Survey and Design Process: Q-Bot

Project lead:

Q-Bot

Partners:

n/a

Contact:

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Funding:

£782,665

What were the objectives of the project?

The 'Free Heat Pump Home Survey and Design Tool' project aimed to deliver an easy-to-use tool which is free for homeowners and enables customers to find suppliers to install a suitable heat pump for their home. The project aimed to build and test a Free Heat Pump Home Survey and Design Tool and a user interface. In particular, the project aimed to:

- Reduce the **time and cost of pre-installation surveys** by allowing **consumers to collect relevant household data** using a **handheld Light Detection and Ranging (LiDAR) device or a LiDAR-enabled smartphone**.
- Provide consumers with **multiple retrofit options** by assessing the **interactions between heat pump installation and fabric improvements** and identifying suitable retrofit packages using **artificial intelligence (AI) and machine learning** techniques.
- **Connect customers with suppliers**, coordinators and installation contractors via the tool to further **streamline the customer journey.**

What activities were funded?

- The project first identified customer needs, analysed the competitive landscape, and developed product specifications, identifying a gap in user-friendly tools for homeowners that consider both heat pumps and retrofit options together.
- In the second stage, the foundational architecture of the tool was constructed for data inputs, storage, and utilisation alongside the survey tool
- Sensors and smartphone capabilities were assessed to evaluate the data capture potential of these technologies
- A rules-based design engine and testing framework was created, delivering a comprehensive suite of test cases alongside a risk register framework to help stakeholders assess risk along the retrofit journey

- The project integrated machine learning, utilising various datasets to generate appropriate retrofit packages
- The project developed the customer interface and integrated with the Parity Projects API[1] for property recommendations whilst prioritising ease of use for the target audience

What did the project achieve?

Project research found a need for user-friendly tools for homeowners, identifying a gap in the market for the proposed solution that easily connects customers with heat pump installers. Sensors and smartphone data collection were not adopted as these were deemed too complex, and customers favoured a simple and quick solution. The survey tool architecture was developed based on the Parity Projects API to return data for a given property address, significantly speeding up the initial consumer survey process and accelerating the customer journey. Machine learning techniques were used to improve accuracy and optimise heat pump installations and retrofit measures. The result was a completed, simple, and easy-to-use tool that was ready for (pending commercial agreements) homeowners in the able-to-pay market.

[1] Parity Projects uses data science, software and analysis to help its clients deliver energy efficiency efficiently and effectively. They have developed an extensive database of the current energy efficiency of individual properties in the UK housing stock, which, via their API, can enable recommendations to be made on future retrofit options.

Objective 1: Reduce the time and cost of pre-installation surveys by allowing consumers to collect relevant household data using a handheld Light Detection and Ranging (LiDAR) device or a LiDAR-enabled smartphone.

Why is this important?

The operation of a heat pump is more sensitive to the physical characteristics of a household than a traditional gas boiler is. Therefore, accurate estimations of household data (e.g., glazing, insulation levels) are required to size and specify a heat pump solution. Conducting home surveys is the traditional method of obtaining these data points but is a time and resource intensive activity for installers and involves disruption for homeowners. The upfront cost and resource requirement of these surveys can be a deterrent for would-be consumers, and it simultaneously reduces installers' availability. The ability to minimise the time and cost involved whilst not impacting quality is an area of innovation that benefits multiple stakeholders in the value chain and has the potential to both speed up the customer journey and reduce costs.

What activities were funded?

Different sensors and smartphone-enabled capabilities were assessed for their ability to capture key building data. The sensors available on the market at the time of the project and the latest smartphone models were assessed with the help of a third-party architectural firm, Constructive Thinking. A case study property was used to capture various data and assess the current state of the property and how that data could be used to inform a retrofit proposal. 3-dimensional data of the property (e.g. room volumes and window sizing) was captured using a smartphone, a Leica BLK360 scanner and Q-Bot's proprietary 360 combined thermal and LiDAR scanner.

The data was collated, combined with the 2-dimensional data collected about the property (e.g., floorplans, EPC data), and shared with Constructive Thinking. Next, this data was assessed, the energy consumption modelled, and used to determine the property's heat loss for heat pump sizing.

What were the project findings and did the project achieve this objective?

LiDAR technology has the ability to generate fast and accurate room scanning but can also be complicated to navigate, especially for new, unfamiliar customers. Testing with able-to-pay homeowners indicated that the key differentiator between the Q-Bot site and other products on the market was the potential simplicity of its interface and required homeowner input. Therefore, during the project, the focus on LiDAR scanning was adjusted to reduce the complexity and facilitate the simple and easy-to-use approach preferred by homeowners, supporting a higher uptake from consumers. The tool has now been built and tested across multiple house types and is still capable of all the other points stated in the objective despite this shift in initial scope away from LiDAR technology.

