Controllable, frightening, or fun? Exploring the gendered dynamics of smart home technology preferences in the United Kingdom

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Abstract: The use of interconnected digital technologies and data offer new and perhaps profound opportunities across the world, whilst holding promises to enhance productivity growth and improved citizen wellbeing. In this research, we explore how people perceive the opportunities and drawbacks of smart homes and smart home technologies via the lens of gender. The study aims to identify what factors shape differing gendered perceptions and the implications this has for future sustainability and technological design. We address these issues through a rigorous mixed methods research design including a nationally representative survey in the United Kingdom (n=1,032) as well as three focus groups in London, Manchester, and Surrey (n=18 respondents). We identify the gendered nature of smart homes inductively across five different dimensions: (1) knowledge, awareness, and adoption patterns; (2) housekeeping and daily domestic life; (3) environmental sustainability; (4) trust and risk tolerance; and (5) emotions and feelings. We conclude with policy implications as well as how these findings point the way towards future research.

Keywords: Gender and technology; smart homes; feminism; privacy; vulnerability

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1. Introduction

The world is becoming increasingly connected and digitized. Internet use has experienced significant growth since the development of the World Wide Web in 1990 [1]. As such, broadband infrastructures are now installed in more than 104 countries with over 4.33 billion active users –56% of the global population—[2], including at least 80% of the world’s youth (15-24 years old) [3]. Digitization is also reshaping economic and financial landscapes, creating new opportunities and challenges not only for consumers, but also new business firms, service providers and regulators [4]. Digital technologies are now present in almost everything we do in the industrialized society, enabling environments in which on-demand services can thrive, from getting your groceries delivered to your house to finding a date through an app, to more challenging tasks such as monitoring the health of users [6-7], better managing household energy flows [7], [8] to coordinating the actions of “smart cities” [10-11, 16–18].

The relevance of smart home technologies is also recognized in international market trends, with Jungwoo et al. estimating that these technologies had diffused to 7.5% of households globally and generated expected revenues of $44.2 billion in 2018 [11]. The consulting firm McKinsey [12] and Deloitte have both reported double digit growth rates for smart and digital technologies year to year [13]. This is perhaps why the International Monetary Fund (IMF) remarked that digitalization “has the power to continually transform itself, progressively branching out and boosting productivity across all sectors and industries [15 p. 6]”. The same report indicates that this digital transformation is rare and only three other technologies earned this distinction: the steam engine, the electricity generator and the printing press.

Given the wide and rapid development of the digital transformation, it is important to consider its potential societal impact and how it may be perceived by and impact certain users. One particularly important, but we would argue is a neglected topic is smart homes and gender1. For instance, Trencher notes that digitalisation has prioritized corporate and economic interests rather than social equality and the enhancement of personal experiences [19-20]. One

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1 In this research, we consider the term gender as a concept consisting of four facets: “physiological/bodily aspects, self-defined gender identity, legal gender and gender expression (including social norms related to appearance and behaviour) (Lindqvist, Sendén and Renström, 2020 p. 10)”. While we acknowledge that there can be more than two genders, in this paper we focus mainly on the two most commonly referred to, i.e. women and men.
implication of this could be that, given the historically overly male technology industry, digital transformation is ultimately a gendered process. A similar perspective is shared by Gallie and colleagues [17], when they note that the digitalization era as a whole has benefited a few political and economic groups (i.e., mainly men) and neglected others (i.e., mainly women). In consequence, some segregated and vulnerable women could be victims of invasion of privacy, denial of services and destruction of property [18]. Other critiques have emerged in regards to the ‘smart technology agenda’, and the fact that its vision and creators have overwhelmingly been male [19]. On the same vein, Hansen and Darby [20] indicate that smart technologies tend to focus on a ‘masculine ideal consumer’, suggesting that more consideration of the gendered roles in everyday life is necessary for a successful transition to a future of smart homes.

In most societies, what happens inside of homes is often culturally determined by gender [21]. In addition, research suggests that when the adoption and use of smart home technologies is approached, homes are usually studied as a neutral, sterile and bland place, rather than a complex space of relationships [25-26]. We argue that household dynamics should be further explored, as homes are one of the most gendered spaces [24]. Along these lines, we agree with Dankwa [23], that considering the gender dimension and the ever changing notions of family and household dynamics in research ought to allow for a more in-depth understanding of how needs, behaviour and attitudes are gendered. At the same time, this should enhance the societal relevance of knowledge [25], providing a better understanding of the use, adoption, services and markets linked to smart home technologies.

In this study, we explore how people perceive the opportunities and drawbacks of smart homes and smart home technologies via the lens of gender [30]. We ask: what factors shape differing perceptions across gender? Critically, what implications does this have for future sustainability as well as technological design? We answer these questions through a rigorous mixed methods research design including a nationally representative survey in the United Kingdom (UK) (n=1,032) as well as focus groups in London, Manchester, and Surrey (n=18 respondents). We identify the gender aspects related to smart homes across five different dimensions: (1) knowledge, awareness, and adoption patterns; (2) housekeeping and daily domestic life; (3) environmental sustainability; (4) trust and risk tolerance; and (5) emotions and feelings. We conclude with policy implications as well as how these findings point the way towards future research.
2. Digitalization and gender: A literature review

To offer background and context to our analysis and study results, we first provide a summary of previous literature relevant to our research. This includes studies on the gender divide in the digitalization era, issues around gender bias in the digital economy, as well as previous research on SHTs, gender, and drivers for smart home adoption.

2.1 A gender divide in the digitalization era

Around 4.1 billion people have access to the internet, however, connectivity is not equally distributed [26]. Globally, on average, 52% of women remain offline, compared to 42% of men [27]. This is a more evident issue in the least developed countries, where a third of women are less likely to have internet access compared to men [28]. Corroborating this, research shows that more than four in 10 rural households in OECD countries lack access to fast fixed broadband needed to support smart home technologies. In contrast, nearly nine in 10 households in urban areas have fast internet access [29]. In developing countries, lack of access to digital technologies in rural and urban contexts, however, is not limited to pure logistical and infrastructural obstacles [30] but also, lack of promotion for building women’s skills and confidence, along with lack of content designed for and by girls and women [31]. Others note that this situation is due to the absence of digital education opportunities for females [32] and the gender-enrooted social and psychological barriers that deter girls and women to use these services [36-38]. In this sense, Wajcman and colleagues [34] warn that the unequitable distribution of benefits resulting from the digitalization across high-, low- and middle-income countries constitute risks of perpetuating existing patterns of gender inequality. Kularski and Moller corroborate this view, and add that emerging technologies “might exacerbate inequality rather than ameliorate it [40 p.1 ]”

The gender divide in digitalization is also closely linked to the relatively small number of women, globally, in careers in the science, technology, engineering, and mathematics (STEM) fields, which stands at less than 30% [36]. In the UK context, for instance, only 23% of women constitute STEM’s workforce [37] and account for 15.8% of the UK’s current generation of engineering and technology undergraduates [38]. The absence of women in the technology world is not limited to their academic enrolment but also lack of opportunities to participate in the workforce. For example, the number of women the on boards of technology companies is below 20% [39] and only 16% of managers in the information technology industry are women [40]. It is under this context, that the International Telecommunication
Union (ITU), argues that until adequate access to information and communication technologies (ICT) is developed and granted for women and girls, their educational opportunities and access to labour markets will remain limited [41]. This unequal distribution could entail other social costs. For instance, Von Braun and colleagues, argue that inequitable distribution of technology and online resources means lack of access to crucial, transparent, and current information as well as lack of opportunities for distance learning and teleworking [42]. Iwata and Chen [43], moreover, argue that the lack of access to these technologies can endanger lives, giving an example of the consequences of limited access to real-time information, which can help improve real-time decision making, in the case of natural disasters such as typhoons and earthquakes.

This gender divide, and the wider skills gap between women and girls in the ICT sector, have led to a gender imbalance in the smart homes arena [44]. For instance, the National Smart Home Survey conducted in the USA found that men are more likely to own smart home devices (11.89 %) in comparison to women (9.63%) [45]. The same study reveals that men are more familiarized with smart home devices (19.88%) in contrast to women (11.89%) [45]. In addition, other research has found that men tend to also hold more positive attitudes towards technology use than women [46]. This may be explained by the culturally existing associations between masculinity and technological skills [47], and a perception about femininity as being ‘incompatible’ with technical pursuits [34]. This unequal dynamic can induce a number of negative outcomes: from the exclusion of using technology and perpetrating asymmetric household dynamics [48] to more disturbing outcomes, such as potential digitally enabled domestic violence towards women and girls [54–55].

2.2 Gender bias in the digital economy

The under representation of women and the male dominance in the tech industry prevails [56–58]. For instance, digital assistants such as Siri, Google Home and Alexa\(^2\) can entrench harmful gender biases since the default speech option of most of these voice assistants is female [54]. This can, in turn, send a signal that women are obliging, docile and keen-to-please commands; perpetuating negative gender stereotypes [55]. UNESCO explains that these dynamics occur since it ‘honours commands and responds to queries regardless of

\(^2\)Amazon Alexa, known as ‘Alexa’, is a virtual assistant developed by the online retailer Amazon. It is a voice-controlled system which enables services such as connecting to digital applications and platforms for streaming music, receiving news, extracting information and connecting to other devices.
their tone or hostility...this reinforces commonly held gender biases that women are subservient and tolerant of poor treatment [56 p.122]. UNESCO’s report I’d Blush if I could, in fact, coins the title after Amazon Alexa’s response to the phrase: ‘You’re a slut’. To this, Alexa replied: ‘well, thanks for the feedback’. Moreover, the study indicates that since most of artificial intelligence (AI) staff are male, ‘feminised digital assistants...greet verbal abuse with catch-me-if-you-can-filtration [56 p. 106]’. Siri and Alexa’s obsequiousness—and servility—thus illustrates how gender biases are prevalent in the technology industry itself, get coded into its products, and are present in digital skills education [56]. The subservience of digital voice assistants becomes particularly concerning when more than 5% of interactions with digital assistants are ‘unambiguously sexually explicit’ [57].

