design [4], a set of field studies are carried out for informing the design of new technologies [8, 14, 25, 26] and new pervasive and ubiquitous technologies are designed for domestic settings that can inform users about energy usage in their homes [5, 10, 11]. However, most of this work has taken place within the developed world. In this paper, we will look at sustainability research from a developing world's point of view. We will provide an account of how women in India facilitate and enrich their daily household activities through sustainable practices. Our target group is the Indian middle class – a symbolic notion referring to a group of people whose population varies between 50 to 300 million [6, 20, 21]. Our focus is on their creativity and empowerment for supporting their family by reusing old things to genuinely support their everyday household needs.

We studied the everyday activities of ten household women belonging to the middle class in India. In this paper, we will provide the results of our ethnographic field study illustrating how sustainability is greatly intertwined with Indian household women's everyday housework. We particularly focus on their practices of reuse. From our field studies, we found that household women construct their home activities and home life in general by creatively and resourcefully appropriating, adapting and mixing existing and worn-out domestic objects to be able to support and enrich their everyday activities. We term these 'new' objects as *domestic artefacts*. Typically, any object found in a domestic setting such as a chair, TV, couch, table and so on can be termed a domestic artefact. However, in this paper, for the sake of our analysis, we use this term to refer to the artefacts that are created by the home dwellers in order to support their home lives. Our notion of domestic artefacts is similar to the conceptualization of everyday design by Wakkary and Maestry [24].

This work takes a slightly different approach, compared to the traditional ICIC works. We will study sustainable household practices in one culture (Indian middle-class) and develop important insights and lessons that can be used to support inter-cultural collaborations. Hence, we will not study the effects of inter-cultural interactions, as such, but provide implications for supporting intercultural interactions by studying one particular culture. In addition, we will use Blevis' [4] principles of sustainable interaction design (SID) as a lens to analyze our results. By utilizing Blevis' principles in the Indian context, we believe that several cultural-specific aspects of sustainability can be extracted and used for designing new technologies. We believe that not all of the sustainable practices that we draw from our results can be easily translated to the Western


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culture, or *v*ice versa. However, several underlying phenomena can be used for designing sustainable products. Our contribution in this paper is threefold:

- Our results provide empirical evidence illustrating the role of women in household matters in the Indian middle class. In doing so, our results bring out several cultural and traditional practices of the Indian middle class that might be new for the HCI community.
- Our notion of domestic artefacts shed light on subjective issues related to family intimacy, care, religious beliefs and family traditions that should be taken into account when designing for sustainability in interactive technologies.
- Since we apply Blevis' principles, our result leads to new intercultural understandings on sustainability research.

In the rest of the paper, we will start by describing our motivations for focusing on sustainability and provide a brief introduction to the Indian middle class. Next, we will provide details of our field study, participants and their family dynamics. Then, we will describe our results and give examples from the field. Finally, we will discuss our findings and lessons for inter-cultural collaborations when designing for sustainability.

## MOTIVATION

### Sustainability

A majority of work towards dealing with sustainability in household matters, as seen in recent CHI and UbiComp literature, focus on developing technologies that can make home residents aware of their 'moral choices' on energy consumption and turn environmental action into a redirection of consumption patterns, for example. WaterBot [2] is a pervasive technology that provides ambient cues about water usage at a kitchen sink. The aim here is to motivate changes in people's behaviors while using water. Power-Aware-Cord [7] uses a dynamic glowing representation on a common electrical power strip that can display the amount of energy passing through it at any given moment. WattBot [19] is a residential electricity monitoring system that uses Apple's iPod and iPhone for allowing people to track their home energy usage and encourages them to reduce consumption. Researchers such as Bang et al. [3] have also attempted to create a game-like system called PowerAgent to provide information about energy consumption patterns in homes.

