"We are not in the loop": Resource Wastage and Conservation Attitude of Employees in Indian Workplace

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ABSTRACT
Though rapid depletion of natural resources has become a global problem, most of the solutions developed to address it are based on studies done in the developed world. Moreover, the commercial sector is among the primary consumers of resources, yet research work has been mostly limited to residential users. We present a study exploring employees' perception, their beliefs and attitudes, towards environmental sustainability at workplaces in a developing region. To obtain broader context, we also conducted a focus group with the facility team members. Our study highlights that in spite of strong motivations to conserve, employees conservative actions are limited due to lack of controls, knowledge and responsibility. We identify new opportunities for design such as designing location specific buildings, removing inefficient choices, and building communal spaces, to facilitate conservation at workplaces.

Author Keywords
Sustainability; Conservation; Wastage; Energy; Water; Trees; Fuel; Workplace; Office; Developing World; India.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Global consumption of energy, water, fuel and trees has been increasing rapidly. The supply cannot always be increased fast enough to meet demand, and some resources such as fuels are non-renewable. An alternative solution is to decrease demand and wastage. This requires a deep understanding of consumption practices, and attitudes towards wastage and conservation. Previous studies provide insight into these factors within residential settings and their potential implications for technology design [5,7,20,23,28]. Recently, studies have started to focus on energy consumption by employees in workplaces [8,22,35].

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The UbiComp community has proposed and explored Context-Aware Power Management (CAPM) systems [11,12], which uses contextual information of employees to effectively manage a building's energy consumption. Because most of these studies have explored developed countries, and primarily the U.S., there is little information about whether or how those results might be applicable to other geographical, cultural, and socioeconomic contexts.

By 2020 the developing world is projected to account for 40% of the global energy use [21]. In particular, India has a population of over 1.2 billion, and its economic growth has been averaging at more than 7% per year since 1997 [29]. These two trends have led to a substantial increase in national consumption of resources, like energy [30] and water [31]. The commercial sector constitutes a significant share (9.89% in 2009-10 [34]) of Indian energy consumption. The residential consumption share is higher at 23.85%; however, because only 34% of India is employed [29], workplace consumption is higher at an individual level. Hence, there is great value in understanding what drives resource consumption and conservation in Indian workplaces from employee's perspective.

In this paper, we studied employees' perception towards wastage and conservation in a workplace environment in India, using a photo-elicitation study. We also discuss how this perception differs at home. We chose to focus on IT organizations, as their contribution to India's 2012 GDP (Gross Domestic Product) was as high as 7.5%. [37]. To understand sustainability initiatives taken by the organization, we also conducted a focus group with the facility team members. Our primary contribution is a rich description of everyday practices around resource management and wastage, including energy, water, fuel, trees, and food, in an Indian workplace. Factors that acted as barriers to conservation were lack of controls, knowledge gap, and lack of ownership at the workplace. We also provide design concepts including removing paradox of choices, building communal spaces, and learning conservation practices from home to build location-specific workplaces.

RELATED WORK
This section starts by reviewing some of the key studies in the developed world around resource usage [1,4,7,8,20,22] and their findings about conservation practices, motivations

and challenges, in residential and workplace setting. This is followed by relevant work from the developing world [6,14,16,18,23,27], with a particular focus on India.

Conservation in the Developed World

Previous works have explored energy conservation behaviours and attitudes in developed countries, including Australia [16] and U.S. households (green households [28], typical middle-income households [4,20], and low-income households [7]). Some of the themes highlighted in this body of work include reasons (such as future generations, spirituality, ethics, habit and trends), approaches (such as re-use, repair work, efficient purchases and monitoring), and barriers to saving energy (such as money, safety, other household members and infrastructural inefficiencies). Pierce *et al.* [20] found that most energy consumption interactions become unconscious, habitual and in some cases, irrational. Many interventions have been designed to reduce energy usage and/or encourage green behaviour in households, as summarized by Abrahamse *et al.* [1]. Although most of this work has focused on energy, Chetty *et al.* [4] discussed water conservation strategies, such as taking shorter showers and doing dishes by hand instead of using a dishwasher. Within the CHI community, eco-feedback for energy [10], water [2] and fuel [9] consumption has been proposed and evaluated, as a way to inform and motivate conservation behaviour.

Recently researchers [3,8,22,35] have started exploring the role of employees in workplace settings. Foster *et al.* [8] conducted a series of seminars at workplaces and found that factors like engagement, incentives, and openness, can play an important role in influencing conservation behaviour. Schwartz *et al.* [22] deployed smart meters and conducted workshops to show that data should be presented such that it encourages collective conservative behaviour. Similar results about comparative feedback were obtained by Siero *et al.* [24]. Carrico *et al.* [3] found 7% and 4% reduction in energy use by feedback and peer education, respectively. Previous research has primarily focused on designing workplace technologies based on participatory feedback, and did not qualitatively examined employees' current practices, beliefs and attitudes towards wastage and conservation. From the UbiComp community, Harris *et al*. proposed Context-Aware Power Management systems [12]; Harle *et al.* [11] showed that such systems can result in savings of ~140Wh per employee per PC per day. Whereas, the scope of most of the existing research has been limited to energy use, our study also explores other resources including water, trees and fuels.

Conservation in the Developing World, especially India

A number of studies have characterized household energy requirements in developing countries such as Brazil [6,16] and India [14,15,18,23,27]. Cohen *et al.* [6] and Pachauri *et al.* [18] established a correlation between household energy requirements and various socioeconomic factors in Brazil and India, respectively. In India, income level is the most important factor that affects household energy use [18]. Other factors include literacy level, household size, and age of the head of the household. Shrinivasan *et al.* [23] studied middle and high-income urban Indian residential consumers; found *deep conservation* practices which are deeply integrated into daily activities and contextually imposed. Other studies found that Indian women practice reuse and recycling [27], household residents are adopting more efficient appliances and light bulbs (CFLs) [15], and thermal comfort is achieved using natural ventilation, clothing, and other adaptive behaviours such as 'drinking cold water' [14].

