Understanding the Gap Between User Expectations and Technology Performance: Case of Heat Pumps

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ABSTRACT

The decarbonization of residential heating is critical to achieving global climate targets, and heat pumps represent a key technology in this transition. However, despite their potential to significantly reduce carbon emissions, users report a gap between perceived and actual performance. This study investigates the factors contributing to this performance gap by applying Expectation-Confirmation Theory (ECT), a cognitive framework that links user expectations, perceived performance, and satisfaction. Using a mixed-methods approach, data was collected from 33 early adopters of heat pump technology in the form of questionnaires, audits, and semi-structured interviews. Quantitative analysis supported the use of ECT to explain the performance gap, displaying moderate correlations between perceived and actual efficiency with comfort, while qualitative findings explored the expectations and satisfaction of users. These findings assist in understanding the performance gap for the 'able to pay' demographic, and explains their satisfaction with the technology despite its underperformance.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**; *HCI theory, concepts and models.*

KEYWORDS

Heat pump, expectation-confirmation theory, smart heating systems, user satisfaction

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1 INTRODUCTION

Heating has been identified as the "greatest challenge in tackling climate change" [32], comprising of around 4.17 billion CO2 equivalent emissions annually in 2022 [22]. In recognition of the role that heating plays in our efforts to address the sustainability challenge, colleagues in the CHI community have recently engaged with the topic of heat and comfort [2, 4, 14, 27, 39, 43].

Heat pumps enable the efficient production of heat and are the key technology in decarbonizing heating, having the potential to reduce global emissions by at least 500 million tonnes by 2030 [22]. While the topic of heat pumps is gaining some attention in HCI research as part of work on interaction between smart home technology and users, the study of scaling up heat pump adoption has remained somewhat under-investigated. Yet, adoption of this technology has had dramatically varying success across countries. For instance, Norway, Sweden and Finland have achieved adoption rates of 60%, 43%, and 41% respectively, whilst the UK has struggled to reach adoption rates above 1% [22].

Moreover, where the adoption of heat pumps is sluggish, researchers have observed a significant gap between predicted and actual heat pump performance [9, 30]. Although slow adoption in places such as the UK is often attributed to weak policy incentives, cultural factors, the relatively high price of electricity compared to gas, and the poor quality of older housing stock [21, 23, 44], the reasons behind the performance gap remain unexplained. Previous studies have identified this gap but have not developed a theoretical understanding of it [9, 30]. This research aims to explore the underlying factors contributing to this gap.

The key question explored in this paper is: *How could the gap between perceived and actual performance in heat pumps be explained*? To address this question, we first look at the related work (see section 2). Next we describe our mixed-method approach to address our key question (see section 3). We then consider the factors contributing to the performance gap of domestic heat pump systems through a qualitative data analysis (see section 4.1). Having recruited a set of able to pay householders who have heat pumps for our study, we find that these householders consider heat pumps to be generally reliable, comfortable, and a 'value for money' technology.

Following this, we undertake an exploratory quantitative analysis to see how their knowledge, perceptions, and interaction with heat pumps influence both satisfaction and operational performance of their heat pumps (see section 4.2).

Finally, we draw on the Expectations Confirmation Theory [31] to explain the mechanisms by which user expectations shape perceptions of performance which diverges from reality (see section 5).

2 RELATED WORK

Heat pumps as a smart home technology. Heat pumps, like other smart home technologies, are often perceived as complex systems [9], which can lead to user friction and dissatisfaction [15]. Research highlights that these technologies can disrupt daily routines, with their adoption requiring significant time and effort to

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master [20]. Central to addressing this challenge is the design of user interfaces, which play a pivotal role in facilitating human-centred smart housing. Effective operational panels [48] should support seamless initial setup and provide intuitive feedback—particularly regarding energy consumption—to enhance transparency [33] and intelligibility [10], thereby minimizing conflict and meeting user needs. Interfaces serve as the access point that conceals underlying system complexities [28], allowing users to "set and forget" the system after configuration [48]. Additionally, automated scheduling can reduce the frequency of user interactions, enabling a system to independently manage energy consumption by shifting usage to periods of high renewable energy availability, and so promoting sustainable operations without requiring behavioral change [7].

Future advancements in HCI for smart homes, aligned with the vision of ubiquitous computing [45], envision technologies operating in the background by predicting and inferring user needs. Advanced sensors and algorithms can further improve the system's capacity to recognize and respond to resident activity, particularly benefiting older individuals, by delivering tailored assistance as needed [7].

