

Awareness and behaviour of occupants' of existing dwellings to ventilation and indoor air quality

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MSc Sustainable Construction

Year 3 – Dissertation

Declaration



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I hereby confirm that this dissertation is the result of my own investigations, except where otherwise referenced.

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Abbreviations

BEIS	-	The Department for Business, Energy & Industrial Strategy; <i>formally DECC</i>
BREDEM	-	BRE Domestic Energy Model
DECC	-	The Department of Energy & Climate Change; <i>became BEIS in Jul 2016</i>
DCLG	-	Department of Communities and Local Government; <i>became MHCLG Jan 2018</i>
ECO	—	Energy Company Obligation
EPC	-	Energy Performance Certificate
IAQ	-	Indoor Air Quality
MHCLG	-	Ministry of Housing, Communities and Local Government; <i>formally DCLG</i>
NHMP	-	The National Hydrological Monitoring Programme
Ofgem	-	Office for Gas and Electricity Markets
SAP	-	Standard Assessment Procedure
WHQS	-	Welsh Housing Quality Standard
WHO	-	World Health Organization

Abstract

After three decades of influence promoting improvements of energy efficiency in new and existing housing stock, driven by the need to limit greenhouse gas emissions, improve energy security and tackle fuel poverty, existing dwellings have been modified and new dwellings have been constructed to use less energy. This has been achieved through installing energy efficient measures and increasing airtightness. Whilst the benefits of reduced energy consumption are well documented the effect these measures have had on the dwellings ability to provide ventilation is little understood, particularly from the perspective of the occupants'' living within them. This study of participants predominantly from social housing tenured dwellings finds a lack of awareness and value towards correctly managing the ventilation strategy of their homes. This study finds this opinion is not limited to social housing tenants it also applies to greater demographic of owner occupiers. Despite efforts of social landlords to install ventilation components particularly mechanical extractor fans above legislative requirements, tenants will still choose not to use them. Unless a greater strategy in highlighting the importance of correctly ventilating homes, the likelihood of negative impacts on occupants' health will increase.

Chapter 1 – Introduction

1.1 Introduction

The purpose of this research study is to evaluate the awareness, value and behaviour pattern of occupants'' living in dwellings that have been constructed or adapted to meet energy efficiency targets driven legislative influence to reduce greenhouse gas emissions, improve energy security and tackle fuel poverty (DECC, 2012).

Despite the number of recent studies highlighting the issues associated with airtightness and changes to legislation promoting ventilation strategies in domestic dwellings, evidence regarding occupant's awareness of their role towards maintaining good indoor air quality remains limited.

The aims and objectives of this research study is to assess the level of understanding how households' interact with their ventilation systems. This study evaluates the impact these measures have made on dwelling occupants'', how it effects their awareness behaviour and values towards maintaining a healthy living environment. Along with a brief account of how existing dwellings constructed before the 1980s have been modified to meet current regulations and energy efficiency targets. The scope of this study involved visiting households' of dwellings which have been constructed or retrofitted with energy efficient measures, to question their awareness, value and behaviour towards ventilation strategies.

1.2 Types of Ventilation in domestic dwellings

There are a number of ventilation systems incorporated into dwellings, infiltration and purpose built ventilation. Infiltration is deemed the uncontrollable flow of air between the inside and outside of a dwelling through gaps and voids (MHCLG, 2010), for example around windows, doors, loft hatches.

This research looks at purpose-built ventilation based on: Trickle vent/ slot vent, windows and doors with vertical or horizontal hinged openings, mechanical extractor fans (manually operated/ automatic or humidistat sensor).

Design requirements for ventilation can vary from occupants' needs to ventilate a dwelling. Occupant's needs are influenced by subjective factors to limit discomfort and health issues, using perceived knowledge and habits towards indoor air quality (Dongen, 2007).

Design requirements consist of: providing oxygen for metabolism and to allow combustion of fuel burning appliances, remove pollutants via dilution to include gases (CO, CO₂, radon), water vapour, particles Volatile Organic Compounds (VOC's), tobacco and thermal comfort (cooling), (Dongen, 2007).

Reasons why occupants' do ventilate dwellings: to allow fresh air into the dwelling, removal of unpleasant odours, removal of condensation and moist air to provide cool air during domestic activities and removal of tobacco smoke.

Reasons why occupants' don't ventilate dwellings: to prevent draughts, protect occupants' from external weather conditions (i.e. wind, rain, cold), limit external environmental issues (i.e. noise and pollution) , maintain temperature levels at comfortable level, maintain security and privacy and reduce energy costs of heating system (Dongen, 2007).

This study is based on questionnaires completed by residents living in South Wales carried out by a researcher whilst visiting Participants' in their homes, along with observations made by the researcher during the visit. Additionally a separate survey was conducted using online direct email, open social media platform "Facebook" and work-based social media platform "Yammer". This study was conducted between February and April 2018. Technical detailed analysis of how buildings have been constructed or changed to meet current energy targets, and analysis of actual air quality within dwellings, this is beyond the scope of this research.

