Exploring Concerns and Expectations of Future Smart Systems for Managing Domestic Water Services

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Undersökning om Farhågor och Förväntningar på Framtida Smarta System som Hanterar Vattenrelaterade Hushållstjänster

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ABSTRACT
With our growing population, we are facing great challenges when it comes to our water consumption. As Stockholm is growing in both population and size, the city’s provider of drinking water, Stockholm Water and Waste, is looking into approaches like smart systems and persuasive strategies that tries to help citizens use water for domestic purposes in more sustainable ways. Some see these approaches as a natural part of the future of urban development and they have already been implemented at several locations around the globe. However, smart systems and persuasive strategies have seen an upswing in critique lately and it have been argued that they tend to treat householders as something separated from the socio-technical context they live in. As a response to this critique, a wide range of suggestions for future development of smart systems and persuasive strategies have been made. While a lot of these suggestions are based on studies that evaluates already existing systems and tend to focus on how to improve them, they still convey a scenario where these systems are a natural part of our future urban lives. However, little research has been made that tries to understand the citizens’ perspective on these systems before they are implemented. By using a future study approach that includes citizens in reflective and exploratory activities of non-existing future smart systems for managing domestic water services, this study aims at exploring their concerns and expectations of said systems and questions the wants and needs for them begin with. This study reveals that citizens might have great concerns when it comes to questions of privacy and control and how smart systems and persuasive strategies run the risk of problematizing individuals. This study also reveals that citizens might be more interested in negotiating and improving current services and infrastructure than having technology negotiate their everyday lives.

SAMMANFATTNING
Vår ökande befolkning ställer oss inför stora utmaningar när det kommer till vår vattenkonsumtion. Dä Stockholm växer både till befolkningsmängd och yta undersöker Stockholm Vatten och Avfall, stadens leverantör av dricksvatten, tillvägagångssätt som smarta system och övertalningsstrategier för att hjälpa medborgare bli mer hållbara i sin vattenförbrukning. En del ser dessa tillvägagångssätt som en naturlig del av framtidens urbana utveckling och de har redan blivit implementerade på flera platser runt omkring i världen. Smarta system och övertalningsstrategier har dock sett en uppsjö av kritik på sistone och det har sagts att de tenderar att behandla personer som något separerat från den sociotekniska kontext de lever i. Som en respons till denna kritik har det tagits fram ett antal förslag för den framtida utvecklingen av både smarta system och de övertalningsstrategier de använder sig av. Då många av förslagen som lagts fram är baserade på studier som utvärderar redan existerande system, samt tenderar att fokusera på hur dessa kan förbättras, förutsätter de fortfarande ett scenario där smarta system och övertalningsstrategier är en naturlig del av vår framtida urbane miljö. Dock har endast mycket lite forskning gjorts i syfte att utröna medborgarnas perspektiv på dessa system innan de implementeras. Genom att inkludera medborgare i reflekterande och utforskningsaktiviteter angående ännu icke-existerande smarta system som handkas med vattenförbrukningen i hemmet, syftar denna studie till att utforska medborgarnas förväntningar, farhågor och inställning till sagda system och ifrågasätter huruvida dessa system är något de över huvud taget vill ta del av. Denna studie visar hur medborgare kan hyssa stor oro när det kommer till frågor berörande kontroll och datasekretess, men även hur smarta system och övertalningsstrategier riskerar att problematisera individer. Studien visar även på möjligheten att medborgare kan vara mer intresserade av att förhandla och förbättra redan existerande tjänster och infrastruktur än att låta teknologi förhandla om deras levnadsvanor.
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With our growing population, we are facing great challenges when it comes to our water consumption. As Stockholm is growing in both population and size, the city’s provider of drinking water, Stockholm Water and Waste, is looking into approaches like smart systems and persuasive strategies that try to help citizens use water for domestic purposes in more sustainable ways. Some see these approaches as a natural part of the future of urban development and they have already been implemented at several locations around the globe. However, smart systems and persuasive strategies have seen an upswing in critique lately and it has been argued that they tend to treat householders as something separated from the socio-technical context they live in. As a response to this critique, a wide range of suggestions for future development of smart systems and persuasive strategies have been made. While a lot of these suggestions are based on studies that evaluates already existing systems and tend to focus on how to improve them, they still convey a scenario where these systems are a natural part of our future urban lives. However, little research has been made that tries to understand the citizens’ perspective on these systems before they are implemented. By using a future study approach that includes citizens in reflective and exploratory activities of non-existing future smart systems for managing domestic water services, this study aims at exploring their concerns and expectations of said systems and questions the wants and needs for them begin with. This study reveals that citizens might have great concerns when it comes to questions of privacy and control and how smart systems and persuasive strategies run the risk of problematizing individuals. This study also reveals that citizens might be more interested in negotiating and improving current services and infrastructure than having technology negotiate their everyday lives.