Although language processing has significantly improved in the last few years, its flawed performance towards women persists. Criado-Perez [58], for example, explains that as automated speech recognition is trained on large databases dominated by male voices, the algorithms are subsequently biased by design. Reflecting on this, Tatman [59] revealed that Google’s voice assistant was 70% more likely to accurately recognize male speech than female speech. One may question this trend in the voice recognition field, since its market value is expected to reach $80 billion by 2023 and around 50% for online searches will be through voice commands by the same year [60].

However, biases in the digital assistants’ sphere are not limited to gender but extend also to ethnicities. For instance, Koenecke et al., [61] show large ethnic disparities in the performance of the top five most commercial voice assistant systems. Making an urgent call to audit emerging machine-learning systems to ensure inclusiveness. Face recognition technologies have been shown to disadvantage women and people of African American and Latino decedents for example [58, 67, 68]. For instance, Buolamwini and Gebru [64] showed that these technologies have trouble identifying women’s faces and faces from ethnic minority groups, whereas facial recognition technology, when applied to white men, was shown to be right 99% of the time [64]. Other research showed that nearly 35% of images of darker skinned women presented errors [70-71].

Bias against women persists in the ‘apps world’ too. This has been shown for example, with Tinder, which is among the highest grossing dating apps generating more than $1.2 billion in revenues in 2019 [67]. Research by Duportail’s [68] has shown that Tinder machines operate using an algorithm which suggests younger, less educated and poorer
women to men; but the algorithm does not work the other way around. This research also showed that the app is ‘one-sided’, as it has mainly been designed by men for men. This bias is not surprising, given that two-thirds of the 4 million clients paying for Tinder Gold are men. Duportail thus suggests that Tinder is a meticulously assembled machine reproducing patriarchal dogma.

All these biases may be unsurprising given that, for example, in the UK, male entrepreneurs are 86% more likely to receive Venture Capital Funds and men are also 59% more likely to secure angel investment\(^3\) [69], while others have coined the coding culture of Silicon Valley a “Brotopia [70].” An explanation to this gender power relation is provided by Faulkner when she indicates that technologies are gendered by design and by association, where association refers not only to work environments but also to technology stereotypes. Therefore, most ‘gendered practices’ “mediate the digital revolution and the political and socio-economic roots of the networks that shape and deploy technological systems [34 p.5]”.

Although men’s control over women’s ICT remains [71], these dynamics are starting to change. There are more technologies designed by women for women, and more women pursuing advanced technology degrees, while ICT literacy differences between boys and girls are narrowing [72]. Surprisingly, more women in countries with low levels of gender equality --such as those in the Arab region-- possess the highest participation percentages of women pursuing advanced technology degrees. This unusual dynamic has been coined the ‘gender equality paradox’ [73]. Indeed, For UNESCO, this presents a paradox since generally, gender-equal countries are those that offer girls and women more equal empowerment and educational opportunities and more often, these countries promote girls’ and women’s engagement in STEM fields so as to close the gender divides breach [74].

### 2.3 Smart homes, gender, and demographic drivers for adoption

Smart technology is not only an instrument of continence or control; it is also an instrument through which gender norms or constructs can maintain, make, and question ideals of masculinity and femininity [75]. In this way, technology design, adoption, and domestication are therefore gendered practices and processes [76]. With the introduction of SHTs, developers and theorists have argued that what makes these technologies unique is the shift from technology-oriented design to user-oriented design. However, criticism has

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\(^3\) An angel investor is a high-net-worth individual that provides financial backing for small start-ups or entrepreneurs typically in exchange for ownership equity in the company.
emerged since users are rarely involved in the design process, and what seems to prevail are masculine hegemonic values in SHTs design [77]. Such dynamic may explain why SHT users have questioned purchasing devices in the first place and the overall performance of technologies, thinking at times that "nothing can be done to improve the use of technology [78]."

Regarding SHTs use and adoption more specifically, Baudier and colleagues note that smart home products can be targeted to specific users. For instance, their study found that perceived health beliefs significantly influence women's intention to use SHTs. In line with previous research [79], their findings reveal that SHTs' level of innovativeness primes towards a more positive attitude on "intention to use" for females compared to males [80]. Similarly, millennial females are consistently over-indexed for interest and smart-home technology usage. This group perceives SHTs – despite their high costs – as a good investment in the long-term. Technologies that appealed more to millennial females varied from smart locks and smart sound systems to smart heating and cooling systems [81]. Parag and Butbul corroborate such findings when they note that Israeli non-technophobic (i.e. those who do not fear or dislike advanced technology) women were more interested in adopting SHT than non-technophobic Israeli men. Their study also shows that there were more technophobic women than there were men. [82]. Others argue that SHTs are integrating into emancipated domestic settings to compensate for the everyday tasks women usually performed at home and as a mean of empowerment to express subjectivity and agency [83].

However, preferences and interests vary according to technology and gender. For instance, robotics is a field where design, preferences, and adoption have been male dominated [58], [84]. We center on this theme, since robotics appeared to be no longer confined to the industrial settings, but instead, have profoundly expanded to the households-domain [83] [85] [86]. Therefore, such devices sit well in the smart homes ecosystem. Regarding unmanned aerial vehicles, men buy 90% of civilian drones; some even indicate that “you never see such one-sided sales figures as you do with the drone industry [87].” This should take relevance since drones play a critical role in the military, health, and commercial industries [88].

Another market dominated by one gender (males) is that of sex robots, an industry currently valued at 30 billion USD and expected to be worth 50 billion USD by 2025 [89], where like drones, male customers comprise over 90% of their market [90]. This industry
appeared to be fully male-dominated until 2018 when a company started selling ‘male’ devices. Before that, only ‘female’ adult sexbots were developed [91]. These market dynamics are well illustrated by Strengers and Kennedy when they note that “women are understandably less enthusiastic about the penetration oriented characteristics of most current offerings [55 p. 9]”

Certainly, sexbots and speakers are dominated by female figures; nevertheless, ‘serious business’ robots are almost entirely male figures [92]. This, despite industry efforts to promote values of gender neutrality [93] and social equality [94] in the AI and robotics field. In line with consumer preferences, while some studies indicate that gender has no effect on the use and adoption of SHTs [95]–[97], others suggest the opposite. Smith [98], for example, has analyzed what types of marketing messages for smart speakers people find acceptable. Her study reveals, from a sample of a 110 undergraduate and graduate students at a US university, that males prefer to listen to messages about electronic products, whereas women would rather listen to marketing products about beauty and personal care. Their results also show that women are open to hearing promotions for home, and kitchen appliances, whereas males show no interest in these products. The roles are inverted regarding computers; males will listen to marketing computer messages, but females will not. These results may explain why industry sales figures indicate that men embrace smart home technology at much higher rates than women [99]; why men have more knowledge about SHTs [100]; and why men are often the initiators for bringing SHTs into the home and in charge of their operation [55].

Perri and colleagues, [101] explore through the theory of planned behavior what motivational factors induce SHT adoption and facilitate smart grid diffusion. Their results indicate that perceived behavioral control positively affects the adoption intention, and the most critical belief linked with attitude is energy savings. Working from the premise that gender has been considered the strongest predictor of behavior [102] [103], they suggest that marketing strategies and initiatives should focus on messages related to specific beliefs, such as the opportunities for energy savings and reducing electricity costs [101].

However, such an approach may vary according to culture. For instance, Micheals and Parag indicate that Israeli Jewish women are less interested in reducing their household energy consumption than males [104]. Their results seem to suggest that Israeli women value convenience more than energy savings. Thus, for this group, marketing messages for
adopting SHTs should target values of comfort and control rather than energy efficiency. Another approach to encourage SHTs adoption and achieve energy savings is presented by Aloise-Young et al., [105]. They note that SHTs’ best system is the one that is capable of mimicking occupant’s preferences with minimal inconvenience and discomfort. However, for the systems to deliver their promise on efficiency, users must be willing to cede control and autonomy, actions that could lead to discomfort. To find this delicate balance, they suggest that systems ought to be designed allowing users to override settings and device operations. Indeed, other studies suggest that users of SHT must always be allowed to perform tasks (i.e., time of use tariffs) when they are needed [8,24].

This collection of evidence all strongly suggests that gender plays a primary role, not a peripheral one, in patterns of SHT design, knowledge, adoption, and use.

3. Methods

To explore more deeply and specifically the possible connections between gender and smart homes, we collected two sources of primary data in the UK via a nationally representative survey (with quantitative and qualitative questions), and three focus groups.

3.1 National representative survey

Our survey instrument, uploaded as Appendix I, built on earlier work examining user perceptions of smart homes conducted by Hargreaves et al. [100] and Wilson et al. [107]. We wanted to build on this earlier work in particular because it also sought to explore the qualitative aspects of smart homes, including aspects of risks and preferences. We thus viewed it a research design that was “tried and tested”, validated already within the research community.

Our specific survey instrument was designed to take 10-15 minutes to complete, and it consisted of twenty questions across four sections. The first section explored the socioeconomic and demographic attributes of respondents. The second section investigated adoption patterns and knowledge of smart home technologies. The third section examined preferences in the technology as well as trust and perceived risks. The fourth had open-ended questions asking for respondents to share experiences about smart homes as well as their willingness to be contacted for future research. Most questions used a 5-point Likert Scale (1 = strongly disagree, 5 = strongly agree), with the survey implemented online by a market
research company, Dynata, using a respondent panel representative of the UK population. Dynata scripted an online version of the survey instrument using their proprietary software. Once checked by the research team, Dynata sent unique person-specific links to the survey to individuals in their respondent panel who have agreed previously to take part in survey research in exchange for incentives. The sampling frame consisted of various households, in the UK, who had to be over the age of at least 18 years old.

A total of 1198 respondents were screened out based on quality checks. These quality checks included “flat-liners,” straight-line responses on blocks of questions; “rushers,” those who gave incomplete, contradictory or unrealistic responses (e.g., the respondent who claimed to have 99 children and that who lived in a house with 60 people); and “speeders,” those who had unrealistically fast survey completion times. A total of n=166 respondents were filtered out for failing one or more of these quality checks. The final sample comprised n=1032 respondents, of which 515 identified as female and 517 as male (none of our respondents identified as other). The majority of our respondents had 2 people living at home (n=381), in owner-occupied homes (n=722) and no children (n=464). There was quite an even split between different ages, with slightly less representation in the younger 18-24 age group (107). Figure 1 shows some of the demographic details of our final sample, including gender, number of people living at the home, number of children living at the home, age, income, home ownership and region.

