Supporting Sustainable Mobility with the Help of Work Organizations: Preliminary Requirements and Future Work

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ABSTRACT
Local governments are seeking effective ways to promote sustainable commuting for reducing energy consumption and improving commuters' experience. They often use so-called "Workplace Travel Plans" as policy interventions to engage work organizations as active players, promoting sustainable commuting amongst their employees. However, it remains difficult to systematically engage work organizations and commuters in such efforts for a number of reasons, ranging from preferences to constraints that they have to deal with. We aim at providing commuters, work organizations, and public administrators with tools that facilitate this engagement. In this paper, we discuss the requirements for the design of technology supporting corresponding services for commuters and work organizations. We also outline the comparative work we are aiming to do to understand how Western requirement differ from countries like India.

Author Keywords
Sustainability, Mobility, Design factors, Incentives

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

INTRODUCTION
Transportation is a key domain for promoting sustainability in the EU and in the US as it accounts for about one third of their energy consumption, but changing the transportation habits of large populations of citizens is a hard challenge.

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Local governments and companies have developed various interventions to support sustainable mobility, but the results are sparse, and the majority of them do not reach the critical mass necessary to have sufficient impact as described in [14]. One typical intervention is the deployment of so-called "Workplace Travel Plans" (WTP). A WTP is a company-specific action, which consists of a set of policies and incentives to reduce Single Occupancy Vehicle (SOV) usage and promote greener commuting choices instead. A WTP may, for instance, include targeted subsidies for busses, trains, or car sharing. WTPs are supported and promoted by local governments to engage work organizations as active players promoting sustainable commuting amongst their employees. Experience from many countries has shown that WTPs have only been partially successfully used, and it still remains difficult for local governments to systematically and actively engage work organizations and commuters in such efforts. This aspect is particularly important as it has been seen that WTPs tend to work best in organizations that are kept engaged until they progress from a reactive to a proactive role, i.e. organizations that can map the benefits of WTPs to their own objectives [19]. These business objectives include showing corporate social responsibility, becoming an "employer of choice" and reducing real estate costs. To achieve this long term engagement, singular or sporadic interventions are not enough, as these organizational benefits are of a special kind and they can be appreciated only in the long term by the organization and/or at specific moments in the life of a company. Our approach is therefore to work on the foundational requirement to support commuting stakeholders, that is, commuters, work organizations, and public administrators, in an on-going program of measures towards sustainable commuting. These measures should have low adoption costs, and increasingly intercept with the company business goals and appropriation of the tools. More specifically, we are working on the design of technology interventions (tools and services) to promote sustainable commuting habits among commuters and within their work organizations to

help commuters change current transportation habits reducing SOV usage.

In this paper we revise first existing literature and our own observations on the topic of personal mobility, commuting and *incentives to move* to more sustainable transportation means. We then present existing HCI interventions, and a summary of what we have learned from stakeholder interviews. We then integrate all these sources to outline our approach in the design of the system to promote sustainable commuting. Finally, as we have the opportunity to collaborate with ethnographers located in India, we outline our plans to compare our results, based on Western countries, to the India ones.

RELATED WORK

Local government sustainability initiatives

A travel plan consists of a set of policies and incentives to reduce Single Occupancy Vehicle (SOV) usage and promote greener commuting choices instead. For example, a travel plan may include targeted subsidies for using buses, trains, or car sharing, and lets the individual organizations adopt selected elements.