Chapter 2 – Literature Review

2.1 Literature Review

The importance of good ventilation in buildings has been acknowledged throughout history, the Bible makes reference to the treatment of dealing with mould in dwellings (Leviticus 14, 34-57). The word 'Ventilation' originates from the Latin word 'ventilare' which means 'to expose to the wind'. Therefore to 'expose a building to the wind' is to reduce the build-up of harmful air pollutants created by the occupants'' such as carbon dioxide, methane, volatile organic compounds (VOC)'s and pollutants by the building itself: radon, formaldehyde and allergens from dust mites (Sundell, 2004). As people spend more than 90% of their time in manmade environments such as buildings, ventilation of buildings is therefore fundamental to the health, well-being and comfort of its occupants'' (Awbi, 1991). Traditionally fire was used a means of forced ventilation in buildings by utilizing a vertical flue known as chimney. Whilst chimneys have been used to heat and ventilate buildings for millennia, it wasn't until the in the 16th century treatise by Nicolas Granger who published *La Méchanique du feu* (The mechanics of fire) in 1713 as a means of ventilating underground mine and tunnels. Fires would be lit near the surface of a mine shaft, the resulting rising hot air would draw foul toxic air from below, in conjunction with an adjacent ventilation shaft which would draw fresh air down from the surface to the miners working below. Similar principals were employed in buildings, fires used to cook food and heat rooms were incorporated into chimneys. Foul air from rooms would be drawn up the chimney, replaces by fresh air drawn from under doorways, windows, and gaps in floor boards (Addis, 2007). Occupants'' would appreciate the benefits of comfort provide by the heat but not the cold drafts of the ventilation. Domestic furnishings and furniture was designed to minimise the effects from drafts, to include heavy curtains and wing chairs (Anon., 2018). Ventilation was incorporated within the building design, including open chimneys, wall vents, window and door openings, without incorporating draft proofing. This method of self-ventilation (uncontrolled infiltration) required limited input from the occupants'' to ensure good Indoor Air Quality (IAQ) to be maintained. This method of heating and ventilation remained common places up to the early 1960s, with solid fuel accounting for over 76% of UK household energy use. The introduction mid-1960s of cheap, clean and more convenient energy, in the form of natural gas discovered in reserves in the North Sea, saw a sharp decline in solid fuel use. By 2011 solid fuel energy accounted for less than 3% UK households' (Uterley & Shorrock, 2012).

The demise of the domestic chimney at this time was due to a number of factors:

- Smoke pollution as a result of inefficient burning of fuel (Closmann, 2004).
- Major shift in domestic energy fuel use from coal to natural gas,
- Increasing costs of maintenance associated with cleaning and repairs.
- Dampness caused by condensation or faulty roof finishes (Carillion, 2001, pp. 49-51).

This time saw the introduction of energy efficient building fabrics such as Unplasticised polyvinyl chloride (uPVC), used for roof boarding, pipework, but primarily for windows and doors. Windows and doors incorporated double glazing, insulation and draft proofing which increased the building air tightness. These measures were used in new build and extensively in existing dwellings from the early 1980's, due to thermal comfort, energy efficiency and perceived low maintenance requirements. Bathing patterns changed too, more people shower in the UK more than ever before (Hand, et al., 2005) due to the introduction of showers made bathing quicker and more convenient.

During the oil crisis of 1970s there became a focus on fuel conservation in the UK, with trials for energy efficient homes (Everett, et al., 1985). This followed by building regulations dictating energy efficiency requirements by increasing levels of insulation and reducing levels of uncontrolled infiltration (Stephenson, 2001).

Since John Desaguliers invented hand held centrifugal fan in 1734, this design was developed to ventilate buildings, one of the first being the House of Commons in 1736 (Tomlinson, 1852). These fans were initially powered using manual labour and later using electricity from 1889 by Philip H. Diehl adaption of Schuyler Wheeler's 1882 invention of the electric fan (Sterjova, 2017). Even at this time Tomlinson (1852), noted "it is difficult to persuade men that respired air can be foul when not visible to the eye". It is difficult for humans to detect indoor air quality through sight and smell alone, this can increase the risk of chronic diseases (Kim & Paulos, 2010).

Occupants' have responsibility for the management of buildings water, heating, ventilation and appliances in a way that does not cause detriment to their or other occupants' health or to the fabric of the building, nor to encourage dampness and mould growth. Building guidance and Regulations do not sufficiently highlight the importance to prevent dampness and control moisture (WHO, 2009a). Occupants' of dwellings that are damp and mouldy are at increased risk of health issues including respiratory symptoms and infections, allergic rhinitis and asthma (WHO, 2009b).

As people spend more than 90% of their time in artificial environments, primarily dwellings (Sundell, 2004), the behaviour of occupants'' living in modern and refurbished dwellings towards moisture and ventilation, can have an impact on their health and that of the building fabric (WHO, 2009a). The 'rebound effect' where occupants'' of modern and refurbished dwellings with energy efficient measures choose to enjoy higher indoor air temperatures along with reduced rates of ventilation for increase comfort level, meant that perceived energy savings were not realised (Guerra Santin, 2013). Almost 40% of housebuilders are concerned high levels of air tightness and lack of ventilation will encourage damp and mould growth leading to chronic respiratory health issues (Davis & Harvey, 2008), low permeability may lead to an increase in indoor air pollutants (Milner, et al., 2015). A questionnaire commissioned in 2008 by the OTB Research Institute for Housing in the Netherlands completed by 313 households' found almost all barely used the mechanical extract ventilation system (Guerra Santin & Itard, 2010). Householders would compound or create a condensation or mould issue because they don't understand the causes of it (Garratt & Nowak, 1991). Tenant education on ventilation can help reduce the risk of moisture being generated and avoid condensation (Guerra Santin, 2013). Regardless of the level of energy efficient improvements made to a home, there will be limited difference in condensation risk, unless an adequate balance of heating and ventilation is implemented (British Standards Institute,, 2002).