However, the environmental crisis is as much a cultural problem as a technical one. It is not just a simple matter of calculating energy and environmental costs of manufacturing, use, and disposal of one technology over another. It is important to understand people's attitudes [8], rationale [17], and their current efforts [26] towards sustainable practices, in order to guide the design of sustainable technologies. We believe that a deeper look into cultural practices and the role of individuals in household matters could lead to a much better understanding of sustainability. In particular, the prominent role of women (especially mothers) in everyday household activities cannot be ignored. We look at sustainability as a socio-cultural issue that should be dealt with using a bottom-up approach rather than a technological top-down approach.

In the West, the reuse and disposal of materials such as plastic, electronics and textiles poses a huge challenge. As an alternative approach towards dealing with sustainability, we believe that solutions to sustainability may be explored from cultures belonging to other parts of the world. Their consumption, reuse or recycling practices may provide an interesting perspective on sustainability.

We study sustainability in the context of middle-class India. In that, we look at household women's existing sustainable practices while carrying out their everyday housework. We believe that these domestic practices can greatly inform the design of new sustainable technologies. In particular, the study of middle class Indian households can be very important for HCI researchers for the following two reasons. 1) The increasing growth of the Indian middle class population would make this group one of the world's largest consumer groups. An understanding of their consumption practices would undoubtedly contribute towards the design of new sustainable technologies. 2) The financial and cultural situations in the Indian middle class have led to different ways of applying sustainability. These ways may be new to the West, but have always existed in this part of the world for a long time.

### Indian Middle Class

Although the notion of class in India is *symbolic* and locally contested, and while there is no official definition of the middle class, the estimated population of the Indian middle class, according to the World Bank and other sources, ranges from 50 million to approximately 300 million [6, 20, 21]. According to a report by the Asian Development Bank, the middle class in India could touch the 1.2 billion mark (India's current population) in the next 20 years if recent economic growth is sustained [1].

Research into ICT for developing countries (in particular, India) has focused largely on rural areas (e.g. [9, 18]). While rural areas desperately need development, in India, it is the middle class that is growing at a much faster rate. The increase in the Indian middle class is due to economic growth in India and migration of low income and rural populations to big cities. As HCI researchers we need to pay more attention to this middle class, not only because, as we said, it is growing really fast, but because it will soon become one of the biggest consumer markets in the world. More importantly, we need to understand their consuming and sustainable practices in order to design sustainable technologies.

Even though, the middle-class in India is quite diverse, there are several cultural traits that are common to this group. In this paper we briefly summarize some of the

important characteristics; for more details please refer to Varma's [23] book, titled *The Great Indian Middle Class*.

The Indian middle class have very strong family values. Middle class residents, traditionally, live in joint families, which include extended family members such as parents and/or in-laws. However, this trend is changing as more and more people prefer to live in single families. Families in the Indian middle class draw their incomes from administrative, knowledge-based and non-manual labor jobs in sectors such as banking, education, IT, and call centers. Typically, households in middle-class families prefer job security and higher education for their children. Financial stability is seen as an imperative and highly desirable factor in these families. Their children are constantly being motivated to study towards Bachelors' and Masters' degrees in medical, technical and financial fields. These households believe in saving as much money as they can rather than spending it on holidays or buying expensive things. In some cases, parents would give priority to spending money on their children's education, over their own needs. These families believe in value for money when buying new things.

## THE FIELD STUDY

To collect a much deeper understanding of household women's sustainable practices and how these practices are connected to their everyday work, we carried out a field study in middle class Indian homes. We studied the everyday activities of ten household women, in the city of Ahmedabad, Gujarat. Table 1 provides details of our participants. We recruited them to have a variation in profession, age range and family dynamics (joint or single family). We believed that these choices would lead to a difference in their household activities and practices. Our participants belonged to the age range of 35 to 75. All the participants were married and had been living with their husband for at least 10 years. Participants included working professionals and housewives. Some of the participants lived in a joint family (with in-laws) and others mainly with their husband and children.

