Putting the Informal on the Map - Tools for Participatory Waste Management

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ABSTRACT
Informal urban infrastructures are a challenging environment for participatory design, both from an organizational and technical perspective. In this paper we reflect on a recent research project involving participatory sensing and design of participatory technologies for informal recycling cooperatives. We collaborated with COOPAMARE, a cooperative in central São Paulo, Brazil, on two goals: to map their spatial organization of waste collection, and to develop software tools for coordinating with clients and planning operations. We discuss how GPS tracking, web-based mapping, and mobile applications allow cooperatives to collect, manage, and interpret spatial data themselves, and to redesign their own system collaboratively with others. We argue for applying participatory design in international development projects, which often neglect design aspects, and discuss the social, economic and technical contexts that impact design.

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informal economy, urban infrastructure, spatial tools

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

INTRODUCTION
As a result of ongoing urbanization, many municipalities face challenges providing basic infrastructure such as waste and recycling collection for their citizens. In many places, these services are provided by a growing informal sector [9,12]. Activities such as waste scavenging are often criminalized in modern cities; however, these policies change as informal economies become better understood. Some policy makers have shifted their focus from prosecution to inclusion, in order to improve the livelihood of those working in the informal sector, by integrating their activities into the formal system.

In Brazil, self-organized cooperatives of "catadores", informal recyclers, have a long history. Today, they are organized countrywide in over 500 cooperatives totalling 60,000 members, forming a national movement that helps shape public waste policies. They collect 90% of recoverable materials, and constitute an essential recycling infrastructure for the city [7].

In 2010, the federal government adopted a new national solid waste law, for the first time recognizing the work of catadores, and requiring cities and private businesses to partner with them [15]. While this law offers vast new opportunities for the cooperatives, it also brings new challenges, putting them under pressure to formalize and professionalize while facing increasing competition from private recycling firms. Currently, many cooperatives are not yet ready to take full advantage of the new laws. Their methods of informal organization and knowledge transfer naturally limit their operational scale. Traditional managerial wisdom offers little benefit to their bottom-up systems.

We need new models that allow informal organizations to survive in a competitive, global market, without crystalizing their dynamic organization or compromising their social mission. This problem encompasses many dimensions exceeding the scope of this paper, but we believe that technology and participatory design can play an important role, by supporting and improving the operations, knowledge transfer, and communications of an informal organization. While many see waste picking as a technologically primitive industry, catadores already use mobile phones to coordinate with each other or schedule meetings with customers.

RESEARCH CONTEXT
Traditionally, participatory design (PD) has been used in formal organizations, often with a clear hierarchical structure [4]. Organizations in the informal sector, with their implicit arrangements and shifting practices/power structures, therefore pose a challenge for PD. Conversely, one can argue that informal organizations also offer advantages for the application of participatory design. Judged by Clement and Van der Besselaar's criteria, many informal organizations are already highly participatory environments [2]: waste cooperatives are often owned by the workers, who are free to take individual approaches, but engage in joint decision-making. Consequently, organizational models for participatory and community-based waste management have been widely discussed in the recent years, but have rarely investigated technological solutions [5,8,13].

Waste pickers constitute a community of practice, developing and spreading best practices for collecting, sorting, safely handling, and selling recyclable material. Outside firms have difficulty matching their expertise, especially in underserved areas; such knowledge results from long-standing, dense networks of connections with local residents and other waste pickers [6].

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METHODS

Our project, Forage Tracking (named after the microeconomic theory of optimal foraging) explored how communication technology could help a recycling cooperative operate. Together with COOPAMARE, one such coop located in central São Paulo, Brazil, we designed, developed, and evaluated tools for running an informal urban infrastructure.

Forage Tracking consisted of two main interventions – mapping the spatial organization of the cooperative using a participatory sensing approach [1,14]; and designing, prototyping and evaluating a software platform for community-based recycling. We used a mixed methods approach, holding individual interviews, collaborative mapping workshops, and prototype development and feedback. Our approach was both problem-driven, as the stakeholders defined the necessary criteria, and vision-driven, as we chose to expose the cooperative to an unfamiliar technology in order to provoke reflection. The stakeholders included cooperative members, local residents, the regional network of recycling cooperatives,[1] academics, activists, and private companies working with the cooperative.

PROBLEMS ADDRESSED

The first phase of the project involved analyzing the problem space together with the project partners inside and outside the cooperative. Three problems recycling cooperatives like COOPAMARE face today are:

1. lack of internal understanding about how they operate,
2. lack of public visibility of the service they offer to the community, and
3. lack of trust between cooperatives and private entities.