2.2 Legislation

Government legislation has been the biggest influence on the way new dwellings have been constructed and existing dwellings modified in respect to ventilation. The Building Regulations established in 1965, came into force in February 1966 consisted of consolidation of 90 years of building control statutes of local byelaws and public health acts (Stephenson, 2001). However it was the Building Act 1984 which addressed the conservation of fuel and power. This act was a game changer towards improving the energy efficiency of dwellings. In 1993 the then Department of the Environment, which became The Department of Energy & Climate Change (DECC) then in July 2016, The Department for Business, Energy & Industrial Strategy (BEIS), first published a Standard Assessment Procedure (SAP). This was developed by Building Research Establishment (BRE) for the government to assess the energy performance rating of new dwellings and as tool to deliver energy policies. The SAP calculation methodology is based on the BRE Domestic Energy Model.

In 1995 SAP calculations became compulsory in Building Regulations for new dwellings. SAP methodology was modified to Reduced Data (RdSAP) specifically for existing dwellings (Energy Performance of Buildings Regulations, 2007).

<u>Rating</u>	<u>Band</u>
1 to 20	G
21 to 38	F
39 to 54	E
55 to 68	D
69 to 80	C
81 to 91	B
92 or more	A

Table 2.2.1: Energy efficiency label for SAP England and Wales (Table 14: Rating bands: SAP 2012 version 9.92 October 2013).

The Housing Act 2004 introduced compulsory Energy Performance of Building Directive (EPBD) Energy Performance Certificates on all existing dwellings when sold implemented from 2007 and 2008 when let (Energy Performance of Buildings Regulations, 2007). The UK government's 'Climate Change Act 2008' saw legislation to reduce greenhouse gas emissions by 80% by 2050 against a 1990 baseline. This act introduced standards partly through building regulations on the development of new dwellings and the retrofit of existing dwellings to reduce energy use.

Building regulations, require the refurbishment of existing dwellings to meet the requirements of part F1 Means of ventilation (MHCLG, 2010), this includes the introduction of a number of controllable manual back ground ventilators such as wall vents, trickle vents on windows in habitable rooms along with mechanical intermittent or continuous running extract fans in areas of high moisture generation including bath/shower/wet rooms, utility rooms and kitchens. The exception to this is dwelling fitted with whole house ventilation systems (MHCLG, 2010). All of these ventilation measures require actions from occupants'' to ensure effective operation.

With increasing installation measures and behaviour changes towards saving energy, guidance towards ventilation and maintain good IAQ appears to be muted. Indeed measures that are seen to highlight good IAQ are deemed contradictory to saving energy (Sharpe, et al., 2015).

Occupants'' of dwellings fitted open flue heating systems would have had limited impact or control over their homes ventilation system, as dwellings were designed and built both intentionally and unintentionally with passive ventilation. Now with changes in design and usage of homes, occupants'' are required to manage the property's heating and ventilation to maintain IAQ. As previously mentioned, there has been a strong influence in recent years by governments to reduce energy usage in the home as well as industry.

Occupants'' receive a wealth of information via various media sources (Energy Saving Trust, 2017), (British Gas Trading Limited, 2013), which provide guidance on reducing energy consumption in dwellings by increasing air tightness:

Removal of:

- Uncontrollable passive wall vents
- Old fan ventilation openings
- Un-draft proofed wooden, uPVC single glazing or old faulty double glazing windows and doors

Replacement and/or installation of:

- Wall, floor, roof insulation to limit the transfer of heat
- Double glazed windows and thermally efficient doors with integral draft proofing
- Heating controls to limit the amount of heat being generated
- Draft proofing to windows, doors, floorboards, skirting boards, loft hatches and service points
- adjustable closures to fireplaces and chimneys
- Mechanical extract fans to bathrooms and kitchens

Behavioural advice includes:

- Keeping doors closed to prevent drafts
- Turn down heating by 1o C

All these measures have a positive effect on a dwelling's ability to reduce energy consumption, however, they also have a negative effect on a dwelling's passive ventilation (figure 2.3.4).

2.3 Energy Efficiency

Energy saving measures introduced consisted of components with high insulating properties to limit heat loss and reduce permeability rates by increasing air tightness, Current Building Regulations part L1A (MHCLG, 2016) have virtually eliminated uncontrolled infiltration in new homes, requiring air tightness design not exceeding 10m³ / (h.m²) at 50Pa. This designed air tightness level does not account for occupant interaction, most habitable rooms in UK dwellings rely on trickle vents to provide background ventilation. As trickle vents are adjustable case studies have shown 60% them to remain shut during the heating season, furthermore they could remain closed throughout the year due to drafts, noise and restricted access (Howieson, et al., 2014).

Therefore maintaining good IAQ through the provision of adequately controlled ventilation through natural or mechanical means is becomes increasingly important (Madgwick & Wood, 2016).

Increasing domestic energy costs, over recent years on average electricity 29.8% and mains gas 21.9% higher than 2008 (BEIS, 2018), (figure 2.3.1), whilst disposable income rose by only 3.72% for same period (Office for National Statistics, 2017), (figure 2.3.2.) Occupants'' have become aware of the consumption of energy has on their finances, particularly those deemed close to or in fuel poverty (low income/ high costs indicator), ventilation initiative that would see fuel costs increased are discouraged.

