DREAMS OR NIGHTMARES?
CONSUMERS' REACTIONS TO HOME ENERGY AUTOMATION

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Abstract
Smart meters are paving the way for a smarter future where automated appliances and intelligent energy systems present ample opportunities for effortless energy efficiency. In this view of the future, smart self-learning systems will optimize a home's heating, switch off forgotten devices, and schedule high demand consumption for low demand periods. However, to ensure that such a smart vision can become a smart reality, it is vital to understand potential future customers' reaction to 'smart automation' scenarios as a guide to their design, implementation and marketing. Accordingly, in the following paper I will present survey and focus group data that investigates the issues surrounding automation and identifies consumers' dreams and nightmares with respect to the "smarter" future. The data suggests that underlying these dreams and nightmares are factors related to the pursuit of subjective well-being through the satiation of some core fundamental human needs: autonomy, competence, and relatedness.

1. INTRODUCTION

The roll out of smart meters provide the necessary infrastructure needed for the future development of all things 'smart' – smart grids, smart appliances, and smart home energy management services (DECC, 2014, 2015). In this smart vision or "ultimate desired state" of the future (Strengers, 2013), automation offers consumers the chance to optimize their homes heating, switch off forgotten appliances, and to ensure that high demand consumption activities occur during low demand periods. Aside from offering consumers effortless energy efficiency, promises of automated energy reduction and in particular the prospect of load shifting is likely to bring significant environment and socio-economic benefits through alleviating the need for network reinforcement costs (Darby, 2010). Consequently, the future development of a smart grid is noted in the UK government's impact assessment report as one of the key benefits of the smart-meter roll out for the domestic and small and medium non-domestic sector (DECC, 2015). However, before such a smart vision of automated and effortless energy efficiency can become a smart reality, it is necessary to understand what is needed to secure consumer acceptances of home energy automation.

Accordingly, in this paper I examine a construct that I propose is key in influencing acceptance of home energy automation -- happiness. While there are many operationalisations of happiness, in the present paper I focus on subjective well-being, which is defined as the extent to which people themselves experience their lives as "good" (Brock, 1993). I propose that in looking through the lens of happiness, we can usefully highlight key facets that should be considered in the design and marketing of home energy automation.

1.1. The Happiness Rationale

To date only a handful of studies have considered happiness in the context of home energy management systems (HEMS; Buchanan et al., 2015; Peleneur & Cruickshank, 2013). In the present paper, the rationale for focusing on happiness is two-fold.

First, with estimates that by 2020 there will be up to 26 connected devices for each person on the planet (all 8 billion of us), the increasing prevalence of technology means there is a real need for it to enhance rather than diminish the experience of our everyday lives (Rubens, 2015). After all, the old adage is that we are fundamentally wired to seek pleasure and to avoid pain (Ryan & Deci, 2001), so a product, regardless of how automated it is or not, that is anticipated or experienced as a nightmare rather than a dream is likely to result in low adoption rates in the first instance, and frustration and rejection in the second instance (Liao et al., 2015). Indeed, consumers themselves have recognised the importance of considering how happiness may be affected by new offerings in domestic energy management. Specifically, interviewees in a study examining acceptance of smart home technologies commented that if mass adoption is to occur then householders must be convinced that they will have a positive impact on their general well-being (Balta-Ozkan et al., 2014).

Second, focusing on happiness expands the limited repertoire of motives often

considered by those marketing home-energy management systems, where the dominant paradigm is often to target either financial and/or environmental motives (Buchanan et al., 2015). While, some consumers may indeed be motivated to adopt HEMS due to a desire to reduce their bills or carbon emissions (e.g., Buchanan et al., 2014; Hargreaves et al., 2010), for those who lack these motives there must be another "pull" -- and what better pull than a product or concept that targets those warm and fuzzy feelings associated with higher well-being?

1.2. Introducing the framework: Basic psychological needs theory

In this paper I adopt the framework provided by the basic psychological needs theory (Ryan & Deci, 2002) which contends that happiness is more likely to occur when the three innate and universal needs are satiated. These three needs are *autonomy* (feelings of personal agency and volition), *competence* (feelings of effectiveness and capability), and *relatedness* (feelings of connecting with others, belonging and social acceptance). This theory has been widely investigated across a diverse range of cultures and there is considerable empirical data that supports the hypothesis that these universal psychological needs must be satisfied to promote psychological well-being (Deci & Ryan, 2008). However, to the best of my knowledge, these three needs have not previously been examined in relation to consumer engagement with technology or home energy management systems.