Author Keywords
Water; Smart Systems; Persuasive Strategies; Future Studies; Sustainability

INTRODUCTION
While expected to still have a good access to water in the future, Stockholm is subject to a rapid growth and increase in population. The growing population puts new demands on water access and usage and the city’s water provider will eventually have to conduct major renovations on the infrastructure. The city’s water provider is therefore looking into ways to postpone this major renovation by increasing the efficiency of the current system. Some of the approaches that are being investigated are smart systems and persuasive strategies that try to load shift domestic water usage away from peak hours.

Water and the World
Already in 1989, Falkenmark pointed out that we would have difficulties to meet the water needs of both new generations and the socioeconomic development of the future [7], and by the year 2000, there were numerous signs that human water usage exceeded sustainable levels [15]. While there is little doubt that climate change will have a significant impact on our access to groundwater in the coming decades [9] [8] [19], global changes in population and economic development are said to be of even greater concern [29] [18]. In 2017, we were estimated to be more than 7,5 billion people living on the planet [28] and we are expected to level out at around 9 billion people if we manage to end world poverty [17]. But we have already overshot the planet’s carrying capacity with our current population and would require the resources of 1.7 Earths for our lifestyles to be sustainable [14]. On top of this, the global water demand has tripled since the mid-20th century [15], and in 2017, the United Nations proclaimed that the global demand for water is expected to grow by another 50% by 2030 [31]. Because of this, the United Nations stresses that a paradigm shift in behavioral change regarding water usage is of paramount importance to reverse the current trend of wastewater generation.

BACKGROUND AND RELATED WORK
While the United Nations call for a behavioral change in wastewater generation, Sweden is currently in a paradigm where a majority of its population expects unlimited access to water at all times [10]. But although the Ministry of Environment and Energy in Sweden have concluded that the country’s general access to water will remain good in the future [11], Sweden is currently subject to a trend of urbanization and rapid population growth. As a result, Sweden’s capital, Stockholm, is growing both in area and populace at a rapid pace. This population growth also means a growing demand for water and will eventually force Stockholm Water and Waste, the provider of freshwater in Stockholm, to conduct major upgrades in the water infrastructure. Stockholm Water and Waste are therefore
looking into ways to postpone this major renovation by increasing the efficiency of the current system.

Today, the domestic water usage in Stockholm has a peak demand during the evenings (see Figure 1) and about 23% of the water is lost in leakages before reaching an end consumer [24]. Load shifting domestic water usage away from peak hours could potentially lower this number, since a more balanced curve would mean a more constant pressure in the pipes, less leakage and less strain on the infrastructure. Because of this, some of the approaches that are being investigated by Stockholm Water and Waste are smart systems and persuasive strategies that could help the citizens achieve a more even distribution of their daily water consumption. However, smart systems and persuasive strategies have lately seen an upswing in critique.

![Figure 1. Daily variation of water consumption in apartment houses in Stockholm over a week. X-hour, Y-factor. Credits: Stockholm Water and Waste.](image)