Heat pump adoption. Heat pump installations are growing across the world. For instance, the UK experienced 41% year-on-year increase in installations in 2023-2024 [26], and this is a persistent trend.

Households are motivated to adopt a heat pump due to a desire to improve the environment [12, 25], especially in the able-to-pay demographic. However, some studies suggest that households generally may not wish to pay extra for environmental improvement [12, 47], and that the decision to purchase a heat pump is based more around financial and convenience factors [13].

Uncertainty in policy, in addition to a lack of a clear heat decarbonisation pathway has been identified as a primary barrier to heat pump uptake globally [16, 29].

The Public acceptance and awareness of HP technology can also pose a barrier to widespread adoption, in the form of misperception and previous negative experiences of heat pumps, worsened by the perceived lack of reliable or trustworthy information [3]. Poor public understanding of the environmental and cost benefits of heat pumps is reported, even in advanced economies [21, 23].

Inconvenience is another public concern - heat pump installations often require major modifications when retrofitted [36], and demand a change in heating habits to achieve high performance [36]. Financial barriers are also significant [5]. EU studies have identified that the price ratio between alternative energy sources and electricity, as well as upfront installation costs are major barriers in the European heat pump market [34, 41]. To achieve a higher uptake of heat pumps, easier access to finance arrangements can also be beneficial [17].

Uncertainty in fuel and electricity prices as well as the higher initial cost of heat pumps also create a significant barrier and influence uptake. Existing market structures combined with public perception hinder the penetration of heat pumps. At the same time, high market share of gas boilers and cheap natural gas are among the biggest challenges facing HP deployment [44].

Furthermore, the widespread adoption of heat pumps in the future can be impacted by the limitations of the electrical network. HP's can potentially double the household annual consumption of electricity [38]. Further adoption of heat pumps will also increase electricity demand during peak periods, which in turn may require additional investment in electricity grid infrastructure. This effect on distribution grids and the increase peak winter loads may cause significant economic and environmental costs [18, 19].

Heat pump performance gap. The gap between the expected and actual performance of heat pumps has been documented in literature. In 2013, the Energy Saving Trust conducted comprehensive field trials [42] to assess the efficiency of heat pumps at 43 locations throughout the UK, supplemented by 35 in-depth interviews with heat pump users. This study monitored the performance of the heat pump system and the user's behavior and perceptions, and performed interventions to improve system performance halfway through the study. It found that the install and design of the heat pump was the most important factor in terms of efficiency, and user behavior was also demonstrated to have a significant impact. Interviewees were very satisfied with the space heating provided by their heat pump, with 80% of participants either satisfied or very satisfied. However, the average seasonal co-efficient of performance (SCOP)[1] in the study was found to be 2.8 for ground source systems and 2.45 for air source systems, which is considered well below the target range of between 3.5 and 4.5 [9].

Additionally, a study by Oikonomou et al. [30] identified a gap between perceived and actual HP performance. Based on a sample of 21 case studies in the UK, thematic analysis was used to identify underlying interactions between the HP system and users. Here too, findings show a gap between what is considered efficient in technical terms and the experience of users.

Theories on technology performance gap. When considering the technology performance gap (i.e., how well technology performs in situ vs how the manufacturers expect it to perform), one would usually consider socio-technical systems theories [40, 46] to see how the human, policy, and technical aspects may cause such performance discrepancies. However, in the present case, the observed gap is not influenced by external factors but rather by *individuals' perceptions of technological performance, which differ from the recorded actual performance of that technology.* Thus, this discrepancy is primarily driven by psychological perceptions and beliefs rather than systemic or environmental influences. The latter factors can cause discrepancies between a manufacturer's specified and actual performance, but cannot cause individuals to perceive something that is different from the reality. Therefore, we have turned to HCI research and cognitive psychology theories that explain such perception gaps and identified the work on Expectation-Confirmation Theory (ECT) [31].

ECT is a cognitive framework that explains satisfaction with and intentions to continue use of technology (referred to as *continuance* in ECT) by analysing the interplay between user's expectations, perceived performance, and the (dis-)confirmation of the user's prior beliefs about this technology. The theory suggests that the user's satisfaction is determined by the relationship between prior expectations and subsequent evaluations, with confirmation or update

[1]The seasonal coefficient of performance (SCOP) is a measure of how efficiently a heat pump performs during a heating season. It is defined as the ratio of the total amount of heat energy delivered to the total amount of energy consumed, usually over the period of a year. A higher SCOP means a more economical heat pump, resulting in lower running costs. A good SCOP should be at least 3-4 in current practice.

of the expectations impacting the user satisfaction. Where actual performance exceeds expectations the user is satisfied; where performance falls short of expectations, the user is dissatisfied. Yet, the expected performance has also a direct impact on the satisfaction, and that direct impact may cause a gap between evaluated reality and the actual satisfaction [31]. This is illustrated in Figure 1.