In the present paper using three sources of pre-existing qualitative data, I aim to demonstrate that consumer acceptance of existing and prospective home energy automation systems is largely dictated by the extent to which these systems fulfil, as opposed to thwart, the three needs required for happiness – autonomy, competence and relatedness.

2. ILLUSTRATING THE THREE NEEDS IN CONSUMERS CONSIDERATION OF PROPOSED HOME ENERGY AUTOMATION SYSTEMS

The present paper makes use of three pre-existing sources of qualitative data:

(i) Written comments in response to a survey administered to gauge consumer appeal of a prospective home energy management system including the automated execution of un-used appliances.

(ii) Focus group data gathered to gauge consumer appetite for home energy management concepts including a system that automates appliance use and load shifting, akin to direct load control but with the option of choosing when to opt-in or out of automation using some controls.

2.1 Description of the data sources and samples

2.1.1 Written comments to concepts following survey participation

In August 2013, an online survey was administered to a convenience sample of 179 participants (51% female, ages 16 to 61, Mean age = 29.95, SD = 11.16) to gauge

householders' receptiveness to the key features of a prospective home energy management system developed by a university led project, known as project DANCER (Digital Agent Networking for Customer Energy Reduction). Consumers were introduced to several energy management suggestions and asked to rate the appeal of each concept using a Likert scale before providing further comments explaining the reason for their rating. In the present paper, I address only comments relating to the feature of the DANCER system that enabled unused household appliances to be automatically turned off. This was described to participants as follows: *"One way in which the system we are developing could reduce household energy use is by using automation. The system could use radar technology to detect which room(s) occupants are in and turn off the appliances that no-one is actively using. E.g., all occupants might be downstairs but an appliance might be switched on upstairs. The system would automatically turn this appliance off."*

2.1.2 Focus group data

In October 2012, the Centre for Sustainable Energy conducted deliberative focus groups to gauge consumer responses to smart meters and three concepts for smart meter enabled services. In total four focus groups were conducted. Each group was segmented by age and socio-economic data and was comprised of 8 participants (see further details in Buchanan et al., 2016).

In this paper, I only present data related to the smart meter enabled service concept of automation. The automation concept was based on the idea of automated electrical household appliances and is comparable to direct load control, where consumers allow energy suppliers control over their appliances and are rewarded for using them during off-peak intervals. Importantly, the concept included an "over-ride" option as the proposed system included an interactive display that allows consumers to choose from several levels of automation, i.e. from 'optimal' (full automation) to 'override' (least system control). The optimal end would effectively mean that if a consumer's energy is billed according to a demand side response tariff the system will save them money by reducing their usage at peak times.

3. ILLUSTRATING THE THREE NEEDS IN CONSUMERS CONSIDERATION OF PROPOSED HOME ENERGY AUTOMATION SYSTEMS

3.1. The need for autonomy

From both data sources, there emerged a strong sense that consumers valued autonomy in ideas of home energy management automation. Indeed, this was evident in both the focus group data and survey comments people outlined a need to provide input about which appliances were controlled and when (SC_ID45: "*There should be an option to "not turn off under any circumstances" for some appliances, such as laptops*", FG_1: "*Can you individualise the things that you want like optimal and over ride? I wouldn't want my fridge freezer being on optimal. My telly could be but I wouldn't want my fridge on that.*"). Any

perceptions that automation could violate their autonomy prompted negativity towards the proposed concepts (SC_ID172: "*if they [my appliances] were turned off by an external method that could be a nightmare – I feel it would take away my independence*", FG1: "*Are you saying that…without your consent they'll be able to do things?*", SC_ID88 "*I would prefer to be in control of my own toaster!*"). In particular participants voiced objections to concepts of automation when they felt they may prevent them from deciding how and when to use energy (e.g., FG4 "*But if I set it to... and they decided that I didn't need mine set to 18, and they'd override it and set it lower, I'd come home to a freezing cold house, and I'm asthmatic.*", FG3: "*I want to make a cup of tea when I want to make a cup of tea*".)

This intense need to retain autonomy in order to accept the prospective home automation system is perhaps best illustrated by the astute yet ironic comment that, "*I think it's a good idea. You have control, I mean you might not have control at that minute, because you've chosen not to have control, but it's still up to you*" (FG1). Such a quote clearly demonstrates the need for householders to retain autonomy - even when relinquishing autonomy! Moreover, ultimately, acceptance of the proposed automated concepts in both data sets was increased by the ability to over-ride the system (e.g., FG2: "*I'd be comfortable with that 'cause I have the control, I can override it if I want to*", SC_ID61: "*Should be able to adjust the settings so if you need to leave appliances on whilst you are out of the house or room you are able to do so*").