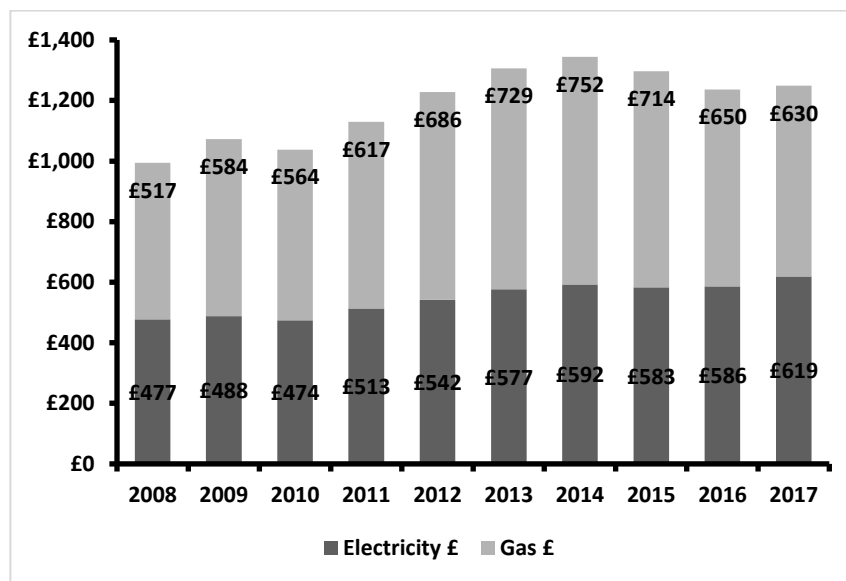


Figure 2.3.1: Average domestic electricity (3800kWh/y) & mains gas (15000kWh/y) energy costs in cash terms between 2008 and 2017 (BEIS, 2018).

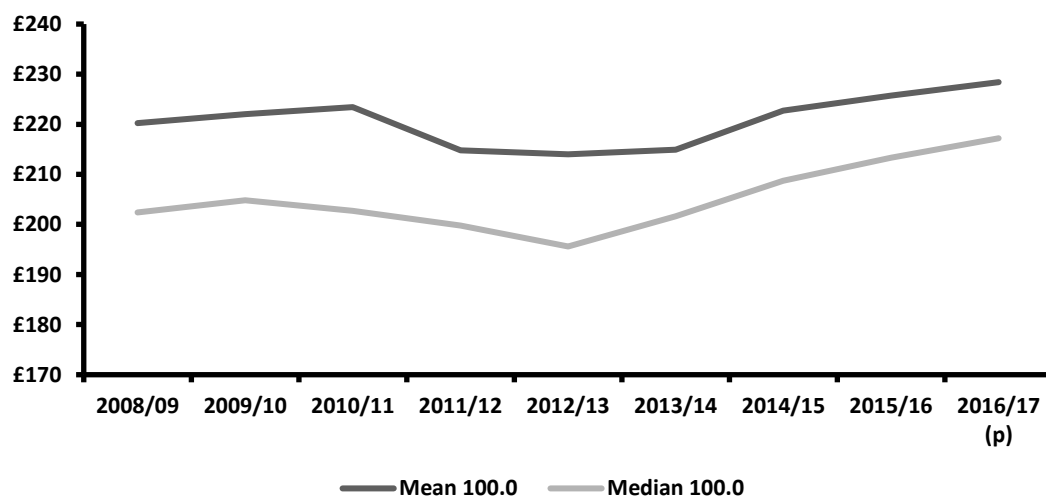


Figure 2.3.2: Index of mean & median UK household disposable income against 1977 baseline. 2016/17 figure provisional (ONS, 2017).

Many homes are under ventilated, mechanical extraction fans unused, energy efficiency and home security are the primary reasons for keeping windows shut (Price & Sherman, 2006). A number of surveys on occupant behaviour to date (Guerra Santin & Itard, 2010), (Guerra Santin, 2013) study the way householders interact with the heating system, whereas ventilation is only considered where it forms part of the heating system. These studies have shown there is limited interaction with ventilation systems.

2.3.1 Grant incentives

Grant funding programmes funded through government legislation, placed obligations on major energy supply companies to add a levy to household energy bills. This funding mechanism currently known as the Energy Companies Obligation (ECO), incentivised the installation of energy efficient components. These incentives are measured in life time savings in tonnes of carbon emissions (Ofgem, 2015). These grant incentives has led to an increase in the installation of energy efficient measures over the last decade (MHCLG, 2018). This funding mechanism provides an unbalanced approach to achieving holistic improvements, where insulation, draft excluders and boiler replacement would be incentivised with grant funding (Welsh Government: NEST, 2014), however ventilation measures such as extract fans and trickle vents would not. This approach of increasing a dwellings energy efficiency and raising SAP scores without an adequate heating and ventilation strategy, along with education of occupants'' to the change of building performance may have a detrimental effect on their health (Sharpe, et al., 2015). Thus making a home cheaper to run but not necessarily a healthy place to live.

Over the last two decades there has been a concerted effort to build and refurbish existing buildings to high energy efficiency standards (figure 2.3.3). In Europe the European Parliament issued the Energy Performance of Buildings Directive 2010/31/EU requiring member states to upgrade the energy performance of existing dwellings to meet cost effective minimum standards. This can be shown with Mean SAP rating has increased over the last 10 years across all household tenures (figure 2.3.3), however data shows this to be slowing down from 2014. A study carried out by University of Nottingham on the effectiveness of retrofit energy improvements on a dwellings airtightness showed a positive correlation of dwelling airtightness with SAP ratings (Gillott, et al., 2015).