We used a combination of semi-structured interviews, in-home visits and observations during our fieldwork. In all cases, we kept our interaction with these household women longer than our initial visit. In some cases, we visited these participants' homes again and in others we prolonged our interactions via telephone calls. We focused our questions

| No | Age | Work | Members in family | Family Dynamics |
|---|---|---|---|---|
| 1 | 50-60 | Working full-time in a Bank | 2 | Lives with her husband who also works fulltime. Has two children living abroad. Her parents-in-law died 20 years ago. The family has a decent income – towards a higher-middle class. She gets help from a maid for some domestic activities. |
| 2 | 40-50 | Housewife | 4 | Lives with her husband and two children. Husband runs a business and both children study. Her parents-in-law live separately. The family has a decent income – towards a higher-middle class. She gets help from a maid for some domestic activities. |
| 3 | 30-40 | Working full-time in a company | 6 | Lives with her husband, two children and parents-in-law. Husband works fulltime, children study at schools and parents-in-law are retired and stay at home. She leads in most of the household activities and her mother-in-law assists whenever she can, but is in bad health. |
| 4 | 50-60 | Working full-time in a Bank | 3 | Lives with her husband who is retired. She has two children, one living abroad and one still studying. Her parents-in-law died recently. |
| 5 | 70-80 | Part-time work | 2 | Lives with her husband who is retired. Has four children, all married and living separately. Her work involves going to a charity for a few hours a week. |
| 6 | 50-60 | Housewife | 9 | Lives with her husband and two sons – both are married and have their own children. Her husband and two sons work full-time. Her two daughters-in-law help her in the house. However, she plays a leading role in the household activities. The family has a large house and has a stable income. |
| 7 | 50-60 | Housewife | 5 | Lives with her husband, a son, a daughter and a daughter-in-law. Her husband is retired and her son, daughter and daughter-in-law work full-time. She gets help from a maid for some domestic activities. |
| 8 | 50-60 | Housewife | 2 | Lives with her husband. Both have health problems. Her daughter and son live separately. Her husband had a heart attack 2 years back and she recently had a knee replacement. She gets help from a maid for all domestic activities. |
| 9 | 30-40 | Part-time work | 3 | Lives with her husband and a son. The family income is very low as her husband has had no settled jobs. She teaches students and earns some money to help in the family. |
| 10 | 40-50 | Part-time work | 4 | Lives with her husband and two daughters. Husband works fulltime but has had health problems. Her elder daughter is finishing her medical education at university and her younger daughter goes to school. She gets help from a maid for some domestic activities. |

**Table 1: Details of our participants.**

mainly to their reuse, but also took into account their everyday household activities. Considering the exploratory nature of our research, we appropriated qualitative methods to understand participants' subjective reasoning and choices in order to understand their practices of reuse. To understand how sustainability is practiced in home life by these participants, we paid particular attention to the artefacts that our participants created to support their household activities. Drawing on some established work in anthropology [13] and some recent attempts to study the use of artefacts in domestic settings [22, 25], we examined the practices surrounding these artefacts as a means of revealing how the home's social order is brought about.

## RESULTS

Our field study generated a large amount of qualitative data, describing different sustainable practices. Figure 1 shows an elderly household who participated in this study. The space limitation will not allow us to describe all the practices in detail, hence in this section we will provide some general themes of reuse practices. In the following section, we will introduce our notion of domestic artefacts.

**Figure 1: An elderly middle-class household.**

### General Themes

We explored the reuse of four types of reusable materials: 1) edible products, 2) paper-based goods, 3) textile and 4) plastic.

In *edible* products, we observed that rather than wasting parts of food products household women made use of it to support several household activities. In some cases unusable food products were processed further to make new edible items. In other cases, food products were reused in other household activities. For example, household women utilized leftover milk to make butter, buttermilk, cheese and home-made sweets. In some cases, sour milk was utilized to make hair oil. Some women utilized the water after boiling potatoes and rice to clean silverware. Whereas, used tea bags were reused as a fertilizer; and mon and orange peel were used to make home-made skin cream. *Paper-based goods* such as newspapers, calendar pages and so on were utilized as notebook covers and as covers for cupboard shelves to avoid dirt. In some cases, leftover pages from different notebooks were combined together to make a new notebook to be used as a diary or telephone book. *Textile-based goods* such as old clothes, curtains and bed sheets were repaired and reused for different purposes. For example, old clothes were modified to be reused as carry bags for grocery shopping; ripped bed sheets were used as pillow covers and covers for electronic appliances such as radios and TVs. Women's saris were sometimes modified to make other types of women's dresses. In some cases, a set of old saris were reused to make a dress utilizing important portions of the saris. *Plastic* bottles and containers were reused to store food related products.