3.2. The need for competence

Given the function of home energy automation to manage energy on the behalf of consumers, it is imperative that the system facilitates rather than violates feelings of competence for householders trying to effortlessly manage their energy. Indeed, participants themselves were quick to point out that it was imperative that the system was competent. E.g., SC_ID88: "*This system sounds as if it would make life more complicated and be yet another thing to go wrong*", FG1: "*you're trusting this being an automated system, you're trusting it to get it right*". FG2: "*I'm still sceptical until…they have some sort of study because we're not sure whether it'll work*".

In order to satiate competence needs it was important for consumers to feel as though they had an understanding of how the proposed automated system would work (FG2: "*I think the issue for me would be to make it simple so that people do have an understanding*") and that they would be capable of operating it (e.g., SC_ID90: "*New technology is good when people have a good understanding of how it works*", FG4: "*With every passing year people are just more technologically able... In the end everyone will be able to do it*", FG3: "*I think you'd find your way around it and find what worked for you, get more confident as time went on*").

Competence needs also appeared to be fulfilled when consumers imagined that the automated system would succeed in effortlessly managing their energy for them, and in a superior means to the way in which they would be able to (SC_ID159: *"Having automated*

switch off is a good idea as it allows you to take control of your energy usage", FG4: "*I think it's quite good for when you're not at home, holidays or at work…it'll kind of look after your house*").

When concepts of automation were perceived to violate householders' sense of competence then participants were more likely to reject it. There seemed to be two key ways in which this could happen. First, competence was threatened if the system disrupted occupants ability to successfully accomplish activities deemed necessary to the execution of life's daily business (SC_ID152: "*I wouldn't like computers/laptops/consoles automatically turned off as I might lose unsaved data*", FG3:"*Sometimes it's essential that you have a bath, something happens and you're absolutely filthy, you need it then, you can't wait an hour!").* Second, competence was also challenged when it was perceived that the system "trumped" householders own knowledge about how best to use energy efficiently in a way that worked for them ("*Have they thought about night workers or split shifts because it's not that easy is it…? It sounds easy but it's not.*" "*There are other practical ways to cut back on energy than this. For example, if you're getting a cup of tea half an hour previous to when you know you're going to put the kettle on, get a massive thermos, put hot water in it...*").

3.3. The need for relatedness

In weighing up the pros and cons of the proposed automated systems while participants did not necessarily consider how the system would enable or disable feelings of closeness to others, they nonetheless showed some consideration of how others they were close to may be impacted by the proposed systems ((E.g., SC_ID145: "*This is a great idea but my kids would hate it as they leave everything on but they'd soon learn to save their games files*").

Notions that the system could potentially cause harm or discomfort to loved ones were likely to act as barriers to acceptance of the proposed automation system (E.g., SC_ID66 "*One concern is that if there is a child/baby in a room asleep, would the gadget be able to pick up that they are there, and in turn prevent the baby monitor, nightlight and heating from being switched off?*", SC_ID91:"*I have small children…I would extremely dislike it if the heating/air conditioner switched off in the rooms they are sleeping in if the system did not pick that up).* Beyond their own immediate family unit participants also voiced concerns about how the more vulnerable members of society would cope given the required technological competencies that might be needed to operate and realise the benefits of automated home energy management (e.g., FG1*: What I'm saying is there's a bit of a worry about the elderly people that will be more locked out, will they be able to use it?*", FG4: "*My father-in-law and mother-in-law… they'd be phoning us saying we've got no electricity. Well, they wouldn't be phoning us, they'd be sitting there in the freezing cold".*)

When participants perceived that the system would allow for a greater number of people's needs to be met then they were more likely to respond positively to the concept of

automation (FG3: "*my girlfriend works from home, so she might need it, especially in the winter she might need four* [note: "flexible comfort" - akin to manual control with the smallest degree of automation]", FG3: "*Because everybody's different aren't they, everybody's got different kinds of need usage and stuff, so if you could customise it for each individual, I think it's a great idea*"."**)**.

People were also quick to observe how the levels of automation incorporated into the system shifted whose responsibility it was to effectively manage the task of energy efficiency (e.g., SC_ID46: "*At the moment the members of my family have the responsibility and habit of switching off appliances when they are out of the room.*"). Given the capacity for forgetfulness and human error, this shifting of responsibility could potentially improve relationships amongst household occupants through reducing the need for energy efficiency related nagging. Indeed, participants noted that automation may be particularly fruitful in situations where people may care about the desired end-state but are reluctant to engage in the process. E.g., "*I think it [automated appliance switch off] has the potential to change the behaviour of even those who do not care about energy usage in the context of environmental protection*".