More recently city-level policies have effectively promoted sustainable commuting. For example:

- In Bellevue (WA) the implementation of the Commute Trip Reduction program, the drive alone commute rate in the city fell by 30% between 1990 and 2000.
- In France, with the "Plan deplacement entreprise" (travel plan for enterprises) government puts in place incentives for companies to motivate their employees to adopt more sustainable commuting habits [17]
- In San Francisco a set of measures supports commuters in adopting sustainable commuting habits [18].
- Belgium put in place laws to involve companies: law obliges companies to regularly conduct a survey about the commuting habits of their employees [16]

These initiatives show that government is interested in making mobility more sustainable, and that they have objectives with respect to carbon footprint reduction To systematically address the effectiveness of these instruments, a few recent studies commenced evaluating the success of travel plans. In a study of 25 organizations in the UK, Roby [19] found that they tend to work in organizations that progress from a reactive to a proactive role, i.e. in organizations that progressively recognize the benefits of travel plans and that adapt them to their own objectives, such as organizational change management, or flexible working practices. Roby also points to the new role that Human Resource Managers are having in those cases, as travel planners for the employees of their organization. Our research has been therefore strongly motivated by this central observation and aims at supporting work organization in moving from the reactive and the proactive organizational role by providing services that continuously support the adoption of workplace travel plans and show the benefits these services can bring to the business. It bases its approach in a deep understanding of the regulatory trends and also the current business evolution of the Human Resources Management role. In a nutshell it will couple the government interest in reducing SOV use with companies' tangible benefits, such as brand image and social corporate responsibility, decreased real estate cost and provision of non-taxable benefits, less stressed workforce.

Persuasive sustainability, HCI, and Behavior Change

In the area of sustainability, HCI (Human Computer Interaction) researchers are building interactive systems that involve users as active decision-makers rather than being mere passive consumers of energy. Consequently, the emphasis for the designers of these systems is on social or technological interventions that can induce behavior changes that reduce energy consumption.

Over the last decade of HCI research, the topic of *sustainability* was associated with a broad range of domains and user behaviors. For example, Blevis [2] proposed that the design process itself should be driven by sustainability values such as promoting disposal, recycling, and reuse, which is a very general take on the topic. Other scattered contributions have emerged, under the label sustainability, in the form of system prototypes that encouraged sustainable behaviors specific: e.g., Walsh's RideNow (2005) project [20] and Hooker's [8] pollution e-Sign.

Over the last decade *persuasive sustainability* became a prominent way to approach Sustainable HCI. Corresponding systems often build on Fogg's behaviour model [7] to design systems that attempt to convince users to behave in a more sustainable way. DiSalvo *et al.* [6] and Brynjarsdottir *et al.* [3] review and criticize related systems and interventions, in particular that the "desired behaviour" is determined by the designers of the systems alone, ignoring the target users motivations and existing institutional, social and cultural influences, and constraints. This leads to the delivery of persuasive sustainability services that are perceived by target users as too prescriptive of behaviours and focused mainly on individual choices/behaviour, thus creating acceptability problems and lack of adoption by user in the long-term.

The work place on the other side can be an influencing and facilitating factor to impact the individual's behaviour and its sustainability. In another behavioral domain, the Print Awareness Tool (PAT) [22] focused specifically on technologies that support the move to more sustainable behaviours in the work place. PAT promotes more sustainable print behaviour in a corporate work environment providing employees with ambient awareness on their printing habits. This is addressed by involving both the individual employee and the work organization in a common effort to reduce unnecessary printing and thus (paper) waste. We know from the results reported by the

authors in [22] about the effectiveness of this approach: participants reported taking it personally, thinking twice before issuing a print job, and, in consequence, adopting various changes in their print behaviour. At the same time participants actively pin pointed ineffective paper based work flows. In line with our own prior findings we therefore rather rely on change models [12, 15, 15] that recognize that behaviour is dependent on a combination of capability, opportunity and motivation, and also that an individual's behaviour is not only dependent on the individual itself but also on the context, and in particular the existing infrastructure and the social environment. Changing human behaviour is not a simple matter of "persuading" but rather it requires first to deeply understand the behaviour and its determinants, and then to design an appropriate intervention addressing the key sources of the behaviour, considering the intervention's practicability, acceptability, and affordability. Therefore, the motivational interventions designed in our research leverage on the active contribution and in-depth knowledge of employees as well as employers' needs, contexts and profiles in order to better adapt them to the local circumstances, opportunities and constraints that can affect user adoption and behaviour change at individual and social level.