We observed that there was multiple and multilevel reuse of certain things, for example, leftover milk. In addition, we found out that there is an industry of cheap laborers who modify or fix broken objects. For example, knife sharpeners go around the streets to sharpen blunt knives. Similarly, another type of laborers would fix plastic buckets and other objects. This clearly helps household women to prolong their use of old objects. Other trends also include making art pieces from unusable objects rather than recycling them. For example, we saw that old pieces of garments were framed and were used as a piece of art in homes.

An important characteristic of these sustainable practices is that they are not necessarily connected with an awareness to save the environment. In fact, several of our participants were more concerned about supporting an economical life. This does not mean that they were not concerned about the environment. The cultural aspects of middle-class Indian households and their reuse practices were inherently intertwined with each other.

## DOMESTIC ARTEFACTS

In this section, we will discuss specific examples from the field that will illustrate sustainable practices of the middle class household women in India. Blivis' [4] principle *promoting renewal and reuse* is central to all these examples. These examples represent different reuse patterns that our participants created by appropriating, adapting and mixing existing, old and worn-out objects from their homes. We term these *new* objects as *domestic artefacts*. To protect the privacy of our participants, we will refer to them with pseudonyms.

### A doormat

It is very common in Indian homes to see gunny sacks lying in the storage rooms. Gunny sacks (Figure 2a) are traditionally used for transporting agricultural food products such as wheat, rice and onions. A gunny sack is an inexpensive bag made from jute or other natural fibers. Gunny sacks can hold 20 to 50 kg of food products and are typically bought in a particular season (e.g. avoiding monsoons) to have it safely stored in the home. People in the Indian middle class tend to buy things in bulk, and they end up collecting several gunny sacks by buying a yearly quota of food products. Because of their strong, thick and dry texture, these gunny sacks are reused as a doormat, as a container for other things, and for other purposes in the

storage room. We also saw highly creative use of these gunny sacks as fashionable carry bags and artistic show pieces for homes. In this paper, we will discuss the reuse of the gunny sack as a doormat.

Kinal is a housewife. She lives with her husband – who runs a business of engineering tools – and two university going teenagers. The family buys a good amount of food products in bulk and stores it in a safer place in the home, to be used for a long time. Kinal saves gunny sacks after putting food products such as wheat and rice away safely into large containers in her storage room. She uses some of the gunny sacks as a doormat at different places around her house. (The rest of the gunny sacks are stacked in the storage room for later use). She has kept these doormats at the backdoor entrance of her house (Figure 2b), in her kitchen, in the bathroom entrance and at the entrance of the storage room itself. When asked about why she does this, she answered:

*"It is very important to enter the kitchen without shoes and with your legs clean. Similarly, in places such as the bathroom, storage room and toilets, one has to clean one's legs before leaving and entering. So, rather than buying new rags I just use these gunny sacks inside the home. Of course, for the main entrance a gunny sack would not look so nice. So, I have a nice welcome doormat there that I bought from a shop."*

**Figure 2: (a) A bunch of gunny sacks, and (b) reuse of gunny sack as a doormat.**

The kitchen is seen as a sacred place in middle-class Indian homes. One should to be clean before entering a kitchen. Kinal tries to keep a disciplined atmosphere in her home for her university going teenagers. With the use of gunny sacks as doormats, she keeps her house clean and as hygienic as possible. She also provided other useful insights into using this kind of doormats.