In terms of relationships beyond the household, the automated concept proposed in the focus groups also had the potential to improve the relationship between consumers and energy suppliers through alleviating some of the mistrust towards energy providers (*What do the energy companies get out of this?*") by providing a service that both parties mutually benefited from (i.e., the supplier get to control when your energy is used and in return your energy costs are lower).

4. DISCUSSION

For the first time, the present paper considered how consumers' perceptions of automation in HEMS could be anticipated as dream or as a nightmare depending on whether the prospective system fulfilled, as opposed to violated, the three fundamental needs required for happiness– autonomy, competence, and relatedness. Using two sources of pre-existing qualitative data, some support was found for the notion that these three needs are important to consumer acceptance of prospective home energy automation systems.

4.1. Summary of findings

Autonomy emerged as a key consideration for consumers as householders were keen to retain some level of control over when and how they used their energy. In particular all were able to outline appliances and situations in which they would like/dislike automation to kick in. Moreover, acceptance of the system was far more likely when the proposed concept included an over-ride button as this enabled "final say" thus allowing them to be the masters/mistresses of their own domain.

Competence was also important to consumers both in terms of understanding and operating the proposed automated systems, but also in terms of the systems working in the intended way because householders would be "*trusting it to get it right*". There was some indication that the proposed systems should be able to manage occupants' energy use more effectively than they themselves could but should not undermine their ability to accomplish tasks necessary to day-to-day living.

Relatedness was also present in the data, though consumers were more likely to consider how others would be affected by the proposed automated systems, and how it might shift the dynamics of the responsibility for energy efficiency, than to explicitly consider how it would influence their relationships to each other. Automation was less likely to be accepted if it was deemed that the system would not cater for everyone, in particular those less technically capable, or engender the safety of or cause discomfort to close others.

4.2. Strengths and weaknesses

4.2.1 Application of a new framework

In applying a theoretical framework previously not utilized in the context of consumer acceptance of automated HEMS, this paper went where other research has not gone before. However, novelty for novelty's sake is rarely commendable and it is worth considering to what extent application of this framework advanced existing understanding in this area.

In terms of leading to new insights, these findings that the system must enable a sense of autonomy and competence are perhaps not that surprising. After all, the findings regarding autonomy are largely consistent with existing research which has found that this idea of autonomy or control emerges as a key theme within consumers discussions of acceptance of smart appliances, direct load control and/or time-of-use tariffs (e.g., Darby & Piscia, 2013; Fell et al., 2014; Lopes et al., 2014; Krishnamurti etl al., 2012; Mert et al., 2008; Patez et al., 2012; Rodden et al., 2013). Similarly, it is perhaps obvious to reveal that consumers want to manage their own environment effectively and that any system should help rather than hinder them in achieving this. However, it seems to be less obvious that consumers acceptance of home-automation will be influenced not only by how it affects them but also by how it may affect others, and not just those in their immediate occupancy. Thus while the framework replicates previous findings and articulates some obvious although sometimes overlooked necessities, it also highlights other facets perhaps not previously considered. Moreover, regardless of novelty of these insights it is not always evident that they have been incorporated into the design and marketing of automated home energy management systems.

4.2.2 Research approach

The present research can be critiqued for "cherry picking" from existing data to support the hypothesis as no attempt was made to find disconfirming evidence or to ensure that interpretations were strictly grounded in the data. E.g., in the relatedness section I alluded

to the possibility that an automated system may improve occupants' relationships due to a decrease in energy efficiency related nagging – I have no data that directly supports this so it is a somewhat speculative proposition rather than a definitive reality.

The use of qualitative data also makes it difficult to determine the links between the three factors in the context of home energy automation. Empirical data shows that when assessed using self-report questionnaires the three needs are related to each other and are significant predictors of well-being. However, while there is some indication that consumers responded more favourably to the automation concepts when they fulfilled rather than violated the posited needs, it is difficult to say this with certainty. Moreover, both the survey and focus group only presented consumers with a concept of home energy automation rather than allowing them to experience a system for themselves. Therefore there is only support for the idea that autonomy, competence, and relatedness are in principle important in consumer acceptance of home-energy automation. This is because the imagined reality and the actual reality may likely differ.

5. CONCLUSION

Overall, the present data found some support for the notion that the three basic needs required for higher levels of subjective well-being may be present in people's consideration of automated home energy management systems. However, further research is needed to establish this more convincingly. Still, there may nonetheless be merit in considering consumers well-being and in particular their needs for autonomy, competence, and relatedness in the design, development, and marketing of prospective home energy management systems.

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