However, none of these works focus on consumption and conservation practices in offices in India. In our study, we explore employees' consumption and conservation patterns, outlook towards wastage, and motivations and barriers to conserve at workplace. Understanding this can help inform the design of appropriate technologies for workplaces. We also compare the conservation practices in workplaces to those in homes, wherever possible.

STUDY

We conducted a photo diary study followed by elicitation interviews with 13 employees and a focus group with 4 Facility Team (FT) members. (*Note*: In this paper, we differentiate between employees and FT members. FT members manage basic facilities in terms of the resources provided to the employees. Hence, *participants* and *employees* are used interchangeably, while facility team members are explicitly referred as *FT*.) The aim of our study is to elicit a detailed picture of employees' current practices and beliefs towards wastage and conservation.

Method

We chose a qualitative approach, a lightweight diary and camera study followed by detailed elicitation interviews. Photos were used to make participants think about the problem and to seed the interview. Our study design is an adaptation of the method employed in Dillahunt *et al.*'s study [7] of low-income residential consumers in U.S. We used a combination of word-of-mouth and snowball sampling to recruit employees as participants.

The study consisted of two steps. First, each participant was asked to *"take pictures related to conservation or wastage of resources that you observe at home or office."* To get a broad level understanding of participants' perception about consumption and conservation practices, they were encouraged to take pictures of themselves, their colleagues and family members. We did not define '*resources*' in order to understand participants' own definition and categorization of resources. We asked the participants to take pictures using their mobile phones or digital cameras. All participants had either or both of those. They were given a maximum of a week to complete the task. During that week, we sent three reminder SMSs to them. On the completion of the task, they were asked to email their photos to the interviewers.

ID	Sex	Age	Education	Marital Staus	Child	Role	Years Work	Internet Savvy	Conservation Orientation
P1	F	29	Bachelor	Married	1	S/W Eng	1	3	4
P2	M	42	Masters	Married	2	S/W Eng	3	5	5
P3	M	27	Bachelor	Single	N/A	S/W Eng	5	4	3
P4	M	42	PhD	Married	2	Manager	5	4	4
P5	M	22	Bachelor	Single	N/A	S/W Eng	1.5	3	3
P6	M	37	PhD	Married	1	Manager	9	4	3
P7	M	40	PhD	Married	1	Researcher	5	5	3
P8	M	36	PhD	Married	2	Manager	1.5	5	3
P9	M	29	PhD	Single	N/A	Researcher	1.5	5	4
P10	M	34	PhD	Single	N/A	Researcher	1	4	4
P11	M	31	PhD	Single	N/A	Researcher	1	4	4
P12	F	27	Masters	Single	N/A	HR Ops	2	4	5
P13	M	32	Bachelor	Married	1	HR Admin	6	4	5
FT1	M	40	Bachelor	Single	N/A	Facility Manager	6	4	5
FT2	M	31	Bachelor	Married	1	Facility Exec	1.5	4	5
FT3	M	26	Bachelor	Single	N/A	Electrical Eng	3	4	5
FT4	M	30	Bachelor	Married	0	Electrical Eng	2	3	5

Table 1. Participants' and FTs' demography.

The second step was a detailed elicitation interview. Two authors conducted the interviews. Interviews lasted for 45 minutes to 1.5 hours and were conducted in English (both, participants and interviewers were fluent in English). In the initial part, participants were asked to give an office tour (similar to home tours study method [17]), mentioning the kind of resources that they see getting wasted and related conservation steps. Following that, the interviewers asked the participants to discuss the conservation or wastage of resources captured in their photos. Participants were also asked about the conservative actions they perform at home and motivations behind them.

We also conducted a three hours focus group with four FT members, discussing sustainability initiatives undertaken by the organization, and any near term future plans. All the interviews and focus group discussion were conducted in office, were voice recorded and later transcribed in English. One of the interviewers took extensive notes during the interviews and focus group discussion. On an average, participants took 5.35 photos (sd=2.07); 26.7% of the photos were taken outside the workplace. Notes, transcripts and photos were used for analysis.

The interview coding and analysis was done in an iterative fashion. Transcriptions were open coded by one author. Two authors then jointly conducted selective coding to identify themes that were representative of the data and were either novel or important according to the literature (*e.g.*, actions, barriers, and motivations [4,7,23,28]).

Demographics

Interviews were conducted with 13 IT employees (2 females, age m=32.9, sd=6.3). The job description of the participants varied, which helped us to understand different perspectives towards workplace conservation. We also conducted a focus group interview with 4 Facility Team (FT) members (4 males, age m=31.8, sd=5.9). All the participants and FTs were Indian, and working full-time for more than a year in the same Bangalore-branch of a U.S. organization. Table 1 provides key demographic data about the participants (P1-P13) and FTs (FT1-FT4). All the participants and FTs were aware of their monthly electricity and water bills, and all (except one) were responsible for paying their monthly bills. On an average, they reported spending 9.2 hours (sd=0.9) in their office daily. All of them had similar seating arrangements, with cubicles in a large area. All the participants answered in neutral to strongly agree (on a 5-point Likert scale) when asked about their orientation towards conservation, "*I am environment-friendly and do everything possible to save the environment?*" (Table 1). The high-scores for conservation orientation could be because either participants do not want to admit to being wasteful, or they practice conservation and hence agreed to participate in our study.

RESULTS

We found certain factors motivated our participants to practice conservation at home and office. We will start this section discussing such motivational factors, followed by the resource wastage observed by the participants. We organized the observations in terms of the type of resources – energy, water, fuel, trees, food – participants discussed getting wasted and their respective conservation efforts at workplace. Wherever possible, we compared conservative actions performed by the participants at home and office. We also discuss the ground truth and organization's initiatives as mentioned by the FTs. Note: The different resources and practices identified by the participants are not necessarily all significant or have the same sustainability impact. The participants identified all the resources; the interviewers did not lead the participants to any set of resources.

Motivation

Learned Reactions. Most of the participants learned to conserve at an early stage through repeated reminders to conserve, from their parents. Similar to [23], we found that as learning happened so early, several conservative practices seem ingrained and habitual.