UNDERSTANDING COMMUTING TO SUPPORT CHANGE

Commuter attitudes toward mobility

As mentioned earlier, behaviour change models [12, 15] recognize behaviour as dependent on a combination of capability, opportunity and motivation, and also on the context, and in particular the existing infrastructure and the social environment. Technology designers should be fully aware of what existing studies about transportation and especially car transportation and commuting (the largest portion of car traffic) have observed, namely the advantages, costs and benefits of SOV usage compared to other transportation means, and how these figure or not when making mobility choices [9,10,11,12]. In the following we present a summary of them.

SOV & other means cost-benefit comparison

In general there is an overwhelming preference for *my car*. Indeed it offers **great flexibility** – adaptable to changes in *time schedule* (a sudden late meeting), *route* (need to pick up something/one unexpectedly), *and carrying capacity* (extra load or passengers). If the routes are relatively clear, delays are rare, parking is available and cheap (or free at home and work), if the commute is relatively short costs are negligible with respect to benefits (convenience, privacy, comfort, pleasure, status, and flexibility) or perceived benefits (ideas of freedom and the possibility) of driving.

Costs and benefits often figure in the choices of people to use other means of transport instead of the car and they are *comparative*, i.e. the cost-benefits of one form of transport can be off-set against another option. People have ways of prioritizing certain costs and benefits over others, but this prioritization may change **according to the particulars of unfolding circumstances**, i.e. I may take my bike to work today even though I have a lot to carry (and would normally take the car) just because it is really important to me to get the fresh air and exercise from cycling.

Obvious costs/benefit dimensions are: (1) *Financial* – buying a car, maintaining it, paying the insurance, and price of fuel. Tolls and parking can also be added. (2) *Time* – if the car does not offer a time saving compared to other forms of transport it loses its appeal, particularly if the time costs come in sitting in traffic, looking for parking (and walking from parking to destination). Financial and time are the obvious dimensions, but other dimensions exist too, e.g. fitness, travel enjoyment, independence, flexibility, environmental impact, etc. [5].

Informal Calculus

Despite the many dimensions that affect and characterize trips, people essentially move around by **habit.** People have routines based on their needs, preferences and constraints. For many, the decision on which mode of transport they will adopt for their commuting is not necessarily made on a daily basis. For example if they are quite restricted in transport options (no public transport available or conversely not owning a car), they work out their favorite commuting option once in the beginning. Then, many of these commuters will by habit, always take a certain bus, walk or drive a certain route. For others, there might be the need and/or the wish to re-organize their transport more frequently, e.g. if their routine is often disrupted and they have to frequently figure out alternative solutions or because they want to improve particular aspects such as increasing physical activity in certain periods of their life.

In any case, as a general rule **people seek economy of effort in their decision making,** choosing the most obvious, simplest 'solution'. People will engage in planning, communicating and monitoring to the extent that they have to. As already stated, the car offers flexibility to deal with changing and unfolding constraints. The interesting cases are those who have and take different transport options, and how their decisions these are made in relation to constraints and an unfolding situation. It is likely that these people need to organize their transport choice **around life requirements** and constraints more, i.e. they are not so immediately flexible, they may well have back up plans and they may well defer certain things until a triggering life event happens [5]. In summary, the interesting thing about those who take different modes of transport is that **their decisions must turn on something** (even if it is just an 'I felt like that today').

Probing the thinking (or lack of thinking) behind transport choices is useful and our research is planning to unveil more details beyond those already published in [21]. However, we would like to close this section with the

observation that this emphasis on the cost/benefit dimensions has to be handled with care by designers. As computer scientists there is a tendency towards us seeing this as a resource allocation and scheduling, and information provision problem, particularly as this seems to apply well to the person who would really like to take the sustainable choice, but has a complicated life (and therefore complicated commuting requirements).

