Cleanly - Trashducation Urban System

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Abstract
Half the world's population is expected to live in urban areas by 2020. The high human density and changes in peoples' consuming habits result in an ever-increasing amount of trash to be handled by governing bodies. Problems created by inefficient or dysfunctional cleaning services are exacerbated by a poor personal trash management culture. In this paper we present Cleanly – a trashducation urban system aimed at creating awareness of the garbage production and its management, serving as an educational platform in the urban environment. We report on data collected form an online survey, which not only motivates our research but also provides useful information on reasons and possible solutions for trash problems.

Keywords
Trashducation, public displays, electronic badges

ACM Classification Keywords
H.5.2 User Interfaces. I.3.1 Hardware Architecture.

Introduction
As the world's population concentrates in urban areas, and higher living standards increase consumption, disposal systems become an important infrastructure to be studied. A comprehensive approach focuses not only on transportation and recycling but also includes more human aspects such as low environmental awareness,

Figure 1: Public square in Jerusalem with existing trash bins.

Figure 2: Public square with Cleanly trash bins. Trashcan ID designs by Woo Seok Park.

and organizational failures, e.g., bad planning and coverage, and worker strikes. In this direction, Strategic Environmental Assessment (SEA) and other frameworks [8] have been applied, including areas such as prevention, recycling, waste treatment and landfill technologies. SEA and sustainable design initiatives aim at ensuring a sustainable future for society. However, despite current global efforts, preserving the environment is ultimately dependant on individual and communal ethical values, and how each perceives their role [9].

The particular focus of our research is the individual's stake in the problem. We study the issue of increased awareness of the environmental impact of one's waste, and the design of systems to support it. The CHI community has looked into related solutions to create awareness about the energy consumption of infrastructures and their environmental impact [1, 2, 3], and to improve waste management habits [4, 5, 6, 7]. However most of these projects lack a holistic approach, run short in time, focus on technologies and entertainment, and do not encourage continuous engagement.

The contributions of this paper are as follows: First, we motivate our research by presenting results from fieldwork and an online survey. Second, we present a holistic approach called **thrashducation**, *an effort to educate people in their trash management behaviors by (i) creating awareness of the trash we produce, (ii) lowering its production, and (iii) fostering environmentally friendly behaviors.* Third, we present Cleanly, a trashducation urban system that integrates public displays, wearable devices, and trashcans. Cleanly provides a point for reflection at the individual and community level. It includes mechanisms for the casual trashducant, for prolonged engagements, and for local communities. Cleanly helps the collective reflection on the habits of a community, by presenting relevant local environmental information, and user generated content.

Related Work

Several projects studied awareness of the environmental impact of our existing infrastructures. OneTrees [1] creates awareness of the impact of the environment on the growing of trees by running an experiment with 3000 cloned trees planted and monitored in the bay area of San Francisco. Users can follow the growing of each tree and see how the environmental conditions affect each of them. The project also creates awareness on paper usage by using a printer queue virus that prints out a slice of tree once the equivalent of one tree has been consumed. In a similar way EcoVisualization [3] looks at the energy consumption of a building and makes environmental performance data publicly accessible and easy to understand for everyone. Finally, Imprint [2] extracts data from a printer queue and visualizes it aiming to support community reflection and conversation about the paper usage or waste.

The special case of waste management has been explored by different projects: WeighYourWaste [4] augments a traditional waste bin with electronic weights and calculates the price of disposing the contents for homeowners and firms. Augmented Trash Can [5] is designed for the public space and exposes the contents of a public waste bin on a floor projection as a way to motivate people to put the trash in the right place. Finally, the Trashcan Arcade and the Trashcan Long-Hole [6][7] projects explore ways of increasing the user experience when throwing the trash in the bin hence increasing their usage and fostering a longer term environment-friendly behavior.

