Designing a Local 'Climate App'

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ABSTRACT

It is widely accepted that climate change requires dramatic behavioural changes. Persuasive technologies have the potential to encourage individuals to develop pro-environmental behaviour, but the design and use of climate persuasive applications is also discussed controversially. This paper describes and discusses selected activities from two user-centred design cycles for a 'climate app' for local use, each resulting in a prototype that was tested over two and four weeks respectively. Prototypes were also used as 'tools for discussion'. The paper argues that climate persuasive apps can be valuable means if they allow, and require, users to actively contribute to their evolution and help them place their individual actions into the broader context of collective action for sustainability.

CCS CONCEPTS

• **Human-centered computing → Interaction design process and methods**; **Field studies**.

KEYWORDS

Persuasive design, climate change, behaviour change, user-centred design, prototyping.

ACM Reference Format:
Jule Kistenfeger, Sven Schmidtke, and Anke Dittmar. 2024. Designing a Local 'Climate App'. In *European Conference on Cognitive Ergonomics (ECCE 2024), October 08–11, 2024, Paris, France.* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/3673805.3673832

1 INTRODUCTION

The Sustainable Development Goals of the United Nations "are a call for action by all countries... to promote prosperity while protecting the planet"[1]. Goal 13 on climate action starts with the observation that "there is a climate cataclysm looming" caused by human activities and that "we are underprepared for what this could mean". It continues with the request to "vastly raise our ambition at all levels" and transform "energy, industry, transport, food, agriculture and forestry systems to ensure that we can limit global temperature rise to well below 2°C, maybe even 1.5°C"[2]. Regarding this topic, an app can be downloaded from the UN website which addresses the individual level by enabling people to choose and track their actions[3]. The app is an example of climate persuasive applications employing behaviour change techniques and persuasive design principles to change a person's attitude and/or behaviour regarding climate change. The potential of persuasive technologies for helping users to reduce resource consumption has been examined and acknowledged by various researchers and studies [3, 9, 16]. However, their design and use is also discussed controversially [2, 4, 10].

This paper describes and discusses selected activities from two user-centred design cycles for a persuasive 'climate app' for local use. In the first cycle, the design focus was on an action-based prototype with a 'climate clock' as central element. The idea of the clock was discarded in the second cycle and more emphasis was put on the information-based parts of the prototype which was tested by users over a period of four weeks but also served as 'tool for discussion' with small audiences. Based on the study, we argue that climate persuasive apps can be valuable means if they allow users to contribute actively to their modification and evolution, and additionally help them place their individual actions into the broader context of collective (un)sustainable behaviour.

The paper is structured as follows. Section 2 provides some background and related work on the subject. Section 3 presents the design study. Section 4 discusses it and points out future work.

2 BACKGROUND AND RELATED WORK

Persuasion is an attempt to change attitudes and/or behaviours of a person or audience without using coercion or deception [12]. Persuasive design is concerned with technology-mediated persuasion and rooted in the fields of behavioural and social sciences, psychology, cognitive engineering, and human-computer interaction (HCI) [1]. There are a number of general persuasive design models (e.g., the eight-steps model by Fogg [7]) as well as frameworks that are oriented towards a specific field such as health promotion [1]. An example of a more comprehensive process model is the Persuasive System Design (PSD) model [12] with its four categories of principles: primary task support, dialogue support, system credibility support, social support. In [13], this approach is combined with the transtheoretical model of behavioural change to better support the five 'stages of change': pre-contemplation, contemplation, preparation, action, and maintenance. Davis [5] refers to the ethical concerns of persuasive technologies[4] and recommends to address them by developing autogeneous systems, that is systems where the persuasive intent comes from the person who is using or adopting the system and not from the developer or distributor [12].

[1] https://www.un.org/sustainabledevelopment/
[2] https://www.un.org/sustainabledevelopment/climate-change/

[3] https://www.un.org/en/actnow
[4] "When we recognize that someone is trying to persuade us... we have many questions. What am I being asked to do? Who is trying to persuade me? Are they telling the truth? Are they open about their intentions? Do they care about my interests?" [5]

ECCE 2024, October 08–11, 2024, Paris, France

ACM ISBN 979-8-4007-1824-3/24/10
https://doi.org/10.1145/3673805.3673832

Ethical persuasive design has to proceed slowly and cautiously, following a participatory design approach [5].