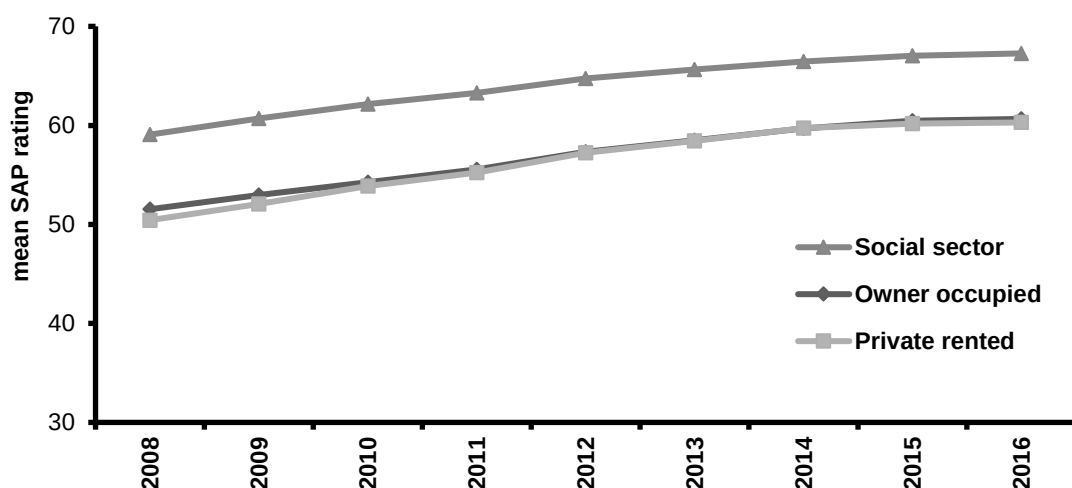


Figure 2.3.3: Mean SAP energy rating by tenure England, 2008 to 2016 (MHCLG, 2018).

Part of this refurbishment to existing housing stock includes removal of open fires, wall vents, open vented heating systems & chimneys. Installation of energy efficient boilers, windows, doors, along with floor, wall, loft insulation, draft excluders and mechanical extractor fans. The removal of the chimneys and room heaters not only reduces maintenance requirements, but also increases the energy efficiency rating (DECC, 2014).

These measures to increase energy efficiency and reduce carbon emissions also reduced the dwelling's ability to ventilate itself. These interventions would likely result in a toxic and hazardous indoor environment (Howieson, et al., 2014). Thus the role and the obligations on the occupants' is to maintain good IAQ is paramount.

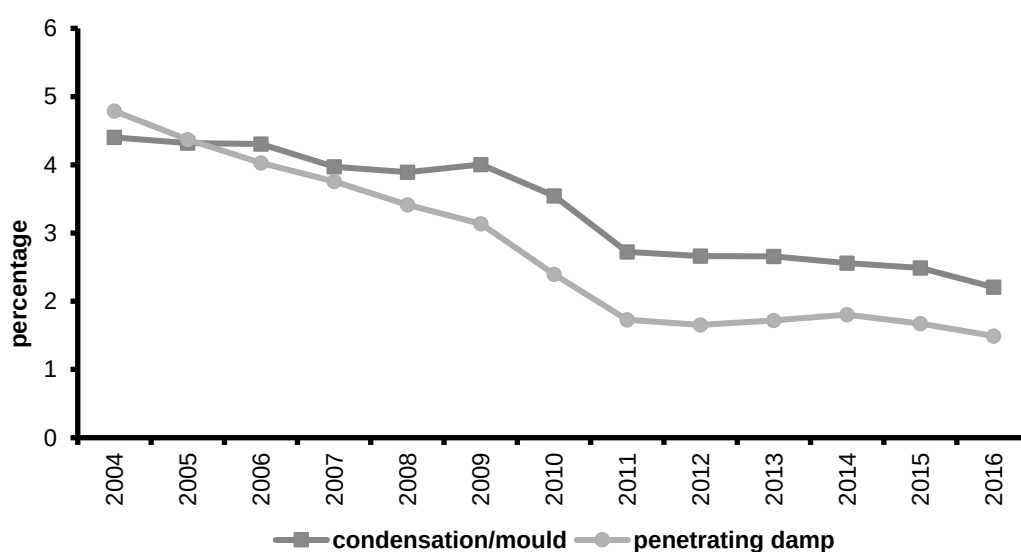


Figure 2.3.4: Damp problems associated with condensation mould and penetrating damp, England, 2004 to 2016 (MHCLG, 2018).

Three decades of modifying our existing housing stock and designing new homes to be energy efficient and air tight, limited consideration has been given to the obligations now placed upon occupants” to manage their homes IAQ in terms of their health and internal fabric of the building. Sample data in the above (figure 2.3.4), shows a downward trend of damp problems, however penetrating damp problems shows a similar trend to the level of rainfall received from 2010 (figure 2.3.5), for the same period. It can be seen that condensation problems has increased during the same period of SAP score increase. The English Housing survey headline report 2016-17 noted all dwellings have some level of condensation. The survey only considered serious levels of condensation and patches of extensive mould on ceilings and walls along with soft furnishings. Accounting for all condensation mould, regardless of size would give a greater representation of IAQ issues.