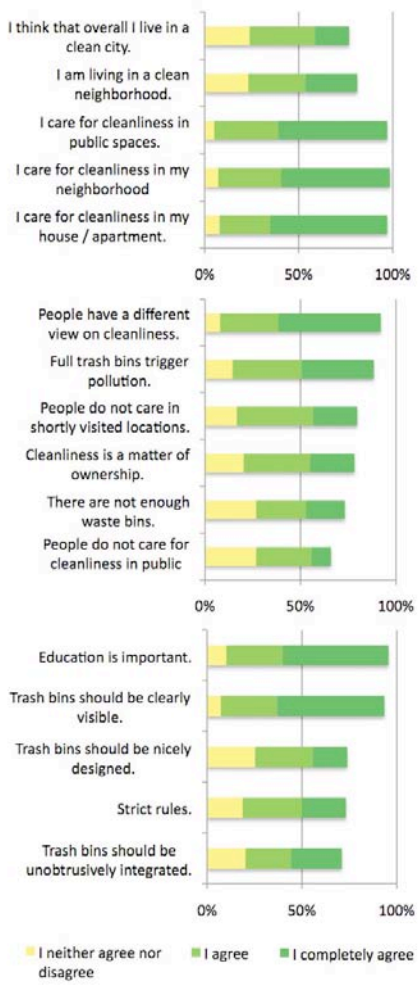

Figure 3: Results of the survey (Top: General question about people's view on cleanliness, Middle: Reasons for trash problems, Bottom: Solutions for trash problems)

Fieldwork

To get an initial idea of the problems at hand, the main reasons for trash problems and feasible solutions, we conducted a full day of observations in the city of Jerusalem. We considered Jerusalem to be a very suitable starting point for our research due to its multicultural character and the fact that social groups mainly aggregate in (pre-determined) neighborhoods. On one hand there is a high number of religious inhabitants, professing the three faiths (Islam, Judaism and Christianity), on the other hand, Jerusalem is an important pilgrimage destination due to its religious significance, attracting many tourists all year round. This allowed us for observing both areas with a rather homogeneous population structure (e.g., resident areas in the new city of Jerusalem) but also areas frequented by a very heterogeneous audience (e.g., tourist areas in the old city).

METHOD

We mainly conducted placed-centered observations at public squares and in random streets of Jerusalem, taking both notes and pictures (see Figure 1). We also did sporadic task-observations of people disposing waste and conducted qualitative interviews with daily commuters and frequent visitors. We were especially interested in their opinion related to multiculturalism and tourism but also on security and political issues.

Preliminary Findings

Based on the analysis of our observations and interviews we believe that there are several factors having a strong impact on the trash problems.

People have different requirements for cleanliness: We observed that this problem exists both on a micro and on a macro level. Whereas a certain level of pollution might be still acceptable for one individual or group, for the other it is not. When visiting the city of Jerusalem we noticed that trash problems were especially obvious in areas shared by different social groups (macro level). Similarly, this occurs in settings where individuals with different needs for cleanliness share the same space, e.g., the same apartment (micro level).

Cleanliness is related to ownership: We observed that trash problems are more serious in areas where people are obviously not the owner of houses or apartments but rather rent them. We assume that people simply care less if they are not the owner.

People do not care for cleanliness in certain areas: During our fieldwork we found out that certain places tend to get polluted more quickly than others. Such areas are, e.g., public spaces or locations where people only spend a limited amount of time (e.g., tourist locations, stadiums, beaches).

Full trash bins trigger further pollution: We observed that in spaces with full trash bins, people tended to throw trash around whereas this didn't happen in locations with empty, clearly visible trash bins. We believe that clearly visible and conveniently located trash bins support the preservation of a clean environment.

Though we found that some of the problems were related to the unique setting (Jerusalem is a cosmopolite, deeply religious, and touristic city), we believe that most problems addressed above are not related to a specific place but may be applied to most major cities. To verify our assumptions we conducted an online survey with a focus on generic problems, which can be found in many places around the globe.

