Designing for Sustainable HCI

Location-Based Mobile Application for Encouraging Environmental Friendly Ways of Transportation

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Abstract

This thesis aims to explore what are the main factors for designers to consider, when they design persuasive technologies for improving environmentally sustainable behavior. This paper starts out with a definition of sustainability as such, while also describing the most pressing issues within ecological sustainability. The biggest part of related research is dedicated to the persuasive technologies and three main factors of ability, trigger and motivation. We also talk about a fourth, additional factor of an emotional relationship. Besides persuasive technologies, this part describes sustainable Human-Computer Interaction, location-based services, and ethical issues are mentioned as well. The first part of the next section is dedicated to the description of a High Fidelity prototype of persuasive mobile application. The second part talks about quantitative and qualitative methods used while collecting data. After that, the reader is presented with the study results, which are then also analyzed. The following part discuss these results in a more depth. In the end, we summarize obtained results and the whole study.

Keywords: HCI, sustainability, persuasive technologies, Fogg’s behavior model, emotional relationship

1. Introduction

Overall living conditions for humans are nowadays better than ever before. For example, child mortality rates in general are decreasing, many countries have emphasized primary health care, including vaccination and sanitation, more and more countries are getting access to drinking water, and education levels amongst the population are also higher than ever before.

On the other hand, we are also aware of an increasing number of global problems like biodiversity and ecosystem losses, deforestation, pollution, poverty, global warming etc. To be more specific, for example, 2015 was ranked as the warmest year on record globally, surpassing year 2014, which itself was record year as well. Also trusted organizations like well trusted UK’s National Weather Service, expect 2016 to set a new temperature record (Carrington, 2016).

Vezzoli and Manzini (2008) associates global problems with the current lifestyle of our western society and describes the situation by the following correlation: to live better, consume more. Kevany and Huisingh (2007) also talks about our current lifestyle as well as external forces like imposed measures of success or aggressive competition, which results in excessive consumption. Continuous demand on purchasing new products and services then

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1 http://data.worldbank.org
inevitably increases exploitation of natural resources, animals and people to threatening, unsustainable levels (Pereira et al., 2010; Vezzoli & Manzini, 2008).

The reference point for sustainability is sustainable development, which was defined by World Commission on Environment and Development (WCED) in the report *Our Common Future* from 1987, as: “...development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987, p. 16). Knowing our actions will and already have adverse effects on the environment, we need to change the way we live our lives.

Information Technologies can help to provide solutions towards sustainable development (Vergnes, 2001). As Oinas-Kukkonen (2013) states, IT usually has an impact on individuals’ behavior. In our thesis, we want to concentrate on the potential of HCI. We find out how the research area of HCI can enhance behavior of individuals towards sustainability. Since sustainability itself is a very wide concept, we are focusing especially on environmental sustainability.

In our thesis, we want to change the user’s attitude intentionally by employing so-called persuasive technology, or more concretely a behavior change support system (BCSS). An example of such systems can be different mobile applications for fitness purposes, or applications helping the user to stop smoking. In addition to BCSS, Location Based Services (LBSs) emerged in recent years as another popular way of influencing user's attitude. These systems provide users with many different kinds of information such as tips to for a good restaurant in the close neighborhood, tips about special offers in the nearby stores, information about public transportation, etc. One of the more specific usages of these kind of mobile applications is location tracking for health and exercise. These applications are capable of tracking user’s movement and speed in order to provide feedback on the distance users have traveled and the amount of calories burned. Even though the topics of persuasive technology as well as the user location based services are covered in many papers, to our knowledge, there is no academic research, which would link these two topics in favor of sustainable development. Therefore, apart from contributing to the research area of HCI and sustainability, we also want to add knowledge to the area of behavior change support systems and location based services research.

Our aim is to combine LBSs and BCSS in a mobile application, which could collect data from users to support their behavioral change towards more environmentally sustainable behavior. By constructing and testing a prototype, we want to answer our research question, which is ‘What are the main factors to consider when designing location-based persuasive technologies for improving environmentally sustainable behavior of the people?’

**2. Background**

As Nyströöm and Mustaquim (2014) state, research on sustainability is now a hot research topic conducted in different research fields. Before analyzing research on sustainability within the area of HCI, we first have to define what sustainability is and what areas it includes.
In his book *The Spirit of Design*, Walker (2011) defines social consideration like human rights and social equity together with the environmental issues, as the two main pillars of sustainability. Economic issues is said to be the third pillar, but the focal point for deeper understanding of sustainability is represented by the notion of personal meaning, where spiritual issues are placed, as well as ethical considerations of conscience and integrity (Walker, 2011).

Different definitions of sustainability are presented in the paper *Sustainable Information System Development*, where Nyström and Mustaquim (2014) group society, financial execution, and the natural environment as Elkington’s ‘Triple bottom line’ (TBL) (Elkington, 2001), while Walker's work is identified as more comprehensive ‘Quadruple bottom line’ (QBL) (Walker, 2011). Another example of the definition of sustainability is provided by Fry (2005), who includes aspects of the environment and biosphere as such, as well as social factors like public health, equality justice, etc.

*Circles of Sustainability*, is another framework for defining sustainability. It consist of fundamental principles that refer to the essential areas of social life like economics, ecology, politics and culture.

As it can be seen from the text above, there is no generally accepted agreement on what the sustainability consists of. This definition is still evolving and broadening according to the trends and current opinions on sustainability not only among scientific community, but also among the general public, and different institutions. A survey conducted in 33 different countries over seven years (from 1993 to 2010) showed that Sweden and other Nordic countries are generally the most concerned about environmental issues (the top position had Norway with 15% of interviewees selecting the environment as the most urgent issue for the nation. For a comparison, in the United States it was only 3.6%) (Harms, 2013). The results from the 2014 Global Green Economy Index also confirms that Nordic countries continue to drive much of the dialogue on environmental sustainability (Dual Citizen LLC, 2014).

For Swedish respondents, as studied by Ipsos MORI (2011), the most important environmental concern is the future of energy sources and supplies (58% of the interviewees) followed by waste management (33%). The third biggest concern is emission issues (31%). Climate change is also important (28%) as well as air pollution (26%) (Ipsos MORI, 2011). In another paper, Khan and Kashif (2010) show, when citizens were asked what they thought could be done to enhance sustainability of everyday practice, people suggested price and tax reduction on eco-food products, lower prices of public transportation or promotion of electric vehicles. Among the things people can do themselves to ensure sustainability, the majority of the answers mentioned biking or walking (instead of driving a car), recycling and saving energy.