Cooperatives of informal recyclers operate on tacit knowledge – undocumented knowledge that is difficult to articulate [11]. In many respects, cooperatives suffer from the tacit nature of their own spatial operations. They face frequent turnover of members, and much knowledge gets lost when experienced members leave. Furthermore, there are little available data regarding the activity and spatial coverage of the cooperative's services. Such data would be instrumental in negotiations between cooperatives and municipalities. For related reasons, private businesses are often reluctant to work with cooperatives. There is a lack of trust in the reliability of their service, and lack of a common basis, or platform, to support a contractual relationship.

Cooperatives are aware of these issues, as well as recent changes in the economic climate, when waste has become a lucrative domain that attracts many private companies. However, their tight financial and organizational constraints leave them no room for experimentation. They are operating at the limit of their capacity and many members are reluctant to take over new responsibilities. Although many catadores own cell-phones, they have little time for training and tasks such as data entry or documenting their daily activities.

[1] Rede CataSampa - http://www.catasampa.org

Figure 1 – clockwise from top-left: prototype of a pickup request website; mapping workshop with cooperative workers; pickup request mobile app for residents; GPS traces of a week of collection activity, showing routes of manual pull-cart (orange) vs. truck collection (blue).

INITIAL HYPOTHESES

After exploratory fieldwork with the cooperative, we came up with three hypotheses to address the problems identified in the previous section:

1. GPS tracking can automatically self-collect valuable spatial data about the coop's operations.
2. Once mapped, these data can help improve the visibility of the coop and the service it offers to the residents, businesses and municipality.
3. With a platform for coordination, businesses and residents can easily work with the catadores, while making it easier for the cooperative to organize routes.

The catadores know many things about the city; they read and navigate the city differently from most other urban dwellers. Documenting and mapping this tacit knowledge, identifying the amounts of waste recovered from respective areas, and discovering opportunities for expansion and optimization would produce valuable information for the cooperative, strengthen their position towards the municipality, and support the internal training of new collectors.

The lack of data and coordination could be effectively addressed through information and communication technology, with minimal disruption to their organization and operations. Rather than manually entering collection data into a database or using bar-code scanners, carrying a GPS logger required far less effort for the collectors. GPS logging was appropriate for gathering data about the collection process and improving the routes, as it makes larger spatial patterns explicit. GPS traces also allowed us to automatically detect stops along the route, important for identifying and quantifying material collection points, as shown in an earlier waste tracking project [10].

Aggregating all collection activity in a digital map could not only improve route planning, but also validate the service they provide to the neighborhood. The jaggedness

of GPS traces and visible random errors actually help their credibility; these data are not easy to fake.

We reasoned that collection could be further improved through a platform for managing real-time geographic information. With this platform, citizens and businesses could directly contact the cooperative to schedule pick-ups for material they want to get rid of. By mapping requests together with GPS data, the catadores could plan their daily routes more effectively.

MAPPING SPATIAL ORGANIZATION

The cooperative uses both a truck and hand-pulled carts to collect material. Truck activity is currently planned in a rudimentary way; only the driver has complete awareness of the locations and schedules of each customer, and keeps them in a handwritten calendar. While most members are involved in the truck stream, either loading, sorting, or baling items, a few manual collectors operate relatively independently from this work. These pickers collect and bind separately from the others, so their peers know little about their specific movements.

In our experiment, each collector carried a small GPS logger on his or her daily route. At the end of the day, we conducted an unstructured interview, showing the mapped trace on a laptop to the collector and asking her to comment on her movement decisions. For this purpose, we developed a software tool for annotating the map, which kept each annotated location synchronized with its recorded audio comments. This provided visual feedback for the interviewee, while supporting later spatial coding of the recorded data. Local research team members provided in-person translation during these interviews.

Following several of these interviews, we conducted a group interview with the entire cooperative. We pinned up three paper maps: the whole city of Sao Paulo (with COOPAMARE's location and known member homes marked), the full set of traces showing truck and manual collector routes, and the same traces overlaid on street map. With markers, the catadores added the locations of their homes and neighbourhoods to the city map, while one collector who didn't carry a GPS unit manually drew out her route on the detailed street map.

Even without context provided by props or photographs, people were adept at interpreting the raw spatial traces: the "naked" GPS traces stimulated a different, more abstract level of reflection about spatial behaviour.

These discussions exposed advantages and disadvantages of manual picking compared with truck collection. The manual pickers' share of the overall amount of materials processed was significant, and underestimated even within the cooperative. Interviews revealed what manual pickers considered while choosing which route to take, including land use, topography, business activity, and, most importantly, road traffic. The maps aggregated from the collected traces reflect this spatial logic of collection and provided a valuable space for the participants to talk about their work; the project brought the truck driver and manual pickers together to exchange their knowledge on the collection process, an exchange that does not happen often at the cooperative. Although meant as a temporary mediator for this project, GPS logging was also discussed as a possible tool for the organization for everyday use.