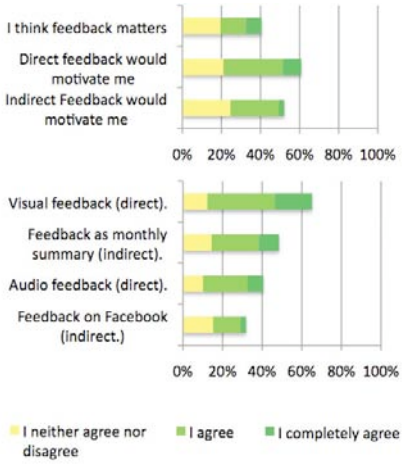

Figure 4: Results of the survey (Top: People's view on motivation to participate in a trashducation program, Bottom: Users' view on concrete forms of feedback)

Online Survey

To get a deeper insight into the trash problem and an indication whether the problems were location-specific or rather generic, we setup an online survey and collected data during a period of 10 days. We distributed the survey among friends, colleagues, students, via Facebook, and University mailing lists.

Demographics

In total 138 people (91 males) with an average age of 31.1 years completed the questionnaire. The most common occupations were student (47), employee (37), and researcher (21). Participants were mainly from Germany (60), Israel (51), Denmark (10), and Colombia (5). Most lived in major cities with more than 500.000 (56) or more than 1.000.000 inhabitants (24).

Questions

The survey was separated into 4 parts and the participants were asked to rate statements on a 5-Point Likert scale (1 = don't agree at all, 5 = completely agree). First, we were interested in the participant's overall view on cleanliness. Second, we were interested in perceived reasons for trash problems, according to our previous findings. Third, we wanted to know which solution the participants felt to be appropriate. Fourth we were interested whether feedback would motivate people to participate in a trashducation program.

Results

The results are depicted in Figure 3 and Figure 4. The values are based on the participants' ratings (3 or above on the Likert scale, where 3=yellow, etc.).

We found out that only 52.8% of the participants felt that they lived in a clean city and only 58.3% that they lived in a clean neighborhood (4 or 5 on the Likert scale). All participants had a rather high requirement for cleanliness: 92.4% stated that they care much or very much for cleanliness in public spaces, 91.7% in their neighborhood, and 89.6% in their apartment.

Regarding the *perceived reasons for trash problems*, 84.7% of the participants felt, that the predominant issue is the people's different requirement for cleanliness (agree or strongly agree). Also full trash bins (74.4%), low care for cleanliness in places where people only spend a short amount of time (63.2%), and ownership (56.9%) seems to have a major impact.

As for *possible solutions to trash problems*, 85.4% of the participants agree (4) or strongly agree (5) that education is important. They also felt that the appearance of the trash cans plays a major role: 86.6% think that trash bins should be clearly visible, 50.0% think that they should be unobtrusively integrated with the environment and 49.3% think that they should be nicely designed. Only 54.2% of the participants agree or strongly agree that strict rules (e.g., by penalties for littering) might help to solve the trash problem.

Finally we were interested in *how to motivate people to participate in programs aimed at solving trash problems*, e.g., by giving feedback. 52.8% of the participants agree or strongly agree, that feedback matters. However, only 40.3% preferred or strongly preferred direct feedback, 28.5% indirect feedback. When asked about concrete forms of feedback 51.4% stated that a visual feedback, such as a changing smiley on the bin, would motivate or strongly motivate them to participate, 27.1% preferred audio feedback. For indirect feedback, only 16.0% think that feedback via social

Figure 5: Cleanly artifacts including electronic bins, data server, and badges. Trashcan ID designs by Woo S. Park.

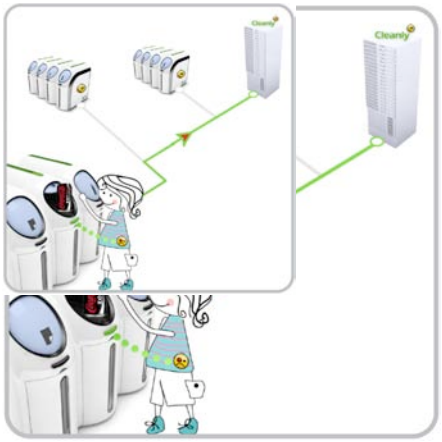

Figure 6: User interaction with Cleanly. Trashcan ID designs by Woo Seok Park.

networks is motivating or strongly motivating, but 35.4% favor a monthly summary of how much trash they collected compared to the community average.