The Swedish Environmental Protection Agency (EPA) handles monitoring the situation of the environment in Sweden. Their annual review of Sweden’s environmental quality showed that in 2015 the air pollution in Sweden was decreasing, but extra move still should be made.

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2 www.circlesofsustainability.org/principles/
to control outflows of nitrogen oxides and of tire particles. Diminishing of the ozone layer in Sweden has likewise ceased, in any case, the ozone-exhausting substances and discharges from end-of-life items can intensify the situation again. The biggest challenge in 2015 was the urbanization. Nevertheless, the impact of transportation slightly decreased. This was caused by a decline in car transportation and of more energy-efficient cars (Environmental & Agency, 2015, pp. 22–23).

Papers mentioned in this part show, that there are differences in awareness on sustainability problems between different countries, as well as there are different opinions on what the sustainability should consist of in general. This section also showed that Sweden together with other Nordic countries is highly aware of these issues, but there is still a space for improvement.

3. Related Research

3.1 Sustainability and HCI

Within the field of HCI many authors presented arguments supporting the role of this area in achieving sustainability. As an example of such efforts we can mention Blevis’ (2007) perspective called Sustainable Interaction Design (SID), in which he proposes sustainability as the main focus for interaction design (Blevis, 2007, p. 503).

Historical overview of efforts linking sustainability with the design research is provided in the paper from Keitsch (2012), in which she also outlines the period from the beginning of 2000 until now, as being more focused on socio-cultural sustainability, user innovation and quality of life (Keitsch, 2012). Another overview on existing research on HCI and sustainability is provided by DiSalvo, Sengers, and Brynjarsdóttir (2010) when compiling and dividing existing research on HCI and sustainability into so-called genres. Each genre is characterized by sharing overall conceptualization of the problem and ideas toward its solving.

Sustainable interaction design (SID) is the smallest genre (approximately 10% of the research) and its’ papers suggest to fundamentally rethink the methods of HCI. Formative User Studies represent about 15% of sustainable design literature. This genre aims to understand how users think about sustainability, and to understand users’ attitudes to the environment or to (un)sustainable design.

Pervasive and Participatory Sensing Studies form a genre concentrating on usage of sensors, which monitor and report on environmental conditions. The aim is to use collected data to change environmental conditions (around 22% of compiled papers). The next genre consists of papers on Ambient Awareness Systems, which make users aware of the consequences their behavior has on targeted areas of sustainability. This genre composes around 25% of papers. The most of the research done on sustainable HCI (45%) is considered with persuasive technologies. Furthermore, almost half of these works are based on BJ Fogg’s theory of persuasive technology, which we are using as a framework for this paper (DiSalvo et al., 2010, pp. 1977–1978).

Overall, the main aim of recent work on sustainability is to stop and minimize the detrimental consequences of different processes; however, lessened, the consequences
remain in the future. Therefore, as Kristin Hanks, William Odom, and David Roedl (2008) say, we need to change our lifestyle to a more efficient and resources conserving one. Mankoff et al. (2007) talk about shaping a sustainable way of life when they present the notion sustainability through design, in opposition to the sustainability in design, which is supposed to reduce negative impact of the devices themselves (software/hardware).

When talking about influencing behavior it is also important to specify on what scale. Mollenbach, Hoff, and Hornbæk (2012) distinguish between efforts aimed for two different structures within the society. Individuals and small structures like, for example, households are seen as ‘microstructures’. To enhance sustainability awareness and to change the behavior on the personal level, researchers employ tactics like ecovisualizations, persuasive computing or computer games (Mollenbach et al., 2012, p. 2160). On the other hand, big networks such as municipalities or transportation companies are defined as ‘macrostructures’. Even though the authors concentrate on the role of macrostructures, they also point out that macro and microstructures are able to interact and produce behavior change together (Mollenbach et al., 2012, p. 2161).

3.2 Persuasive Technologies

In search for the answer to what persuasive technologies are, the comprehensive answer as Fogg (1999) explains, would be “As we see it, a persuasive computing technology is a computing system, device, or application intentionally designed to change a person’s attitudes or behavior in a predetermined way” (Fogg, 1999, p. 27). Later, while researching persuasive technologies, we found that motivation, ability and triggers are described as the main factors of a persuasive technology, in different studies. These three factors are usable, when both designing as well as investigating persuasive technologies. In this section we will start with reviewing the studies done on persuasive technologies and investigate the usage of these three factors in the both the design and study process. While reviewing these studies we will also look at the goal-setting theory, which focuses mainly on the motivation factor, but also takes the ability factor into consideration. Later we will explain the FBM (Fogg’s Behavior Model). We found this framework promising for designing and investigating the persuasive technologies, regarding that it is also created based on the same three factors of motivation, ability and triggers. In our research on persuasive technologies we also encountered Tamagotchi virtual pet which as a persuasive technology, has a much stronger persuasion effect on users than most other persuasive technologies. While studying the examples of persuasive technologies, we encountered a fourth factor involved in Tamagotchi’s success, and that is the factor of an ‘emotional relationship’, which we will explain more in detail in this section.

3.2.1 Motivation, Ability and Triggers

For identifying the main factors involved in designing persuasive technologies, we explored different studies done by researchers in this area. In one study, Berkovsky, Bhandari, Kimani, Colineau, and Paris (2009) explored the possibility of using the factor of motivation in the form of increasing the level of enjoyment while designing games, which motivate physical activity. In this study, researchers focused mostly on the motivation factor as they believed that people, who are motivated will do the desired activities, while others with lack of the
motivation factor would refuse to do it. Ability is also pointed out as an acting factor, but is not explored further. To achieve the purpose of motivating the user to do more physical activities, the researchers suggest a method of game design that they call PLAY, MATE!, which is an abbreviation for Physical Activity Motivating Games. In this technique, the level of the game difficulty is being used to motivate users towards increasing physical activity. The user’s movements are tracked by the game equipment, and as the difficulty of the game increases during the subsequent levels, a higher amount of the user's movements are required to proceed in the game play. Researchers mention that further studies are still required for evaluating the validity of this method, but their current studies suggest the motivation as the main acting factor in their conceptual game design method (Berkovsky et al., 2009).