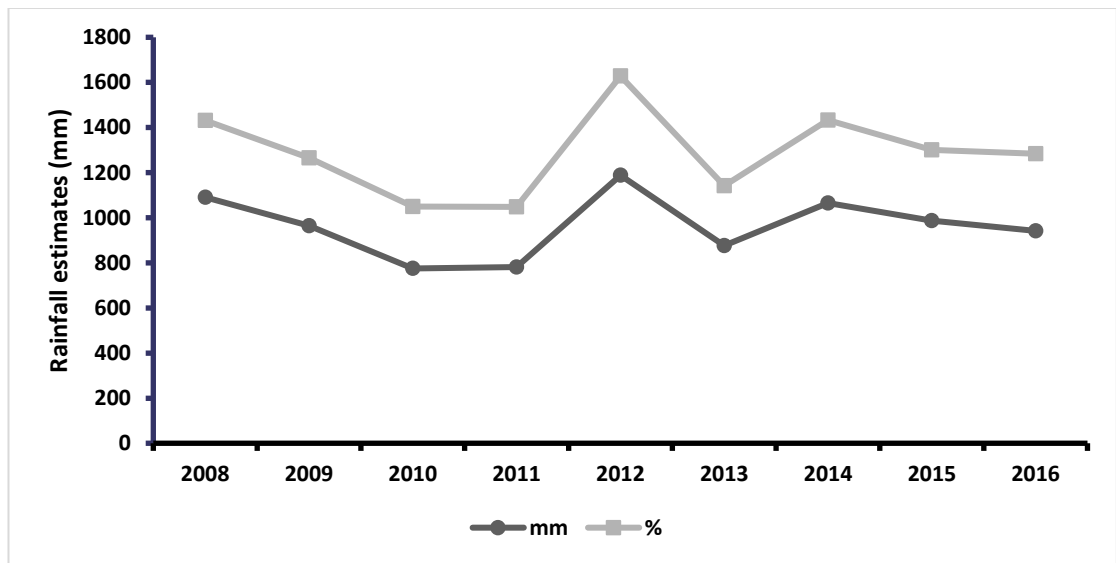


Figure 2.3.5: Monthly rainfall summaries combined to provide annual rainfall England, 2004 to 2016 (% from 1981-2010 average), (NHMP, 2008-16).

2.4 UK Households' by tenure (England & Wales)

England and Wales are estimated to have 23.1 and 1.4 million households' (MHCLG, 2018), (Welsh Government, 2017). Tenure was proportioned England and (Wales): 63% (70%) Owner occupier, Private renter 20% (14%) and Social renter 17% (16%) (figure 2.4.1& 2.4.2).

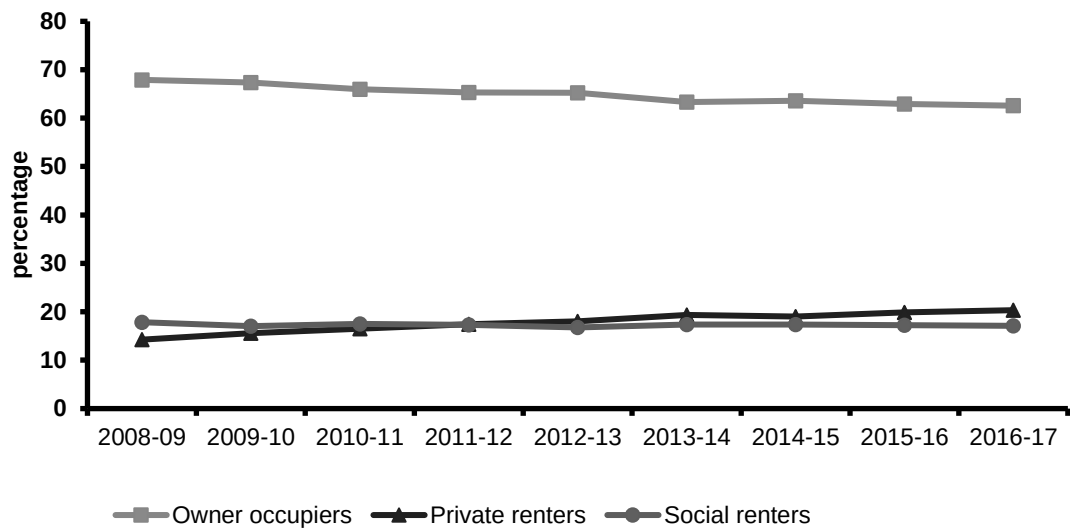


Figure 2.4.1: Trends in household tenure England (proportions), 2008-09 to 2016-17 (MHCLG, 2018).

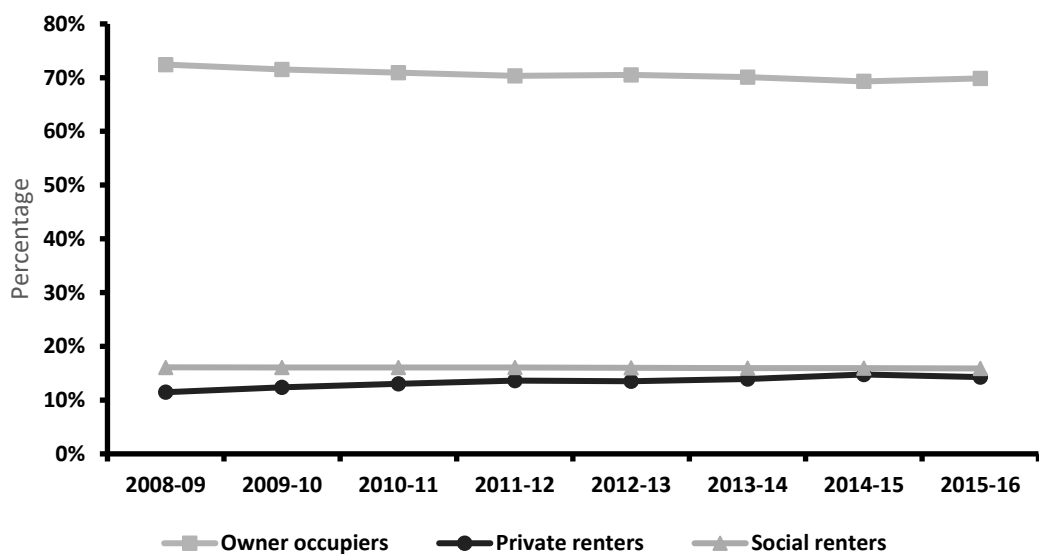


Figure 2.4.2 Trends in household tenure Wales, 2008-09 to 2015-16 (Welsh Government, 2017). Note: figures for local authority and housing associations combined as social renters. Data not available 2016-17.