Discussion

Despite the high requirement for cleanliness people obviously are not willing to take responsibility. While 95% of the people claim to care about the environment, 65% of them blame the trash problem on other people. This, however, has to be studied further since this can be an instance of mismatch between what people say and what people do. With only 52% of support, it is not clear whether feedback could have a positive impact in motivating people to keep a cleaner environment.

Trashducation

Based on the results from our fieldwork and survey, we define the guidelines of our work in the notion of *trashducation*: trash (physical garbage/digital recycle bin) + education. We see 'trashducation' as the core value of sustainability technologies for urban communities: (i) trashducation solutions *draw the individual's attention to a particular environmental problem*, e.g., inadequate recycling solutions and non-habitual recycling practice, (ii) trashducation systems *encourage day-to-day green behavior on the particular problem*, and (iii) trashducation solutions *endorse proactive thinking about the environment*, by 'fashioning' the environmentally friendly processes into a holistically designed solution.

Following Marshall McLuhan quote *"We shape our tools and then our tools shape us."* trashducation solutions are born from the concerns on the current deterioration of the planet, and we hope those solutions shape and support our future, greener behaviors.

Design of Cleanly

We designed Cleanly as a trashducation system aiming at drawing attention on trash management in public spaces. Our system consists of networked trash bins equipped with a touch-enabled public display, and RFID and Bluetooth interfaces (see Figure 5 and Figure 6). This setup allows for tracking users either based on the Bluetooth MAC address of their cell phones or users may carry an intelligent (RFID augmented) badge showing the user's contribution in the community as a smiley on the badge. The system can build anonymous user models and display information of interest according to location, preferences, and habits. The system includes a server for aggregating data and allows users to distribute content through the local public displays in the bins, input their Bluetooth address, order a badge, and see their monthly summary.

Based on an awareness model [9] Cleanly can show personal / community contribution and environmental tips (user's focus) on public displays (nimbus). Hence, cleanly supports day-to-day engagement by showing and adjusting content based on constructed user models, intelligent dynamic badges, and environmental tips. We plan to display relevant information about related environmental problems in the local area.

With Cleanly's design we take into account the users' concerns by providing nice looking and visible bins, and create awareness of both individual and collective efforts. By comparing local efforts with those in other parts of the city we aim at increasing the sense of ownership in public spaces. Further, we support the distribution of (educational) system- and user-generated content and provide a backchannel to raise environmental concerns.

Cleanly serves as a platform to explore the potential of feedback for solving trash problems using dynamic badges, monthly personal reports, adaptive content based on dynamic user and community profiles, comparative information, and public conversations.

Conclusion and Future Work

In this paper we presented Cleanly, a trashducation urban system. We reported on data collected during fieldwork in Jerusalem, which helped us shaping our idea and gaining an initial understanding of trash problems in large cities. We presented the results of a survey among 138 participants in which we evaluated reasons for trash problems and potential solutions.

At the current state we are working together with the University of Haifa and a team of designers, helping us to develop a first prototype of the proposed system. The results from the fieldwork and the online survey strongly encourage us to continue the deployment of our system in the city of Jerusalem. We plan to follow an urban probes methodological approach [5]: First, we will carry out field studies to identify public zones of intervention. Second, we will carry out interventions to help us understand the potential of Cleanly's features; we would like to enquire whether the different cultures living is Jerusalem react differently to the interventions, and what are suitable ways to engage them. Third, we will enhance Cleanly's design and focus on features supporting collective reflection like the numerical analysis, bulletin board messages, and content creation and management. Finally, we will run a large-scale user study, not only showing the importance and success of education when it comes to trash management but also fostering (local) communities which engage in solving problems at hand.

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