In another attempt for motivating the users to do more physical activities, Munson and Consolvo (2012) have considered designing a mobile application for encouraging users towards this behavior. While designing the mobile application, researchers used four different strategies to encourage physical activities including goal setting, rewards, self-monitoring, and sharing. The application that researchers designed, allows the users to set a primary and a secondary goal in the form of weekly goals for themselves. The user will try to reach amount of physical activity set as the goal during the week. By achieving the defined amount of activity, users will be rewarded by symbols like ribbons for smaller amounts, and by trophies for bigger goals. The self-monitoring feature works in the form of notifications and application badges that work as the reminders for the user. Finally, the sharing feature of the application works by integrating the possibility of sharing the achievements of the user on Facebook with their friends and family.

The results from Munson and Consolvo (2012) study reveals that users considered the goal-setting feature of the application to be beneficial regarding the possibility of pursuing the goals. Although researchers tried to follow the principles being used by commercial applications when rewarding the users for achievements with symbolic gifts like trophies, users reflected on this feature of the application as not to be motivating. The sharing feature of the application was not very welcomed either, but the people who used this feature reported it to be beneficial in motivating them. Users’ feedback reveal that sharing feature will be more beneficial if they belong to a group in opposition to using the feature individually. The self-monitoring feature was one of the most appreciated features of the application. Users believed that the self-monitoring feature as notifications, have been more effective and efficient in combination with the goal-setting feature. They mentioned that more specific notifications like “Don’t forget to go to the gym after the class” (Munson & Consolvo, 2012), had been more effective than general, for instance health tip notification. The results from Munson and Consolvo (2012) study show the factors of goal-setting as motivation factor, together with notifications as a type of trigger, are the most important factors playing role in motivating and encouraging the users towards the desired behavior.

3.2.2 Goal-Setting Theory
Researchers and designers have introduced different theories and frameworks for persuading human behavior. One of the popular theories being used for designing persuasive technologies is the theory of a goal setting. According to Consolvo, Klasnja, McDonald, and
Landay (2009), “Goal Setting Theory describes how individuals respond to different types of goals, and thus how to set goals to motivate behavior” (Consolvo, Klasnja, et al., 2009, p. 2). Consolvo et al. (2009) also explain that according to Locke and Latham (Locke & Latham, 2002), the two industrial organizational psychologists who have done a lot of work on the goal-setting theory, “people give the highest levels of effort and performance to the highest or most difficult goals” (Consolvo, Klasnja, et al., 2009, p. 2; Locke & Latham, 2002). They also mention that Locke and Latham argue that “Specific, difficult goals consistently led to higher performance than urging people to do their best” (Consolvo, Klasnja, et al., 2009, p. 2).

Furthermore, Consolvo et al. (2009) explain “the importance of the goal attainment to the individual, including the outcomes they are expecting to result” (Consolvo, Klasnja, et al., 2009, p. 2) and also “self-efficacy that is the belief that they can achieve the goal” (Consolvo, Klasnja, et al., 2009, p. 2; Locke & Latham, 2002) as the two most important factors for goal commitment. In their study, Consolvo et al. (2009) also attempt to change the user’s behavior towards doing more physical activity, by using the theory of goal-setting. For doing so, they have implemented a mobile application which tracks the user’s physical activities in a field study.

As the outcome of their study, Consolvo et al. (2009) mention that the encouragement only towards achieving the goal might result in dropping the performance, and the encouragement should be presented in a wider, more general manner. They also mention that feedback seemed to be an essential element because without feedback the user will not know how they are progressing. Both factors of encouragement and feedback will generally result in motivation, although negative feedback might have an opposite effect and should be avoided.

The other result that Consolvo et al. (2009) mention is the fact that goals set by users themselves are more likely to be achieved in opposition to preset goals or goals set by others. In regards to that the self-set goals are more likely to be in accordance to user’s abilities. They place strong emphasis on the factor of ability for reaching the goal, citing without ability it is obviously unlikely that the goal will be achieved.

In other words, the conclusion from Consolvo et al. (2009) study reveals the two factors of motivation and ability as the two important factors of goal-setting theory for encouraging users to do a specific behavior or activity.

### 3.2.3 Fogg’s Behavior Model

As can be seen from the results of these studies, the three factors of motivation, ability and triggers are the three main factors playing an important role in changing the user’s behavior in a persuasive manner. Following we will present the Fogg’s Behavior Model, which is structured based on the same factors.

In the paper A Behavior Model for Persuasive Design, Fogg (2009) introduces a framework called Fogg’s Behavior Model (FBM). The Fogg’s Behavior Model is based on the three factors that we encountered previously. Fogg describes this framework as: “In this model (FBM), behavior is a product of three factors: motivation, ability, and triggers, each of which has subcomponents. The FBM asserts that for a person to perform a target behavior, he or she must (1) be sufficiently motivated, (2) have the ability to perform the behavior, and (3) be triggered to perform the behavior” (Fogg, 2009a, p. 1). Fogg also explains that for a
behavior to happen, these three elements must happen at the same time. The FBM is described to be useful when analyzing and/or designing persuasive technology.

In the following paragraphs, we will briefly explain the Fogg’s Behavior Model with its factors and subcomponents. As Fogg (2009) explains, he has developed FBM because he believes, that unless designers get a better understanding of how human behavior works, their attempts to change the behavior would most probably fail. He also mentions that it should be considered when using the FBM that this behavior model attempts to improve human’s behavior and not the attitude of the user.

As mentioned above, FBM consists of three factors of motivation, ability and triggers. When these 3 factors happen at the same time, a behavior is likely to happen by the user. According to FBM, there are three pairs of core motivators, each in different ways. These motivators are:

- Pleasure/Pain
- Hope/Fear
- Social Acceptance/Rejection

By presence of one or more of these motivators, the motivation level of the person will increase to do a target behavior. Respectively, the elements of ability (simplicity) have been explained by FBM as

- Time (lack of enough time)
- Money (lack of enough money)
- Physical Effort (if the behavior needs physical activity to be done)
- Brain Cycles (if the behavior causes the person to think harder)
- Social Deviance (if the behavior causes to break social rules)
- Non-Routine (unusual tasks in opposition to tasks that users have done over and over)

These elements decrease the simplicity of the task or behavior and as a result, the ability will decrease too. FBM explains that motivation and ability factors are tradeoffs. This means that when the motivation level is low but the ability level of doing a task is high, it’s more likely for the user to do the task. Similarly, if the ability of doing a task is very low for the user but there is high motivation, user will most likely try to improve their ability in a way to be able to do the task.