2.4.1 Owner occupier

Whilst there has been a slight decline in numbers over the last 10 years, however owner occupier households' remain the largest sector of household tenure in England (63%) and Wales (70%). The questionnaire using a social networking facility for this study found that 85% of Participants' fell into this category. (Figure 2.4.2), shows owner occupier dwellings follow a similar trend to that of private rented dwellings are shown to increase in SAP score between 2008 and 2016 of around 10% they remain on average 7% lower than social housing stock (figure 2.3.2).

2.4.2 Private rental housing

With UK rental of housing on the increase (Kollewe, 2017), legislation of the Housing Act 2004, is placing obligations on landlords in England and Wales to ensure their housing stock to meet safety and quality standards. The Act provides local authorities a tool for calculating a risk based rating system (MHCLG, 2006a), which provides powers and duties to deal with poor housing, primarily in the private rental sector. Although marginal it can be seen in (figure 2.3.3), SAP scores for private rented housing stock were initially lower than that for owner occupied dwellings in 2008, have increase to match by 2016. This is likely as a result of government grant incentives and legislation. The Energy Act 2011 place obligations on the private rental sector to ensure their housing stock meets Minimum Energy Efficiency Standards (MEES). MEES require all new lettings and lease renewals from April 2018 for private rented property which are legally required to have an energy performance certificate (EPC), both domestic and non-domestic must achieve a minimum EPC rating of band E (table 2.2.1). This rule also applies to existing lettings and leases from April 2020.

2.4.3 Social Housing

Social housing has additional responsibility to meet safety and quality standards (MHCLG, 2006b), (Welsh Assembly Government, 2008). Social housing upgrade focus on safety, security and energy efficiency measures. This has occurred due to the availability of funds through the voluntary transfer programme of housing stock from local authority ownership to Registered Social Landlords (RSL)'s more commonly known as Housing Associations. Moneys are raised directly from tenants along with government grants.

2.5 Attitudes towards ventilation

Long before energy efficiency became high on political agendas, attitudes towards ventilation were changing. During the late 1970s double glazing manufacturers were promoting windows with draught proof capabilities. 'Everest Ltd' ran high profile television advertisements throughout the early 1980s with celebrity farmer Ted Moul's catchphrase image of a descending white feather adjacent to a draft proofed window (Matthews, 2016). These advertisements promoted the notion that drafts from windows was a bad thing. As prior to this point draught proofing to window and door opening was limited. The 1990s saw the biggest uplift in dwellings fitted with double glazing. The building regulations of 2006 required new windows to be double glazing, along with existing windows to be replaced with double glazing (Department for Communities and Local Government, 2010, p. 112).

2.6 Aims and Objectives:

The aim of this study is to understand people's awareness and behaviour towards ventilation to maintain good indoor air quality, which will impact upon a healthy environment and long term serviceable use of a dwelling.

This study will examines how householders interact with components fitted to their homes specifically for the purpose of ventilation. As new homes are constructed to high airtight standards and existing homes modified to the same, thus requiring occupants'' to adapt their role in managing the internal environment of their homes. This study will examines the variance of behaviour of householders which are owner occupier, private rented tenant and social housing tenant.

- Householders have limited understanding of IAQ and ventilation and its impact to their health and their home.
- Householders have limited understanding of how their behaviour effects the IAQ of their home and their health.

A housing provider could spend significant capital refurbishing dwellings, only to find after a period of occupation they have become damp with condensation, simply because the occupants'' have not understood how to correctly manage the heating and ventilation system.

2.6.1 Research Objectives:

To enable the researcher to gather data for this study it was a requirement to question consenting participants' who were the primary occupants'' of dwellings: i.e. those responsible for the management of the household. It was also necessary to visit Participants' in their home, therefore allowing the validation of Participants' responses with the researchers own observations.

- To evaluate householders level of understanding to IAQ and ventilation and its impact to their health and their home.
- To analyse householders understanding of how their behaviour effects the IAQ of their home and their health.
- To show importance and value occupants'' place on components installed in their home specifically to improve indoor air quality through ventilation.

2.6.2 Occupants'' awareness and understanding towards dampness, IAQ and ventilation.

The first element is to establish the level of awareness, and understanding towards ventilation and IAQ. What measures are fitted to their home which allow them to control the IAQ i.e. are there trickle vents fitted to the windows? Is there mechanical intermittent extract fans in bath/shower rooms, toilet and cooker hood? Are the occupants'' aware that these measures are fitted to their home and what they do? This information and guidance on dampness and condensation is freely available online World Health Organization (WHO, 2009a). Building Regulations (MHCLG, 2010), 2010 Approved Document F1 Means of ventilation and NHS (NHS choices, 2015). However, this information is not easily located unless you specifically know where to look and outweighed by the volume of information and resources available towards saving energy. The Energy Saving Trust, a UK government and industry funded independent organisation, established to help and advise consumers and industry on energy efficiency and energy conservation. Ventilation is mentioned in its advice but is limited. Occupant assessment of IAQ is based on room odour being acceptable by visitors on entering (Sundell, 2004).

2.6.3 Behavioural characteristic towards IAQ and ventilation

This element focuses on how the occupants'' behaviour affects the IAQ. If there is an awareness of the ventilation measures fitted to their home, do occupants'' use them? The Building regulation (MHCLG, 2010), recommends leaving extract fans running during periods of high moisture generation, and for 15 minutes after use in bathroom and kitchens; that trickle vents should be kept open at all times unless the external environment is to its detriment.