Expectation-Confirmation Theory (ECT) has been applied to study continued use of information systems, with continuance usage intention serving as the consistent dependent variable, while independent variables vary significantly due to the contextual factors specific to individual studies [1, 6, 11, 24]. For instance, in Bhattacherjee's study of online banking app use [6] the initial expectations coupled with perceived usefulness influenced sustained usage of the app. Others used ECT to explore continuance in e-learning apps [11, 24], mobile apps [35], and digital platforms [1], to name a few.

3 METHODOLOGY

This research uses a mixed-methods approach using data from 33 households in the Bristol city area in the UK, each with a heat pump installed. Of these, 21 consented to a semi-structured interview, and 28 filled out a pre-audit questionnaire. The study was approved by the University of Bristol ethics board, as well as the local city council. The study was initiated at request of the local city council in order to understand issues around heat pump installation, in preparation for planning an upcoming heat pump installation program across the city.

3.1 Participant Recruitment and Data collection

Participant recruitment. Given that in order to qualify for participation in the study, the householders needed to have a pre-installed heat pump, the recruitment efforts were directed through groups with known heat pump engagement. These included posting to a Facebook group (by the city council), to the local energy network group (by the group coordinator) and to the university's renewable energy-related malign list (by the researchers). The post invited local householders who had a pre-installed heat pump to take part in the study in return for a free audit of the heat pump. The interested householders were directed to a web page with information about the study, as well as with a calendar for booking the audit and research visit. The booking required signing a consent form. Upon booking, the householders were emailed the study information again, with option to change or cancel the booking, if they so preferred.

It is important to note that the recruited sample was neither representative of the general population nor intended to be. Instead, the research focused on local early adopters of heat pump technology. Given that the heat pumps were and are still quite expensive, these householders were considered to be 'able to pay' (i.e., likely to be at the top third of the city's earners, not other two thirds). Thus, though these findings may not generalize to the broader population of the city as a whole, they provide valuable insights into an influential user group as well as the installation quality of the heat pumps.

Data collection was carried out through several instruments, in collaboration with a qualified heat pump auditor and the local city council. First, 33 participants were asked to complete a pre-audit survey, comprising nine Likert scale questions, as well as free text comments (see Supplementary Materials: Appendix A), of which 28 gave complete information. These questions were intended to assess user perceptions, knowledge, and self-reported satisfaction regarding the heat pump systems. Following the survey, a home visit was arranged for all participating households, whereby (after written self-registration and confirmation of the visit and research terms by the householder) a qualified (and city council approved) auditor and an accompanying researcher visited the household. During the visit, the researcher conducted 21 semi-structured interviews, each lasting between 30 and 60 minutes (see Supplementary Materials: Appendix B). While, at the same time, the auditor carried out installation quality review for the heat pump against a list of 32 installation related issues. Post visit, the reports were submitted to the householders, informing them on the installation quality and issues to be addressed. The interviews were transcribed, anonymized, and analyzed. Relevant excerpts from the interviews were also codified into binary variables to enable integration into the broader data analysis framework, as were the audit checklist records.

The exclusion criteria for the quantitative segment of the study are listed in Table 1. Complete information could only be acquired for 15 of the 33 study participants, primarily due to the inability to collect performance (SCOP) readings from the heat pump control panel.

Table 1: Exclusion criteria for the statistical analysis.

Exclusion criteria	No. of participants that meet criteria
All participants	**33**
Completed audit	**33**
Completed pre-audit questionairre	**28**
Completed interview	**21**
Able to record SCOP of heat pump	**15**

3.2 Data analysis

A mixed-methods analytical approach was employed to explore the variables affecting heat pump performance and user satisfaction. We first carried out thematic analysis [8] of the interview data to identify recurring themes in participant responses. The qualitative coding was carried out iteratively by 2 researchers, until an agreed coding schema was arrived at. This process helped us identify the core topics on living with a heat pump at home, and also led to theorizing about a number of relationships between use, satisfaction and performance.