> *"It's about good habit and knowing that we should not waste… That's the way we have been brought up." – P6.*

> *"What you get ingrained in. I mean, in general, if you grow up in a middle class family, everything is considered precious… You cannot waste food, you cannot waste energy." – P4.*

Similar to their parents, participants mentioned repeatedly telling their children about conservation, to inculcate energy saving habits in them. Additionally, schools also taught conservation, *"We are well educated. We know what is good and what is bad." – P13*. Because of what the participants have been taught all their lives, conservation has become part of their belief system. As a result, participants reported believing that conserving resources when possible was simply *"the right thing to do." – P2*.

Scarcity. One of the major motivations to save resource was participants' past experiences with the scarcity of that resource. P7 talked about the water problems that he faced during his childhood days: *"Water is a very precious thing for me. Since I have seen this scarcity, now… I can't see water getting wasted."* P2 mentioned food scarcity, *"In my childhood days, opposite to my house there was a slum and there was a marriage*

hall nearby. When they throw waste food, I saw people fighting for that food." Similar examples related to scarcity resulting in conservation have been previously identified [7,23].

Money. Monetary savings is a strong motivator for conservation at home. *"Switching off the lights, I don't think anybody does because of love for the environment… It's all about finances." – P3*. P13 talked about the rising electricity tariffs, while P8 mentioned that the tiered-structure of electricity pricing acts as a motivator. High price of fuels like petrol, diesel (for transportation), and gas (used for cooking in India) was another major concern of the participants.

Knowledge. All the participants were aware of their personal resource usage, in terms of their monthly electricity and water bill. According to P8, his water bill amount was negligible, but the amount of water his family consumes was astonishingly high which motivated him to conserve water: *"that's a lot of water man. Think about it, 150 liters per person per day." – P8* (similar data reported in [26]). Some participants were concerned about the global warming and resource limitations, and were motivated by the fact that individuals can make a difference:

> *"*(We should) *contribute towards fixing these problems of climate change and global warming… If you can do your part, if everyone does their part, I think we can do much better than what we are doing currently." – P11.*

Peer-group Effect. Participants mentioned getting motivated by the colleagues who are actively involved in sustainability projects: *"I feel happy that there is a group, which is consciously looking at these* (sustainability) *things as part of their work… So having people around who actually work on these things does influence me." – P6*. Similarly, one of P11's friends was doing a PhD in Climate Change, *"so, from him I came to know about all these problems especially, food security, water problem and the energy problem and all that."*

Perceived ***Energy*** Waste and Conservation Efforts

All the participants perceived energy as the major resource getting wasted in the organization in the form of cooling, lighting, operating elevators, and charging equipment including computers, phones, and projectors. This is in accordance with the reported data [32] that the top three end uses in the commercial sector are space heating, lighting, and cooling, which represent close to half of the commercial site energy consumption.

Lights

Participants raised concerns about excess lighting in the workplace including cubicle area, meeting rooms, café, corridors, and car-parking. P3 commented on the meeting room in which we conducted this interview, *"here we got about 12 lights, right. So that's about four lights per person… we can manage with two lights per person."* The facility team provided an explanation for "extra" lighting:

> *"There are* (lighting) *standards you are supposed to maintain. We cannot go below that. It is thumb rule for us… It is from OSHA* (Occupational Safety and Health Administration). *It's a US standard, as this is a US company." – FT.*

Participants also complained about unavailability or lack of visibility of light switches, *"there is no control for meeting room lights…* (Pointing to a switch in the meeting room) *Does that, I don't know, does that work?* (After trying the switch) *No that doesn't." – P9.* Participants were also against the idea of a single switch for multiple light sources, *"a centralized thing where one switch is for everything* (12 lights) *does not work." – P8.* Though the centralized switches might be more convenient, participants were of the opinion that they do not provide the required granularity for controlling lights and might result in overuse. P1 and P4 suggested exploiting natural light to reduce dependence on electricity.

Participants mentioned that many lights are always ON, irrespective of the occupancy or exposure to natural light. This is mainly due to non-functional or inaccurate motion sensors: *"There are some* (not working) *motion detectors… now I think all of them* (lights) *are ON, right, whereas, at least 50%* (employees are) *working from home today." – P12* (Figure 1A). Participants mentioned accuracy as one of the major limitations with current automated systems, and suggested manual controls: *"sometime automation will not work but manual we can do by ourselves immediately" – P9*. Participants discussed the need of more motion-sensor-operated lights.

> *"They can put motion detectors* (in car-parking) *because for large periods of time, I think it would be no movement." – P9*

Figure 1B (P8) shows that office lights are ON even when the area is exposed to ample amount of direct sunlight. Similarly in the car parking, *"MLCP* (multilevel car parking) *lights are on all the time, even when there is natural light in there… At night, it is okay." – P9*. On the other hand, at home, participants mentioned being highly active in switching off the unnecessary lights, and using natural light as much as possible, similar to previous studies [23].

Heating, Ventilation, and Air Conditioning (HVAC)

FT members mentioned that *"HVAC consumes about 50-60% of the total building energy"*. Interestingly, none of the participants used air-conditioning at home (may be because Bangalore enjoys a moderate climate throughout the year), whereas, at workplace, HVACs are installed as per American standards (FT).

> *"We don't need an air conditioning, why is the company providing us?" – P4.*

Participants complained that HVACs result in over-cooling. Health factors motivated minimal HVAC usage, *"I keep getting headache if I have too much AC" – P4*. P1 was wondering about the reason for cooling, *"Usually they say if it's a place with desktop, it needs a minimum amount of cooling, right? Here, everybody, almost everybody has a laptop, so that is not the reason."* Participants suggested solutions for reducing HVAC usage, by *"having it* (HVAC) *ON for only 60-80% of the time every hour" – P3*. FT mentioned that HVACs are operational from 8am to 8pm.