Triggers are usually the missing factor in persuasion. This means that a behavior with high level of motivation and ability can still be missed because of the lack of the right trigger at the right time. This can also be explained from another point of view. A successful trigger has three characteristics. First the user notices the trigger, second the user associates the trigger with a target behavior, and thirdly the trigger happens when the user is both motivated and has the ability to perform the behavior. Triggers can be categorized in three categories as listed below:

- Spark as Trigger (triggers that motivate the behavior)
- Facilitator as Trigger (triggers that make behavior easier to be done)
- Signal as Trigger (reminds the user to do a behavior)

As explained above, FBM helps us to explain why some behaviors happen on cue, while other attempts to change a behavior lead only to negative emotion (Fogg, 2009a).
3.2.4 Persuasive Social Actors and Tamagotchi

In the book *Persuasive Technology: Using Computers to Change What We Think and Do*, Fogg (2002) explains the role of the Computers in persuading the user's behavior. As he explains, “human beings are hardwired to respond to cues in the environment, especially to things that seem alive in some way” (Fogg, 2002, p. 89). Computers can be designed in a way that by giving an assortment of social signals, they can inspire social reactions from their human users. Fogg (2002) explains these kind of specially designed computers as persuasive social actors. These social actors can be persuasive by rewarding individuals with positive feedback, demonstrating a target behavior or attitude, and giving social support. When the user accepts these computers as social actors, they can motivate and convince the user towards a target behavior. Computers can motivate the users by conveying ostensible emotion, such as happiness, anger or fear (Fogg, 2002).

Tamagotchi, a toy from 1990s as mentioned by Fogg (2002) “is the first dramatic demonstration of how interacting directly with a computer could be a social experience. People interacted with these virtual pets as though they were alive. They played with them, fed them, bathed them, and mourned them when they died” (Fogg, 2002, p. 90). Tamagotchi was followed by a product from Nintendo's Pocket Pikachu which was a digital pet designed to persuade users for doing physical activity. Like the previous example, Pocket Pikachu also required care and feeding however with a turn; the owner had to do physical activity like walking, running, or jumping with the pet to activate the pedometer and take care of the pet. Nintendo’s Pocket Pikachu was an example of a computer device serving as a persuasive social actor (Fogg, 2002).

Looking at Tamagotchi as an example of persuasive technology through the FBM framework, there is a stronger factor involved that has a much stronger effect on the user than the three factors of motivation, ability or triggers. For example, we couldn’t find any mobile fitness app having a strong impression, the same way Tamagotchi toy has had on the users.

Tamagotchi benefits from a broader and stronger factor which causes very high motivation and as a tradeoff increases the user’s ability to dedicate a lot of their time and effort to the toy. It also causes automated triggers in the user’s mind to go and check on the toy without even receiving any notifications.

As Fogg (2002) briefly mentions, “Social Actors create relationship” (Fogg, 2002, p. 90). From what is mentioned by Fogg (2002) and also to our understanding, it’s the connection that Tamagotchi toy makes with the users that makes it so powerfully persuasive. We see the connection that Tamagotchi establishes with the user as an emotional relationship. This factor of emotional relationship seems a powerful factor to us which can be combined with motivation, ability, and triggers. However, the actual impact of this factor should be studied and evaluated before drawing any conclusions.

3.2.5 Persuasive Technologies and Mobility

When reviewing related research with a focus on persuasive technologies, the domain for application has almost exclusively been on physical activities (Berkovsky et al., 2009; Consolvo, Klasnja, et al., 2009; Edwards, McDonald, Zhao, & Humphries, 2014; Munson & Consolvo, 2012). One of the characteristics that seems essential for a persuasive technology
meant for encouraging the physical activities is the portability. Portable persuasive technology provides the user with mobility which in turn enables the designer to implement location-aware triggers and motivation into the persuasive technology. Today smart phones are widely available amongst users. Most of these smartphones are equipped with components like GPS sensors which enables them to track the user's location (Junglas & Watson, 2013). In addition to these components the very advanced mobile operating systems running on these mobile devices allow designers to design very complicated mobile application for changing user's behavior. These specifications turn smartphones into very powerful persuasive technologies. Researchers have studied the usage of smartphones as persuasive technologies and reported very high potential in smartphones as persuasive technologies (Consolvo, Markle, Patrick, & Chanasyk, 2009; Edwards et al., 2014).

Consolvo, Klasnja, et al. (2009) have considered using the mobile tools, in their research on efficiency of location-aware mobile applications for social support on new behaviors. Their attempt has been specifically on improving users’ health behavior through tracking and logging the user’s behavior and providing them awareness and insight on their health improvement process. As the results for their study shows, the researchers mention that “context/location-aware mobile applications are an incredible platform to create impact and make positive change in our collective health” (Consolvo, Markle, et al., 2009, p. 1). Similarly Edwards et al. (2014) in a field study tried to investigate the effect of design probes in the form of mobile applications for encouraging users to do more physical activity. They considered 4 important areas to explore including “portability and accuracy of activity-monitoring devices; social support for users; goal setting; and incentives and rewards” (Edwards et al., 2014, p. 16). The conclusions from this study in general prove that mobile applications are one of the best tools widely available for designing persuasive technologies. These devices are suitable for this reason regarding the features of portability and level of accuracy and also connectivity to social media (in general internet based services).

3.3 Location-Based Services

While explaining the importance of mobility in persuasive technologies, we discussed the location-aware feature of current smartphones provided by GPS sensors (Junglas & Watson, 2013). The location-aware mobile applications are part of a more general term explained as Location-Based Services or LBSs. We found it helpful to explain what LBSs is about in general and what the general usages for these services are.

According to Küpper (2005) “Location-based Services (LBSs) are mobile services for providing information that has been created, compiled, selected or filtered under consideration of the users current locations or those of other persons or mobile devices”. Examples of LBSs can be found in navigation applications meant for guiding users through urban areas, restaurant finders, buddy finders or mobile marketing and mobile gaming (Küpper, 2005). LBSs helps users with automatically providing their current locations to the applications for the application to provide the desired information or action. This feature comforts users from manually inputting their current location to the location-aware applications by automatically providing this information to these applications (Küpper, 2005).
3.4 Ethical Perspective on Persuasive Technologies and LBSs

Persuasive technologies like any other technology also have their critics and are not supported by every researcher. As Fogg (2002) mentions, “designing psychological cues into computing products can raise ethical and practical questions” (Fogg, 2002, p. 100). Some researchers recommend that intentionally designing computers to extend psychological cues is unethical and unhelpful. They contend that psychological cues deceive clients about the genuine nature of the machine (Shneiderman, 1998). Other researchers keep up that designing computers without regard for psychological cues is not sufficient since clients will deduce a psychology to the technology eventually (Reeves & Nass, 1998; Shneiderman & Maes, 1997).