*"In Hinduism, we do not use cotton materials as our doormats. Since, gunny bags are made from jute, it is natural and much holier than the cotton materials."*

*"This gunny sack is useful in all kinds of weathers. In monsoon, it soaks up water. So wet shoes and legs can be easily cleaned, and in a way useful to keep dirt away from entering the house. And because it is made of jute, it gives warmth in the winter. I normally keep a gunny sack on the kitchen floor where I can stand and do the cooking. So, I avoid standing on a cold floor."*

Religious beliefs are important in Indian middle class homes. It is important that one enters the home clean. Normally, household members would clean their legs on these gunny sacks and then enter the house. Scientific literature has shown how different aspects of Hindu cultures and beliefs intersect with environmental values, and behaviors, with varying environmental consequences [12, 15, 16]. The example of a gunny sack as a doormat points to how sustainability and religious beliefs coincide. From Kinal's second quote, one can read the multipurpose character of gunny sacks. Climate plays an important role in people's everyday lives. In India, the climate is generally warmer compared to Europe and North America. Gunny sacks are seen to be very useful in these different weathers. Lastly, Kinal shows how purposefully she uses her gunny sacks to avoid dirt and keep herself warm while she cooks for her family.

This example refers to a number of principles and rubric of Blevis: *linking invention & disposal, promoting renewal and reuse, decoupling ownership & identity, salvage, reuse as is, and sharing for maximal use*. The use of jute for gunny sacks is inherently environmentally friendly, where after its original use it can be disposed of without making and worse impact on the environment. The material quality of a gunny sack allows multiple reuses, in addition to a doormat. Gunny sacks as such are inexpensive and do not get attached to any ownership, hence, they promote sharing for maximal use.

*Inter-cultural insights for sustainability*

- Religious beliefs are inherent in the reuse of objects.
- Health issues and family care are important in the reuse of household objects
- Specific areas in homes (e.g. kitchen) are treated differently while reuse of old objects.
- Practical needs and climate (e.g. cold floors in winters) encourage reuse.

**A dress**

Clothes have a significant value in Indian households, in particular, during marriages, religious gatherings, and other types of celebrations. For women in India, the sari is one of the traditional dresses. In the following, we provide an account on the reuse of an old sari by one of our participants. This is a particular example of how a mother's intimate and care-giving activity towards her daughter is intertwined with sustainability.

Mala works fulltime at a local bank as an officer and lives with her husband and two daughters. Her husband also works fulltime in a school as an administrator. Her elder daughter is about to finish her medical education and her

younger one studies in a school. She reused her old sari to make a dress (Figure 3) for her daughter who is about to graduate. The following is Mala's account of how and why she reused her saris to make a dress.

*"Over the years, I have bought several saris. I have a large collection of them in my cupboard. Sometimes the fashion goes away or a sari gets damaged after using it for years. Then we can either renovate the old sari with a professional tailor's help or make something else out of it. When I got married and came to live with my husband and in-laws in a joint family, my mother-in-law gifted me a very expensive brocade sari* - [a sari used during marriages]. *I have used it for 20 years for different celebrations and occasions and even though it is old I don't want to throw it away as it is part of our family tradition and family values. Now when my daughter is old enough I want to pass this on to her."*

**Figure 3: Daughter showing her 'new' dress made from mother's old saris.**

What we see in Figure 3 is a dress made of Mala's old sari and other materials that could no longer be used. But as she suggested this sari is so important and valuable that she does not want to throw it away for recycling. Mala did not make this dress herself; she got help from a professional tailor in sewing the dress. (Unlike in the Western countries, tailor-made dresses are not expensive, because of the cheaper labor and skills). Mala selected a set of her old saris, including the gift from her mother-in-law, with different color combinations and explained the design to the tailor. The reason behind getting help from a professional was that the material of the sari was very expensive and the type of sari and its material was no longer available in the market. So, she wanted to make sure that the dress was made by a professional.

Importantly, the 'new' dress signifies both a family tradition of gifting an important object to the next generation and at the same time intimacy and love for a daughter by her mother. In Indian marriages, saris are commonly used for exchanging gifts between families. A gift of a sari to Mala from her mother-in-law was considered as a blessing and an auspicious object for beginning a new life in the hope of a long lasting marriage, when she joined her husband after the marriage. This was a family tradition to pass on such an auspicious gift to the next generation (with the same hopes and blessings). So, following the family tradition and taking into account her daughter's choice and the current day fashion, Mala chose to make a dress out of her old sari.