Figure 1: Demographic details of smart home technology survey respondents in the UK (n=1032)
3.2 Survey data analysis

We analyzed our survey data using IBM SPSS Statistics software to produce descriptive statistics on our quantitative survey data, which was supported by inductive thematic analysis of the qualitative data from focus groups and the survey (discussed below. We used Mann Whitney U non-parametric tests (this was used to compare two independent groups and is appropriate to use for ordinal variables e.g. Likert scale items) as well as Chi square tests (which is appropriate for testing binary variables). We followed guidance by
Field [108] and Nachar [109]. We also used Benjamini-Hochberg Procedure as a post-hoc test to control for false positives (e.g. Thissen, Steinberg and Steinberg [110])

3.3 Focus Groups: London, Greater Manchester and Surrey

To triangulate the findings from the survey, we also conducted three focus groups in the last quarter of 2019 across London (n=7), Greater Manchester (n=4), and Surrey (n=7). This included two urban locations (London and Manchester) and one rural (Surrey). The focus groups were organized and managed by a separate market research company, YouGov. The focus groups lasted between two and three hours, and involved a mix of different demographic respondents with the details summarized by Table 1. Again, participants identified as either male or female and no other genders. The focus groups followed a similar structure to the survey, examining general knowledge of smart home technologies, experience and usage patterns, perceived benefits and disadvantages, trust, and values. Even though they were recorded and fully transcribed by YouGov, at least one member of the research team observed all of the focus groups. The demographics of our focus group participants are shown in Table 1.

3.4 Focus group data analysis

We analyzed our focus group data inductively. At first, we read transcripts from all focus groups, identifying emerging common themes across the three groups. We also triangulated these findings with responses to our survey. These were then grouped in the following core themes: (1) knowledge, awareness and adoption; (2) housekeeping and daily domestic life; (3) environmental sustainability; (4) trust and risk tolerance; and (5) emotions and feelings. We report results from these fully in sections 4.1 to 4.5. To ensure anonymity, focus group participants are referred to in our results as follows: London male (FGLM), London female (FGLF); Manchester male (FGMM), Manchester female (FGMF); Surrey male (FGSM) and Surrey female (FGSF). The survey respondents are reported as male / female and respondent number (e.g. MXX, FXX).
Table 1: Demographic Attributes of Focus Groups in London, Manchester, and Surrey (n=18)

a. Focus Group 1 London (Urban)

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Social Grade</th>
<th>Gross household income</th>
<th>Smart devices owned</th>
<th>Current property</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Female</td>
<td>White and Black African</td>
<td>B</td>
<td>£60,000 to £69,999 per year</td>
<td>1</td>
<td>Rented from private landlord</td>
</tr>
<tr>
<td>21</td>
<td>Female</td>
<td>Chinese</td>
<td>C1</td>
<td>£10,000 to £14,999 per year</td>
<td>1</td>
<td>Rented from private landlord</td>
</tr>
<tr>
<td>24</td>
<td>Female</td>
<td>White and Asian</td>
<td>C1</td>
<td>£100,000 to £149,999 per year</td>
<td>1</td>
<td>Rented from private landlord</td>
</tr>
<tr>
<td>54</td>
<td>Female</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>E</td>
<td>Prefer not to answer</td>
<td>3</td>
<td>Buying leasehold/freehold on a mortgage</td>
</tr>
<tr>
<td>56</td>
<td>Male</td>
<td>Any other ethnic group</td>
<td>D</td>
<td>£20,000 to £24,999 per year</td>
<td>4</td>
<td>Buying leasehold/freehold on a mortgage</td>
</tr>
<tr>
<td>62</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>C1</td>
<td>£10,000 to £14,999 per year</td>
<td>1</td>
<td>It belongs to a Housing Association</td>
</tr>
<tr>
<td>73</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>A</td>
<td>£50,000 to £59,999 per year</td>
<td>3</td>
<td>Own the leasehold/freehold outright</td>
</tr>
</tbody>
</table>

b. Focus Group 2 Greater Manchester (Rural)

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Social Grade</th>
<th>Gross household income</th>
<th>Smart devices owned</th>
<th>Current property</th>
</tr>
</thead>
</table>

-16-
<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Social Grade</th>
<th>Gross household income</th>
<th>Smart devices owned</th>
<th>Current property</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>C1</td>
<td>£10,000 to £14,999 per year</td>
<td>1</td>
<td>Own the leasehold/freehold outright</td>
</tr>
<tr>
<td>65</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>B</td>
<td>£35,000 to £39,999 per year</td>
<td>4</td>
<td>Own the leasehold/freehold outright</td>
</tr>
<tr>
<td>73</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>C2</td>
<td>£45,000 to £49,999 per year</td>
<td>2</td>
<td>Own the leasehold/freehold outright</td>
</tr>
<tr>
<td>59</td>
<td>Female</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>B</td>
<td>Prefer not to answer</td>
<td>2</td>
<td>Own the leasehold/freehold outright</td>
</tr>
</tbody>
</table>

**c. Focus Group 3 Surrey (Rural)**

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Social Grade</th>
<th>Gross household income</th>
<th>Smart devices owned</th>
<th>Current property</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>B</td>
<td>£100,000 to £149,999 per year</td>
<td>5</td>
<td>Own the leasehold/freehold outright</td>
</tr>
<tr>
<td>29</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>A</td>
<td>Prefer not to answer</td>
<td>1</td>
<td>Rented from local authority</td>
</tr>
<tr>
<td>33</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>A</td>
<td>£70,000 to £99,999 per year</td>
<td>5</td>
<td>Rented from private landlord</td>
</tr>
<tr>
<td>40</td>
<td>Female</td>
<td>Any other Mixed / Multiple ethnic background</td>
<td>E</td>
<td>£35,000 to £39,999 per year</td>
<td>4</td>
<td>Own the leasehold/freehold outright</td>
</tr>
<tr>
<td>49</td>
<td>Female</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>B</td>
<td>Prefer not to answer</td>
<td>3</td>
<td>Buying leasehold/freehold on a mortgage</td>
</tr>
<tr>
<td>52</td>
<td>Male</td>
<td>Arab</td>
<td>B</td>
<td>£100,000 to £149,999 per year</td>
<td>2</td>
<td>Buying leasehold/freehold on a mortgage</td>
</tr>
<tr>
<td>----</td>
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<td>----------------------------------------</td>
</tr>
<tr>
<td>58</td>
<td>Male</td>
<td>English / Welsh / Scottish / Northern Irish / British</td>
<td>D</td>
<td>£20,000 to £24,999 per year</td>
<td>1</td>
<td>Own the leasehold/freehold outright</td>
</tr>
</tbody>
</table>
3.5 Limitations

We note that our study has some limitations, mainly the way our survey and focus group questions were designed, since most notably, these centered on the general risks and benefits of smart home technologies. Moreover, it is very likely that participants in our focus groups could have been biased due to the Hawthorne effect [111], that is, they behaved differently because they knew they were being observed by researchers. Thus, participants could have answered what we, the researchers, wanted to hear since they knew they were being observed. We also set out to make a largely empirical contribution.

4. Results and Discussion

The five core themes that emerged inductively from our survey and focus group materials were (1) knowledge, awareness and adoption; (2) housekeeping and daily domestic life; (3) environmental sustainability; (4) trust and risk tolerance; and (5) emotions and feelings. These themes were determined only after data collection was complete, and after the authoring team had multiple discussions about how to best structure our results. This makes our analysis “data-driven” and “grounded” in the results rather than predetermined by any pre-set theoretical framework.

4.1 Adoption, use and purposes of smart home technologies

Our results suggest that there was an association between gender and respondents saying who is most likely to use smart home technologies at home. Based on a Chi Square test, men were significantly more likely to say that they, themselves, use smart home technologies with 84.9% of male respondents compared to 71.7% of women ($X^2$ (1df) = 26.703 (p<.05) selecting this option. This association was minimal. Similarly, men were significantly less likely to say that their partner uses smart home technologies, with 63.8% of men compared to 56.5% of women ($X^2$ (1df) = 5.776 (p<.05). This association was weak. These results correspond with a female focus group participant who not only noted the dominant male role in the use of smart home technologies, but also, how their uptake was linked to income: “Males like my husband. He is the typical targeted customer and user as it’s somebody with disposable income [laughs]. Joking aside, he is always been an early adopter. I would say it’s a gadgety type person. So, he’s not necessarily somebody that’s looking for efficiencies or looking for savings but looking at technology itself.” (FGSF). A female participant corroborated the income aspect when she mentioned: “Users of these technologies are people with money”
(FGLF). However, another participant agreed that although he was the one who bought smart home equipment, it was his girlfriend who used it: “I buy it, she uses it” (FGSM).

Moreover, our results show, in Figure 2, that men responded higher for the main purpose of smart home technologies being to prioritize convenience (U=118410.5, z=-1.458, p =.145), manage home security and safety (U=121979, z=-.362, p =.718), as well as enhance communication (U=112888, z=-1.077, p =.282). While the difference between men and women was not statistically significant, participants in our focus groups echoed these findings when they mentioned: “Smart home technology is generally positive once you can get it working... As long as you’re willing to sacrifice a bit of privacy for a bit of convenience” (FGSM). Or a survey participant that commented: “Make everyday living a lot easier” (M885). On security, a participant stated: “Security cameras are quite useful. I live in a farm where you get many dodgy visitors” (FGSM).

Women responded higher to the purpose of smart home technologies being to control smart appliances (U=120659, z=-.509, p =.611), and manage energy and heat (U=118747, z=-.964, p =.335), as well as support assisted living or health (U=106063, z=-1.115, p =.265) (see Figure 3). This finding was not statistically significant. However, there was a statistically significant difference in women responding higher to smart home technologies’ main purpose being to control family members (U=97471.5, z=-2.990, p <.05).

Participants’ perceptions in our focus groups elaborated on the purpose of smart home technologies. For instance, FGSF stated: “if your home is not occupied 100% of the time, to have control of it remotely is a necessity nowadays. You know, to be able to nip in, have a quick look, have look at the front door, and have a look in the sitting room. It’s piece of mind”. On energy, a female participant from Surrey commented: “I think the biggest benefits are monitoring and efficiency. With Nest, for example, you’re meant to be more efficient in terms of energy. The same with Hue”. Whilst on the theme pertaining health and assisted living, a female participant from London stated: “My friend is paralyzed but he uses voice control for all sorts of things. It could definitely make a difference” (FGLF).