Subsequently, exploratory statistical analysis was conducted to test three hypotheses formulated based on the findings from the qualitative data analysis. For all tests, the null hypothesis (H_0) stated that no significant relationship exists between the specified variables. The formulated alterative hypothesis then are:

- H_1 Perceived efficiency is positively correlated to actual efficiency.
- H_2 Perceived efficiency is positively correlated to comfort.

H_3 Actual efficiency is positively correlated to comfort.

Table 2 defines the variables used in the hypothesis and their source from the data collection. For each hypothesis, we assessed both the statistical significance and the magnitude of the association between the examined variables. The strength of these relationships was evaluated using the Pearson correlation coefficient, a parametric statistical measure suited for assessing the linear correlation between the two independent variables. This approach was selected due to the relatively small sample size, which limits the statistical reliability and generalizability of the results. To illustrate the statistical significance of the findings, p-values are reported alongside the correlation coefficients. Furthermore, to mitigate the risk of inflated Type I error rates associated with multiple comparisons, the Bonferroni correction was applied (alpha value). This method adjusts the significance threshold according to the number of simultaneous tests conducted on overlapping variables, ensuring a robust analytical framework while addressing the family-wise error rate (FWER) concerns [37].

Table 2: Hypothesis components: variables, types, and sources.

Variable	Description	Data type	Data source
Perceived Efficiency	The rating given by the participants of how cheap they think the HP is to run.	Likert scale (1-5)	Pre-audit questionnaire
Actual Efficiency	The SCOP reading from the heat pump's control panel. For every unit of electricity consumed by the HP, the SCOP notes the corresponding production of heat.	Numerical	Audit checklist
Comfort	The rating given by the participants of their level of thermal comfort.	Likert scale (1-5)	Pre-audit questionnaire

4 FINDINGS

4.1 Thematic analysis

The thematic analysis led to development of a 8 main themes: Factors for HP choice, Investment, Installers and Installation Process, Handover Process, Maintenance, Satisfaction of Users, HP Use Patterns, and Next Steps Post Adoption. This paper will only discuss extracts relevant to the topic of study (factors that impact the gap in perception and performance as per ECT). Therefore, only 2 themes were used as findings below. Comments regarding HP expectations pre-installation were extracted from the theme of Factors for HP Choice, whilst comments on the perceived efficiency and satisfaction of users were extracted from the main theme of Satisfaction of Users.

4.1.1 ***Heat pump expectations pre-installation.*** Users were asked about the motivations for installing their heat pump, and their expectations of what it would provide them. **Reducing fossil fuel emissions** and **benefitting the environment** are listed as the **primary motivation** for HP install by the majority of (12 of 21) participants. For instance, Participant 12 stated: *"We wanted to do it for environmental reasons, basically."* And Participant 13 noted: *"The fact it's zero carbon is that was the overwhelming reason why we did it."*

The **expectation** that installing heat pumps would contribute to climate change mitigation is the driving factor for such installs in this sample, with factors such as **cheaper bills** (5 of 21), **comfort** (2 of 21), and **energy security** (2 of 21) also listed as motivations.

Thus, the study participants were motivated to install a heat pump based for comfort and environmental protection. Whilst **cost** is considered, in the thematic analysis it does not appear to be the main driving factor, as the householders state that installing a heat pump does not make financial sense in isolation. Instead, participants expect positive externalities (environmental, comfort) and are prepared to contribute toward this with the additional expenses. Indeed, 14 participants were asked whether the HP was a worthwhile financial investment. Of those,

- Three stated that it wasn't. For instance, Participant 1 said: *"I don't think we will save money over [heat pump's] lifetime".* For these 3 respondents, gaining a financial return from the installation was not a motivational factor to start with. This is re-iterated by Participant 7: *"That was never the point for us [. . .], we didn't install the heat pump and get rid of the gas boiler for financial reasons."*
- The other 11 participants spoke positively about the effects of the HP on their long-term finances, with the availability of **grants**, **cheaper bills**, and increased **house valuations** cited as significant factors. For instance, Participant 12 said: *"Our EPC [Energy Performance Certificate] has gone from a D to a B, [. . .] which nowadays is a big plus when trying to sell a house and adds value".* Participant 10 added: "It costs nothing. The grant covers the whole cost", and Participant 11 agreed *"It pays itself back [in bills savings] over seven years of having it, which works well"* .