This example refers to the following principles and rubric of Blevis: *promoting quality & equality, salvage, remanufacturing of use, and achieving heirloom status*. This example shows how the practice of gift-giving of an auspicious object received the heirloom status. The cheap labor and antique qualities of the sari motivated the mother to remanufacture it to make a dress out of it.

*Inter-cultural insights for sustainability*

- Emotional objects pass through generations and original objects are remanufactured to convey family intimacy.
- Auspicious practices may enhance the sustainability of objects
- Family legacy and heirloom status [4] play an important role in supporting sustainability.

**A flower pot**

It is very common to see a large water jug made of clay in Indian middle class kitchens – commonly known as "Matki" (See Figure 4a). People use it to keep drinking water cold during summer time (temperatures typically go above 40° in the city of Ahmedabad). However, it is used throughout the year. These water jugs are made of clay which is environmentally friendly and can be easily recycled in their current form. We describe a case where a water jug was reused as a flower pot (Figure 4b) in the garden of one of our participants. The following example shows a typical water jug used in a kitchen and its reuse as a flower pot.

**Figure 4: (a) A clay-based water jug used in kitchens and (b) An old water jug now reused as a flower pot in a garden.**

Jayshree is a housewife who lives with her husband. Both of them are retired and are currently living on their pension

money. Jayshree is fond of gardening and tries to look after the plants in her garden. Figure 4 shows an example where Jayshree has reused a used water jug for making a pot for plants. The following is her account on this pot:

*"I have been using two clay water jugs in my kitchen. A smaller one* (Figure 4b) *got a crack one day. So, it was no longer useful as a water jug. I cut off its lid and started using it as a flower pot by growing a small plant in it. The use of clay water jug is as good as any other flower pots that you buy in the market. The body of the pot provides adequate air flow to the plant and lets the extra water out easily. I also decorated it a bit by coloring it. I like it when the pot looks beautiful; it is really pleasurable to water these plants."*

The example shows Jayshree's resourcefulness and creativity to reuse a broken water pot. From a practicality point of view, this is very important. These kinds of water jugs have porous capabilities which are very important for the growth of the plant. Jayshree's awareness towards environmental issue is reflected in her choice for creating such a domestic artefact. Clearly, pottery would not be hazardous to the environment, the example, however, illustrates an activity that gives Jayshree pleasure to do her gardening. She also had some houseplants for which she reused nicely shaped whisky bottles. These plants do not need direct sun or porosity.

This example refers to the following principles and rubric of Blevis: *linking invention & disposal, salvage, reuse as is, and sharing for maximal use*. The use of clay for water jugs is inherently environmentally friendly, where after its use it can be disposed of without making a worse impact on the environment. The material qualities of the jug allows for reuse as a flower pot without much effort for remanufacturing.

*Inter-cultural insights for sustainability*

- Certain cultural practices such as use of clay water jugs have sustainability inherent in them, and also their reuse.
- Economical decoration for the home and thoughtful reuse.

**Storage boxes**

As we mentioned earlier, it is very common in Indian middle class families to buy groceries and food products in bulk. An example of a wheat gunny sack was given in a previous section, which can carry around 50 kg. of wheat. In this section, we will show how a steel oil box (Figure 5a) was modified to be used as a storage box for food products.

The practice of buying 15 to 20 kg. of food oil in a large steel container (Figure 5a) is very common in India. These steel boxes are used for easy transportation. They have a handle at the top to carry them around and a hole to pour the oil from. After use these steel boxes are either given out for manual recycling or reused for other purposes. We provide a very brief account of the reuse of a steel oil box by one of our participants. She modified the original oil box to use it for storing dry food products such as flour, wheat and snacks.


