
I Wish You Were Smart(er): Investigating Users' Desires and Needs Towards Home Appliances

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Abstract

In this work, we present findings from an online survey (N=77) in which we assessed situations of users wishing for features or devices in their home to be smart(er). Our work is motivated by the fact that on one hand, several successful smart devices and features found their way into users' homes (e.g., smart TVs, smart assistants, smart toothbrushes). On the other hand, a more holistic understanding of when and why users would like devices and features to be smart is missing as of today. Such knowledge is valuable for researchers and practitioners to inform the design of future smart home devices and features, in particular with regards to interaction techniques, privacy mechanisms, and, ultimately, acceptance and uptake. We found that users would appreciate smart features for various use cases, including remote control and multi-tasking, and are willing to share devices. We believe our work to be useful for designers and HCI researchers by supporting the design and evaluation of future smart devices.

Author Keywords

Smart Homes; Smart Devices; Online Survey

CCS Concepts

•**Human-centered computing** → **Human computer interaction (HCI)**; *Ubiquitous and mobile computing*; User studies;

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Survey Questions

- Can you imagine a recent situation in which having a smart home device would have been helpful? *free text entry*
- Was anybody with you in that situation? *free text entry*
- Where did that situation occur? *free text entry*
- When did the situation occur? *free text entry*
- How did you cope without having the “smart” device? *free text entry*
- Which device / feature of this device would you have wished to be “smart”? *free text entry*
- In which room would you use it? *free text entry*
- For which purpose? *free text entry*
- With whom would you share this device? *free text entry*
- How often would you use it? *single choice field*

Motivation & Background

Our homes are becoming increasingly smart. Networked devices with different interaction technologies (e.g., smart TVs, smart assistants, smart toothbrushes) [13] that have access to different information enable products promising an ever-increasing number of features for users’ homes serving various purposes (e.g., energy savings or home automation). Furthermore, researchers are exploring opportunities of smart homes, including, e.g., supporting ageing in place [1, 18] or detecting health issues [3, 4].

Prior work investigating users’ needs and preferences focused on user groups with special needs, such as elderly and users with physical disabilities [20], predefined goals (e.g., sustainable energy consumption [12]) or artificial settings (e.g., [11]). Moreover, recent research addressed users’ needs with regards to concerns in smart homes (mostly privacy related, e.g. [16, 19]) or looked into how to design for usable interaction and domestication [17] as well as secure smart home interaction and settings [13]. Also, user benefits of smart homes have been widely discussed in the literature (refer to, e.g., this literature review [10]). To summarise, we see work in HCI evolving around user interfaces in smart homes [9], user perception and privacy concerns towards existing devices [19], potential adoption and domestication [17], and sharing of IoT devices [7].

At the same time, prior research was oftentimes not conducted in context (i.e., users’ actual homes) but by means of focus groups [12, 19], interviews [20] or lab settings [11]. Furthermore, investigation of users’ needs was oftentimes driven by technology or industry (refer to, e.g., this literature survey [8]) rather than HCI research and did rarely consider inevitable sharing of devices in shared living scenarios.

In an online survey ($N = 77$), we explicitly asked for so far underexplored aspects, i.e., living situation and potential

sharing of devices. We also studied users and their (actual) homes by the means of our survey, referring to concrete (i.e. real) situations in their lives and homes. We investigate users’ wishes for smart devices and features at home.

Our results include a description of different situations, desired functionalities, current workarounds and practices as well as the need for sharing of devices. Based on our findings, we discuss potential designs of (future) smart home devices as well as directions for future research.

Online Survey: Smart Incidents

We conducted a qualitative online survey, asking for situations in which participants would have wished for a device or feature in their homes to be smart(er). We chose this method since by asking for real-life situations users recently encountered we obtained insights closely connected to users’ actual homes. We asked for a general description of the situation, along with details (e.g., where and when it occurred), the specific device or feature (refer to Sidebar for full list of questions) and concluded with demographic questions (e.g., living situation) including the ATI (affinity for technology) scale [6]. We distributed the survey via university mailing lists and social networks in Germany, available in two languages (German and English).

Participants

We recruited 77 participants (42 *female*, 35 *male*). Participants’ age was between 18 and 64, most of them *students* (42) and living with their *family* (28) or *partner* (23) (refer to Tab. 1 for details). Their ATI scale [6] ranged from 1.00 to 5.78 ($M=4.14$, $SD=1.19$).