Participants were not aware of the initiatives taken by the facility team, which works in the background to make systems, including HVAC, more efficient. For instance, FT

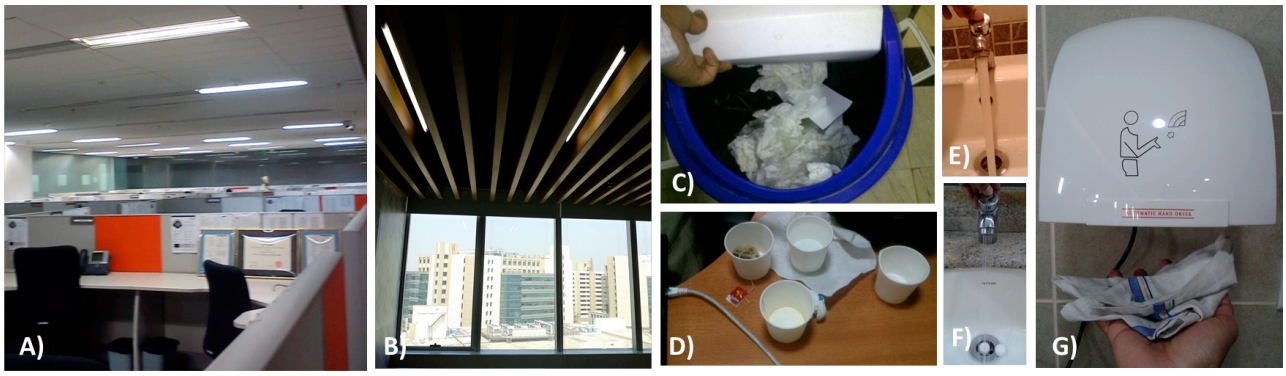

Figure 1. Energy, Water and Paper Conservation and Wastage. (A) Non-functional light sensors (P12). **(B)** Lights are ON irrespective of natural sunlight (P8). **(C)** Trash bin full of paper towels (P13). **(D)** Wastage of multiple paper cups every day, *"I have at least three tea per day." – P1*. **(E)** and **(F)** Water flow restrictor, "*If the tap is giving 100% flow of water, by putting this restrictor about 40% of water comes" – FT.*(**G)** Using hand air dryer to dry handkerchief, instead of using paper towels (P7)

installed automatic actuator that switches off the HVAC's AHU (Air Handling Unit) after reaching the required temperature. This reduces 5-10% of AHU consumption. P4 suggested using *"occupancy sensors"* to control the temperature. The facility team has already been doing that:

> *"If number of people is reduced in this room, then the airflow will be more so we will feel cold. To have a control over this, actuator is fitted with thermostat… such that valve* (supplying cold water to HVAC) *will close* (automatically) *and the temperature is maintained." – FT.*

FT knew that this system is not perfect, as *"during weekends if five or six employees are working in a floor* (each floor capacity is around 700 employees)*, switching on HVAC will result in very heavy consumption." – FT*. Hence they have proposed pedestal fans for employees, during weekends.

As per the participants, the major barrier in reducing HVAC usage is the lack of controls: *"There are no distributed controls for cooling… So, you cannot do anything about it at an individual level… We are not in the loop." – P4*. This may be due to the centralized cooling, compared to Indian homes where there is individual control for each appliance. Participants were aware that they can call the FT to change the temperature, and FT mentioned that they do receive calls, mostly to decrease the cooling. However, as P12 mentioned, *"if we call the facility, again we are using electricity to call them. And they will come down using lift…* (Instead if we have controls) *then we can just go and reduce or switch off, simple."* P9 suggested having *"crowd sourced method…* (When) *some number of people say it's cold that automatically changes the temperature."*

Elevators

FT mentioned that the second most energy consuming devices after HVACs are elevators. Usually participants preferred elevators while going up, but use stairs while coming down, *"walk down for coffee. I generally don't take the elevator." – P1,* motivated by health reasons. (P1's office is on the 7th floor, while café is on the 3rd floor.) For some participants, it was the convenience factor:

> *"It's very annoying to wait for it (the elevator)… it's usually crowded, so just climb it* (the stairs)*." - P10.*

> *"I don't take the elevator because of the recent changes of the elevators being divided into specific floors. So I have to go to fifth floor* (from my office on 7th floor)*, cross over to the other set of elevators and then go to third floor. So that's little too complicated!" – P2.*

P1 suggested thought-provoking posters to motivate people to use stairs, like *"put up a poster on the elevator door itself… sort of asking them, 'Are you too old to take stairs?'"*

Other Equipment

Some participants mentioned switching off their computers at night, however *"in the night, you see their* (IM, Instant Messenger) *status is away, which means the computer is running." – P4*. The reason for being 'away' rather than 'offline' is that it might be convenient for others to contact them by sending an IM rather than an email. P3 and P11 put their laptops on sleep/hibernate mode before going for lunch, while P10 had to keep switching off his laptop regularly as it gets heated up. Participants mentioned that due to hectic work schedule they forget to switch off projectors and laptops, while few participants mentioned switching off all the devices before leaving office.

P1 stated excessive usage of phones:

> *"I log in to the day-long conference call from my phone. At the next desk my colleague also logs into the same call. The person behind me also does the same. That's not required… At least four cubicles can share a phone… I mean if I could hear it* (from my colleagues desk)*, I disconnect my call. When I am asked for update I just walk and give update." – P1.*

FT mentioned that to deal with power cuts (India faces severe power cuts [38]), the workplace *"have multiple inverters, multiple UPS* (Uninterruptible Power Supply) *across floors, and even DGs* (Diesel Generators)*"*. These power backups result in a lot of energy wastage.

Perceived *Water* Waste and Conservation Efforts

Participants were concerned about water wastage at the workplace. P1 pointed out that some of the faucets (or taps) in washrooms are leaky, while P8 and P13 mentioned human errors in terms of *"people are not that careful about turning the taps completely off" – P8*. Participants tried to deter

these actions, *"I just keep on going and closing those* (leaky) *taps." – P13.* While similar problem of leaky faucets also exists at home, participants try to collect and reuse that water, *"I keep a glass or something underneath there, and use that water" – P1*. Waste water coming out of water purifying units was used for gardening and cleaning, while P12 uses the waste water after cleaning clothes for washing floors (similar to [23]).