**(a)** **(b)**

**Figure 5: (a) Food oil in a manufactured steel box, and (b) Flour stored in one of the boxes.**

Kumud is a retired elderly lady who lives with her husband who is also retired. Over the years, she has bought several oil boxes and reused some of them as a container. She did not do this herself. There are professional welders who can modify oil boxes by cutting off the top and fixing a new lid onto it. Figure 5b shows Kumud's current use of her old oil box for storing flour (used to make 'roti' or 'chapatti' – a typical Indian bread). In her storage room, we found several of these reused boxes that were used for storing different food products. The oil box is a cultural object. People have been reusing it for years and over the years they have explored and appropriated different uses of this oil box. Although, not part of this study, we have seen the use of these modified steel boxes as travel bags by people in villages. They would store their clothes and other objects that are used in travelling.

This example refers to the following rubric of Blevis: *salvage, remanufacturing for reuse and achieving longevity in use*. The material quality of the oil box can be easily converted into a container box for storing food products. Its strong material qualities also offer multiple uses, not only as a storage box but also as a useful object for transportation.

*Inter-cultural insights for sustainability*

- The practice of buying food products in bulk and storing for longer periods encourages new ideas for reuse.

**Carry bags**

We already discussed reuse of clothes in a previous section, where a mother's sari was reused and modified to make a dress for her daughter. In this example, we will provide a more practical reuse of clothes. Figure 6 shows a set of carry bags designed by one of our participants from her grandchildren's jeans. The example shows the creativity of the participant and her active participation in the family activities.

Hansa is a housewife, who lives with her husband and nine other members in a large joint family. Her husband works fulltime in an insurance firm. Hansa has two sons who also have young children themselves. Hansa – a grandmother – is active in almost all the household activities such as cooking, cleaning and grocery shopping. She is well assisted by her two daughters-in-law, who are also housewives. Hansa's family is financially stable and she has a big house for her joint family. Hansa's grandchildren are growing fast and their old clothes are no longer in use. Hansa has a hand sewing machine at home and she designed carry bags reusing the denim material from her grandchildren's old jeans. The following is her account of these particular artefacts.

*"When kids grow up, their clothes are not used anymore. I sometimes make use of the material from their old clothes for cleaning purposes. Sometimes, I make carry bags out of their clothes so that they can be used in grocery shopping or moving small things around. Here, I made these carry bags from the denim material. In the past, I used to make bags like these from synthetic material but those bags wear out easily. Denim is much stronger as a material. The good thing about these bags is that they are very easy to keep in cupboards, they are washable so can be used for a longer period. Importantly, these are good for travelling. And anybody in the home can use it and we don't have to spend money for buying bags. In one of the bags, I also did small embroidery on the bag so that it looks more attractive."*

**Figure 6: Carry bags made from old Jeans.**

The above account shows how actively Hansa is involved in her large family's day-to-day matters. This example refers to the following rubric and principles of Blevis: *salvage, remanufacturing for reuse and de-coupling ownership & identity*. She made use of the denim material of the jeans and created carry bags that can be used by all the family members. The rubric *sharing for maximal use* is also an important aspect of this example. She knows about her grandchildren's clothing and remembers to reuse their clothes rather than throwing them away. Her particular interest is in practicality of household activities and having an economical lifestyle. Her personal interest in sewing also helps in creating these bags.

*Inter-cultural insights for sustainability*

- Shared use is common in large middle-class families, which encourages maximal sharing.
- Storage of used objects (e.g. jeans) allows people to find alternative reuse for future.
- Reuse is encouraged by collaboration among and between families
- Creativity and resourcefulness is inherent in the reuse of objects.

## LESSONS FOR INTER-CULTURAL COLLABORATION

Our study provides a useful insight into how the cultural practices of women in the Indian middle-class are connected to supporting sustainability. Our paper shows that Blevis' principles and rubrics for sustainable interaction design are quite universal. Of course, certain principles and rubrics are more common and significant in the context of Indian middle-class. For example, the principle *promoting renewal and reuse* was the one seen in all the households, due to economical living standards. In the same way, rubric such as, *salvage, remanufacturing for reuse, achieving longevity of use* and *sharing or maximal use* were seen to be prevalent in the Indian middle-class. Similarly, due to a lesser individualistic culture, the same rubric played a significant role in supporting household sustainability.