Limitations

Our study sample is biased towards young people, students, and family households. We believe this age to be the main target group as smart home users in Germany

Age	
Mean	26.85
SD	9.26
Living	
I'm living with my family.	28
I'm living with my partner.	23
I'm living in a flat share	11
I'm living alone.	11
Other	3
Employment	
student	42
employed full time	16
employed part time	10
unemployed and not currently looking for work	2
unemployed and currently looking for work	1
self-employed	1
Other	5
Smart Devices	
smart device owners	17
Alexa, Google/Apple	7
Home	
Heater	3
TV	3
Lights	3
Plug	2
Others	8

Table 1: Participants' demographics and prior experience with smart devices.

are mainly between 25-34 years old [15]. We further focused on single devices in our survey to receive detailed reports (though some reports involved connections between devices). Future work could evaluate sets of devices and further housing situations in more detail.

Results

From 77 participants, 9 did not report a situation, stating *no* (4), *refuse to use* (3), *not really* (1), and *not so far* (1) for the first question. We applied thematic analysis [2] on the remaining 68 answers. One participant reported two situations, resulting in a total of 69. Quotes were translated from the original language where necessary.

Situations

In the participants' reports, we found various actions that users would have wished to be supported by smart devices, e.g., checking device states when leaving or away from home, support for multi-tasking within the home, facilitating household tasks, or controlling home devices automatically and/or remotely. Some reported on wishing for smart functionality in specific situations, e.g., being injured (thus limited mobility, P106) or sudden weather changes, such as thunderstorms (P35 and P212).

Bystanders & Companions. Most situations occurred when *nobody* (49) was with the participants. Other situations included the main user and their *partner* (9), *family* (5), *friend(s)* (one (3) or multiple (2)), a *child* (2), *flatmates* (1), the *owner* (1), or potential *bystanders*(1) (i.e., P158 was not at home but on a train when realising the oven was still on). Note that 5 participants reported on multiple of these in one situation (e.g., “*Yes, my flatmates (3) and three further friends*”, P48) or on companions with them and at home (e.g., “*one family member with me, one in the house*”, P5).

Locations. While most situations occurred at *home* (55), some also reported on situations *away* (12) from home, or in a *temporary* (1) home (i.e., a “*short-term leased apartment*”, P42). Away from home included *travel* (6), *car* (2), *on the way home* (2), *in the city* (1), or on a *suburban train* (1). Home-based situations mainly (i.e., 2 or more occurrences) included (if specified) *kitchen* (12), *bedroom* (5), *living room* (5), a *friend's home* (2), or *bathroom* (2). Note that 6 situations included multiple of these (e.g., bedroom and kitchen, P188).

Timings. Situations mostly occurred in the *evening* (25), followed by *morning* (15), *afternoon* (6), *noon* (3) or generally *during the day* (2). Some situations explicitly included *winter* (4), *summer* (2) or *holidays* (4). Some situations reoccur *frequently* (11) (e.g., in the morning) or are a permanent state (*always* (2)).

“(Non-)Smart” Workarounds

Users applied various strategies to cope with not having the desired smart devices, mostly acting manually and, hence, creating effort and/or additional burden on users. Examples include users getting up from their bed or sofa (“*I had to get up from my bed and go to the living room in order to turn off the light*”, P213), interrupting their main task (e.g., “*I had to dry my hands and turn on the timer on my smartphone (I couldn't have unlocked it with wet hands). Then I had to look at the recipe again on the phone.*”, P7) or calling for help (“*Short message to family member in the home*”, P5).

Smart Devices & Features

Participants mentioned whole home appliances they wished to be smart, including, but not limited to, *lights* (9), *doors* (7), *ovens* (7), and *heaters* (2). Others mentioned single features like *voice control* (8), *temperature settings* (4), and *automatic turn off* (2) for one or several devices.

Rooms. Most participants reported they would use the new smart device or feature in their *whole home* (21) (i.e., the whole flat or house, all rooms or a whole 1-room-flat). Concrete rooms mainly included the *kitchen* (21), *living room* (18), and *bedroom* (16). Note that some participants included multiple rooms (or whole homes with highlights of single rooms) for the desired device or feature.