Persuasive Design for Sustainability. Environmental sustainability is a prominent application domain for persuasive technologies. The emergence of mobile phones, pervasive sensors, and social media enabled tracking a person's carbon footprint and social comparison [2, 16]. The underlying assumption of climate persuasive applications is that the disproportionately high climate change is human-caused and that technological solutions to reduce greenhouse gas emissions are not sufficient enough, so that dramatic behavioural changes are needed [9]. Generally, it is difficult to achieve behavioural changes if there is a large temporal gap between the person's action and its consequence [9]. An additional obstacle is the difficulty to imagine consequences of global temperature rise [4] even if harmful effects are already visible today. Climate persuasive apps typically aim to encourage individuals, sometimes in a community context, to develop better pro-environmental behaviour in their everyday life (e.g., reducing energy consumption, changing mode of transport or recycling resources). While most early systems were endogeneous or exogeneous ones, recent publications report more active involvement of users in the design process [3, 15].

Coulton et al. [4] stress that climate change is a 'wicked problem' [14] with huge political and social dimensions that "cannot be reduced to easily actionable personal goals". Unsustainable behaviour is the result of interactions between individuals, groups, corporations, governments and so on [2]. A broader understanding of persuasion for sustainability beyond individual consumption reduction is needed together with a shift from prescription to reflection [2]. Knowles and Davis [10] even characterise global climate change as 'super-wicked problem' and recommend to constrain participation in the design process to domain experts only who have more insight into urgently needed collective action and effective persuasive technology goals than the end users. In [2], persuasive sustainability is seen as an example of modernist technology design that is characterised, among other things, by trust in scientific thinking and expert knowledge, optimization of life conditions and technological supported top-down control. We will take up this view in section 4 when discussing the study that is presented in the following section.

3 THE DESIGN STUDY

The design activities described in this section are selected from two user-centred design cycles of an exploratory project that started in fall 2021 as a collaboration between representatives of the city administration (responsible for digitization and for environmental and climate protection respectively), a local software company (represented by a team leader and a developer), and two of the authors. Data collection included retaining created design artifacts, material from user studies, meeting notes and diary keeping.

3.1 Design Cycle 1

The early goal of the project was to explore the design of a local 'climate clock', an idea that was initially communicated publicly by the mayor in the context of a smart city project. The analogous clock was portrayed as an app, which involves residents in the municipal goal to become climate neutral until 2035. Users should be able to inform the system about their activities and the clock should represent the progress made. The examples of winning 2 seconds for riding the bike to work and losing 8 minutes for using the plane to fly to Mallorca were used. Design activities in the first cycle (Sep 2021 - April 2022) included three design meetings between the above mentioned parties, two co-design workshops with 22 students attending a HCI related course, and prototyping.

In the first design meetings, existing climate clocks were reviewed. Typically, they are digital countdowns with no interactivity and no transparency about one's own impact on greenhouse emissions which are based on calculations regularly published by the Intergovernmental Panel on Climate Change (IPCC), see the example on the left-hand side of figure 1. The smartboard in the middle part of figure 1 shows meeting notes about initial constraints, requirements and ideas, including a sketch of the local clock with a minute hand which, depending on the person's activities, should jump back and forward. Although until the end of design cycle 1 no convincing solution was proposed how to calculate the clock's behaviour, the idea of the clock was still present in the tested prototype and only discarded in the second design cycle.

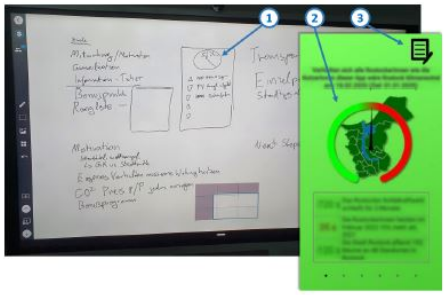
The co-design workshops, each consisting of two sessions, were conducted in online mode (due to the Covid restrictions at the university). In the first session, participants were briefly introduced to the problem of climate change, local consequences, and existing climate clocks and apps. They were given the design task (figure 1, right-hand side) and worked in sub-teams of 3 or 4 members using Miro boards (https://miro.com). In the second session, the whole group shared their ideas and was introduced to persuasive design principles. The sub-teams were then asked to revise and comment on their sketches over a period of one week. The results were analysed by two authors in terms of applied PSD principles and informed the design of subsequent prototypes. The idea of one subteam to depict the clock as speedometer (with the needle moving to the 'green side' if the municipal goal would be achieved and to the 'red side' otherwise) was adopted (middle part of figure 1).