On the other hand, regarding the fact that LBSs can create significant privacy risks, users are usually very concerned about their location being tracked by LBSs applications. Users need to be assured that their location will always be kept private in the sense that it will not be used for any other purposes than what they have agreed to. This also includes the safety of the information. The information has to be kept in a safe way that cannot be stolen and used for any malicious intent. Also keeping the user’s locational information anonymous in any type of data gathering and statistics is a requirement asked for by the users. This issues have to be considered when designing any LBSs based system (Gruteser & Grunwald, 2003).

3.5 Main factors for designing persuasive technologies

As the studies showed while designing a persuasive technology, there are three main factors that should be considered. These three factors are the factors of motivation, ability and triggers. We also notice a fourth factor which seems to be a strong factor for increasing the level of persuasion. We call this fourth factor, the emotional relationship. Therefore, to sum up the factors of persuasion design, we came up with motivation, ability, triggers and emotional relationship.

4. Method

The overall purpose of this study is to understand what are the main factors to consider when designing location-based persuasive technologies for improving environmentally sustainable behavior of people.

To express designs of such an interactive artifact, we decided to build and test a prototype. As Houde and Hill (1997) say, building a prototype is common practice which enables designer to represent different states of an evolving design, and also to explore different options. Furthermore, Lim, Stolterman, and Tenenberg (2008) see prototypes as manifestations of a design ideas, but they also add aspect of “traversing a design space, leading to the creation of meaningful knowledge about the final design as envisioned in the process of design” (Lim et al., 2008, p. 3). We also hope that this prototype will enable us to study users’ attitude towards persuasive mobile applications, and therefore positively influence development of such an application.
To test the prototype in practice, we prepared a session where participants:

1. Tried out the prototype while following a predefined scenario
2. Responded to the questions prepared in the form of a questionnaire
3. Underwent semi structured interview

Prior to the following steps, we used a scenario which was a narrative descriptions of envisioned usage episodes (Reeder & Turner, 2011) since this method can clarify implicit assumptions, raise design questions, and suggest design solutions. It also helps to maintain user focus (Benyon & Macaulay, 2002).

Combining quantitative data collection method of questionnaire together with qualitative method of semi structured interviews, enabled us to come together best features of both of these approaches. For gathering quantitative data we employed questionnaire used by Chang, Kaasinen, and Kaipainen (2012) in their work on persuasive and engaging design in mobile apps for well-being. Using this questionnaire allowed us to compare our prototype with twelve other already existing mobile applications meant for the reason of enhancing mobility. Semi structured interviews helped us to explore our prototype in a more detailed way and understand an interviewee’s perspective on the topic (Leech, 2002). By using semi structured interviews, we were also able to gather suggestions and opinions which was not possible only by using quantitative data collection methods. Following section describes first the prototype itself, and then the testing of this prototype. The last part presents user evaluation methods.

4.1. Prototype

As mentioned above, to be able to test our ideas and get feedback on them we built a prototype. Even though Low Fidelity prototypes are much easier to make, they have limited effect on usability tests mostly because of the navigational and flow constraints (Rudd, Stern, & Isensee, 1996). Therefore, we decided to build a HI-FI prototype, which is not as quick and easy to create as Lo-Fi prototypes, but has the look and feel of the final product and is more suitable for exploration and testing (Rudd et al., 1996, p. 78). This prototype was conceived as a mobile application which is able to recognize and track movement of the user, as well as sending them notifications related to:

1. Meetings and appointments the user has in their calendar, to help enhance their ability by keeping a better track of travel time.
2. To trigger desired behavior, we provided notifications related to the time, the user should start moving to arrive to the destination on time. That was also depending on the three different modes of transportation we specified in the prototype, which were: walking, biking and taking a bus. (The idea with notification was that the application will also consider external factors like weather conditions, while calculating time needed for the transportation).
3. To motivate the user, we provided data reports about how much CO2 they helped to prevent (if they did), as well as the amount of calories they burned while acting sustainably.
Figure 1 – Screenshots of the prototype.
To enhance additional factor of an emotional relationship, we also implemented an interactive companion, a visualization of a fox. This fox interacts with the user, and as it was shown in previous chapter on a case of the Tamagotchi, helps influence users’ behavior. For example, if the user used one of suggested transportation modes instead of the car for a whole week, their fox will be happy and dancing, jumping, etc. Also the environment around the fox would evolve, which means more trees, flowers, etc. will appear.

If the user used the car, they won’t receive any negative notification about their actions, but the fox may act sad, e.g. wears anti-pollution mask, and also the environment around the fox will degrade. Construction of this prototype took us around two and half weeks, and while designing, we followed an 8 step design process by Fogg (2009), which follows as:

**Step 1:** Target simple behavior. Achieving a simple goal can be more effective than expected because, motivating individuals to do a simple thing, is usually followed by them adopting more eager behaviors, even without a greater mediation. According to Fogg (2009) this is the most important step, but it is more difficult that it seems like.

**Step 2:** Select a receptive group as audience. It is best to choose the easiest target audience since the beginning. It is important for the target audience to be the most receptive group and also well experienced with the technology being used in the product.

**Step 3:** Find what keeps the target behavior from happening. The answer is always a mixture of lack of motivation, ability, and/or a well-timed trigger to conduct the behavior. According to Fogg (2009) technology mediations that require just a trigger are the simplest to make and the most likely to succeed. This step is the step where the Fogg’s Behavior Model will enter the process for identifying the missing factor or factors. Using the FBM designers can then focus on the missing factor for forming the base of their design.

**Step 4:** Select a familiar technology. Designers should find a technology channel which is suitable for the target behavior, answers the question why the user is not conducting the target behavior, and finally, it should be familiar to the chosen audience.

**Step 5:** Find relevant examples of the Persuasive Technology. Designers should try to find the similar examples of the technologies designed for persuading similar behaviors.

**Step 6:** Imitate successful examples. Designers should try to identify what it is that’s working in these successful examples of similar persuasive technologies.