**Figure 2: Differences in mean scores for the “main purpose of smart home technologies” (Likert type response of 1 to 5, with 5 = strongly agree)**
Our results show that men responded higher to using smart home technologies compared to women, which may be a reflection from the overall lack of women participating in the digital arena. Research on this domain has indicated that females are 25% less likely than males to know how to leverage digital technology for basic purposes, four times less likely to program computers and thirteen times less likely to file for a technology patent [56]. Regarding technology use, women are less likely to know how to operate a smartphone, use social media, navigate the internet and understand how to protect digitalized information [112]. Lerman et al., [113] provide a tentative explanation to this dynamic. They argue that male domination in the tech space is a one-sided-coercive-process, where men not only control economic and institutional spaces but also control access to capital and capital-intensive production, leaving little space for women to participate in the tech arena.

Further literature supports our findings. For instance, Strengers and team [48] note that the uptake of smart home technologies has been lower than anticipated, but this low interest is more prominent among women. The low uptake, from the technical perspective has been attributed to interoperability and compatibility issues, price, usefulness and desirability. Another challenge identified and closer to the social domain, is that there has tended to be a technical “czar” (often a man) who brings smart technologies into the home [53, 86, 87]. This figure is usually responsible for setting up, maintaining and introducing technologies to other household members. Participants in our focus groups supported this idea when they mentioned (FGMM): “I do enjoy doing setting these things up... I sort all tech related things at home”. Or FGSM who commented that men will intrinsically desire such technologies: “I think the
new toys appeal to men. They really do. We love trinkets and things like that. Maybe it’s an old-fashioned view, but I genuinely believe that” (FGSM).

Research in this area helps corroborating our participants’ claims. For instance, Day [116] explains that in the smart homes dimension, “chivalry behaviors”–actions often carryout by men-- could mean providing technological support (e.g. setting up a smart security system) to have an opportunity to demonstrate their masculinity. Be the “technology czar”, thus, provides an opportunity for men to demonstrate chivalry and hence, allowing further assertion of masculinity [114]. Although the language/conduct could explicitly not state “protect a partner”, in the digital world, we argue it could instead focus on controlling and setting up technologies.

In this context, male attitudes towards technologies could focus on control and mastery and as control is a mechanism to provide protection, it comes as no surprise that men would formulate their views of protection on these terms [48] [117]. In this sense, when men provide computer and digital assistance, they reaffirm their masculinity, because women reaffirm and ground their feminine identities in allowing men to control technologies and protect them from any emerging risk from these devices [114]. In other words, “by calling on male protection, women reinforce traditional feminine identities that emphasize fragility and dependence [88 p. 122]”.

The stereotype of allowing men only to be “geeks” can affect girls’ confidence and their digital skills [34]. Rode and Poole [114] outlined that presenting as a technically sophisticated person could often be challenging for some women, mainly as interests in technology is often connected with negative stereotypes. Turkle’s [118] research highlighted this issue before. She characterized geeks as comfortable with technology, but also as being avoidant of personal relationships, which could result in raising issues of gender inauthenticity. These perspectives where corroborated by FGLM who commented on the stereotype of men being geekier than women: “We’ve been allowed to be geeks, we’ve been allowed to be eccentric and we’re eccentric, where women, we say it all the time to women, ‘You’re interested in speakers? You’re odd.”. Indeed, this could be further validated by a study conducted by the OECD which found that 0.5 % of girls aspire towards ICT-related careers at the age of 15 in comparison to 5% of boys [1].

-22-
This has, however, not always been the case as women have been working in technology for over century\(^4\). Yet, many of their stories have remained in secrecy and hence, many of their insights remain invisible. From coders to decipher encrypted messages sent from the Japanese and Germans in the World War II [119] and encryption method for signaling torpedoes [53] to inventing the science of cryptography for the FBI [120]. Some even argue that the omission from women from the history of computer science has generated misconceptions of women being uninterested and incapable of working on this field [58].

Fisher and Margolis [121] investigated the reasons that led to the decrease of women enrolling in computer science programs. Their findings reveal that boys were more than twice as likely to be given computers as a gift by their parents. In other cases, if households owned a computer, they most often put it in the boys’ room. Other influencing factors were that learning basic computer languages was deemed as a “father and son activity”. Hence, men came with greater IT experience than women when they started college. Indeed, for Lagesen [122] there is a dominant Western perception that computer science and coding are masculine domains with little space for women to participate in. Another study from the MIT [123] demonstrated that often women were ignored in academia. The study shows that women that raised their hands in class were often ignored by lecturers and talked over by other students. In fact, some of the things that were said to women during lectures reinforced certain stereotypes, such as: “they were not aggressive enough” whilst, if they challenged or contradicted other students, women were told that: “you are bitchy today – must be your period” and were also accused of incompetence: “I really don’t think the woman students around here are as good as the men [123]”. Regardless of this study having been conducted in 1983, to date, across all academic disciplines in the UK, women are still being ignored, as they account for 58% of postgraduate students but only 25% of professors [124]. Furthermore, Vitores and Gil-Juarez [125] highlight that while the number of women has increased in many other science fields, the number of women in computing has, in fact, been declining. Indeed, these stereotypes are felt and supported by women nowadays. For instance, FGLF firmly stated when talking about men allowed to be ‘techier’ than women: “My point is that, we, women, tend to get shut down”.

Other reason for women being excluded in the technology field is provided by Lerman and team [113], who explain that engineering has deeply been entangled to military service, an

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\(^4\) Almost 200 hundred years ago, the first person to be what we would considered a coder was an English mathematician woman named Lady Ada Lovelace.
institution always regarded as a masculine political identity. Whilst Wajcman notes that the prevalence of young men in engineering, has left the responsibilities of care to women [126]. However, results from our focus groups seem to indicate that the perceptions on what the role of women is in this area is changing. For example, FGLM mentioned: “I don’t think smart home technology is gendered at this point. I ended up doing Alexa and Hive through my girlfriends’ recommendations”. Or FGSM who noted how technologies could be useful in breaking the gender divide: “I think the element of boys wanting toys is real, but as smart home technology has become more embedded into society, I don’t think that there will be much gender difference... It’s just useful for everyone.”

Therefore, to further encourage women’s participation in this arena, UN Women [34] indicates that gender analysis must be an integral element of technological investment, research and design. Whilst Poster [53], suggests that the way forward could be through programs that promote technology specifically for young women and girls. Such programs include for instance girls who code\textsuperscript{5}, which aims to increase women in computer science and engineering. In addition, Poster argues that job advertisement should use more inclusive language and seek candidates not only with a background in computer science or the military, but also in social sciences, arts and law.

4.2 Housekeeping and daily domestic life

Our survey also asked about smart home technologies use in daily domestic life. Women responded higher for smart home technologies being relevant to working, studying and learning (U=104507, \(z=-2.008, p =.054\)), and for entertaining and socializing (U=106784, \(z=-2.723, p =.20\)). Women also responded higher than men for smart home technologies being relevant for cooking, preparing food, and eating (U=106691.5, \(z=-1.153, p =.249\)) as well as doing laundry, cleaning and housework (U=108588.5, \(z=-1.254, p =.210\)) (see Figure 3). A Mann Whitney U test however, showed that these findings were not statistically significant.

Figure 3: Differences in mean scores for “smart home technologies are relevant for activities such as” (Likert scale of 1 to 5, with 5 = strongly agree)

\textsuperscript{5} Further information can be found at: https://girlswhocode.com/about-us/
In regards to housekeeping, Rode and Poole [114] have coined the term “digital housekeeping”, which consists of the activities one does in the smart home. Strengers [127] argue that despite the significant advancements in smart home technologies such as system integration, improved connectivity and the identification of challenges; smart technologies have failed to deliver the promises for effortless and easy living. Schwartz [113] explored a similar area before and found that the introduction of science into housekeeping raised standards of nutrition and cleanliness, and has promoted modern cooking methods. In turn, this has resulted in the cumulative effect of creating “more work for mothers”. In fact, Schwartz’s research indicates that women spent the same amount of time in 1970s doing housework as their grandmothers did in the 1920s, before the widespread use of most “labor-savings” appliances. During those times, women spent around 52 to 54 hours doing domestic chores.

In all likelihood, the same could happen with smart home technologies. For instance, a male participant from our focus groups doubted how efficient these technologies are when he mentioned: “Like any new technology, it’s about efficiency and time saving, but then it’s like the vacuum cleaner and washing machine, it may make things easier for you to do. But does it save time? does it dry things any quicker?” (FGLM). FGSF, meanwhile, commented on how much time is spent to set these technologies up: “The extra time it takes you to set up a more complex system. You know, we’re talking about light systems. When you’re talking about lightbulbs, you could just stick it in and run away. Here, you have to program it with a name. So it takes a lot of time… By the time you’ve turned Hive on and off because it won’t recognize a new light, it has driven you mad for a half hour”. To this FGMM added: “These systems are too complex for us, old duffers… I do not think is worth the amount of time it takes to set up and
grasp new technologies in comparison to what they can do for us”. Similarly, there could be time and effort linked to keeping smart home technologies updated with latest security and operating systems.

4.3 Environmental sustainability

A third dimension in our survey concerns environmental awareness and preferences about sustainability. Intuitively, one of the selling points for smart home technologies is their ability to be more efficient, and thus, to save energy, save money, or reduce carbon emissions [128]. These points were reflected in our data, with one survey respondent (M71) stating that “Smart heating controls are saving me 11% on my energy bills compared to previously, they paid for themselves in well under five months.” M70 noted that “My gas usage has gone down since getting new boiler controlled by nest thermostat,” and M118 “Smart meter/thermostat has reduced our heating spend and given us more control.”

However, the sustainability attributes of smart home technologies are not a given, nor uniformly shared [129]. In the focus groups, we gave each of the participants a task—we gave them a list of six factors that smart home technologies developers could take into consideration when developing smart technology products and asked them to rank them in order of most to least important (1=most important to 6=least important, see Table 2). Note that “environment” was rated fairly poorly as a key concern when compared to other aspects such as convenience, privacy or cost.