Objective 2: Provide consumers with multiple retrofit options that include heat pumps and fabric improvements, using artificial intelligence (AI) and machine learning techniques to improve speed and accuracy.

Why is this important?

Appropriately sizing a heat pump is important to ensure user comfort and optimise costs – an undersized heat pump may not be able to meet the heat demand of a household, and an oversized heat pump will cost more upfront and operate sub-optimally, increasing energy bills. Heat pumps are sized based on the thermal properties of a household, and fabric improvements can be made prior to heat pump installation to influence the required size and potential operating performance. Many retrofit combinations can, therefore, be available to a consumer, all with different capital requirements, ongoing costs, and potential disruption. However, many existing tools do not consider the interactions between heat pump installation and ancillary energy efficiency measures.

Identifying these options and communicating them clearly to a consumer creates informed consumers who can make decisions appropriate for their circumstances. AI and machine learning techniques offer the potential to improve the accuracy and speed at which these recommendations can be made.

What activities were funded?

Analysis of heat pump specifying tools was conducted to understand the capabilities of existing tools. In tandem, stakeholder mapping was performed to understand consumer motivations, challenges and needs. These activities informed the product specification and design as well as the final business model and value proposition. User testing was carried out to test the assumptions and make iterative improvements.

A data lake (large database) of various open-source datasets, proprietary retrofit survey data, and the Parity Projects' API data was created. The data lake contained information on the UK housing stock across various building archetypes (inc. age, construction type), energy efficiency performance, and location. Much of the open-source data was of too poor quality for the required purpose, so extensive data cleaning was required. The latest machine learning, artificial intelligence and deep learning techniques (inc. learnt decision trees, collaborative filtering and graph-based classification) were reviewed to assess their suitability for providing appropriate retrofit packages based on the data lake, household-specific data provided by the consumer, and the automated heat loss calculation.

What were the project findings and did the project achieve this objective?

Self-supervised learning with graph-based classification was highlighted as a key emerging technology that could support the fast and accurate creation of property recommendations for improving energy efficiency. While straightforward cases yield clear outcomes – for example, properties with solid concrete floors can't be suggested to install underfloor insulation – subtler requirements pose challenges for standard software procedures. Subjective factors like region and residents' choices also influence recommendations. Algorithms must learn relationships rather than rely on rigid rules, making AI an appealing solution. Learnt decision trees, collaborative filtering and graph-based classification were all approaches that were assessed and tested on small sample datasets. Graph based classification was selected as the most promising approach and was taken forward into

implementation, testing and integration. The project delivered on its objective to incorporate machine learning, and recommendations will improve as more data is incorporated into the tool.

The main takeaway from the customer testing was that the initial interface, which was designed to convey lots of information to the homeowner, was found to be too complex. The majority of customers felt that the level of information presented back about the current state of fabric measures was too confusing. Some customers wanted to skip to the suggestions whilst others (retrofit customers) wanted more information. The interface was, therefore, redesigned following the feedback to provide a balance of being simple and easy to use whilst still providing the desired level of detail via the incorporation of drop downs and expansions from a simplified default path. The interface is now easy to navigate for non-experts, whether it delivers sensible suggestions is something that will improve over time as more data is available.

Objective 3: Connect customers with suppliers, coordinators and installation contractors through the tool to further streamline the customer journey.

Why is this important?

The current customer journey for heat pump and retrofit installations requires a lot of effort on the part of the consumer when it comes to finding suppliers. It can be a very time consuming and complex task to navigate the installer landscape and find reputable, qualified and affordable suppliers that can install a heat pump alongside any refurbishment works. By connecting customers with potential contractors directly through the tool, the time, effort, and stress required by the customer is greatly reduced, and the contractors also receive a qualified lead, which reduces the time and effort on their side. This feature of the 'Free Heat Pump Home Survey and Design Tool' streamlines the customer journey and can potentially reduce costs for both the customer and supplier.

What activities were funded?