A first prototype was created in Axure (https://www.axure.com/) and revised several times, based on feedback from the third design meeting and from students who already participated in the workshops. Suggestions for improvement concerned persuasive features, content, overall design, and the complexity of the prototype ('keep it simple'). Finally, two modes of use were introduced and a pilot system of the 'self-monitoring' mode was implemented and hosted (using Angular, C#, a ASP.NET core webserver and a SQL database). This prototype was exploratively tested for two weeks by 15 persons in their daily environment from which 11 used the feedback feature to directly comment on the app (middle part of figure 1).

3.2 Design Cycle 2

In spring 2022, the mayor who promoted the local climate clock unexpectedly resigned his post, resulting in less interest from the city administration and company side. However, the overall positive feedback from workshops and user test was encouraging and, together with the third author who was one of the workshop participants, we started a second design cycle in Sep 2022. Design activities

[5] https://www.nytimes.com/2020/09/20/arts/design/climate-clock-metronome-nyc.html (access: 20.10.2021, 14:15 pm)



Sketch out ideas for the local ``climate app'':
- *Motivation for climate-friendly way of life.*
- *Offers transparent presentation how the activities of individual citizens influence the climate clock and the city progresses towards climate neutrality.*
- *Bonus points program as a reward. Points can be redeemed for discounts in participating stores.*
- *Industry can be included in calculations (e.g., local trains, municipal utilities).*

Figure 1: *Left:* a climate clock as digital countdown[5]. *Middle part:* local climate clock in cycle 1: (1) first sketch as analogous clock, (2) as speedometer on start page of tested prototype (with feedback button (3) on each page). *Right:* design task in workshop.

included the analysis of existing prototypes and user feedback, a comprehensive redesign, and a four weeks user study. Additionally, we used the new prototype for discussions with small audiences.

Analysis and redesign. The focus in cycle 1 was on action-based components such as setting predefined or self goals and indicating their achievement (without real-time tracking). However, many of the comments in the user test were related to the information part and participants made suggestions for new themes. The climate clock on the startpage were perceived as confusing or demotivating by a number of participants. In the second cycle, the idea of the clock was discarded and more emphasis was put on the instructive component to provide more context for goals/challenges. The new prototype (figure 2) was implemented using Axure in connection with a database (for managing dynamic features, getting user feedback via the app etc.). Main features include the following.

- Predefined and self-defined challenges,
- Active goals and weekly statistics,
- Climate calendar with coins,
- Short information texts and tips for actions from trustworthy sources (e.g., IPCC) with links and references,
- Information about companies, local shops, projects,
- Motivation image with dynamic elements,
- Praise by seagull (local symbol) and seagull as feedback button,
- Ranking and displaying number of users,
- Settings for mode and motivation image.

The prototype offers 40 short information texts and 60 related challenges in six categories (e.g., household, current directives, mobility) as well as basic information about climate change. 21 PSD principles were implemented, five of them supporting system credibility. Target audience are people who are, according to the transtheoretical model [13], at least in the contemplation phase. The prototypical app can be used in three modes to support the different stages described in the model: *competition mode* (preparation and action phase), *challenge mode* without ranking (maintenance and action phase), and *information mode* without challenges, ranking and climate calendar (contemplation and preparation phase).

User study and 'tool for discussion'. 20 participants from our local area (with 2 exceptions) and from different age groups (ranging from 20 to 80 years) voluntarily agreed to participate in a four-week user study in the field in March 2023. The focus of the study was not on an 'objective' assessment of behavioural changes but on the participants' perceived utility and usability of the prototype and its

Figure 2: Screenshots of prototype in cycle 2: start page with dynamic motivation image and tip & news of the day; challenges; selecting and/or defining goals (from left to right).

actual use. The analysis of the short questionnaire at the beginning suggests that about a half of the participants were in the preparation phase, and an equal number in the action/maintenance or contemplation/preparation phase. Participants used the prototype on their own smartphone. Data was collected via the feedback feature and logging mechanism during the testing phase and through a questionnaire at the end of the study (filled in by 18 participants). Due to technical problems, some data collected got lost.