**Smart Systems and Persuasive Strategies**

The goal of sustainability in a city could be defined in making the city more livable, while at the same time reducing its use of natural resources and production of waste [12]. As changes in demand and increases in energy and water consumption have contributed to both economic and environmental problems [25], many see smart systems and persuasive strategies both as a way to help householders become more sustainable in their energy and water consumption [16] and as a natural part of the future of urban development [20]. These smart systems are primarily interacted with through informative displays, such as In-House Displays, Energy Monitors, Home Energy Management Systems and website portals, which provide detailed feedback on a household’s resource consumption [26]. But, while persuasive strategies like dynamic pricing models and informative displays have proved to reduce the energy consumption in households by around 5 to 10% [5] on a short-term basis, it has been argued that these approaches overlook what people actually do in their homes [26] and that designers and evaluators of smart visualization feedback programs tend to treat householders as something separated from the socio-technical context they live in [25] [16]. It has also been said that it lies in the very nature of persuasive strategies like these to portray environmental damage as a consequence of individual action, and that by presenting individuals with better information, we rely on the individual’s common sense to adopt pro-environmental behaviors [21]. Persuasive techniques can therefore be said to efficiently shift the responsibility to the individuals instead of the system that have both taught and reinforced their unsustainable behaviors and practices [23]. By focusing on what we can save instead of what is considered normal or necessary, the moral messages conveyed by smart, informative displays also runs the risk of legitimizing existing water and energy demanding practices [25]. Apart from running the risk of reinforcing unsustainable practices, the introduction of new sociotechnical systems, like the internet, can create new and unforeseen energy demands [27]. Becoming smart also necessitates the consumption of smart things [26]. But, if *smartness* is defined as engagement and management of energy data and technology, it also creates a vision of a reality where all smart human action and social change is mediated through data or technology.

While things like energy and water efficiency can lead to short-term economic prosperity, there is no consensus that it makes civilization more sustainable [27]. Through a narrow lens, smart systems that tries to make us more efficient in our consumption can appear to help us live more sustainable, since they for example can help us reduce our carbon emissions. But the indirect effects of these systems could potentially outweigh the positive effects. Just like efficiency improvements in the steam engine led to an increased usage of coal rather than a reduction, persuasive strategies like dynamic pricing on energy and water usage could just as well lead to consumers buying more energy or water demanding products.

As a response to the critique of smart systems and persuasive strategies, a wide range of suggestions for future development and improvement of smart systems and persuasive strategies have been made. [16] e.g. shows how dilemmas of trust and ownership of smart systems can be approached and [4] highlights how automated systems would benefit from providing a sense of empowerment. However, these suggestions still convey a scenario where smart systems and persuasive strategies exist as a natural part of our future urban lives. As little research has been made that tries to understand citizens’ perspective on these systems before they are implemented, this study aims at exploring citizen’s concerns, expectations and attitudes towards future smart systems and persuasive strategies that manages domestic water services.

**METHOD**

This study used a three-step model consisting of a preparatory phase, an exploratory phase and an analytical phase. The participants of this study consisted of a group of five people. During the preparatory phase, the study participants were asked to use a cultural probe for a three-day period. The cultural probe was designed to prepare the study participants for the exploratory phase by engaging them in activities that made them reflect on their everyday domestic water usage. The preparatory phase was closely
followed up by the explorative phase, which consisted of two workshops. During the first workshop, the study participants discussed experiences and insights gained from using the cultural probe. During the second workshop, the study participants were presented with a conceptual scenario cross, which was used as a basis for discussions about their concerns and expectations of future smart systems for domestic water usage. Both workshops were recorded and transcribed. This transcription was then used in the analytical phase, where patterns and recurring topics were identified as interesting findings and summarized in the results.

**Study Participants**

The study participants consisted of five people who, at the time of the study, were all living and using water in Stockholm. They all lived in apartments, but their housing situations differed (see Table 1). The participants all agreed to participate and to be recorded during the workshops on the terms that they were to remain anonymous. As such, the study participants are therefore referenced to as P1, P2, P3, P4 and P5.

<table>
<thead>
<tr>
<th>P#</th>
<th>Age</th>
<th>Occupation</th>
<th>Living</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>28</td>
<td>Studying a medical degree.</td>
<td>Own apartment. Living alone.</td>
</tr>
<tr>
<td>P2</td>
<td>30</td>
<td>Studying a master’s degree.</td>
<td>Apartment. Lodger.</td>
</tr>
<tr>
<td>P3</td>
<td>30</td>
<td>Nurse on parental leave.</td>
<td>Apartment. Living with their family.</td>
</tr>
<tr>
<td>P4</td>
<td>31</td>
<td>Studying a master’s degree.</td>
<td>Apartment. Living with their parents.</td>
</tr>
<tr>
<td>P5</td>
<td>36</td>
<td>Secondary school teacher.</td>
<td>Living alone in a sublet.</td>
</tr>
</tbody>
</table>

Table 1. A short summary of the study participants.