Adding local administration and the work organizations attitudes

As mentioned in the introduction, WTPs have been implemented with different levels of success. On the base of what we described in the previous section, we believe that they can be more successful if they intercept the favorable moments where mobility changes can happen while intersecting also with the business needs of the work organizations [19]. Little literature is available on the topic and we have complemented it with our own still under way. A first step has been a small study [21], where we interviewed 11 people from the three stakeholders for sustainable commuting (public administrators, organizational personnel, and commuters) about their motivations and behaviors with respect to commuting and WTPs. In particular we have been interested in understanding what makes them more or less successful. The analysis of our interviews pointed to four problems that undercut the potential of WTPs in promoting sustainable commuting and complement the observations already presented about the mobility "informal calculus".

The first problem pertains to the **poor synergy** amongst the three stakeholders who formulate, put in place, and follow their own "siloed" initiatives thus reducing their global impact. There is a need to support better communication and coordination between the stakeholders and their initiatives by supporting tailored, traceable, and continuous interactions among them.

A second problem is that WTPs' **benefits, costs, and impact** are difficult to estimate in advance for the three stakeholders, and this can prevent work organizations' engagement since it can be hard for them to understand the benefits before allocating resources. Technology has then to support the systematic tracking of WTPs benefits, costs, and impact.

The third problem is that each work organization and commuter has a **unique profile** and current WTPs are not easily adaptable to these profiles. A corresponding requirement is to support multi-level profiling (of work organizations and commuters) and low-cost tailoring of WTPs to fit the individual actor's resources, needs, and motivational factors.

Last but not least, WTPs are often perceived as a short term effort and punctual intervention, while organizations and individuals are not always equally open for change - and behavior change is inherently rather a long term process. In response, technology should support travel planning as **a program of continuous behavior-change interventions** with a long-term perspective. Technology support should help to intercept favorable moments when individual organizations or commuters are more receptive. Also, since a WTP takes years to run, the interventions should be scheduled and monitored to capture their long-term impact.

We found these four barriers also resonating with the complexity of supporting change we learned from literature [12, 15].

ONGOING WORK: ELICITING INDIAN REQUIREMENTS

So far we have presented our understanding of what requirements should be satisfied by an intervention aimed at promoting sustainable commuting. We have addressed this problem by adopting a change behavior framework [15] that is fairly generic and we have shown how to apply it to the domain of commuting. In particular, we have shown the relevance of supporting and connecting three levels of stakeholders: the commuter, the company where he or she works, and the public administration. We have also argued that to promote behavior change is a matter of leveraging motivation *and* supporting the ability to change by providing the means to do so, again at the commuter, organization and local government level. While this approach can be replicated and we are working on a generic platform to support this motivational ecosystem [4], it is also important to stress the great specificity that each intervention has. As we have the opportunity to collaborate around this topic among two sister labs, one located in Europe, and one located in India, in Bangalore, we are currently developing and organizing users studies to critically compare the two settings. In particular we want to understand what elements of our approach can be widely applied to support behaviour change, and which ones are setting dependant. More specifically we plan to highlight the overlaps (or not) in the problem definition (issues), with a particular attention to the fact that stakeholders choices are both pragmatic and cultural and are taken in a specific infrastructural context.

Understanding infrastructure and geographical context

While social and cultural perspectives such as social status and upward mobility are important, the geographical context also needs to be assessed, as the tropical weather in India coupled with long distances between places (with bad roads) can be a deterrent for people to opt for more 'sustainable' means such as cycling. which is not the case for European countries where the climate as well as distance is more friendly to cyclists. Additionally, people often modify their vehicles to better serve their specific purpose. For instance, Figure 1 shows a crate tied to the back of a two wheeler to enable easy transport of grocery such as tomatoes. Will the meaning of sustainability then differ in this context? What components and experiences of commuting need to be factored in?

Understanding the context of roads

Typically, roads in India are vibrant beehives of activity sheltering a variety of enterprises not limited to transportation and mobility. Consequently, a wide range of vehicles including buses, autorickshaws, cars, two-wheelers, cycles, pedestrians, and the odd bullock drawn cart are just some of the few objects that compete for space on Indian roads along with many street vendors who conduct small scale commercial activities. This informal economy is a vital part of street life in India serving an important function and is an important contributor to traffic.