Participants mentioned that some of their colleagues use running taps to *"completely wash their face or hands or whatever it is" – P2.* At home, people use mugs instead of running taps while shaving or brushing, to minimize water wastage (similar to [23]). Interestingly, participants also mentioned water getting wasted in workplaces which are not visible, such as for cleaning and cooling purposes, *"in chillers* (HVAC) *and other things which I don't see" – P4*. Similarly, P1 noted that it was difficult to conserve water at home as most of the usage occurs in background, by housemaids for house cleaning and washing clothes.

While participants ask their children to minimize water wastage at home, in office they were hesitant to ask their colleagues to minimize wastage, as they were not sure about their reaction, and whether it would have any impact.

> *"When I tried to close the tap when someone had kept it open, that person gave me a long stare… I don't do it again as I don't know how people will react." – P2*.

> *"I could tell people who leave the restroom taps open, like why don't you close this tap? But I don't, as personal perspective or attitude of people cannot be changed easily." – P1.*

To minimize water wastage at faucets, FT members have installed water flow restrictors (Figure 1E and 1F), which reduces the water flow to 40%. FT also mentioned that due to cultural reasons, they have not installed waterless urinals: *"Many people chew chewing gums, Pan Parag* (a food product made of betel nuts)*, and spit them* (in the urinals)*. Also, due to the high traffic, it can fail at certain point."*

Perceived ***Fuel*** Waste and Conservation Efforts

Participants raised concerns about increasing pollution, and non-renewable nature of fossil fuels. At an organization level, P13 observed that the transportation provided by the organization to pick-and-drop employees is under-utilized, *"it usually has only 4-5 people* (while the capacity is of 16 people)*."* At an individual level, P12 mentioned, *"I know people who come alone by a four wheeler car* (to work)*"*, which also results in traffic congestion.

In spite of these notions, only one of the participants bike to work, 2 uses two-wheeler, 6 uses public or office transport, while 4 uses four-wheeler. None of the participants were part of any car-pooling, as they felt insecure traveling with strangers. Moreover, public transportation was said to be usually uncertain, and riding bikes was not considered safe in absence of designated bike lanes in the city. Safety, security and poor public transportation has been cited as barriers to reduce usage of private vehicles [23].

Participants opined that the organization should aggressively promote car-pooling. Participants mentioned other motivational factors for car-pooling such as comfort: *"It's the same time as it would take me to drive my car, plus there is added comfort and I could work in the car." – P10.* Money plays an interesting role in fuel usage. Participants mentioned increasing fuel prices has encouraged them to minimize private vehicle usage. On the other hand, P3 mentioned, *"as you earn more, you move from public transport to a bike to a car, and you waste more."* Hence switching to a car may be due to various factors such as convenience, safety, timing, or showing car as a financial status symbol.

Perceived ***Paper (Trees)*** Waste & Conservation Efforts

Participants mentioned paper to be the second most wasted resource in workplace after energy, in the form of paper towels (Figure 1C), paper cups (Figure 1D), and printouts. Participants used multiple paper cups every day (Figure 1D) for drinking tea, coffee and water, *"If you have a coffee in a paper cup invariably one cup doesn't suffice, it will be hot so you need one more cup to hold it." – P10.* In spite of having mugs, participants cannot use it as paper cups available in office also serve as a measurement scale for the coffee vendor. Some participants used (reusable) water bottles, and re-used paper cups whenever possible. They suggested that the organization should provide bottles and coffee mugs to minimize the use of paper cups.

Participants mentioned not being judicious about the usage of paper towels in office, *"Sometimes I have seen people… take a bunch of hand towels and then start soaking their head, face, hands and all, as if they are using a cloth towel." – P2.* Participants tried to conserve by using hand air dryer instead of paper towels (P10); P7 use a cloth handkerchief, instead of paper towels, and use the dryer to dry the handkerchief, if required (Figure 1G). Interestingly, none of the participants use paper cups or paper towels at home.

Participants mentioned excessive printing as part of the corporate culture. *"People just print for no cause… Whenever I come to the printer room to collect my print, I see people firing like books of printout… Also I don't understand there is always a pile of uncollected printouts." – P1*. P12 mentioned employees giving the same printout multiple times, *"Sometimes there are so many* (uncollected) *printouts, you can't find your own printout and you have to print again."* Participants were aware of such wastage and tried to minimize them by printing on both sides of the paper, reading documents on their laptop, and putting unused papers back in the printer.

> *"I generally suggest my team members not to print documents because you have the electronic media. You can open your laptop and you can read the documents… print only the required, necessary, part of the pdf, not the entire file." – P2*.

> *"All the printouts when I flipped through… only top one line was printed… I put it* (the papers) *back in the printer." – P1.*

P2 also minimized printouts at home, "*I make sure that they* (children) *collect pictures and keep it in a folder. I just arrange it* (pictures) *in a document, and then print, so that not many pages*

*are waste*d." P10 reads newspaper on his laptop, and P1 uses an e-reader for reading books. Interestingly, all uncollected printouts were *"converted into one sided notebooks"* by FT. The facility team placed many posters, including *'how to use a paper towel'* and *'celebrate a no paper-cup day'*. However, P5 pointed out that these posters have not influenced him as they are just one time encouragement.

Perceived *Food* Waste and Conservation Efforts

Participants mentioned wasting food at their workplace because the food is not as per their personal preference.

> *"Food is something that I unfortunately tend to waste because… the food here is very spicy." – P10.*

> *"The food looked really good... but when we tasted… it's not that good, that's why we are wasting it." – P2.*

One way to reduce food wastage is by being selective, *"I am most of the times selective about what I want to eat and then I will make sure whatever I took I will finish." – P11*. Participants mentioned minimal food wastage at home as *"whatever I want, I make. I will eat whatever I like.*" – P5, *"I tell my wife okay, cook whatever is sufficient for the family to eat. Like don't cook extra." – P2*.

Food wastage in office increases during business meetings as *"they bring some fancy boxes which have far more food than necessary, and that leads to a phenomenal waste." – P4*. Participants mentioned posters in the café at work urging people not to waste food, *"in café, you have a lot of things* (posters) *about don't waste food. You know, somebody can go hungry… posters saying it takes so many hours to grow a carrot." – P4*. However the posters have not been very effective, as the message on such posters is not very explicit, *"what is it trying to convey to us?" – P2*.