**Step 7:** Test and iterate quickly. From a group of small, fast tests, designers can usually learn more than one big test. Ideally doing the most effortless and quickest arrangement first. Fogg (2009) mentions the example of successful online services. According to his studies, “successful online services have become successful through starting small and iterating quickly” (Fogg, 2009b, p. 6).

**Step 8:** Expand on success. Finally, based on the results from international designs, designers should expand the successful features and approaches towards a more complete and featureful product.

In the end we were able to implement movement tracking, which means that application was able to recognize when the user started to move and also calculate the walked distance. We also implemented notifications about the appointments of the user, as well as reminders to start moving in a specified amount of time.
In this stage of the prototype we had two moods for the visualizations of the fox companion, sad fox and happy one, however regarding the time limitations, the creature wasn’t interactive. We also came up with an idea of eco-friendly shopping list (but again because of the limited time, we could not implement it). The idea behind this feature was that the user will be provided with a shopping list which consist of different eco-friendly food items within the application, user ticks the items needed, and if in a later phase they are close to a store which provides these items, they will receive a notification about the items available at the store. In this case we were considering two possible options. Eco-friendly products as such, and in this case, specifically Fairtrade products, which ensure a fair price for disadvantageous producers in the developing countries (Stafford Borough Council, 2014). We were considering Fairtrade products especially because of the literature review on this topic, in which we found that one of the main reasons why people don’t buy Fairtrade products is that they are simply hard to find in stores, as well as the fact that people forget about them while shopping (Nilsson & Eckerblad, 2014).

### 4.2. Testing of the prototype

Our prototype was tested by 8 participants, from whom 3 were male, and 5 were female.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender</th>
<th>Age</th>
<th>Nationality</th>
</tr>
</thead>
<tbody>
<tr>
<td>John</td>
<td>Male</td>
<td>29</td>
<td>Swedish</td>
</tr>
<tr>
<td>Anna</td>
<td>Female</td>
<td>25</td>
<td>Russian</td>
</tr>
<tr>
<td>Kate</td>
<td>Female</td>
<td>28</td>
<td>Czech</td>
</tr>
<tr>
<td>Andre</td>
<td>Male</td>
<td>25</td>
<td>French</td>
</tr>
<tr>
<td>Leo</td>
<td>Male</td>
<td>26</td>
<td>Swedish</td>
</tr>
<tr>
<td>Agnes</td>
<td>Female</td>
<td>30</td>
<td>German</td>
</tr>
<tr>
<td>Julia</td>
<td>Female</td>
<td>21</td>
<td>French</td>
</tr>
<tr>
<td>Melody</td>
<td>Female</td>
<td>32</td>
<td>Iran</td>
</tr>
</tbody>
</table>

*Table 1- Information about the participants (used names are fictional)*

Before we started to test the prototype, we shortly explained to our participant the overall concept of the application, and what is going to happen. We also asked them for permission to record the whole session and informed them about the usage of collected data.

Our prototype was introduced to the participants in the form of an iOS mobile application. For the reason of testing, we also prepared a scenario which aimed for helping the participants for better envisioning the process of how our application would function in a real life. The whole testing session took approximately 10 minutes and was followed by an evaluation part. In the scenario, participants were asked to imagine that it is happening in a morning when they have a meeting downtown in two hours. We gave them a mobile phone.
with application installed, and after 30 seconds they received notification which informed them that they have a meeting downtown in two hours and if they leave within an hour, they can walk to their destination as a way of sustainable transportation. They had the choice to start walking at the right time or stay at their place for a longer period. After another 30 seconds (which represented 30 minutes in real life), participants again received a reminder telling them to leave the place if they want to walk to the destination on time. If they decided not to walk, after another 30 seconds they received notification to take a bike, and if they didn’t want to bike to their destination either, they finally received notification to take a bus. Since our prototype was trying to enhance environmentally friendly behavior, it will never suggest taking the person’s car as a way of transportation.

Once they chose preferable transportation way and they would walk for 20 meters, the notification disappeared from the mobile’s screen. After an additional 10 meters walk they would receive another type of notification which we used as a motivational factor. The recently received feedback was concerned with amount of CO2 the user helped to prevent, and also how many calories they burned. This information was presented together with a picture of a happy, dancing fox, and we also added a ‘cheerful’ sound for the notification. In the case they would prefer to use the car (we didn’t experience such a case) participants would see a sad fox in case they would run the application, but no negative notifications.

The whole experiment took place at the area of Umeå University, Sweden, and after the testing semi-structured interviews were conducted, about which we talk in the next part.

4.3. Evaluation

As already mentioned, for the quantitative part of the evaluation and the data analysis, we used the framework suggested by Chang et al. (2012) in the paper *What Influences Users’ Decisions to Take Apps into Use?: A Framework for Evaluating As already*. We found this framework suitable regarding to the fact that it has been developed especially for evaluating persuasive mobile applications meant for motivating the users towards more physical activities. This also meant that we were able to compare our prototype with 12 other mobile applications developed for enhancing physical activity. The framework itself consists of 7 factors which play a role in influencing users’ decisions to take a mobile app into use. Those factors are:

- *Attractiveness for engaging user experience*
- *Perceive value/Personalization*
- *Ease of Use*
- *Trustworthiness/System Credibility*
- *Fun and Excitement*
- *Diffusivities, whether the app will be accepted, mentioned, and spread easily and fast*
- *Social support (Chang et al., 2012, p. 2).*
The used questionnaire (also from the paper by Chang et al. (2012)), consisted of 10 questions where the participants had to choose from the predefined answers (from “totally agree”, “somewhat agree”, “somewhat disagree”, “totally disagree”, and “I don't know”):

1. I would download this App and use it.
2. This App seems easy to use.
3. I find this App attractive.
4. This App suits my needs.
5. I find this App exciting.
6. This App seems useful.
7. This App seems fun.
8. This App seems safe and trustworthy.
9. I would consider mentioning this App to my friends or family.
10. I would like to connect my Facebook profile with this App.

(Chang et al., 2012, pp. 3–4)

Followed by two open end questions:

*I would like to use this App because...*
*I don't want to use this App because...*

(Chang et al., 2012)

We also added extra questions to the ones we borrowed from the Chang et al. (2012) paper:
We asked participants if they would like to have a shopping list feature, which would remind them about eco-friendly and Fairtrade products.