Functionality. Many of the described devices should takeover (annoying) tasks (e.g., “(..) *telling her [Alexa] to make coffee without leaving my bed. Or taking care of my inbox. (...)*”, P44), support multi-tasking (e.g., “*When I was doing the dishes and listening to my podcast. I wanted to increase the volume, (...) with my voice and continue washing.*”, P136) or enable remote control or automation within the home. Others should provide access to the home from outside to get information about the house (e.g., surveillance, P5) or control devices remotely (e.g., turn on oven, heater or air condition in advance of arrival back home). Note that one device (i.e., from one situation report) could also provide multiple functionalities or serve multiple purposes.

Shared Devices. Participants reported to potentially share their devices with their *family member(s)* (24), *partner* (17), *room mate(s)* (14), *friends* (3) or *guest(s)* (5). 10 would *not share* their device and 2 did *not specify*. 2 participants mentioned purpose-bound sharing with guests (“*the other ones who would also cook at my home*”, P7; “*let them [friends/family] in when I am not home*”, P48), while others did not further specify who and why but would share with *everybody present* (3).

Of those who would not share their device (10), only 2 were also living alone, while others were living in a flat share (4), with their family (3) or partner (1). Of those who were generally willing to share their device (a total of 58 participants), 9 were living alone, 5 in a flat share, 22 with their family,

and 19 with their partner (3 other). The type of device and its physical position may have additional influence on sharing behaviour (cf. [7]), however this is not represented in our dataset (e.g., we found smart assistants potentially (not) being shared (2 each)).

Usage Frequency

Participants’ reported to use desired devices fairly often, i.e., *more than once a day* (40), *multiple times a week* (12), *once a day* (11), *once a month* (1), *once a week* (1). 12 participants mentioned special usage frequencies, e.g. depending on environmental factors (e.g., “*depending on the weather*”, P60; “*Whenever an incident occurs*”, P173) or relying on automation (“*I’d imagine to use the smart device to configure the temperature once and then let the system automatically control it.*”, P42; “*If it was smart, couldn’t it be controlled automatically? Hence, the user does not have to do anything? But probably I would readjust the design depending on environmental conditions*”, P55).

Design Recommendations

Participants wished for whole smart homes or single features and devices, for various purposes and in various situations. We discuss how our findings can enhance HCI research by informing the design of devices and features.

Smart Home Appliances: Purposes & Use Cases

Participants described various scenarios for their desired smart home appliances (refer to Fig. 1 for an overview), mainly in three phases: (1) (before) *coming home*, (2) being *at home*, and (3) *leaving home* (including the actual leaving as well as *away from home* scenarios).

Before coming home, users wished to *pre-control* devices (e.g., “*It would have been practical to preheat the oven via an app*”, P230) to save time upon arrival or increase comfort by, e.g., pre-heating the home (e.g., “(..) *Therefore, I*

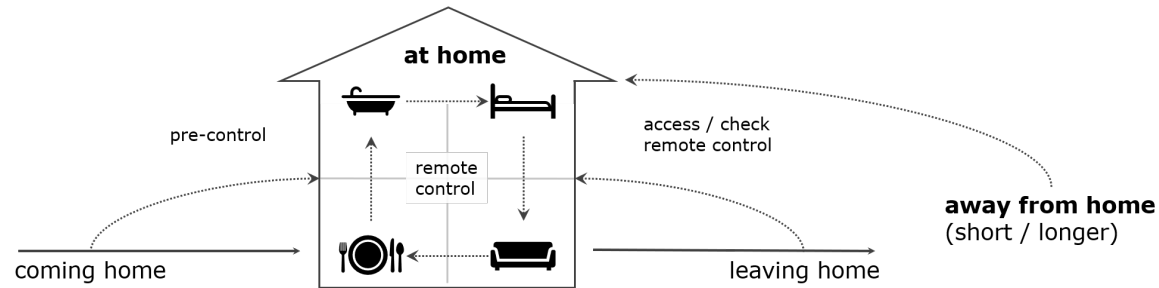


Figure 1: Scenarios for Smart Home Appliances. We found three phases (from left to right): coming home, at home (i.e., scenarios within the home, including within- and between-rooms remote control), and leaving home (including the actual leaving and away-from-home scenarios).

would like to have the opportunity to turn on the heating an hour before getting home.”, P202) or turn on the lights to not arrive in the dark (“(...) This [the automatic lights] is especially practical since the user usually arrives home late at night and wants to find his flat lighted. (...)”, P139).