DISCUSSION: BARRIERS AND POTENTIAL SOLUTIONS

The workplace imposes a different social context than home, which results in differences in conservation practices between the two settings. In this section, we will discuss observed barriers to conservation at workplaces, followed by future solutions suggested by the participants.

Barriers

Role of Self: Lack of Responsibility and Ownership. Participants mentioned an attitude that they own their home, they have control over it, and hence they are responsible for its welfare. On the other hand, office is an impersonal space with no sense of ownership, hence they do not feel responsible to conserve.

> *"I don't bother about it* (conserving in office) *because I don't have any control. I don't have any sense of control." – P4.*

> *"Ownership is one of the major things… It is 'my' thing, I have to do something to save, that sense of ownership is something that is very much missing. It's not that this is company property, it should be how will I use it judiciously if it is mine… That is how people should start thinking." – P2.*

Such lack of controls also results in a feeling that they do not have the right to impose conservation onto others.

Role of Others: Volunteer's Dilemma and Bystander Effect. Participants were apprehensive about saving resources in workplace due to *volunteer's dilemma*, as they feel that even though they are saving, other employees are wasting it: *"I save energy. But what happens is that someone else uses lot of that energy whatever I save… At the end of the day, I am saving, somebody is using." – P2.* Moreover, we also found references of *bystander's effect,* as employees were demotivated because other employees were not performing conservative actions. *"If I had to switch off a light and that switch is close to some other person… So it's better he takes the action. If he doesn't take the action, even I don't care" – P5.* Even when the participants performed conservative actions, they were not appreciated by their colleagues. Participants felt that an individual effort cannot make a difference in an organization; it is the cumulative effort that matters.

Financial Freedom. Monthly electricity and water bill played an important motivating factor in conservation at home, while their absence acted as a barrier in performing conservative actions in workplace. *"I don't feel like saving* (in office) *because it won't bring something to me… I don't feel like it will be reflecting in my bills." – P5; "People who are working from home, they might think that they are wasting energy at home, so it's better to come to the office and waste that energy at office, because they need not pay for that." – P3.*

Information Gaps. Lack of knowledge at times acted as a barrier to conservation, *"I don't know what kind of wastage happen here" – P11*. Participants were not aware of organization's conservation policies or sustainability initiatives; none of the participants knew monthly water or energy bill of their workplace (FT members were aware of the bills). Participants were also confused between similar options such as hand air dryer versus paper towels. Interestingly, though the majority of energy consumption at workplace is attributed to HVAC, only six participants mentioned it, may be because it is not visible. Even the information presented to employees in the form of posters, was not clear and/or precise. On the other hand, even complete knowledge might result in negative behaviour: *"we don't turn off tube-lights…* (as they) *are what 30 W." – P4*.

Bureaucracy. The facility team has several ideas to conserve like switching from CFL to LED lights, installing motion-sensor-operated lights everywhere. The major barrier for them is bureaucracy, *"Proposals takes time for approval… We need to forward these proposals to design team. Based on their approval, we need to approach energy management teams… Finally it comes through RESO* (Real Estate Site Obligations, the department that is responsible for building operations and energy management)*"*. Due to the same bureaucratic reasons, participants hesitated to complain for wastage (such as non-functional motion sensors).

Potential Solutions

In this section, we report solutions proposed by participants to overcome these barriers and influence employees' conservation behaviour.

Direct Feedback. Participants were uncertain about the impact of their actions. Hence providing direct feedback at an individual level can help, *e.g.*, communicating the number of printouts and trees required to make that many pages; connecting weighing machine to the trash bin in café to provide instant feedback on the amount of food an individual is wasting and number of people it could feed; tracking elevator's usage using swiping of security badges and communicating their elevator usage in terms of energy consumed and opportunity lost (calories they could have burnt by taking stairs instead). Feedback in terms of units of resource saved may not be motivating as the numbers can be small, hence intelligent and impactful feedback obtained from aggregated data should be delivered. Participants also suggested measuring floor-level consumption to provide comparisons across different floors of a building. This can lead to healthy competition motivating employees working on the same floor to collaborate for conservation, similar to [22,24]. Interestingly, none of the participants raised privacy concerns about the data being collected by such sensors (may be because privacy concerns in India are low [19]).

Tangible and Intangible Incentives. Lack of incentives acted as a barrier in practicing conservation at workplace. Tangible benefits in the form of lunch coupons, reduced coffee prices to employees who use coffee mugs, can act as a motivator (similar to Foster *et al*. [8]). Rather than rewards for conserving, participants suggested penalties for wasting or for exceeding pre-defined threshold resource consumption. Some participants were sceptical about small rewards or penalties as employees are well paid in the organization. In such scenarios, non-financial benefits such as visible recognition in forms of certificate (*'Green Employee'*) might work. India is a masculine society [13], *i.e.,* driven by competition, achievement and success, hence visible symbols of success at workplace can motivate employees.

Manual Controls and Strict Automation. Participants mentioned lack of manual controls as one of the major barriers in conservation. More manual controls such as light switches and thermostats to control cooling should be implemented in workplaces, similar to homes. Manual controls can enable employees to take responsibility and control of usage consumption. However, as manual controls rely on people who tend to forget and make mistakes, participants opined for more and better automation. Participants suggested automated savings by using HVAC for minimal time and dimming lights when not in use, and *strict automation* in terms of shutting down devices (*e.g.* printer) instead of putting them in energy-saving mode.

Educate and Spread Awareness. Participants learned about conservation during childhood from their parents and teachers. Similarly, participants suggested conducting seminars and talks on conservation practices to educate employees about current climate change, consequences of their actions and how they can contribute. Teaching about future climate crisis can act as strong motivator as Indians have long term orientation [13]. Organization's conservation policies and sustainability initiatives should also be conveyed to the employees to motivate them for participation. Graphical and easy to understand evocative posters with specific messages (*e.g.*, five steps to conserve power in office) can help in influencing behaviour.