Q-Bot undertook a market analysis as part of its business plan review, which investigated the pain points for homeowners, finance providers, landlords, retrofit contractors, and retrofit coordinators. This exercise highlighted the current friction areas and potential drop-offs in the customer journey, and the opportunities for these to be eased via the use of the tool. For instance, when a homeowner contacts a contractor to discuss installing one of the recommended measures, the cost quoted is often 30–60% higher than the generic advice due to required enabling works (e.g. adjusting service locations to enable external wall insulation), resulting in a high drop-out rate. The tool would provide the customer with a more accurate initial cost to avoid this. The business model and value proposition canvases were sketched out with key assumptions drawn out and prioritised for customer testing. It was important that the tool be marketable to both customers and suppliers, so a market scoping exercise was carried out to develop the proposition further. As the software developed, Q-Bot used some of its homeowner users and existing suppliers to provide feedback on the user experience to help with iterative improvements.

What were the project findings and did the project achieve this objective?

Q-Bot have achieved their objective of streamlining the customer journey through their free app for customers. The app has been developed to be used by homeowners to check retrofit options and costs as well as retrofit surveyors and contractors to secure commitments before full surveys are conducted. Whilst the consumer research demonstrated that the app needs to be free for homeowners to enable uptake, it will require a small fee from contractors to finance the proposition and enable a sustainable business model..Homeowners can now select a local trusted contractor from a suggested list to proceed with the work and have confidence in the quality since the contractor is required to upload evidence of having installed it correctly. The creation of validated sales referrals through the tool means that contractors can spend less time travelling to surveys and preparing quotes for clients that ultimately do not go ahead with the work. The market analysis demonstrated that initial quotes can often be underestimated, which reduces the success rate when an installer quotes a higher cost based on detailed information. Through using the app, suppliers will now be able to gain clients who have an appreciation of the budget required and are serious about proceeding, since robust initial costings and information will have already been presented to them. The development of the tool and iterative feedback from user testing has enabled a streamlined quote/survey process resulting in a faster

turnaround for the client and greater profits for the contractor. The ambition is to roll out the app nationwide, however, to give the early release the best chance of success it was decided that the app will first focus on Greater Manchester to take advantage of an existing supply of available contractors. The proposition will be rolled out to a wider geographic area as the tool develops.

Potential further research

Opportunities for future research

The 'Free Heat Pump Home Survey and Design Tool' project has identified several areas that would benefit from further research. These were unable to be explored in the scope of this Heat Pump Ready project but represent opportunities for future investigation. These include:

- **Engaging with installers**: The project developed a tool to streamline the customer and installer journeys. However, further work is necessary to incorporate installer feedback into the tool's development to ensure the tool maximises benefits to installers. In contrast to customers, installers tended to request more detail (of the property and proposed measures) in the tool so a balance may need to be found with detail over simplicity and ease of use. More research in this area could support future versions of the tool and other tools being developed.
- **Installer costs**: The tool's commercialisation will require a small fee for installers. However, a more detailed understanding of the acceptable costs for installers is required. Research is required to understand if any of these costs would be transferred to customers in order to accurately quantify the net cost savings of the tool from a customer perspective.
- **Time and cost savings**: The project aimed to save both time and cost in the installer and customer journeys, though this was not quantified. Quantifying the tool's savings against the business-as-usual counterfactual approach would help the tool's commercialisation and aid others looking to develop a similar tool.
- **Customer drop-off points**: The project identified the survey stage as a key drop-off point in the heat pump customer journey. This was deduced from the project team's experience within the sector, but there is a lack of data to substantiate the proportion of customers who consider the heat pump survey process a barrier. Further research into customer drop-off points and the contributing factors could support the future development of the tool.

Summary:

What impact will this have?

The simple and free-to-use app requires homeowners or surveyors to fill in a 15-minute survey, a short questionnaire, and it also pulls from background data. The app then helps the users to understand a building, generate heat loss calculations, and explore various installation options (including radiator sizing) with appropriately sized heat pumps and initial costs. The app also provides links to installers, which could then lead to securing initial commitments from customers for a heat pump installation with approved contractors. This adds a new tool to the market that bridges the gap between the current heat pump focussed tools that don't include retrofit options and those more aimed at the retrofit market where heat pumps are only sometimes an option. This tool also uses machine learning to increase the speed of recommendations and improve the accuracy of the recommendations over time as more data is added.

Next steps:

The site is live in production and poised for launch pending the finalisation of commercial agreements. The next steps involve initiating a marketing campaign (initially targeting the Greater Manchester geographic region), closely monitoring post-launch success, and further developing the technology to enhance retrofit suggestions. The technology will continue to develop, with the RetrofitAI module building functionality to produce better retrofit suggestions, eventually replacing the need for the Parity Projects API.

Where to find out more

More information related to this project can be found on the Q-bot website and the Heat Pump Ready programme website.

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