4.1.2 ***Perceived efficiency.*** Many of our study participants believe their HP is efficient. For instance, Participant 21: *"I think it is [efficient]"*, and Participant 4: *"I think it does [perform efficiently]"* . However, this perception is based upon very **limited knowledge of the system** – of the 33 audit reports, only 15 are able to view the actual efficiency (SCOP) of the HP, and even then, participants do not know what value of the performance coefficient is considered to be 'good'. This intuition-based evaluation is often incorrect when compared to the actual efficiency of the system (see section 4.2). In our sample performance at SCOPs of 2.5 and lower are reported, which is below stated technical performance expectations for an efficient HP. This lack of knowledge mixed with optimistic expectations often displayed in our study sample can be surmised in a statement by Participant 10: *"Yeah, I think it's energy efficient. I can't really tell if it's energy efficient".*

4.1.3 ***User satisfaction of heat pump adoption.*** Householder's satisfaction with their heat pumps can be expressed in two ways: the level of **thermal comfort** a user experiences, and the **cost in bills** they pay. 14 of the 15 participants were satisfied with the warmth provided by the heat pumps. Users have a notably lower satisfaction with running costs - 6 of 15 participants claim the heat pump is cheap to run, whilst 4 of 15 say it is expensive to run.

4.2 Exploratory statistical analysis

The summary of the results from the analysis is presented in Table 3, and is discussed below.

Table 3: Summary Results of Explorative Statistical Analysis

	Variable 1	Variable 2	R value	p value	alpha value
H_1	Perceived efficiency	Actual efficiency	0.451	0.141	0.025
H_2	Perceived efficiency	Comfort	0.588	0.0443	0.025
H_3	Actual efficiency	Comfort	0.5	0.098	0.025

H1: Moderately positive relationship between perceived efficiency and actual efficiency. There is a moderately positive effect (R = 0.451) observed in regards to perceived and actual efficiency. In other words, the user who believes their system is efficient is more likely to have an actually more efficient system.

The moderate magnitude (0.451) of the relationship can still be considered lower than expected, as there is a considerable gap between perceptions and reality. The qualitative analysis suggests an explanation for this: Some respondents understand how to view SCOP figures and what they mean, and so their perception is positively influenced by this. Others, who either cannot view their SCOP figure or do not understand what it means, rely on a "best guess" that is not based on technical performance. This is illustrated, for instance, with opinions from Participant 9: *"[I don't know] how to check [the efficiency]"*; *"I like [that it's] being efficient"*.

H2: Moderately positive relationship between perceived efficiency and comfort. The strongest relationship was observed between perceived efficiency and comfort (R = 0.588), with a statistically significant p-value of 0.0443. This indicates that user satisfaction with their heat pump systems is heavily influenced by their perceptions of efficiency, even more so than by objective performance metrics. This finding underscores the importance of user expectations in our sample: the more convinced (for real or imaginary reasons) the users are that they HP is efficient the more satisfied they are with it.

H3: Moderately positive relationship between actual efficiency and comfort. A moderately positive relationship (R = 0.500) was found between actual efficiency and user-reported comfort levels. This suggests that improved technical performance translates into improved thermal comfort. However, the p -value of 0.098 indicates that the relationship does not reach statistical significance at the chosen alpha level, highlighting the potential influence of other subjective or environmental factors on comfort perceptions.

5 DISCUSSION

Having explored the motivations of participants for heat pump installations, their beliefs regarding the system's financial viability, and their perceived comfort through thematic analysis, we then defined a set of hypotheses to explore the quantitative relationships between these variables, as we explore the relevance of expectation-confirmation theory for our research question.

As shown in Fig.1, the theoretical relationships of ECT are driven by expectations and perceived performance of the technology. These are evaluated through the practical technology use resulting in (dis)confirmation of expectations, which then forms the satisfaction level of the user. However, the perceived performance itself also has a direct impact on user satisfaction.

We have previously (see section 4.1) discussed the motivations which form our study group's expectations of positive environmental impact and financial relevance of the heat pumps, their perceived performance of these systems, and their rating of the comfort in using HP's. Fig. 2 shows how the hypothesis formulated in section 3 and evaluated in section 4.2 map to the ECT framework. Overall, we observe that there is moderately well established evidence from these results that the responding group:

- has expectations of *positive environmental impact from heat pumps* (as evidenced with the *benefiting environment* theme being the prime motivation of HP installation, discussed in 4.1.1). They also believe in the long term financial viability of heat pumps (due to cheeper bills, use of grants, increase of house value, see section 4.1.1), though for some respondents even financial viability is tramped by the expected environmental impact (e.g., P7 *"…we didn't install the heat pump …for financial reasons…"*).
- believes that their heat pumps *exhibit good performance*, (see section 4.1.2).
- is *satisfied with their heap pump performance* having been using it for some time in their homes (as noted 14 out of 15 participants were satisfied, see section 4.1.3).