**Cultural Probes**

The strength of cultural probes lies in their playful approach towards gathering information, generating conversations and understanding people and settings [1]. Cultural probes focus on hopes, fears, curiosities and dreams, rather than problems and needs. They can thus be integrated as a natural approach for future studies exploring concerns, and expectations of future technologies and systems. While cultural probes were not developed to be a part of the social sciences, [1] have argued how they easily could be adopted to this format by e.g. collecting data in the shape of a more interesting and interactive type of survey. For this study, this adaption of a cultural probe was chosen for both preparing the study participants for the topics of the workshops and to gain a deeper insight in their thoughts and experiences of domestic water usage.

**Water Mirror**

Water Mirror is a cultural probe, designed and developed for this study (see Figure 2). Water Mirror is a box with a set of notes. Each note contains an instruction and all in all there are nine different types of notes. The study participants were asked to use the cultural probe for a period of three days (Thursday - Saturday) and were allowed to use up the notes at any given time. During these three days, the study participants were asked to take a note, fill in the instructions on the note and put it inside the box whenever they used water for domestic purposes. The instructions on the notes focus on the experience of domestic water usage from a social and reflective perspective and were evaluated with three independent testers. Before being handed out to the participants, the Water Mirror was field tested by and on the researcher. To capture the here-and-now experiences of the participants domestic water usage, Water Mirror was designed to function like a ballot box that is opened first in the follow-up workshop session. The main purpose of Water Mirror was to prepare the participants for the workshops by engaging them in actions that encourages them to reflect on their domestic water usage.

![Figure 2. The cultural probe, Water Mirror.](image)
patterns were considered interesting findings and used as a basis for the discussion and the conclusion (see Figure 3).

Figure 3. An example of a note with a completed instruction.
This was one of the notes that was used to strengthen the argument of a reluctance of sharing certain information.
Translation: “Wash your hair/take a bath”, “I do it too seldom”.

Explorative Scenarios
When envisioning the future, explorative scenarios can be used to explore the consequences and concerns that an intended target group might have to take into consideration [3]. Explorative scenarios are often presented as a set of scenarios and placed in a scenario cross, with four alternative scenarios that combine two extremes on a two-dimensional space [13].

The Scenario Cross
For the second workshop, a scenario cross of conceptual explorative scenarios was created and presented to the study participants (see Figure 4). As previous studies show how both control and privacy are issues that already existing smart systems are struggling with [16] [4], they were chosen as the high and low values of the scenario cross. By keeping the scenarios open and at a conceptual level instead of a detailed level, the participants were encouraged to be more explorative in their definitions and relations to the topics of control and privacy. During the workshop, the scenario cross was used as a basis for discussion, where the participants talked about what the different topics meant to them and what scenarios like these potentially could look like in reality. The discussion moved freely between the different rule sets of the conceptual scenarios, persuasive strategies and load shifting from peak hours. As such, the topics and quotes are all intertwined with each other in the results.

Figure 4. A figure of the scenario cross used during the workshops.

RESULTS / FINDINGS
This section will present the topics that stood out in the results of the cultural probes and the workshops. Some of the things that surfaced was the participants desire for control, anonymity and to be perceived as having a normal behaviour.

Control
The participants made a clear distinction between the acceptance towards a smart system that manages activities that are already considered more automatic and run by machines, and activities that are considered to be more manual. P1, P2 and P4 explicitly expressed a distress for a smart system that tried to negotiate their manual labour, as it would feel imposing on their personal space. However, there seemed to be a general acceptance towards a smart system that managed machines. P4 highlighted this shift in attitude by using an example of doing the dishes by hand or using a dishwasher.

P4: I think that a dishwasher that does the dishes whenever it feels like, you know, I have no problem with that at all. However, if it is something that says, when I am planning to do the dishes by hand and it tries to tell me what time to do it, I would be very annoyed.

Something that surfaced both through the cultural probes and during the workshops was also how some activities were considered to have a greater here-and-now demand than others. For example, all participants reported that they were more open to the thought of negotiating the time they water their flowers than they were to the thought of negotiating when they e.g. would drink water or coffee, visit the restroom or take a shower. Apart from the question of automatic or manual labour, the here-and-now demand also seemed to play an important role when discussing what services were considered more naturally managed by a smart system.
As they were considered both more automatic and did not have a strong here-and-now demand, two of the domestic water usage services the participants found more reasonable to be managed by a smart system were dishwashers and washing machines. Using these two services as an example, the participants imagined and discussed a smart automated system where the users would just load the machine and then let the system run it at an appropriate time.