DESIGN CONCEPTS

The findings we have presented provide a rich basis for redesigning workplaces to increase resource conservation.

Build Communal Spaces. Participants do not feel that they have ownership at their workplace. This may lead to differential treatment of homes and office spaces. The problem lies in the design of office spaces. In cubicle-structured workplaces, each individual is responsible only for his/her cubicle, however resources like lights, HVAC's, and water, are shared between multiple cubicles. This results in a perception that employees do not have controls. Moreover, due to existing social distance between colleagues in India [25], they feel uncomfortable taking actions, because a single control might affect multiple people. Design solutions such as building communal spaces might help. Teams should be given rooms or specific wings of a building to work in, encouraging sense of ownership and responsibility. This might result in more conservation, as the team members could collaborate to efficiently manage their team space. It follows collectivism, which is deeply rooted in Indian society [13].

Design Location Specific Workplaces. Participants felt that cooling at workplace is not required. Facility team mentioned that office buildings are constructed and operated (lighting and cooling) as per accepted western standards. In the western world, the reason behind completely closed structures is mostly because of the extreme winter climate; this is not the case in India. Ideally, office buildings should be constructed in accordance with the local climatic conditions. In India, office spaces should utilize natural air and sunlight, which is available almost throughout the year. However, high noise and air pollution in certain Indian cities limits this design recommendation. Moreover, lighting standards and cooling comfort level should follow local standards such as LEED [36] for India.

Manage the Paradox of Choices. Multiple options might affect the decision-making process. With incomplete information, it is hard to choose between similar options, such as hand air dryer versus paper towels (energy versus trees), paper cups versus mugs (trees versus water for washing the mug), and printed newspapers versus e-newspapers. As a design rule, organizations should reduce choices by completely replacing inefficient options with the most environment-friendly option. *E.g.*, instead of displaying posters advocating minimal paper cup usage, removing paper cups altogether will enforce employees to use reusable water bottles. This might seem like enforcement from an employee's perspective; hence the organization must justify such actions by revealing the reasons behind the decision-making (*e.g.,* energy efficient e-ink tablets releases 32 to 140 times less CO_2 and uses 27

times less water than reading the paper version [33]). Such initiatives may also help to inculcate environment friendly habits in employees, at large.

Make Wasteful Actions Inconvenient. Participants conserved by not repairing lights at home and opting for stairs instead of changing elevators, due to inconvenience. In future, we can design systems that impose additional user efforts to waste resources. *E.g.*, adding levels of bureaucracy in terms of mandatory manager approval to take printouts beyond a certain count; segregating printers based on the number of printouts that can be taken, such that heavy duty printers are placed farther from the sitting area, even may be on a different floor. This concept even generalizes to the developed world, as people, in general, lack the motivation to perform inconvenient tasks.

Make the Roles of Others Visible. People are reluctant to take initiatives if they feel that while they are going out of their way to do it, others are not playing their role (similar to *volunteer's dilemma*). Systems should be designed to provide visibility to peer's actions and performance, *e.g.*, showing that a group in the organization has been following a policy of switching lights out for 10-11am daily. Similarly, actions by FTs need more visibility through a feedback loop, which would help in reducing disconnect between employees and FTs. Even organization-wide policies (*e.g.,* deployment of automated solutions like CAPM [12], VPs must take normal flights rather than private jets) should be communicated to employees. Such policy and infrastructural level changes may lead employees to think that the company culture cares about conservation and this might motivate them to adopt a similar behaviour. This is in accordance with Hofstede's cultural dimension scores [13], which states that Indians appreciate hierarchy, and learns from their superiors.

Associate Shame Factor to Wastage. Indian workplaces and society, in general, is characterized by greater concern for inter-personal relationships and mutual respect [25]. This aspect can be used to the advantage of conservation by associating a shame factor to wastage. *E.g.*, trash bins providing audio feedback when someone throws food in it; heavy duty printer installation in common areas along with audio feedback. This might help in reducing wastage as people would not like being noticed.

CONCLUSION

Resources consumed within workspace buildings and their corresponding waste puts a significant burden on the local environment and communities. We argue that the users of these buildings—workplace employees—can potentially contribute in conservation efforts. To understand how employees perceive conservation, the conservation activities they engage in and the factors that thwart those efforts, we conducted a photo diary study followed by elicitation interviews with 13 employees and a focus group with 4 Facility Team (FT) members working for an IT company located in Bangalore, India. We have provided a rich description of the practices around resource conservation and wastage in an Indian workplace, and propose key design concepts. We learned the key to conservation in the workplace is accountability, awareness, ownership, and communication. In essence, for workplace conservation efforts to succeed, employees must be kept in the loop in terms of design and decision-making processes.

LIMITATIONS AND FUTURE WORK

Our study is, at best, a first step towards characterizing workplace conservation outside of the developed regions context. Even within India, wide socio-economical, climatic, cultural, and demographic diversity makes it difficult to know exactly how broadly these findings generalize. *E.g.*, our study was limited to a single organization in Bangalore, which enjoys a moderate temperature throughout the year. Additionally, our participants work in an organization that primarily requires dealing with state of art technologies and sciences, and most of the participants have an engineering background. This perhaps explains the technology-laden solutions suggested by the participants. This may not be generalizable to employees with different backgrounds and/or work environments. Thus, we plan to conduct an extensive study involving many workplaces with different characteristics.

As the categorization and identification of resource wastage was according to participants' response, all the wastage may not necessarily have the same sustainability impact. Also, it is possible that certain practices and/or categories might have been left out entirely by the participants. In the future, we hope to extend this study to establish ground truth using sensors or diary journals, to validate employees' perceptions with reality. Finally, commercial organizations are only likely to incorporate any conservation ideas only if the costs involved are reasonable. Thus, a cost-benefit analysis must be performed on each design recommendation to understand how it would affect a specific organization. The design recommendations also require careful evaluation to ensure that they are applicable to everyone, and do not impose hardship to those with atypical physical characteristics and disabilities.