In reality, the heat pumps perform much poorer than they should (proscribed average SCOP of minimum 3 as per manufacturer specifications, observed average SCOP of 2.7 in this study). This data was collected from the HP's during the audit. Yet, our study group does carry on believing that their HPs perform a lot better (e.g., P17 claimed he was very satisfied with his heat pump's performance, whilst actual SCOP of HP in his home was observed to be 2.6). In short, **the impact of the perceived efficiency (H2 in Figure 2) drives their satisfaction, which explained the gap between the much poorer real performance and their self-reported expected performance for our study group.**

As noted previously, our study participants are from the able-to-pay user group with a particularly high focus on the environmental impact of their energy use. As a result, they have a uniquely positive perception of heat pump technology and its use to provide comfort, environmental protection, and, for some, reduce energy bills. This implies that given all these preconditions (i.e., financial ability and environmental focus), the users would be willing to adopt heat pumps without real concern about their actual performance.

On the other hand, this theory implies that all other (prospective) users in the given locality[2] could be dissatisfied with their

[2]While the heat pump technology itself is well tested and proven to be performant, local issues, such as poor install quality due to lack of qualified installers, lack of configuration of thermostats after installs coupled with lack of users' skills to update them and alike, will have significant impact on how well that technology performs in a given locality

HPs, given their locally observed lower than average technical performance.

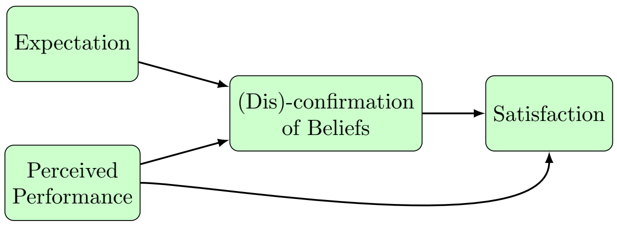

Figure 1: Expectation-Confirmation Theory.

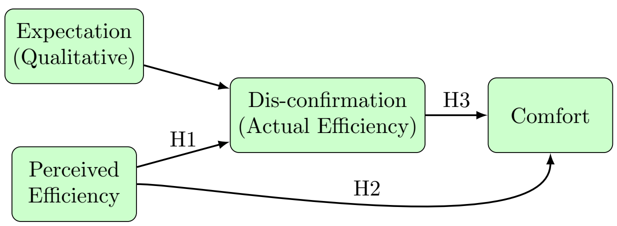

Figure 2: ECT diagram mapping.

We also observed that 18 out of 33 participants in our study were unable to view their seasonal HP coefficient of performance (SCOP) due to errors in installation (e.g., screen on HP not accessible), or lack of technology understanding (did not know where to look or for what).

Without a clear understanding of efficiency indicators, and limited technical knowledge, users often resort to "best guess" assessments. This gap in understanding could lead to an overestimation of system performance, as is in case of our study user group, or underestimation of it. This misalignment underscores the importance of improving the HP interface design, contributing to the body of this work [9, 10, 48] with the specific impact that lack of clear measurements and feedback mechanisms can have through the ECT lens.

Similarly, improving user education and installation quality, as well as ensuring that installation processes include detailed handovers, is necessary to bridge the gap between perceived and actual performance. Addressing these challenges is crucial for enhancing objective user satisfaction (i.e., that is based on actual good performance) and maximizing the environmental and economic benefits of heat pump technology.

6 CONCLUSIONS AND FINDINGS VALIDITY

This study explains the previously observed gap of the perceived vs. actual performance gap in heat pumps using Expectation-Confirmation theory. We note the critical role of the visibility of actual HP performance (i.e., its SCOP results) and good feedback to the user for the true quality and relevance of this technology to evolve.

However, we must note that this study is limited by a relatively small sample of self-selected participants, comprising 33 "able-to-pay" households from the Bristol city, UK. Nonetheless, our results offer a robust framework for explaining the perceived and actual performance gap. Furthermore, the investigation focused exclusively on a single demographic: early adopters of heat pump technology, who are primarily motivated by environmental and non-financial considerations. As such, the conclusions drawn from this research are not intended to be representative of the broader population or other user categories. Study of such populations and scaled review for each population itself are future directions for our research.

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