P1: ...I think some things should be really appropriate. For example, you should be able to, like.. I mean, washing machines and dishwashers. Sometimes it doesn’t matter when you do the laundry or the dishes. Then you should be able to say like “you can choose a time, as long as it i within this time frame” for example. And then it runs when there are few users. I can start the laundry or dishwasher now, but it runs like... tomorrow at 11am when I am at work.

However, the more autonomous the system became, the more concerns the participants seemed to have and one of the topics that stirred a discussion was who the participants could hold accountable if something went wrong. Using the smart system managing dishwashers and washing machines as a standpoint, P2 and P4 pointed how these issues also were prominent in other discussions of autonomous systems.

P4: It is a question like that, “whose fault is it when two automatic cars collide with each other?”. Whose responsibility is it when the autonomous system ruins my shirt?

P2: But that is one of the concerns people have with autonomous systems: like, who is accountable. Like, hello? Who should I talk to if something goes wrong?

The fully automated system for managing domestic water services soon became substituted with a more supportive and empowering one. At first, the participants imagined the new smart system to use some sort of timer for when to start the dishwasher or washing machine. But, as they also expressed a general disinterest and a lack of energy for interacting with advanced systems, they soon pointed out that the smart system would increase its chances of negotiating the time to run dishwashers and washing machines if it were to suggest an appropriate time to do it. The need for control also surfaced in a discussion about a smart, advanced toilet. The participants imagined the advanced toilet to have a large tank that stored enough water for several uses, as well as a tank for storing wastewater for later. The system would then flush and refill the tank outside of peak hours. But as expressed by P3 and P1, there was a desire for the possibility to manually override the system.

P3: Manual override is important.

P1: It should exist. And should preferably not be tracked like in The Fifth Element. Like: *Beep* *Beep* *Beep* “You have used manual override four times” and then it automatically prints a fine.

The discussion also became interweaved with one of dynamic pricing. P1 expressed that dynamic pricing models were more acceptable if they targeted workplaces and companies, but also that dynamic pricing models targeting individuals might impose on the individual’s personal space. This perspective was shared by P2 and P4 and seemed to be based on the difficulties in postponing water usage in some situations, making the individual feel forced to use water at times when the price would be higher.

P1: ...For me at least, it feels okay that companies would pay a different amount of money at different times of the day. But as an individual, it might not feel as good. It would feel bad as an individual because you might...

P2: You would feel forced to use it (water) when you have to.

P1: You don’t want to be exposed to competition like that as an individual on that market.

P4: You are used to not being that, it wouldn’t feel that good.

While discussing systems that tried to encourage load shifting from peak hours, the participants also imagined a system that connected thousands of devices from different households. The devices would communicate with each other and try to prevent all the householders from e.g. using their washing machines at the same time. As expressed by P1, there is nothing that stops a system like this from being developed. But apart from running the risk of exposing the users, a system like this also requires the existence of smart devices in the households. And the citizens might not be that interested in in purchasing them.

P1: ...you don’t want to feel exposed. That is like alpha and omega. But basically, it is, in the long run, nothing that stops you from making different apparatus to communicate like that. But it is also like, you maybe... I don’t know, to me it is like, maybe you don’t want to have... maybe I don’t want to buy a smart toilet?

Privacy

At first, the participants seemed unsure as of why the water providers would want to collect the data. Concerns were raised whether the data would leak to other authorities, or if the water providers would sell it to interested parties. This was highlighted through an example given by P4, who imagined that the usual times the participant went to the restroom would be monitored, sold and used for commercial purposes.

P4: ...about the same time as you are starting to plan to go to the toilet, you get a lot of toilet related commercials, because they think that “this is the time he is susceptible”.