Within their home, users imagined *remote control* of arbitrary devices, within one room (e.g., “In the bedroom - turn off lights without leaving the bed”, P200), but also between rooms (e.g., “You have to go to the bathroom and want to switch on the heating from the bedroom.”, P55). Other common scenarios included *multi-tasking* (e.g., in kitchen scenarios: cooking and looking up recipes or controlling music, P47, P136, and P167) or automatic communication between devices and rooms (e.g., curtains that rise upon the alarm, P88). Scenarios within the home were mainly meant to *ease* certain tasks or increase *comfort*.

When leaving or being away from home, users would appreciate a possibility to check the state of their devices (e.g., “We are leaving the house and my boyfriend wants to double check for the 5th time whether we really turned off the oven. With a smart home, we could check.”, P214) or

access information about their home (e.g., “I have two cats. Sometimes it would be nice to check what they’re doing in the house when I am away (...)”, P36). These use cases were mainly serving the users’ *peace-of-mind*. After having been away for a short or longer time, users may start again in the first phase: coming home.

Supporting these phases by design may ultimately foster the uptake of novel smart home technology in users’ homes, since related work shows that not only privacy and security factors [5], but also “perceived usefulness” have effects on purchase behaviour of IoT devices [14].

Interaction Modalities

While some participants simply described the desired devices and features as *smart* (7) (presumably acting independently or recognising the legitimate user, e.g. “Hands dirty and no lights in the kitchen. Would have been easy with smart lights.”, P143; “(...) Having a smart door to let me in without a key would be great in those situations”, P48), others mentioned desired interaction modalities and control mechanisms in their answers. Generally, participants mentioned *remote* (23), *automatic* (12), as well as

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Project Material

The survey responses (anonymised, German original as well as translated to English) are available at <https://www.unibw.de/usable-security-and-privacy/downloads/datasets>.

handsfree (7) as desired features of interaction. Note that *remotely* was mentioned in both, away-from-home as well as at-home, use cases (cf. Fig. 1).

Furthermore, *cameras* (3) were mentioned as device with no specific interaction (e.g., for surveillance purposes, P5) and *two-way-intercoms* (2) for interaction with foreigners at the door. Some mentioned more concrete modalities like *voice* (6), their *smartphone* (4), or an *app* (2) to control the desired device or feature. *Pre-programmable* (2) devices were also mentioned: “A smart curtain that would rise up and allow the sun in when my alarm goes off would be very helpful for this situation.”, P88 and “(...) The device allows the user to set specific timings [in which lights turn on or off automatically]. (...)”, P139. Some also described a mix of these, referring to usage frequency rather than interaction itself, e.g. automatic as well as manual control if need be (P55) or manual configuration followed by automatic acting of the device (P42). As future smart home devices come with various built-in sensors (e.g., microphones), this opens opportunities for novel (handsfree, remote) interaction techniques as imagined by users. Also, as they are more frequently used, and hence provide more data, automatic control based on user preferences will become promising.

Shared Devices

58 participants reported on sharing the potential device with internal (e.g., room mates, family members) or external users (e.g., remote family members, guests). Interestingly, shared living situations did not lead participants to share by default (e.g., of 23 participants living with their partner, only 17 were willing to share the device). This brings up interesting questions for HCI research with regards to access control in the sense of a) how to design for shared devices (e.g., managing various user profiles) and b) how to protect

devices in case participants are not willing to share (even not with “insiders”, i.e. other users they live with).

Workarounds: Coping without Smart Features

While common workarounds as described by users included additional efforts, some also reported that there was *no solution* (6) for their incident. Some also mentioned concrete consequences they have or would have encountered without the smart device (e.g., “I tend to forget the washing machine which means that I’m leaving the wet clothes in it. A while ago I totally forgot about it and had to wash my clothes again. The washing machine is totally out of sight, therefore a smart washing machine that notifies me when it’s done would be very helpful.”, P211). This opens two directions for the design of future smart devices: a) avoid effort-heavy workarounds and foster home comfort by providing smart features (e.g., automatic temperature adjustments or remote control of lightnings), and b) support cases where participants saw no solution so far (e.g., notify users if an - potentially urgent - action is required).

Conclusion

In our online survey ($N = 77$), we investigated users’ desires and needs towards home appliances. We found participants wishing for smart(er) features for situations (before) coming home, being at home, and leaving / being away from home, to increase their comfort or peace-of-mind. We discuss directions for future HCI research as well as for the design of novel smart home devices.

By presenting this work at CHI we hope to stimulate a discussion on how the identified aspects can be implemented in future smart home appliances and which challenges for user interfaces arise.

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