REFERENCES

1. Abrahamse, W., Steg, L., Vlek, C., and Rothengatter, T. A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology 25*, 3 (2005), 273–291.
2. Arroyo, E., Bonanni, L., and Selker, T. Waterbot: Exploring Feedback and Persuasive Techniques at the Sink. *CHI*, ACM (2005), 631–639.
3. Carrico, A.R. and Riemer, M. Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education. *Journal of Environmental Psychology 31*, 1 (2011), 1–13.
4. Chetty, M., Tran, D., and Grinter, R.E. Getting to Green: Understanding Resource Consumption in the Home. *UbiComp*, ACM (2008), 242–251.

5. Clark-IbáÑez, M. Framing the social world with photo-elicitation interviews. *American Behavioral Scientist 47*, 12 (2004), 1507–1527.
6. Cohen, C., Lenzen, M., and Schaeffer, R. Energy requirements of households in Brazil. *Energy Policy 33*, 4 (2005), 555–562.
7. Dillahunt, T., Mankoff, J., Paulos, E., and Fussell, S. It's Not All About "Green": Energy Use in Low-Income Communities. *UbiComp*, ACM (2009), 255–264.
8. Foster, D., Lawson, S., Linehan, C., et al. 'Watts in it for me?' Design Implications for Implementing Effective Energy Interventions in Organisations. *CHI*, ACM (2012), 2357–2366.
9. Froehlich, J., Dillahunt, T., Klasnja, P., et al. UbiGreen : Investigating a Mobile Tool for Tracking and Supporting Green Transportation Habits. *CHI*, ACM (2009), 1043–1052.
10. Froehlich, J., Findlater, L., and Landay, J. The Design of Eco-Feedback Technology. *CHI*, ACM (2010), 1999–2008.
11. Harle, R.K. and Hopper, A. The Potential for Location-Aware Power Management. *UbiComp*, ACM (2008), 302–311.
12. Harris, C. and Cahill, V. An Empirical Study of the Potential for Context-Aware Power Management. *UbiComp*, Springer-Verlag (2007), 235–252.
13. Hofstede, G. *Culture's Consequences, Comparing Values, Behaviors, Institutions, and Organizations Across Nations*. Sage Publications, CA, 2001.
14. Indraganti, M. Thermal comfort in apartments in India: Adaptive use of environmental controls and hindrances. *Renewable Energy 36*, 4 (2011), 1182–1189.
15. Kumar, A., Jain, S.K., and Bansal, N.K. Disseminating energy-efficient technologies: A case study of compact fluorescent lamps (CFLs) in India. *Energy Policy 31*, 3 (2003), 259–272.
16. Lenzen, M., Wier, M., Cohen, C., et al. A comparative multivariate analysis of household energy requirements in Australia, Brazil, Denmark, India and Japan. *Energy 31*, 2-3 (2006), 181–207.
17. McGee-Lennon, M., Wolters, M., and Brewster, S. Designing Reminders for the Home: The Role of Home Tours. *INCLUDE*, (2011), 1–10.
18. Pachauri, S. An analysis of cross-sectional variations in total household energy requirements in India using micro survey data. *Energy Policy 32*, 15 (2004), 1723–1735.
19. Patil, S., Kobsa, A., John, A., and Seligmann, D. Comparing Privacy Attitudes of Knowledge Workers in the U.S. and India. *ICIC*, ACM (2010), 141–150.
20. Pierce, J., Schiano, D.J., and Paulos, E. Home, Habits, and Energy : Examining Domestic Interactions and Energy Consumption. *CHI*, ACM (2010), 1985–1994.
21. Rao, N., Sant, G., and Rajan, S.C. An Overview of Indian Energy Trends. *Prayas, Energy Group, India*, (2009).
22. Schwartz, T., Betz, M., Ramirez, L., et al. Sustainable Energy Practices at Work: Understanding the Role of Workers in Energy Conservation. *NordiCHI*, ACM (2010), 452–462.
23. Shrinivasan, Y.B., Jain, M., Seetharam, D.P., et al. Deep Conservation in Urban India and its Implications for the Design of Conservation Technologies. *CHI*, ACM (2013), 1969–1978.
24. Siero, F.W., Bakker, A.B., Dekker, G.B., Burg, M.T.C. Changing Organizational Energy Consumption Behaviour through Comparative Feedback. *Journal of Environmental Psychology 16*, (1996), 235–246.
25. Ulus, E. Studying Workplace Emotions in India: A Rapprochement of Psychoanalytic and Social Constructionist Approaches. *PhD Thesis, University of Bath*, (2012).
26. Varghese, M. and Miglani, R. Privatization of Water in Karnataka: Special Focus on Bangalore. *Centre for Civil Society*, 2007.
27. Vyas, D. Domestic Artefacts: Sustainability in the context of Indian Middle Class. *ICIC*, ACM (2012), 119–128.
28. Woodruff, A., Hasbrouck, J., and Augustin, S. A Bright Green Perspective on Sustainable Choices. *CHI*, ACM (2008), 313–322.
29. The CIA World Factbook. *Central Intelligence Agency, India*. http://www.webcitation.org/6FJqJCGKV.
30. Country Analysis and Briefs. *Energy Information and Administration*. http://www.webcitation.org/6AngIeQWq.
31. Riding the Wave. *Ernst and Young*. http://www.webcitation.org/6AmevWAIJ.
32. Buildings Energy Data Book: Commercial Sector. *U.S. Department of Energy*. http://www.webcitation.org/6FJpnAxfB.
33. ePaper vs. Printed Paper. *Eink*. http://www.webcitation.org/6FJqbjS04.
34. Sector-wise Electricity Consumption in India. *IASRI*, 2010. http://www.webcitation.org/6FJqecmds.
35. Sustainability in the Workplace. *Sustainability at Work*, 2011. http://www.sustainabilityatwork.com.au/downloads/research-report.pdf.
36. LEED Reference Guide. *India Green Building Council*, 2011. http://www.webcitation.org/6FJqwHZEZ.
37. Indian IT-BPO Industry. *NASSCOM*, 2012. http://www.webcitation.org/6FJr5CAxM.
38. Monthly Power Supply Position. *Central Electricity Authority*, 2012. http://www.cea.nic.in/monthly_power_sup.html.