In the last question we wanted to know if the rewarding of ecologically sustainable behavior would also help to enhance sustainable behavior. We asked if they would like the situation, in case the application was owned by municipality and the application usage would be rewarded by e.g. coupons for gym or discount coupons for Fairtrade products. After these questions participants also had the opportunity to provide us with an overall feedback and suggestions for improvements.

5. Results

This section provides the results we gathered from the questionnaire and following semi-structured interviews.

5.1 Predefined Answers Questions
The following table shows answers to the questions with predefined answer where 1= totally disagree 2=somewhat disagree, 3=somewhat agree, 4=totally agree. In the case that participant didn’t know or didn’t want to answer we mark the answer as “-”.
<table>
<thead>
<tr>
<th>Participant/Question</th>
<th>John</th>
<th>Anna</th>
<th>Kate</th>
<th>Andre</th>
<th>Leo</th>
<th>Agnes</th>
<th>Julia</th>
<th>Melody</th>
</tr>
</thead>
<tbody>
<tr>
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<td>4</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2- Answers to the questions with four possible answers

5.2 Open-Ended Questions

5.2.1 Positive Feedback

After answering first set of questions, participants shared their thoughts about why they would use the application.

John liked the time reminder. This function was also appreciated by Melody, when she said: “Sometimes I have problems with time, like when I should go, when I should leave the house”. John, Kate and Leo appreciated the artwork a lot, and thought that the theme is “kind of” fun (John). Leo said “the virtual pet is a nice visualization of your own progress, so I like that, because the numbers are maybe not so clear (on the contrary Kate would like to see statistics in the form of numbers because she thinks people have more trust in numbers). Nevertheless, both John and Leo stated they would feel guilty seeing a sad animal because of them behaving unsustainable and therefore they would maybe not open the application. John would like to have an easy and fast option to interact with the pet and make it happy again.

Anna stated she is lazy, and regarding the different alternatives available locally, she needs encouragement to use the more sustainable ones. Also interestingly, she mentioned the previous experience she had with a step counter app designed based on the goal-setting theory about which she said: “I don’t really care about calorie counting. I would prefer to do the more sustainable behavior to keep my pet happy”. Kate on the other hand, was excited especially about burned calories counting feature. Andre liked that the application “keeps the
user aware of the environmental sustainability without too much effort. In other words, because the app will do the task of deciding when to leave, it helps to be both environmentally friendly, and again, to be on time for schedule. Because the user doesn’t have to do all these calculations themselves it’s encouraging to use the app”. Leo found it interesting to see his own progress as he stated “How much better person I get over the time”.

5.2.2 Negative Feedback
On the question on why they wouldn’t use the app the most common answer was that participants were afraid to be spammed with notifications (Anna, Andre, Agnes, Julia and Melody). When they were reminded and assured that all the notifications can be adjusted, they changed their minds. Apart from this reason most of the answers were from Agnes, who doesn’t use mobile applications at all, and stated: “I don’t like to be influenced by an app, I just do a physical activity or whatever I think is better. I want to do those activities for fun, and just because the reason that I want to do them. I don’t need an app to do that for me. And especially here in Umeå, because I just take a bike regarding that it’s the fastest option for me, I don’t care about the other things. Also I don’t want to be woken up by the app in the morning telling me to get up and walk, because I never walk, I always take a bike. I have all sorts of the notifications on my phone turned off. I don’t want to be disturbed by my phone”.

Kate told us she already is environmentally aware and doesn’t need this kind of application, but she acknowledged its importance for the general public. Leo saw potential problems with security, and Melody wanted to be assured that the location is not being used for any other purposes from the very beginning when she starts using the application.

5.3 Additional Questions

5.3.1 Shopping List
When asked about eco-friendly shopping list, John, Anna and Agnes didn’t want to be bothered by notifications and didn’t support the idea at all. Leo stated that he usually does his shopping according to the price of the product, and he doesn’t differentiate between eco-friendly and Fairtrade products, so he couldn’t decide. Kate and Andre liked the idea of both eco-friendly and Fairtrade shopping lists. Nevertheless, Andre, as well as Julia, would preferred Fairtrade products. Melody would like to receive notifications about eco-friendly products, however she is not interested in buying Fairtrade ones.

5.3.2 Rewarding Sustainable Behavior
All the participants excluding Agnes found the idea of rewarding system with coupons very good and they thought it would definitely support usage of the application. Agnes stated, that she is not keen about the idea because the application itself is motivating enough.

5.3.3 Suggestions
Suggestions from the participants varied. For example, Anna would like to see an overall behavior report. Kate suggested different tone options for the app notifications. Melody would like to see the pet evolving. “It would be nice if I install the app and the pet is a baby, it evolves and get nicer and nicer when I behave sustainable. Also more gamification aspects are needed for the character. For example, if I can gain points and there will be different
types of flowers or other features that I need to collect certain amount of points to unlock for my pet, or some toy for instance, it would be much more fun to use the application”.

6. Analysis

After the evaluation phase, we mapped the data to the Chang et al. (2012) framework for the analysis purpose. For mapping the results from the evaluation to the framework we needed to associate the answers to the 10 questions of the interview with the 7 factors of the framework. For doing so, we considered the parameters as following, based on what have been suggested by Chang et al. (2012)’s framework.

*Attractiveness* for engaging user experience *(A)* and users’ responses to “I would download this app and use it; I find this App attractive”;  
*Value (V)* and users’ responses to “this app seems useful; this app suits my needs”;  
*Ease of Use (U)* and users’ responses to “this app seems easy to use”;  
*Trustworthiness (T)* and users’ responses to “this app seems safe and trustworthy”;  
*Fun & excitement (F)* and users’ responses to “I find this app exciting; this app seems fun”;  
*Diffusiveness (D)* and users’ responses to “I would consider mentioning this App to my friends or family”;  
*Social sharing (S)* and users’ responses to “I would like to connect my Facebook profile with this app” (Chang et al., 2012, p. 2).

Based on the user's replies to the related questions and the mapping of the framework's factors, the following results were delivered from the evaluation session.