Table 2: Focus Group Ranking of the Prioritized Values for Smart Home Technologies (n=18)

| Value          | R1 (F) | R2 (F) | R3 (F) | R4 (F) | R5 (M) | R6 (M) | R7 (M) | R8 (M) | R9 (M) | R10 (M) | R11 (F) | R12 (M) | R13 (M) | R14 (M) | R15 (F) | R16 (F) | R17 (M) | R18 (M) | Total sum of ranks |
|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|--------|--------|--------|--------|--------|--------|--------|-------------------|
| Convenience    | 2      | 4      | 2      | 5      | 4      | 5      | 4      | 2      | 3      | 1       | 3      | 2      | 1      | 5      | 1      | 1      | 1      | 47                |
| Privacy        | 3      | 1      | 1      | 2      | 3      | 1      | 1      | 3      | 1      | 6       | 2      | 5      | 3      | 4      | 2      | 2      | 4      | 49                |
| Cost           | 1      | 6      | 4      | 3      | 1      | 2      | 5      | 5      | 4      | 5       | 6      | 1      | 2      | 3      | 3      | 4      | 2      | 59                |
| Control        | 4      | 3      | 5      | 1      | 2      | 4      | 2      | 1      | 2      | 2       | 5      | 3      | 4      | 6      | 4      | 5      | 6      | 65                |
| Environment    | 6      | 2      | 6      | 4      | 6      | 3      | 4      | 5      | 3      | 1       | 4      | 5      | 2      | 5      | 6      | 3      | 4      | 72                |
| Comfort        | 5      | 5      | 3      | 6      | 5      | 6      | 6      | 6      | 6      | 4       | 4      | 4      | 6      | 1      | 6      | 3      | 5      | 88                |
Figure 4 replots the mean scores for these rankings based on gender, and it shows noticeable differences in the rankings for cost, the environment, and comfort. Where convenience was almost equally rated, women within the focus groups were more concerned about both cost and the environment. Men were more concerned with comfort.

**Figure 4: Mean scores from the focus group ranking of smart home attributes by gender (n=18)**

In our survey, women responded higher to smart home technologies’ potential benefits being environmental considerations ($U=114542.5, z=-.788, p =.431$), although this finding was not statistically significant as shown by a Mann Whitney U test. Nevertheless, as Figure 6 indicates, environmental considerations rank lowly compared to other aspects among both genders—i.e., resource use and environmental sustainability is ranked behind issues such as making life easier, security, saving money, leisure and saving time. An explanation on why smart home technologies ranked considerably low regarding environmental matters was brought by FGSM: “I don’t see how smart technologies could benefit the environment, because, you’re actually generating more plastic and more crap that’s going to go to landfill”. To this, FGSM added: “I think there is an environmental damage done from the rare materials that go into the smart chips”. And FGLM pinpointed how these technologies are built in obsolesce and thus could affect the environment: “Most of the items are designed to discourage you from repairing them, and most of the perceived wisdom is that you can’t repair them, or you’re told culturally that you’re not to repair it”.

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As Figure 5 also suggests, women responded higher for the potential benefits of ability smart home technologies being to save time (U=116283, z=-1.770, p =.077); slightly more women positively rank saving energy (U=118584.5, z=-1.271, p =.204), and more women rank environmental sustainability regarding the use of resources (U=114542.5, z=-.788, p =.431). However, there was no statistically significant difference between women and men in a Mann Whitney U test. Women also responded higher to smart home technologies potentially increasing property values (U=108300, z=-1.204, p =.229), but this was not statistically significant. The latter was nevertheless illustrated by FGMF when she explained: “I see it as enhancing the value of your property. I do believe it is going to become the modern way”.

**Figure 5: Differences in mean scores for “the potential benefits of smart home technologies are to” (Likert scale of 1 to 5, with 5 = strongly agree)**

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make life easier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase property value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve quality of life</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide care</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve security</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide comfort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhance leisure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Save energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Save money</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Save time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Although by a small margin, our findings lend some support to the idea that women have higher levels of environmental awareness. Indeed, in earlier research, “gender-based” disparity has been shown in regard to attitudes to and the perception of climate change [130]. Women have for example been shown to be “more fearful of the risks of climate change” and that “traditional divisions of labor account for higher levels of environmental concern among women [131].” Research conducted for example in Finland has found that men were more skeptical about climate change induced impacts [132] while Denton [133] has argued that women place greater importance on mitigating climate change as they would also be disproportionately affected by it. Women have, for example, shown to be more likely than
men to be aware of environmental concerns such as healthy food and sorting out waste [134]. Further evidence is provided by Dietz et al., [135], who report that women tend to be more active on certain pro-environmental behaviors related to consumers’ attitudes. In the same vein, Molina et al., [136] confirms that gender does have an influence on environmental behaviors. In turn, women are more likely to conduct environmentally friendly activities in both advanced and emerging countries. Swim [137] explains that engaging in traditional gender roles, in this case pro-environmental behaviors, may be used as a marker of sexual identity. In other words, if being seen as heterosexual is important to a person, they would priorities gender-conforming behaviors over gender non-conforming in anticipation of how other people might see them.

4.4 Trust and risk tolerance

A fourth area that emerged from our data were notions of trust and tolerance of risks. These concerns were prominently featured in the qualitative aspects of the survey and the focus groups. As M127 wrote in the open-ended question on the survey, “smart home technologies may help users saving time and doing domestic chores but can you really trust them? To date, it is not possible to know to where the data is transmitted. Manufacturer’s claims cannot be guaranteed.” M372 wrote that “I worry when you hear stories such as Amazon Echo can listen to conversation in your home. People get spied on with this.” M337 said, “it feels like someone is always listening”, F36 commented “it just feels a bit Big Brother watching” and M76 “It’s like Big Brother watching all the time, which is potentially very dangerous.” M537 wrote an extended comment:

Smart home technologies are creep. Not long after I got my first Alexa product myself and my wife were watching Guardians of the Galaxy 2 on DVD and the following day I received recommendations from Amazon via email on a range of products all branded in [Guardians of the Galaxy]. I don’t like the idea of AI listening into my conversations. I have become aware of Facebook and Groupon email advertising arriving in my feed/inbox following conversations I have had with friends about specific issues, e.g. bio-resonance hair testing.

Whilst M23 wrote that:

We have a very basic digital thermostat, not even connected online, but it still has a mind of its own. It kept resetting temperature to stupidly hot. How can you trust devices that think they know better than you?
These issues of trust also came up in the focus groups, with respondents from both women and men articulating concerns about privacy, control, surveillance, and monitoring.

However, as Figure 6 summarizes, based on a Mann Whitney U test women seem to trust technology (U=106998.5, z=-3.117, p<.05) and service providers (U=104936, z=-3.101, p<.05) statistically significantly more than men. Furthermore, women responded significantly higher than men to trusting social media platforms (U=98310.5, z=-4.442, p<.05). Women also responded significantly higher than men to trusting family (U=102274, z=-3.506, p<.05) and energy suppliers (U=102605.5, z=-3.979, p<.05).

**Figure 6: Differences in mean scores for “who is trustworthy in relation to smart home technologies” (Likert scale of 1 to 5, with 5 = strongly agree)**

Yet, people have reasons to distrust industry. For example, a recent report indicates that Google have acknowledged its contractors are able to listen to recordings of what people say to the company’s AI system [138]. Amazon conducts similar practices as they have also recognized that when users talk to AI powered voice assistant Alexa, Amazon employees around the world regularly listen to recordings in order to develop new services, enhance customers’ experience and improve the quality of the software [139]. Certainly, participants in our focus groups and survey commented on these issues when they expressed: “I find it worrying that all the people who own smart speakers are delight that it can listen to them when they want it to. They don’t seem to realize that it also listens to them when they don’t want it to - a total invasion of privacy billed as a modern-day technology” (F855). FGLM corroborated on that point: “I’m struggling to understand why it’s cool to have Alexa turn on my lights when
the price I pay for that is Alexa is listening to everything that goes on in my house. Even when it’s off”. These notions where further supported when FGLF commented on her own experience: *I find Amazon Alexa so intrusive, the fact that they’re listening to you, I just keep it off the whole time*. Or FGLF who expressed: “not to put a downer on it but devices are always listening to you. Cameras are watching you. Who knows who is going to be listening to you or watching you, it could be anyone”.

Further concerns are raised when Wyze Labs, company that makes smart cameras and connected home gadgets, confirmed that millions of customers’ personal information was exposed to the public since it was hit with a customer data breach in 2019 [140]. Circumstances such as these, led to M150 comment bluntly: “They may be useful but are completely untrustworthy”. In addition, other reports have found industries allowing ethical breaches, such as storing employees and users’ information in an insecure manner [141]. Although users from our focus groups were aware of such risks, FGMM for example commented the following concerns in relation to data security: “There are always data breaches, all the time it’s happening… and you’re not just talking about one supplier, you’re talking about many suppliers for different products”. Participants also mentioned what would it take to trust these technologies: “if I read something on the news from a trusted website, and they say that these smart homes can be trusted, I would trust them. Like when the thing about Facebook came out, and my viewpoint of Facebook completely changed” or FGLF who tied trust with transparency: “I think the trust, when it comes to smart home technologies ties back into transparency. Because we all know that there is a trade-off. If you want more functionality you need to give them more details, but it’s not very clear, and I think deliberately so, what exactly the trade-off is. Like, what piece of data is required for the functionality?”. Notions of risk and tolerance of risks also had gendered differences. As Figure 7 indicates, women in our survey responded higher to potential risks of smart home technologies being to waste money (U=110045, z=-1.075, p=.282), cause households to worry more (U=104127.5, z=-.665, p=.506), and be intrusive (U=109875, z=-1.966, p=.196). By contrast, men responded higher to risks related to loss of privacy (U=116256, z=-4.36, p=.663), revelation of sensitive data (U=1021495, z=-1.582, p=.114), disruption of routines (U=114060.5, z=-.155, p=.877), loss of control (U=116429.5, z=-4.38, p=.661), dependence on experts (U=112821, z=-.056, p=.955), and increased dependency on electricity networks (U=113450, z=-.778, p=.437). These results were not statistically significant based on a Mann Whitney U test. There was, however, a statistically significant difference between women
and men to smart home technologies risks being that they are non-essential luxuries (U=111461, z=-2.694, p<.05) and cause laziness (U=106037, z=-3.067, p<.05), to which women responded higher.