The frequency the data would be shared or read also seemed to be a concern for all the participants, as a higher frequency would make them feel more exposed in their actions. There also seemed to be a difference in the acceptance towards the monitoring of domestic water usage data depending on the data’s level of detail. While the participants seemed to be
more supportive of a system that monitors the overall domestic water usage of a household than of a system that monitors every individual use of domestic water, P2, P4 and P5 also pointed out how a shift from private to open data could problematize apartments and individuals with a greater water demand. As expressed by P5, the more open data becomes, the more exposed the individual.

P5: But I am thinking, that when you go from open to private... as soon as it gets more open, then you... your higher consumption becomes a problem. Or at least it stands out.

However, all the participants seemed to agree that it was reasonable for the water provider to collect data to a certain extent, if that data was used to make the services better. But as expressed by P1 and P3, there seemed to be a strong desire for the data to be anonymous and a need for a clear agreement of data usage.

P1: For me, the important thing... the important thing, like, what would feel good is that you... That they don’t... I mean, it is okay that they are tracking data, but I would prefer if they disconnected your name in that process. That would feel better.

P3: It would feel better if there was a clear agreement that says like “this is what we are using the data for.” And if they use it, then maybe they should use it for analysing purposes. It could be that kind of... But then, if they look at how often you flush the toilet. That would feel a bit... not nice.

One thing that seemed to give cause for the participants desire for anonymity was the fear of being singled out. One of the ways this expressed itself was when the participants imagined a situation where a whole apartment building would be tracked together. The participants imagined that everyone in the building could see how much water each apartment was using and what apartments were above or below the recommendations. The participants did not seem fond of the idea and highlighted how a scenario like this could lead to a situation where you reported your neighbour. Another way the fear of being singled out expressed itself was through a discussion between P1 and P4, where they imagined a situation where someone at Stockholm Water and Waste would monitor their domestic water habits. Taking a stance in the desire to be anonymous, this discussion highlighted how the very knowledge of being monitored could be problematic in itself.

P1: ...you don’t want some dude at the water service to be like “oh, he is doing the dishes again”. You kinda want it to be anonymous, right?

P4: Yeah, and some people are very anxious whether they have it tidy enough or if they have cleaned enough. If you are, it might feel a bit extra disturbing to know that someone can keep track of how often you use the dishwasher or something.

P1: But also, to know that they are portrayed as environmental bad guys if they run their dishwasher at 18:pm (peak hour) and it is documented, and they know that someone can see it. Like, they know that it is me doing it.

Another thing that seemed to be a basis for anonymity was the desire to be perceived as having a normal behaviour, which was a recurring issue during both the preparatory phase and the exploratory phase. When the cultural probes were handed out, P5 explicitly expressed a need to shower more so that the other participants would not think they showered too infrequently. P3 also reported that they did not want others to know how often they washed their hair, with the motivation of “I do it too seldom”. However, the participants pointed out that they did not mind if others knew how often they performed actions they perceived to be at normal intervals, like washing their faces or brushing their teeth. While this indicated that data related to hygiene could be sensitive to share, some actions were considered more personal than others. P2, for example, expressed that they felt uneasy towards documenting certain actions associated with privacy (e.g. toilet usage) and P3 and P4 choose to not document them at all. But while the participants considered actions like going to the toilet more personal, they pointed out that just documenting the action of flushing the toilet rather than what the toilet had been used for would make the documentation less personal and more acceptable. However, P2 also highlighted that more neutral actions, like using the faucet, could prove to be problematic if they were performed in quantities that was experienced as deviating from the norm.

P2: ...it felt like some activities became abundant. It started to feel shameful to log them after a while. I sometimes avoided using the faucet, just so I didn’t have to log it.

Services, Quality and Design

One topic that surfaced during the workshops was how the current design of water services conflicted with the desire to lower the load on the infrastructure. While some participants choose to not document certain situations when using the cultural probe, all of them said that using it had helped them to reflect on their domestic water usage. The participants said that they had realized that they used tap water for a lot of things, but also that the poor design and quality of water faucets and showerheads enforces a leave the tap running-behaviour. P1 and P5 had for example identified that they often let the tap run until the water was considered cold enough to drink and how hard it was to keep the water at a steady temperature.

P5: It is hard to keep the temperature steady. It becomes boiling hot and you have to lower it.

P1: It is the same thing with the shower as well, but that is more like a fault with the shower. The faucet is crappy.