We aimed to explore alternative approaches to look at sustainability research, which provided us some insightful results. It showed us how cultural, religious and traditional aspects related to households can shape sustainable practices. In the following, we discuss some important lessons for supporting intercultural collaboration when designing sustainable technologies in the context of the developing world.

- **Sustainability intertwined with culture:** One of the important aspects of our results is that through ethnography it brings the cultural issues to the fore and shows how the sustainable practices of household women are inherently intertwined with their culture. We showed how the reuse of a gunny sack as a doormat, for example, supported some religious beliefs and how modifying a mother's old sari into a dress for her daughter supported an ongoing family tradition, in addition to an auspicious belief. These religious beliefs and traditions are not limited only to the families in question. We believe that religious beliefs at large affect people's domestic lives and cannot be ignored while designing interactive technologies. A much detailed account on the role of religion on ICT use is provided by Wyche and Grinter [27]. Moreover, we saw a connection between the culture and trend of buying household products in large quantities (e.g. a 50 kg. gunny sack of wheat and 15 kg. steel can of food oil) and reusing the containers for other household activities. Women's roles have been central

in this. They sustain the family needs and values by taking into account their financial situation. Household women would refrain from throwing food products in the garbage and rather make other uses of it. For example, using sour milk to make hair oil. Another cultural theme that was visible from our research was "home-made is better". For example, household women would rather make their own butter and buttermilk from their leftover milk than buy them from shops. This is one of the ways women nurtured their family members by providing them with home-made things. For designing interactive and sustainable technologies, one needs to take into account cultural and traditional values of different communities.

- **From reuse to enrichment:** An important aspect of our participants' sustainable practices was not the mere reuse of old and worn-out things, they in fact attempted to make their lives better and enrich their household activities. The example of the reuse of a mother's sari for making a dress for her daughter shows how an old fashioned but expensive sari that was part of a long family tradition was modified to make a new fashionable dress that a young daughter would appreciate shows that it is not about only reusing old things but make them suit the current needs and choices. It shows a woman's constant efforts and desire to improve the current life for herself and her family. And as we mentioned in an earlier section, there are professional tailors in India who would make a nice designer dress from old clothes. Similarly, the example of denim carry bags shows that it is about making a creative and much more practical reuse of old things. The carry bags made of denim material are strong (for carrying heavy things), foldable (to be kept in a woman's purse) and washable (for keeping them clean). From an interaction design point of view, we suggest that going beyond the principles such as *linking invention & disposal*, *achieving longevity of use* and *sharing for maximal reuse* [4], we need to think about how we can make a reuse valuable and an enhancement from its original use.
- **Creative & Intimate:** Two strong themes that came out of our research were household women's inherent creativity in their everyday work and intimacy towards their family. Examples of the flower pot, storage boxes and carry bags showed how household women creatively used broken and unusable things to make usable and practical things that can support different household activities. Their craving for making embroideries on carry bags and coloring the flower pot were examples of their personal satisfaction in doing these activities. Similarly, family intimacy was also inherent in the examples of the doormat and the dress. Taking the family hygiene in mind a participant reused gunny sacks in her kitchen and different parts of her home so that everyone could first clean his/her legs before entering the house. The example of the dress represented a mother's love towards her daughter, keeping the family traditions in mind.

As designers, we need to respect people's creativity, resourcefulness and appropriation capabilities for supporting their household activities including care giving and family intimacy. As a design philosophy, we propose to design technologies to support activities and practices that are already in existence in household lives, and not technologies that do these activities for them.

## CONCLUSIONS

The population of the Indian middle class ranges from 50 to 300 million people, depending on how we define the middle class. It will be one of the largest consumer groups in the world, as it is growing rapidly. We as HCI researchers need to understand their consuming and reusing practices to be able to support intercultural collaboration with the West. Our notion of domestic artefacts gives an account of women's creativity and resourcefulness. Our results show that to support intercultural interaction, one should not have a limited focus on supporting practicality and usefulness, but also consider religious beliefs, traditions, family intimacy, personal interests and health issues.

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