**Figure 7: Differences in mean scores for “there is a risk that smart home technologies …” (Likert scale of 1 to 5, with 5 = strongly agree)**

These gendered implications of trust and risk become less surprising when one discovers how gendered the design of smart homes (and other technologies) can be. Criado-Perez [58] argues that with the current pace of technology, many women are living in a world designed by men and built around male data. She explains that AI, for example, has been trained on data sets riddled with data gaps on women. The problem, we argue, relies on the fact that algorithms are often protected as proprietary software, hence, people are unable to examine if these gaps are taken into account. This, in consequence, has shown that algorithms trained with biased data have resulted in algorithmic discrimination [66]. In these circumstances, if programmers are not aware on how these biases operate and are not collecting data to produce evidence-based processes, the model will continue to perpetuate old injustices towards women and other vulnerable groups. These factors may explain why women experience higher levels of hacking anxiety [142] and why this group also engages in more proactive privacy protection behaviors [143], [144]

In their work Strengers et al., [48] also showed that women were less tolerant of technology than men, as they perceived it as glitch or time consuming; “they just wanted the technology to work”. While men also wanted the technology to work, they were nevertheless
more likely to persist with technical difficulties and for some, these complications were identified as a pleasurable “hobby”. Although participants in our survey held a different perspective, to this, M960 said: “They are incredibly complex to set up”.

In this sense, Berg [145] suggested that while smart homes have prioritized technically enhanced security and entertainment, they have, at the same time, been underpinned by engineering concepts of control, efficiency and optimization where men have held, and are likely to continue to hold a leading role. Meanwhile, women that are not commonly associated with technology proficiency are likely to have less tolerance and time to set-up, use and maintain technology. This premise, however, was dismissed when FGSM and FGMM commented on their own experience respectively: “I suspect the early adopters are more likely to correlate with men, but the users, certainly in my experience are, and at home with my parents, it’s my Mum who uses it”. And “I think, perhaps two or three years back, these things were only for men. But I think now that Smart Technology is hitting primary schools. I mean, both my grandchildren, male and female, can work things that I can’t”.

4.5 Emotions and feelings

A final dimension where smart home technology preferences differ relates to statements about emotion and feelings. FGLM went so far as to comment:

The Internet of All Things fills me with dread. At the end of the day, it becomes sentient and takes over. You know what, I don’t like being used, I will use you. I will be equal. I am afraid of all of the systems going wrong at the same time. It’s fear.

Another noted that smart home technologies not working filled them with panic and anxiety. FGLM remarked that:

When the internet goes down, you panic. And it is, it is a panic, I’ve felt it before. We have Hive, and it went down, and it was a case of, how do I turn it on? I’m at home, how do I turn my heating on at home? That was a moment of panic.

A third stated:

What I am afraid of is a cyber-attack from a terrorist, or, you know, an enemy nation, or a flare from the sun, that suddenly puts all the electronics out of business, we could be in trouble there. I think you are probably fairly safe with a smart home, but if you’ve got smart buildings, what happens then? Where, physically your whole
environment is controlled by a third digital partner... Hospitals are going that way and it will move down to individuals, like block of flats.

These were not isolated statements. Within the survey, respondents stated that smart home technologies made them feel “insecure,” “anxious,” “afraid,” and “it just worries me, because I don’t know what it will make the future look like.”

These dark and despondent emotions were countered by almost equally positive emotions among respondents. FGLM remarked that:

*Despite my nightmare scenarios, I’m positive about smart homes and a smart tech future. It may seem really odd, but I am. I hope, that we’re going to get the built in, we’re going to get to a point where we start to legislate more personally, I like smart home technology, I save up for it, wait for the money to buy it, anticipate it, and am totally excited about it.*

In the survey, respondents mentioned how smart home technologies made them feel reassured, safe, and protected, with one noting “smart home technologies are very useful to me, they help me to feel safe and protected” and another stating “All I have to say on this matter is that I would be lost without this technology.” Others talked about how they “enjoy” having “smart cameras to monitor my house” and “I enjoy the information smart homes provide to me.”

As Figure 8 summarizes, our results reveal that both men and women state to have a range of emotions in relation to smart home technologies. Our results, based on a Chi Square test, suggest that smart homes make many women reportedly feel lazier ($X^2 (1df) = 4.926$, p=.26), though there was not a statistically significant difference between women and men in this response. Women also responded higher to smart home technologies making them feel exposed ($X^2 (1df) = 1.351$, p=.245), dependent on technology ($X^2 (1df) =.197$, p=.657), and unsafe ($X^2 (1df) =.163$, p=.687), but responses to these questions were not statistically significant. Our results suggest that smart homes make men feel more protected ($X^2 (1df) =.315$, p=.575), empowered and in control ($X^2 (1df) =.212$, p=.645), and safe ($X^2 (1df) =.392$, p=.531), but these were not statistically significant.

Figure 8: Percentage of men and women selecting “smart home technologies make me feel overall …”
These results counter, or at least add context, to earlier work suggesting that women unilaterally view smart home technologies with enthusiasm. Raptis’ et al. [146] highlight the importance of “coolness” in user experiences in the digital arena; not only by generating fun, but also other sensory experiences and more relaxing home environments. In this area, they reported that women expressed more enthusiasm, where they reflected some opportunities to express the feminine side as homemakers, partners and hosts [48]. For men, on the other hand, setting up, tinkering and playing with the devices was where they found pleasure. These results are similar to those found by Mennicken et al. [147] where they showed that (most likely and often men) technologically-competent users experienced a “joy of hacking”. A woman focus group participant commented on her own experience: “I have a few friends who all happen to be male who have the bots and things like that, because they want it to program and they think it’s fun. I think both genders can find it fun, but it tends to be men” (FGLF).

Our results also deepen the lexicon of emotions reported in the literature about anxiety and wariness about smart homes. Despite some celebrated inventions such as driverless cars and robot caregivers for the elderly, this enthusiasm is not necessarily reflected in the population as a whole. For instance, more than 70% of Americans express wariness and concerns about a world where machines perform many tasks done by humans [148]. Most ordinary Americans are worried about the growing trend that automation of jobs will
exacerbate economic inequality. Indeed, the word robot popularized in 1921 by Czech playwright Karel Capek [149], was used to designate work robota, to stress that these machines could replace labor in different forms [150].

This vision was shared in our focus groups when FGMF expressed: “So smart meters, it reads your meter automatically, doesn’t it? So, what about the poor man who’s going around now and that’s his job?...I must admit, even now if I’m at a supermarket, I prefer to go to a checkout, rather than an automatic checkout because I want people to still have jobs”. M478 remarked, in all caps, “NO – I WOULD NOT HAVE THESE SMART HOME DEVICES IN MY HOUSE! TECHNOLOGY WILL BE THE RUINATION OF MANKIND IN THE END, NO ONE WILL KNOW WHAT TO DO IF IT ALL CRASHES!” The idea of “machines are coming to take our jobs” or will spiral out of control has been a concern for hundreds of years, at least since the early nineteenth century, when Karl Marx stated: “machinery does not just act as a superior competitor to the worker, always on the point of making him superfluous. It is the most powerful weapon for suppressing strikes [151]”. Another example refers to when the Luddites resisted and tried to destroy machines that reduced their waving skills obsolete [152], even though, machines themselves helped building new skills and jobs [14], a theme also picked up by Keynes in the twentieth century [153]. More recently, Gaia theorist James Lovelock [154] has envisioned that super intelligent machines will need humans to help them keep cool, and save the planet, in a warming climate.

Granted, not all respondents were able to elucidate a clear emotional reaction—positive or negative—with smart home technology, and instead stated to have uncertain, contradictory, or ambiguous emotions. One survey respondent (F727) stated that “smart home technologies are meant to be helpful and save you time but most of the time you are wasting time setting them up and adjusting them... but hey they are fun.” FGLM stated that “I have some reservations about smart home technology, which we’ve discussed, but I think it’s healthy to question things and not just to accept them blindly, but yes, on the whole, I feel positive towards smart technology. Alongside the reservations.” FGLF said that “despite nightmare scenarios in my head about smart home technologies, I am still filled with hope.” FGLM stated they did not know how they ought to feel, remarking that “I think if there was that definition of smart technology it might help with understanding it better. Now it feels quite broad and vague.”

One emotional aspect of smart home technology that we found striking was its ability to make people laugh—to make them revel in humorous or funny situations. One survey
respondent (M27) wrote that “Alexa has interrupted a conversation with fart noises, and then wouldn’t stop;” another (F370) stated that “Sometimes Alexa will interrupt our conversation about the cats and start meowing. A third (M392) state that “I have an Alexa and when doing my shopping list it misunderstood my item. So I said you’re a piece of junk! Alexa replied I’ve added you’re a piece of junk to your shopping list!” A fourth (F997) that “My friend has Alexa. She tried to get it to repeat a Chinese recipe she had used and all it did was try to teach her how to say recipe in Chinese!” While probably unintentional, and limited currently to one device (Alexa), these encounters do reveal the ability for smart homes to also amuse and bemuse their adopters.

4.6 Synthesis: The gendering of smart homes

Ultimately, our qualitative data strongly suggests that smart home technology dynamics are gendered. This comes up in the gendered nature of the adoption of smart homes, which seem more appealing to men than women. It occurs in statements of how smart home technologies would be put to use such as how they can alter gendered practices in the home related to domestic tasks such as cleaning, entertaining, or cooking. Gender is present in discussions about the sustainability of smart homes, their consequent effects on energy consumption, or their relationship to carbon emissions. Issues of trust, tolerance for risk, and even the affiliated emotions of smart homes are all mediated by gender. Gender is not a peripheral matter to smart home technology; it affects multiple aspects of smart home innovation, from design and deployment to diffusion and demonstrable impacts.