During a discussion of the current infrastructure, the participants also highlighted two specific situations where the current paradigm in Stockholm enforces domestic water
usage within specific time frames and peak hours, rather than trying to shift the load to off hours. The two situations were when using a shared utility room and when taking a shower. Shared utility rooms are a common occurrence in apartment buildings in Stockholm, where the householders can book shared washing machines during specific hours. The issue the participants pointed out with these shared utility rooms was that they were unable to book a time later than 6–9pm. The issue the participants pointed out with taking a shower was how some people might not be allowed to shower after a certain hour, due to the rules of conduct in their apartment contracts.

P1: You are not allowed to like, run the washing machine or shower after 10pm in most places. If you read your contract, that is.

P4: That is strange, because I don’t think it makes a lot of noise.

P3: But I think it is the same, we have shared utility room. I don’t think anyone cares about that, it is like isolated.

P1: Yeah, but you still can’t book hours after 9:pm.

P4: I think that is really strange.

P5: I have not seen any of utility rooms you can book after 10pm.

P1: Mine is not after 10pm either. Or maybe even 9:pm.

P5: But that is the time you usually want it. It is a win/win if you can book your laundry to 12:am.

While the social construct of when we should perform certain tasks was identified to reinforce domestic water usage during peak hours, P2 imagined that it just as well could relieve stress on the infrastructure by simply not allowing people to use specific services during certain hours.

P2: I guess what you could do is that you could like, when it comes to utility rooms, is that you just can’t book times at peak hours. You can book until that time, but not that time. I guess that would be regarded as a bit strange by people, but at the same time, they have... well, there are some places in Japan where the 4th floor doesn’t exist because it is the number of death.

DISCUSSION
Tackling a stance in the observation that persuasive strategies tends to overlook what people actually do in their homes [26], this study is based on the conception that we should aim to understand the sociocultural landscape new technologies will exist in before we design and implement them. As such, this study has tried to broaden our understanding of possible concerns and expectations citizens might have towards future smart systems that manages domestic water services. While some consider smart systems and persuasive strategies a natural part of the future of urban development, this study shows that these approaches run the risk of problematizing their target audience if they are not used with caution. This study also shows that these approaches not necessarily are something the citizens neither want or need, and that they might be more interested in negotiating the designs of already existing services than their everyday practices.

Problematizing Citizens
Studies show how smart systems and persuasive strategies are full of assumptions of how we live and inherently tend to assume a normal way of life based on the designer’s own conception of our everyday practices [26] [6] [2]. What constitutes as a sustainable behaviour can therefore be argued to be defined and determined by the designers of these systems, as the designers ultimately are entrusted with the responsibility to decide what constitutes as an appropriate way of life. While smart systems and eco-feedback technologies might expect and promote a certain way of living, this way of living might not correspond to the different realities of the citizens using them.

A Desire to be “Normal”
The participants of this study expressed a strong desire to be perceived as having a normal behaviour and consumption pattern. As data moves from private to public, a higher consumption of water runs the risk of becoming a problem or standing out. Taking the participants of this studies reluctance towards monitoring individual data into consideration, a smart system for managing domestic water services would preferably, at the highest level of detail, look upon a household level. But the problem then arises that households are made up of different numbers of people, living different lives. Deciding that “this is an acceptable amount of water usage per household” or a “normal” behaviour will then automatically problematize households with a greater water demand, while at the same time run the risk of promoting an even greater water consumption for households with a lower water demand.

Reinforcing Anxiety
While dynamic pricing models and approaches like In House Displays have proven to slightly reduce both energy and domestic water usage on a short-term basis [5], this study shows that the target audience of these persuasive strategies might find them both imposing on their personal space and outright unpleasant. As expressed by the study participants, some water demanding activities are preferably not postponed until later. For example: you want to drink water when you are thirsty, you want to take a shower when you are sweaty, and you want to flush the toilet after using it. The need for using water in certain situations will remain even during peak hours, and persuasive strategies can cause citizens to feel forced to use the service even though they know that it is not recommended. If not handled carefully, persuasive strategies could also reinforce feelings of guilt and anxiety related to climate change, which according to a survey conducted by Cint on behalf of WWF in 2013 is already reported to be experienced to some degree by 78% of the populace in Sweden [32]. While this might seem far-fetched at a first glance, Simm et al. have arrived at a similar conclusion and highlights the importance of designing...
feedback systems that does not problematize and blame individuals [22]. This reinforced eco-related guilt is also reported in an evaluation on water and energy consumption feedback, where one participant’s daughter was described as having a panic attack when the eco-feedback switched from green (reasonable consumption) to red (over-consumption) [25].