According to the final questionnaire, 8 participants used the prototype irregularly, 7 participants 1 to 2 times per week, and 3 participants 3 to 6 times per week. Infos and tips were used most often, followed by challenges and news. The logging data show that the majority of participants accomplished challenges. The overall number of challenges decreased over time, but some participants were inactive in one week and later became active again. Participants were also asked about their susceptibility to persuasion, whether they would use the final app and think it has persuasive potential (a shortened version of the questions in [11]). The results and participants' comments indicate the potential of the prototype to facilitate pro-environmental behaviour. Overall, there were 47 positive and 41 critical textual comments in testing phase

and questionnaire which were categorised into features (challenges: +8/-8, information pages: +18/-3), usability: +4/-10, design (layout: +10/-11, structure: +7/-1), and technical issues: -8. What is striking is the positive feedback about the provided information. For example, *"I read some texts this morning and I noticed that I was thinking about it during the day. Although I think that I care about the topic I had new insights"*, *"Very interesting texts about different topics, in a comprehensible way, with references, well written. Still some typos."*.

One of the participants wrote: *"I am already aware of the problem of climate change. The app would continuously provide new impulses, give practical tips. Thus the topic is not too abstract and one can contribute somehow. Even if one (I) knows that alone is not enough."* Climate change is often characterised as a collective-action problem [8, 10]. In addition to the user study, the prototype was presented to and discussed by small audiences of up to 20 participants (two student groups in fall 2022 and 2023, and at a public event of the university in spring 2023). The above problem was a dominant topic in the discussions.

4 DISCUSSION AND FUTURE WORK

For reasons of brevity, only some aspects of the briefly described design activities can be discussed in this paper.

Prototypes with the 'climate clock' in cycle 1 were mostly action-based systems. Brynjarsdóttir et al. [2] characterise persuasive sustainability as 'modernist enterprise' with "trust in technoscientific reasoning and top-down, expert knowledge" and calculability, predictability, and efficiency as central values. Climate clocks corroborate this description. While countdowns such as the one in figure 1 may help raising awareness about climate change, they can also easily be misinterpreted or meaningless, and even misused. One reason why the city administration (and the local software company) lost their interest could be that the climate clock was perceived as marketing gimmick of the mayor.

The responses in workshops and user test in cycle 1 show an interest in supporting behavioural change by a 'climate app'. However, climate change is a wicked, collective-action problem [4, 8]. The thoughtful comments of some participants in the second user study suggest that the prototype's improved provision of trustworthy information and system credibility can help to support a broader understanding of sustainability beyond individual actions while, at the same time, encouraging these 'little steps' as well. The results not only encourage more long-term studies but also further investigations into using prototypes as 'tools for discussion' to share in groups a broader perspective on climate change.

As mentioned in section 2, Knowles and Davis [10] describe climate change even as 'super-wicked' problem which should be tackled in participatory work with only domain experts (and user-centred design with all users). However, Rittel and Webber [14] already stress in their original paper on wicked problems "that the expert is also the player in a political game, seeking to promote his private vision of goodness over others". The interplay between 'top-down' initiatives (e.g., governments enacting regulations) and 'bottom-up' initiatives (e.g., community members who jointly reduce energy consumption) was discussed throughout the present example study. Especially the second design cycle can be considered as 'bottom-up initiative'. The value of emerging small-scale pro-environmental behaviour of individuals and self-organised groups is shown, for instance, in [8]. To support 'bottom-up' initiatives, climate persuasive applications have to be understood as 'open' systems [6] that can be designed during use. Prototyping should not only focus on usability aspects or effectiveness in terms of certain behaviour changes but allow participants to evolve the system and understand it as part of an 'ecosystem' of artifacts (including technological artifacts, regulatory instruments and civic actions) that evolves to increase pro-environmental behaviour at different levels. In future work, we want to further examine how the concept of open system can be employed to support a responsible design and use of persuasive applications for sustainability.

ACKNOWLEDGMENTS

We thank the participants in the design study.

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