Gender is also a variable that extends well beyond the five inductive analytical categories we have discussed so far. To give a few examples, in the open-ended questions on the survey where respondents were permitted to enter statements directly, a female participant (F822) commented that “Alexa never works. It’s so much easier to just go turn the light on than repeatedly asking her. I hate it. But my Hubby loves it.” Whilst F766 joked that, “For some reason, our smart television cannot understand male voices (laughter emoji) so only us females can use the voice control.” And, a female respondent from the focus group in London (FGLF) said that:

Smart home technologies are definitely gendered. Think about smart stereos and speakers. My friends or women never talk about stereos or speakers, it is always men. Plus, men have been allowed to be geeks, allowed to be eccentric, where women are seen as odd if they are techy. There is thus a natural affinity of men towards smart home tech, whereas women tend to get shot down if they express a preference for
smart technology. I believe that society is telling us that women do the shopping, so they may use smart tech to order a clean pair of pants on Monday morning. These roles get built into smart technology.

These statements were far from isolated; Table 3 draws from all three focus groups to qualitatively illustrate how expressions of favoritism, conceptualizations, awareness, and perceptions of benefits and drawbacks all differed by the gender of respondents.

### Table 3: Qualitative differences in smart home technologies by gender

<table>
<thead>
<tr>
<th>Location</th>
<th>Theme</th>
<th>Common patterns</th>
</tr>
</thead>
</table>
| London   | Favorite peace of technology | Females: smart phones and smart speakers  
Males: smart phones, entertainment devices (speakers and TVs) and PCs |
| London   | What comes to mind when you think about the term smart homes | Females: energy efficiency, technology, remote control, staying connected and apps  
Males: automation, more control, having to learn another piece of technology (helpdesk), energy control and isolation |
| London   | What smart home technologies do you own | Females: smart meter, Hive and Amazon Echo  
Males: smart meter Sonos, burglar alarms, Amazon Alexa |
| London   | What smart home technologies are (For this activity males and females were mixed and divided into groups) | Group benefits: products that save time and are efficient, things that are connected and give you feedback, homes that try to anticipate my requirements and needs |
| London   | What smart home technologies you are aware of | Females: Alexa, Hive, IKettle, smart TV, smart fridge, vacuum cleaner and smart phone  
Males: smart meters and Sonos speaker |
| London   | Benefits of smart home technologies (For this activity males and females were mixed and divided into groups) | Group benefits identified: smart home technologies can save users money and energy, provide individuals with more control and deliver more efficient routines, more security, enhance connectivity and should also be fun to use |
| London   | Drawbacks (For this activity males and females were mixed and divided into groups) | Drawbacks identified: dependency on being connected, privacy, tech companies stealing users’ data, pressure on children to have the latest gadget and overall, it makes life more complicated |
| Manchester | Favorite peace of technology | Females: mobile phones  
Males: computers |
| Manchester | What comes to mind when you think about the term smart homes? | Females: Hive to control heating, Google home and Alexa and smart plugs  
Males: security systems, doorbells, smart and water meters, things to control your lightning, outside weather stations, Artificial Intelligence, efficiency, voice activation and energy |
<table>
<thead>
<tr>
<th>Questions</th>
<th>Responses</th>
</tr>
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</table>
| What smart home technologies do you own                                  | Females: Google Home Hub, Alexa and Nest  
Males: Smart meter, Amazon Stick, Google Home, smart meter and Amazon Echo                                                                                                                                     |
| Benefits (For this activity males and females were mixed and divided into groups) | Group benefits identified: enhanced control, remote control, enhance security and voice control                                                                                                             |
| Drawbacks (For this activity males and females were mixed and divided into groups) | Group drawbacks identified: reliability, possible costs and tends to deskill people, hacking, loss of privacy and personal information given away and encourage users to be lazy. |
| Surrey                                                                   | Females: Sonos, Nest and mobile phones  
Males: Ipad, computer, Ring Doorbell                                                                                                                                                                |
| Favorite piece of technology                                             | Females: Enable, efficiency, connected, sophisticated  
Males: Automation, compatibility, cost, monitoring, convenience, intelligent                                                                                                                                      |
| What comes to mind when you think about the term smart homes             | Females: Hive, Nest Hue, Reolik cameras and Hive lights  
Males: Yale security systems, Amazon Alexa and smart TVs                                                                                                                                                    |
| What smart home technologies do you own                                  | Females: a smart house is something where you can control everything  
Males: smart home means something you can control remotely, or maybe monitor. So the system making decisions itself, and this is what probably smart involves  
M: All related to AI, so it learns what you do                                                                                                             |
| What smart home technologies are                                         | Females: Nest, Sonos  
Males: Alexa, smart fridges, kettles, robot vacuums                                                                                                                                                    |
| Benefits (For this activity males and females were mixed and divided into groups) | Group benefits identified: remote control, energy efficiency, cost efficiency, control, security and monitoring activities within the home                                                                 |
| Drawbacks (For this activity males and females were mixed and divided into groups) | Group drawbacks identified: data breaches, privacy, initial cost and setting technologies up                                                                                                                   |

Source: Authors.

As much as the use of interconnected digital technologies and data has fundamentally changed the world, gender has the potential to shape and change smart home technologies. To millions of young people across the world, these technologies have offered new and profound opportunities, and have promised unspeakable enhancements in productivity and improved citizens well-being. When used in a highly gendered space such as the household, these technologies can no longer remain gender-neutral: they interact with, and affect gender human beings, differently because the needs, behaviors and attitudes of them are gendered.
5. Implications for research and technology design

In addition to helping guide future smart homes policy and contributing to the growing research on the gender of technology, our study also contributes to the body of literature on human-computer interaction. Particularly, our study attends to urgent calls for expanding the research agenda for feminist human-computer interaction [48, 51, 75, 114, 154, 155, 156] and complements a number of gaps in this area.

For instance, to the authors’ knowledge, this is one of the first studies that explores gendered emotions along with perceived trust, risks, and tolerance emanating from the adoption and use of SHTs. Furthermore, from an environmental sustainability perspective, our research is one of the first to examine gendered environmental awareness and preferences about SHTs. However, results from the latter help validate the idea that women have higher levels of environmental awareness, as presented in Section 4.3.

Moreover, we found a duality in our results. On the one hand, our survey instrument corroborates previous studies suggesting gendered imbalances in smart homes and SHTs ranging from the stereotypically gendered divisions of household labour, to men often presented as technology ‘Czars’, to the common notion of these technologies being more appealing to a masculine technophile user. On the other hand, experiences emerging from the focus groups points to a more uplifting future. For instance, participants indicated that among younger generations, gender did not influence in aspects such as use, uptake, knowledge, and skills of SHT. This contests, in consequence, gender stereotypes pervading existing technologies. Our results, thus, support the findings from Gnambs [72] that suggest that ICT literacy differences between boys and girls are narrowing.

Furthermore, our research has important implications for technology developers and their agendas. Most importantly, our research calls for a more sensitive technology design that integrates values and information beyond white-Anglo Saxon males. Instead, technology design need to integrate gender diversity, cultural background and ethnicity, which is in line with more recent research calling for the integration of “value sensitive design” [158] or “responsible research and innovation” [159] into the technology design process. By considering these elements, we can potentially mitigate harmful biases, promote technology inclusion and achieve technology justice so that SHTs benefit all groups [155].

In terms of environmental sustainability, our findings suggest that this aspect of SHTs ranked behind issues such as making life easier, security, saving money, leisure, and saving
Participants in our focus groups and survey identified SHTs with the generation of more ‘crap’ going into landfills and without fully understanding the links between these technologies and sustainability. We thus call the SHT industry to emphasize the potential sustainability attributes of these technologies, and to promote them as enabling more efficient energy behaviors and practices among consumers.

6. Conclusion

In this study, we investigated the factors shaping differing perceptions of smart home technologies across self-identified men and women, drawing from original data from a nationally representative survey in the United Kingdom (n=1,032) as well as focus groups in London, Manchester, and Surrey (n=18 respondents). Our findings showed the following emerging themes and how they differ between females and males:

- Adoption, use and purposes: men state they are statistically significantly more likely to use smart home technology themselves, by a considerable margin, and men are also statistically significantly less likely to say that their partner uses the technology;
- Housekeeping and daily domestic life: women state they prefer to use smart home technologies for cooking, preparing food, and eating as well as doing laundry, learning, and studying, whereas men prefer to focus on control and mastery of technology, though these differences were not statistically significant;
- Environmental sustainability: women express more concern about both cost and the environmental implications of smart home technologies, whereas men are more concerned with comfort. More importantly, the environment is ranked behind issues such as convenience, security, saving money, saving energy, and saving time. Women also express a greater desire to control heat services and energy within the household, contrary to much of the literature. These differences were nevertheless not statistically significant.
- Trust and risk tolerance: women state to have statistically significantly more trust in smart home technology and service providers, social media platforms, and energy supplies more than men, also contrary to the literature.
- Emotions and feelings: smart home technologies provoke intense emotions from both men and women, with women reporting affiliated emotions that smart homes make them feel lazy, exposed, dependent on technology, and unsafe, though the
differences between men and women were not statistically significant. Men responded feeling more protected, empowered and in control, and safe, but again these differences were not statistically significant. More complicatingly, a fraction of respondents also either held mixed emotions (positive and negative) or were uncertain and ambivalent about their emotions. Some even found the technologies amusing and funny.

Given our findings, our study does point the way towards fruitful future research. Methodologically, full regression models and multivariate data analysis focusing on gender as well as gender in context (age, employment, income etc.) would complement the analysis here, as would specified gender-oriented surveys among non-smart-home buyers vs. smart home buyers. A mixed-methods exploration of other demographic, geographic, or political aspects such as culture, politics, and spatial diffusion would also add depth to our results, explicating how gender gaps, values, preferences, and norms intersect with other attributes of identity (which then influence household consumption patterns, preferences, etc.). We therefore would encourage more theory-focused research on this topic.

Relatedly, we focus on fairly binary categories of gender in our analysis and mostly gender as a defining attribute, but not intersections of gender with other demographic attributes such as race, class, or geographic setting. For instance, it would be very interesting to investigate how better-off women's (or men's) responses vary in content from poorer-off women (or men), what difference education, technological literacy, their work experience, exposure to the world, ownership of technological resources/assets or money, and even ethnicity make in their use of smart technology. It could be that those living at the heart of an urban city or living in highly-secure apartments might require an easier entry into technological knowledge and hence greater use, contrasted with those living in rural areas or in “dumb” or “traditional” flats without smart capabilities.

Topically, more attention to gendering vs. use value would generate practical information for marketing efforts on behalf of designers, manufacturers, and retailers. Furthermore, we focus our research here on the “demand side,” on users, but a focus on the “supply side,” on industry and manufacturers, could also be fruitful to explore.