Figure 1: Modifying vehicles to make them more functional

Figure 2: Vendors during Ganesh Chathurthi in Bangalore

Additionally, the characteristics of roads also vary seasonally (Figure 2). For instance, in the days leading up to a festival, roadsides are temporarily transformed into makeshift markets that offer passing commuters choices to make quick purchases of festival essentials. The diversity of modes of transportation that jostle for space along with these activities impact mobility factors such as vehicle choice, traffic congestion, ease of navigating traffic, and time taken to reach destination.

Understanding public transportation

There might be completely different infrastructural constraints for the Indian roads that can influence how sustainable commuting gets promoted and supported. For example public transport is already used heavily in India however, there may be some inefficiency in planning and optimizing, which could be an opportunity of intervention to expand adoption further. Another aspect is to understand how lack of automation affects public transportation services. For instance, a commuter challenge while traveling in buses in Bangalore BMTC is that conductors often do not return excess change for tickets. Is this merely dishonesty or is there a genuine problem with lack of change? We need to understand driver/conductor challenges especially because they directly interact with the public to issue tickets unlike Western countries where automation is widespread.

Understanding evolution of private services

In the Indian context shared hired vehicles, such as auto-rickshaws, have been a common and widely accepted practice. Recently such informal and very flexible practices, have been structured by entrepreneurs in to web-based ride sharing services such as Urban Drive. Continuing success of these types of services in India is still to be seen, but a possibility is also that the infrastructure will jump directly to the newer models, not following the transformational path that Europe had. In the Indian context of high population density, it would be even more crucial to balance environmental and economic sustainability.

Understanding the stakeholders

The under 35 age group which constitutes a majority of the working population of India, could be open to behaviour change if appropriately incentivized. On the other side, although some local governments have recently been engaging with non-governmental organizations to create and implement policies on public transport and infrastructure, as of today local governments in India offer little by way of incentives to private companies for sustainable commuting. It will be important to understand if they envisage going more in the direction of joint plans as the WTPs described in this article. In addition to local governments, we will study the kind of perks and incentives that companies themselves offer to employees. For instance, we are aware of companies which reimburse petrol costs based on actual bills that are submitted to payroll, but we are not aware of any reimbursement for employees who commute to work by public transport. They do not get compensated for their expense on bus tickets and it will be interesting to understand how this is perceived by employees and if work organizations are planning to evolve these schemes.

Understanding commuters

Commuter concerns and needs also need to be understood and contextualized. As an example the safety need can play an important role in this setting.

Safety as a factor in commuting decisions has two parts. Rising increase in mortality rates as a consequence of traffic accidents involving two-wheelers and pedestrians may have an impact on transportation choices exercised by commuters. For instance, according to statistics released by the Bangalore Traffic Police for the city of Bangalore, already 409 fatal accidents have been recorded between the period January – July 2014 [1]. While the statistics do not give a breakdown about the kind of vehicles involved in these accidents, public perception generally leans towards viewing two-wheelers as a more risky medium of transport though it is also the most economical and popular choice for a majority of Indians. The second aspect of safety speaks to a gendered perception of the use of public spaces in India. Although women form a very visible part of public spaces in India, public transportation may not always be

friendly to their needs in terms of timings and frequency. Additionally, women may also have to combat sexual harassment from male co-commuters. While some modes of public transportation sometimes mandate separate compartments and seats for women, to mitigate harassment, this may not always be the case. Overcrowded public transportation systems and inconvenient timings may force women to abandon public transportation systems in favour of their own vehicles.

CONCLUSIONS

To inform the design of technology in support of sustainable commuting, we have presented the requirements that we have identified and collected through an analysis of existing related work in the domains of work journeys planning, motivational mechanisms and tools, complemented by a field study. While we believe that these results are widely applicable, we have also presented examples of what may have to be adapted when considering a different context, like the Indian one.

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