Learnings of Future Smart Systems Managing Domestic Water Services
This study shows a reluctance towards the notion of being monitored, concerns regarding data privacy and how tensions can arise from having your everyday practices negotiated by a system. Based on the findings of this study, it would not be recommended to implement persuasive strategies that provide feedback on water consumption or dynamic pricing models before a solution to the accompanying problematizing of citizens is presented. However, as highlighted by the study participants, monitoring data to a certain degree is considered okay, assuming that the data is used to remain anonymous and that there is a clear agreement regarding the usage of the data.

The results of this study indicate that the design of a smart system trying to negotiate everyday practices of domestic water usage should be wary of negotiating actions with a here-and-now demand, like drinking a glass of water, flushing the toilet or taking a shower. The study participants also expressed a greater acceptance towards smart systems that tried to negotiate or manage actions that were already run by machines, e.g. dishwashers and washing machines. However, as made clear by the study participants’ desire for the option to manually override these smart systems, there is a want for manual control. A smart system managing domestic water services could therefore potentially be more successful and better received if it took on a supportive role that tried to empower the user’s actions by e.g. suggesting to run machines or services that are already considered more automatic at appropriate times.

Negotiating Services
If we look at cities as ecosystems, it means that the inputs equal the outputs. The best way to reduce a city’s output of negative environmental effects and consumption would therefore be to reduce its inputs [12]. It has also been argued that persuasive sustainability is a modernist perspective that proposes technical solutions to social problems [2]. As shown by the inventive mindset of the participants of this study, citizens might rather negotiate the current infrastructure than having smart systems negotiate their everyday lives. In other words, it would perhaps be more reasonable to investigate ways of negotiating modern society and what is considered normal, rather than the current focus on directly negotiating the everyday practices of the populace. An interesting finding in this study was for example how the rules of conduct for apartments in Stockholm efficiently can enforce the domestic water usage during certain hours. This became apparent in a discussion where the study participants explicitly expressed that they were not allowed by contract to shower at late hours or use the utility rooms after 9pm. The peak hours of domestic water usage are approximately between 6-8pm, when people get home from work or activities. This is also when they often take a shower, do the dishes, laundry and cook dinner. Another modern issue addressed by the participants in this study was how the poor quality of water faucets made them keep the tap running a long time just to get the temperature right. As of today, the amount of water used by faucets in Sweden is not tracked, but a report from the Water Research Foundation show that around 19% of the residential end uses of water in the U.S comes from faucets [30]. If these numbers are somewhat transferable to Sweden, it might be worth investigating how improvements in the design, quality and performance of already existing water services might help reduce the domestic water usage. Perhaps some of the activities we use domestic water for today could do just as well without using water at all or be redesigned to offer a more sustainable solution without negotiating the citizens everyday practices. Taking the smart toilet discussed by the study participants as an example, water could be stored in a small tank that is emptied and refilled at preferable hours by a smart system. And maybe those are the kinds of smart systems we should be investigating when it comes to domestic water usage. It could also be worth investigating whether domestic water usage could shift load from peak hours by allowing the citizens to e.g. shower and do the laundry at later hours.

CONCLUSION
By using an explorative approach where the study participants were encouraged to freely share their thoughts of future smart systems managing domestic water services, this study have explored concerns and expectations citizens might have of these systems.

While smart systems and persuasive strategies can look like an alluring path to more sustainable lifestyles, this study shows that there are many problems that needs to be solved along the way. Apart from issues with privacy and control, smart systems and persuasive strategies also run the risk of problematizing individuals and reinforce anxiety related to climate change. As there is a strong desire to be perceived as having a normal behaviour, the very act of monitoring domestic water usage could become problematic and even encourage citizens to use more water. If we are to approach smart systems and persuasive strategies, it is therefore of great importance to take the different realities of the end users into consideration, before we design and implement them. But we should also ask ourselves whether these approaches are something the end users want to be a part of at all, as this study shows that citizens rather would negotiate and improve the current services and infrastructure than having technology negotiate their everyday practices.

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