<table>
<thead>
<tr>
<th>Framework Factor</th>
<th>Average User Ranking (Out of 4)</th>
<th>Average Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attractiveness (A)</td>
<td>3</td>
<td>75%</td>
</tr>
<tr>
<td>Value (V)</td>
<td>3.43</td>
<td>86%</td>
</tr>
<tr>
<td>Ease of Use (U)</td>
<td>4</td>
<td>100%</td>
</tr>
<tr>
<td>Trustworthiness (T)</td>
<td>3.2</td>
<td>80%</td>
</tr>
<tr>
<td>Fun &amp; excitement (F)</td>
<td>3.2</td>
<td>80%</td>
</tr>
<tr>
<td>Diffusiveness (D)</td>
<td>3.57</td>
<td>89%</td>
</tr>
<tr>
<td>Social sharing (S)</td>
<td>1.86</td>
<td>46.5%</td>
</tr>
</tbody>
</table>

*Table 3 - Average User Rankings*
According to the results from the evaluation, based on the 7 factored framework suggested by Chang et al. (2012) for evaluating persuasive and engaging design in mobile apps, the average value for the early prototype we created is 79.5%. In their study, Chang et al. (2012) analyzed 12 different mobile apps meant for persuading user's behavior towards more physical activity. Researchers mapped the data they extracted from the framework on a chart with corresponding 7 factors with a scale of 0 to 100 for each factor and projected this data on the chart in the form of a polygon connecting the scores for each app’s 7 factors.

Following, the chart from the research done by Chang et al. (2012) can be seen on the left. We used the same chart for comparing the results for our prototype to these 12 mobile apps by mapping the results from our user evaluations in the form of a similar polygon on top of the existing results. The chart on the right shows the mapping of the data from our prototype evaluation on top of the other mobile apps in a different color.

![Chart](image)

**Figure 2**: Results from the study on 12 mobile apps by Chang et al. (2012) on the left. Results from our study, mapped on top of the chart from study by Chang et al. (2012) on the right. The blue areas show the previous study results and the brown area presents the results from evaluation on our prototype.

### 7. Discussion

As the data from our studies show, according to the framework suggested by Chang et al. (2012), the prototype we designed for this study has a high influence on users for taking this application into use. Participates mentioned a high probability for either using the fully functional version of the application in the future or mentioning the app to family or friends.

In addition, when looking at the charts, only 2 out of 12 mobile applications with their results mapped on the chart have their scores higher than our prototype in 5 out of 7 factors. In the factors of perceived value, fun & excitement, trust and social support, only one of these two applications has a higher score than our prototype and the difference between the scores is low. In the factor of attractiveness though, both applications have higher score than our prototype.

According to the framework suggested by Chang et al. (2012), these results show a high potential for our prototype as an influential mobile application for encouraging the user towards the desired behavior. While claiming this, we should consider that the prototype that
we used was in a very early stage and users could not really interact with the application beyond receiving notifications, and at the same time, the other applications were fully functional and ready to use.

We tried to implement the Fogg’s Behavior Model, which we found as a promising design framework for our design process, and among our studies, we came up with an additional factor to this framework as emotional relationship influenced by the efficiency of the Tamagotchi toy. We also developed this factor in the form of a virtual pet at some level similar to Tamagotchi toy, which is the representative of the nature and by making emotional relationship with the user encourages them towards a more sustainable behavior. Through our interviews with the participants, we received the feedback that this emotional relationship is an effective factor for persuading the user. Seven out of 8 participants were really excited and interested in the concept of a virtual pet as the representative for the nature and environment. Later we heard from some of the participants that they have been explaining this concept to their friends, and their friends were interested in trying the application too, mainly because they wanted to see the virtual pet. They were even referring to it as ‘my pet’ and mentioning that they will behave more sustainable to keep their pet happy. These made us think that the factor of emotional relationship is a powerful extension to the Fogg’s Behavior Model.

However, some of the participants were concerned about the location and behavior tracking privacy issues. They wanted to be assured that these data would be kept safely; however, their anxiety seemed to disappear when we explained to them that there would be a notice in the application mentioning that their data will be kept private and safe.

After presenting the project, in the discussions we had with other researchers we concluded that for future development it might be better to design the virtual pet in a way that it does not have any negative impact on the user when their behavior is not sustainable. Even fox being sad should not do this and instead the state of the fox’s interaction should stay from neutral (not very active) to positive (happily active). This deduction is very well in synchrony with the recommendations from other studies and with our results.

Among the outcomes from this study, we learned that the three factors of motivation, ability and triggers are definitely powerful factors to consider when designing persuasive technologies. Persuasive technologies designed with these factors in mind are more likely to succeed. We learnt this, both from the literature we explored and the results from our own study.

We also learnt about the difference between designing a persuasive technology for encouraging user towards physical activity, for healthcare reasons and environmental sustainability. These two differ from each other in the sense that the former behavior affects the users themselves in the first place whereas in the latter behavior, it is the environment, nature and other human kinds that are affected in the first place and as a result, the user will be affected in the second place. In the latter situation, users might need a stronger factor to encourage them towards the target behavior in opposition to the former behavior. Moreover, this stronger factor could be the emotional relationship element suggested by this study.

Finally, we would like to mention that, we think, when it comes to human behavior, the factor of ‘authority’ plays a very important role. People do not like to be persuaded or in other
words, they do not like their minds to be manipulated by a computer, which has been created by another human being. At the same time, it is very well accepted by people to use tools for making things easier. Therefore, we think that people will be more open towards encouragement instead of persuasion. As a result, we can imagine a ‘behavior encouraging technology’ to be better accepted and adopted by the users than a persuasive technology. Behavior encouraging technology should not be mistaken with “Encouragement design” (Bradlow, 1998) although there are similarities between the two.

8. Conclusion

Our study investigated the main factors to be considered when designing location-based persuasive technologies for improving environmentally sustainable behavior of the people. We combined Fogg (2009) behavior model factors of motivation, ability, trigger and added an extra factor of emotional relationship for designing our prototype. As our results show, implementing these factors in the prototype, had a positive effect on overall success of the prototype application. Especially additional factor of emotional relationship received very positive responses from the participants and helped the prototype of our application to reach good results when compared with other persuasive mobile applications.

The limitations of our study were mostly time related and we believe the application would receive even better results if we implement all the features mentioned in the study. Therefore, for the future development, we suggest to further develop and implement all aspects that were not added in the first prototype.

This work contributed to the area of research on HCI and sustainability by adding new knowledge and by filling in the gap in the research field, where combining location-based services with behavior change systems is considered as a research area. We also think that the additional factor of emotional relationship we added to the FBM framework can help to broaden the knowledge within the research field of persuasive technologies, and will be helpful to the overall success of mobile applications on the market. Finally, we think that our work can help changing the behavior of people towards more sustainable life style, and as a result help for solving one of the most pressing problems of our society.
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