Our interviews revealed catadores as people who reject authority and rigid structures, and particularly sensitive to issues of privacy and control. By using offline GPS loggers rather than real-time trackers, we emphasized the active role of self-documenting, rather than the passive role of being observed. Since most decisions in the cooperative are reached through democratic vote, and opting out from individuals is accepted, pressure to participate was less of a concern. On the other hand, a few members of the cooperative said real-time tracking would be really useful for coordination in the future.

Finally, a very important spatial aspect was revealed in the mapping workshop; most of the workers lived on the periphery of the city, with commutes up to three hours in each direction. This reinforced the overall impression that the cooperative is very much a fragile "economy of movement," in which they must factor travel time and uncertainty into every business decision. Spatial and temporal constraints are met by exploiting the specific advantages of both truck and manual collection.

DESIGNING A PARTICIPATORY PLATFORM

In the second major part of the project, we explored the design of a participatory media platform with the cooperative. Internally, this platform would allow for real-time data management; externally, the data would also facilitate coordination with potential clients. Using smartphones, websites, and text messages, local residents and businesses could get in touch with the cooperative, inform them about material (metals, paper, plastic, etc.) they had available, and schedule pick-up times. This real-time information could reduce frequency of trips, while generating more material for the cooperative to collect.

We chose to demonstrate a working system, in this case an Ushahidi[2] instance with modified interfaces, to technologically inexperienced catadores in order to prove its potential. Based on their feedback, we developed a series of prototypes, such as a data management website that could interface with low-end cell phones.

While our ultimate goal was to have the cooperative take ownership of this system for daily use, several obstacles remained. Many of our initial assumptions did not survive the critical input from the cooperative during the design dialogue, particularly the notification system. While individual collectors frequently scheduled pickups with residents, the cooperative feared that institutionalizing this process would increase pressure on them by raising expectations that they might not be able to reliably meet.

A second concern was the type of participation such a system would encourage. Currently, a significant number of residents visit the cooperative to drop off material, contributing a quarter of the total volume processed and sold. The digital platform would have to be designed to encourage such drop-offs when possible, rather than individual pick-ups.

[2] A platform for collaborative spatial data collection, see http://ushahidi.com/

Generally, collectors were more comfortable with face-to-face relationships, and residents seemed accustomed to direct contact as well. Those we spoke with mentioned that their motivation for dealing with the cooperative was trust; that materials would not be wasted, that the neighbourhood would be kept clean, and that profits would stay with those most in need, the catadores. Since these personal relationships of trust constitute the main asset of the cooperative, the interface between these two sides is a crucial element that involves far more than technical or usability aspects.

CONCLUSION

Our work with the cooperative has shown that informal waste infrastructures operate under a different logic than traditional urban infrastructures, and every technological solution has to address this difference. The recyclers' movements are highly selective, focusing on spatially-dispersed individual sources – apartments, markets, and businesses – rather than servicing a coherent area. This approach allows them to pick out the most profitable clients from the area, but creates logistic problems.

The cooperative is also a complex social system, in which many internal and external actors fulfill important roles. The cooperative has to address the different motivations of their clients: to ensure that their donated material ends up actually being recycled, to support the social mission of providing an exit from poverty and homelessness, and to maintain a clean and orderly neighbourhood. COOPAMARE relies on establishing trust in meeting these goals through personal contact.

The participatory sensing exercise generated new insights both for us and the collectors. Visual representation was important both in making tacit knowledge explicit, as well as accessible to all. GPS technology proved useful in interviews and the workshop, and the generated traces inspired lively discussions within the cooperative.

Beyond explicating the hidden knowledge of the cooperative, participatory mapping had another important effect. By placing their movements "on the map," it conveyed a sense of identity for the cooperative, providing tangible evidence of their place in the city.

The potential of the Forage Tracking project is to give the cooperative the capability to truly design their own collection system, to break from path dependence and choose what is best for them. Participatory design is perhaps the only way the cooperative and their community can evolve without forgoing their values. Any attempt to impose a new, more efficient solution from the outside is likely to fail, because efficiency is a subjective target. Here, it does not mean covering the widest possible range of homes and providing a regular, baseline level of service to each home. Rather, it means collecting enough quality recyclable material to support the lives of however many members the cooperative has at the time.

Informal, vulnerable environments require us to rethink traditional formats of Participatory Design. While such environments use highly participatory decision-making processes, time and material resources for collaborative activities are scarce, calling for formats that engage more directly with their goals and constraints. Methods might shift considerably throughout the process; what was considered a design problem might turn out to be a problem of a different nature.

Action Research methodologies [3] embrace such shifts and may offer lessons for navigating these challenges, yet often neglect design aspects. Participatory design offers valuable tools for development in the informal sector.

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