We, furthermore, suggest that future research could explore smart home applications that promote gender equity and diversity. We also call for further research to focus on how
smart home technologies integrate in the lives of people living non-western countries and how their development and deployment could promote exclusion from vulnerable groups.

Ultimately, our analysis suggests that homes and domestic spaces are undergoing significant technological transitions, and these affects, and are affected by, gendered knowledge, practices, risks, and emotions. These changes could continue to erode so-called “traditional” gender norms—such as men wanting to control or pay for energy services (a finding our results dispute), men not being emotional (findings we dispute), and women having less trust in technology and energy suppliers (findings we dispute)—and the gender roles associated with them. In sum: We see a prominent association between self-identified gender and knowledge, practices, sustainability implications, trust, and emotions surrounding the smart home.

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Appendix

**Smart Home Technologies (smart home technologies) Survey**

We would like to find out what you know and think about ‘smart home technologies’. This simple questionnaire should take no more than 15 minutes to complete.

**Part 1. Socioeconomic and demographic dimensions**
Q1. How many people, including yourself, live in your current home? [numeric box 1 to 99]

[Enter number]

[OE1]

Q2. How many children live in your current home? [numeric box 0 to 99]

[Enter number]

[OE2] [if Q1=1, then HIDE Q2]

Q3. What is your age? [numeric box 1 to 100]

[Enter number]


Q4. What is your gender?

(1) Male
(2) Female
(3) Something else

Q5. What is your annual household income before tax? [numeric box 0 to 1000000]

[Enter number]
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<tr>
<td>Q6. My home is…</td>
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<tr>
<td>1.</td>
<td>Owned-outright</td>
</tr>
<tr>
<td>2.</td>
<td>Owned with a mortgage</td>
</tr>
<tr>
<td>3.</td>
<td>Rented from a private landlord</td>
</tr>
<tr>
<td>4.</td>
<td>Rented from social housing / local authority</td>
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</tbody>
</table>
Q7. How much would you say you know about smart home technologies?

(1) Nothing at all, I have no idea what they are.
(2) I have a vague idea of what they are.
(3) I have a good idea what they are.
(4) I have a very good idea of what they are.

Q8. Do you own or use any smart home technologies? If so, how many? Smart home technologies are a large category of products that includes everything from smart meters and smart appliances to voice activated controls such as Alexa, programmable heating, and more. (Enter 0 for none).
Q9. Who would be most likely to use smart home technology in your household? (Please select all options that apply) [MULTIPLE SELECT]

(1) Myself
(2) My partner
(3) My children
(4) Other family members
(5) Guests and visitors
(6) Others [Please specify] [OE6]

Please state how much you agree or disagree with the following statements. If you do not have a clear opinion or are unsure what to answer, please just tick ‘don’t know’. There are no right or wrong answers!
Q10. Thinking about smart home technologies generally, the main purposes of smart home technologies are ...

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’

<table>
<thead>
<tr>
<th>Q10_1</th>
<th>Enhancing entertainment</th>
<th>☐</th>
<th>☐</th>
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<tr>
<td>Q10_2</td>
<td>Making life at home more convenient</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Q10_3</td>
<td>Controlling smart appliances</td>
<td>☐</td>
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<tr>
<td>Q10_4</td>
<td>Monitoring family members</td>
<td>☐</td>
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<tr>
<td>Q10_5</td>
<td>Managing energy use and heat</td>
<td>☐</td>
<td>☐</td>
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<td>[ ☐ ]</td>
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<tr>
<td>Q10_6</td>
<td>Enhancing communication</td>
<td>☐</td>
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<tr>
<td>Q10_7</td>
<td>Supporting assisted living or health</td>
<td>☐</td>
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<tr>
<td>Q10_8</td>
<td>Managing home security and safety</td>
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<td>[ ☐ ]</td>
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Q11. Thinking about smart home technologies generally, the potential benefits of smart home technologies are to ...

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’
Q12. Thinking about smart home technologies generally, Smart home technologies are relevant for certain activities such as ...

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’
Q12. | Activity | Options |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Q12_2</td>
<td>Showering, washing</td>
</tr>
<tr>
<td>Q12_3</td>
<td>Working, studying, learning</td>
</tr>
<tr>
<td>Q12_4</td>
<td>Entertaining, socializing</td>
</tr>
<tr>
<td>Q12_5</td>
<td>Relaxing, leisure, hobbies, games</td>
</tr>
<tr>
<td>Q12_6</td>
<td>Doing laundry, cleaning, housework</td>
</tr>
<tr>
<td>Q12_7</td>
<td>Parenting, caring for household members</td>
</tr>
<tr>
<td>Q12_8</td>
<td>Mobility</td>
</tr>
<tr>
<td>Q12_9</td>
<td>Improving health</td>
</tr>
</tbody>
</table>

Q13. Thinking about smart home technologies generally, for there to be personal trust in smart home technologies, it is important that they …

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’

Q13 | Item | Options |
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<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Q13_1</td>
<td>Are reliable and easy to use</td>
<td>☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>Q13_2</td>
<td>Can be controlled and over-ridden</td>
<td>☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>Q13_3</td>
<td>Protect personal data/information</td>
<td>☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>Q13_4</td>
<td>Guarantee privacy and confidentiality</td>
<td>☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>Q13_5</td>
<td>Come with performance warranties</td>
<td>☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>Q13_6</td>
<td>Are made by credible manufacturers</td>
<td>☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
</tbody>
</table>
Q13. Are compatible with other devices in the home

Q14. Thinking about smart home technologies generally, when I think about who is trustworthy in the smart homes technology sector, I trust...

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’

<table>
<thead>
<tr>
<th>Q14_1</th>
<th>Technology suppliers (e.g. Apple, Samsung)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q14_2</td>
<td>Service providers (e.g., Netflix and Amazon)</td>
</tr>
<tr>
<td>Q14_3</td>
<td>Energy suppliers (e.g. EDF or British Gas)</td>
</tr>
<tr>
<td>Q14_4</td>
<td>Government departments (BEIS, Ofgem)</td>
</tr>
<tr>
<td>Q14_5</td>
<td>Researchers and scientists (universities)</td>
</tr>
</tbody>
</table>
Q14. Thinking about smart home technologies generally, there is a risk that smart home technologies…

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>Q14_6</td>
<td>Friends</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q14_7</td>
<td>Family</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q14_8</td>
<td>Neighbors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q14_9</td>
<td>Traditional media (newspapers, TV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q14_10</td>
<td>Social media (Twitter, Facebook, Instagram)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
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<th>[ ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q15_1</td>
<td>Increase dependency on technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15_2</td>
<td>Increase dependency on electricity networks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15_3</td>
<td>Increase dependency on outside experts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15_4</td>
<td>Result in a loss of control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15_5</td>
<td>Disrupt daily routines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15_6</td>
<td>Make household members lazy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15_7</td>
<td>Are intrusive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q15_8</td>
<td>Reveal sensitive data</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Q15_9</td>
<td>Are an invasion of privacy</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Q15_10</td>
<td>Are non-essential luxuries</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Q15_11</td>
<td>Make households worry more</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Q15_12</td>
<td>Waste household income and money</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Q16. Thinking about smart home technologies generally, I am comfortable with smart home technologies monitoring …

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’

| Q16_1          | My basic health (steps, heartrate, sleeping) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | [ ☐ ] |
| Q16_2          | Home energy or heat use (e.g. smart meter, smart thermostats) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | [ ☐ ] |
| Q16_3          | Household security (e.g. burglars and crime) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | [ ☐ ] |
| Q16_4          | Entertainment preferences (e.g. BT, SKY) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | [ ☐ ] |
| Q16_5          | Young children (e.g. portable parent) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | [ ☐ ] |
| Q16_6          | The elderly or ill (e.g. assisted living) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | [ ☐ ] |
| Q16_7   | Tracking cars and vehicles | [ ] |
| Q16_8   | Household objects (forks, spoons) | [ ] |
| Q16_9   | Clothing and laundry (smart washing machines) | [ ] |
| Q16_10  | Food and diet (smart refrigerators) | [ ] |
| Q16_11  | Pets | [ ] |
| Q16_12  | Financial history (e.g. banking) | [ ] |
| Q16_13  | Menstruation and pregnancy | [ ] |
| Q16_14  | Tracking all family members | [ ] |

**Q17. Thinking about smart home technologies generally, smart home technologies could lead to conflict in the home related to …**

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’
### Q17. Questions on Relationships

<table>
<thead>
<tr>
<th>Q17_1</th>
<th>Housemates</th>
<th>□</th>
<th>□</th>
<th>□</th>
<th>□</th>
<th>□</th>
<th>[ □ ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q17_2</td>
<td>Couples and partners</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>[ □ ]</td>
</tr>
<tr>
<td>Q17_3</td>
<td>Children and parents</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>[ □ ]</td>
</tr>
<tr>
<td>Q17_4</td>
<td>Landlords and tenants</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>[ □ ]</td>
</tr>
<tr>
<td>Q17_5</td>
<td>Hosts and guests</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>[ □ ]</td>
</tr>
<tr>
<td>Q17_6</td>
<td>Neighbors</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>[ □ ]</td>
</tr>
</tbody>
</table>

### Q18. Thinking about Smart Home Technologies

Thinking about smart home technologies generally, smart home technology makes me feel overall … [MULTIPLE SELECT]

Note: You may have an answer to this question whether or not you own any smart home technologies and regardless of how much knowledge you have of smart home technologies. However, it is also fine to not know the answer and to select ‘I don’t know.’

1. Safe
2. Unsafe
3. Empowered/In control of the house
4. Dependent on technologies
5. Lazy
6. Ambivalent
7. Exposed
8. Protected
9. Other: [Please specify]
10. None of these - [EXCLUSIVE]
Q19. Do you have an insightful story or anecdote to tell regarding smart home technologies?

[open ended] [OE7]

Completion screen [not visible]

Thank you for participating in our survey!

If you would like to find out more about smart home technologies, please click here [https://www.creds.ac.uk/digital-society/]

Would you be willing to be contacted in the future by the research team for the opportunity to be contacted by a follow-up interview or to have the opportunity to participate in a similar survey?

(1) Yes
(2) No

[If (1)YES ]