WHO recommends leaving bedroom windows open for a period of 15 minutes each morning to allow moisture generated during sleeping to escape, and to dry clothes outside or use a dryer located in a closed bathroom with an open window or with a continuously operating fan (WHO, 2009a).

2.6.4 Factors that influence occupants' behaviour

It is important to understand what occupants do to ventilate their homes; why they do it and what makes them choose to use or not use provided measures. Do they leave the bathroom fan off because it's noisy or expensive to run? Do they keep the trickle vents closed because they let in a cold draft and increase energy bills? Do they simply forget to switch on the extract vent on the cooker hood? Do they worry that if they open a bedroom window to let fresh air in, that they will forget to shut it before leaving the home?

Chapter 3 – Research Methodology

3.1 Method of research evaluation

Of the different primary research strategies available, data collected through sampling (questionnaire) would provide the most suitable time and cost effective method of research. The questioning can be geared to suit the topic of the dissertation questions, however, care must be taken to ensure the questionnaire design does not lead the participant. Therefore, the Survey method of research is chosen to be the most appropriate means of collecting data for this dissertation.

With the topic area of “behaviour to indoor air quality in a domestic environment” the purpose of this exercise is to establish the parameters of the dissertation subject.

Indoor air quality is a very broad subject area, it is therefore important to define the specific subject area for this dissertation to ensure a meaningful outcome.

3.2 Overview of topic selection

The researcher for this dissertation is currently employed as a stock condition surveyor and domestic energy assessor for a housing association. The primary role of a stock condition and energy assessment is to visit occupied dwellings within the housing associations portfolio to establish the condition of the dwelling and that it meets statutory housing requirements along with producing EPCs as required. This work activity presents an opportunity for the researcher to meet residents in their homes with a potential view to gather data for the dissertation during the visit.

The housing association called Valleys to Coast most commonly referred to as “V2C” operates in the county of Bridgend, South Wales. It manages a portfolio of approximately 5900 dwellings. The bulk of the stock consists of post-war 1950s to 1970s built housing estates, acquired in 2003 by V2C as part of a stock transfer program from the local authority (Bridgend County Borough Council) ownership. The stock is made up of detached, semi-detached, terraced houses, flats, maisonettes and bedsits, along with sheltered accommodation for vulnerable or elderly residents. Property construction varies from traditional (solid masonry or Cavity wall) to non-traditional (steel, timber, prefabricate concrete and insitu concrete i.e. no fines concrete). The bulk of the housing stock both traditional and non-traditional, were built during the 1950s-1960s.

Most dwellings have had upgrades between 2003 and 2016 to include energy efficient measures (roofs, insulation, windows & doors, boilers). Non-traditional dwellings have received structural life extending upgrades to foundations and walls during this time.

With the exception of one estate of approximately 300 dwellings (Wildmill, Bridgend) built with district heating, the majority of dwellings in the housing associations portfolio were original built with chimneys and heated with solid fuel (coal). The U.K.'s transition of primary energy consumption from coal to gas during the 1970s and 1980s (DECC, 2009), saw many solid fuel heating systems converted to gas boilers. Many of these boilers, known as back boilers were designed to fit within existing fireplaces utilising the chimney as a natural open vented flu.

The structural and energy efficiency refurbishment upgrades involved replacing roofs on dwellings along with replacing ageing 1980s installed mains gas back boilers with high-energy efficient condensing combination boilers. This activity saw the existing chimneys become redundant and were capped off within the roof space and blocked up within the rooms of the dwelling. This was done to minimise maintenance requirements and prevent drafts.

The researcher visits typically 4 to 5 dwellings per day to carry out stock condition surveys and where required energy assessments. All dwellings are owned and managed by the housing association V2C, the occupancy status of each dwelling can vary from occupied and void. As this dissertation focuses on how occupants' interact with their homes all void properties and recently tenanted dwellings will be disregarded from the survey.

The quality of stock condition data held by the housing association varies across its estate, the programme of stock condition visits focus on areas of the poorest data or where knowledge exists of where building components are deemed to be coming to the end of their useful life. Surveying dwellings in this area provides a broad range and condition of building components, ranging from those in poor condition to dwellings that have recently had new components installed.

One of the elements of the stock condition survey is to establish the presence of extract ventilation in the property along with type and condition. The researcher having previously assessed in the region of 800 dwellings has noticed occupant behaviour trend towards IAQ.

Whilst there are other areas of behaviour patterns that effect IAQ, such as the opening windows or doors it is difficult to determine during site visits. This is therefore deemed to be beyond the scope of this research.

The researcher has observed a particular behaviour pattern towards the use of mechanical extract ventilation. This personal observation noted that where the fan motors of mechanical extract units could be heard or where visual evidence existed of the fans operating i.e. a spinning rotor or an “on light” they tended to be switched off by the tenant.

The housing association is aware that tenants switch off extractor fans, but doesn’t understand why?

The housing association goes to a number of lengths to discourage this behaviour, such as locating the fan isolation switch beyond the reach of most people or removing the switch altogether. But this behaviour pattern continues.

This observation has formed the basis for this particular area of study, which will focus on how occupants’ interact with mechanical extract ventilation systems installed in their homes. What motivates occupants’ to switch them off?

3.3 Study parameters

3.3.1 Inclusions

The primary participant demographic of this research study will be consenting social housing tenants. The reason for this is to utilise the researcher’s current position visiting tenants for stock condition surveys. This position allows the researcher the greatest potential opportunity to procure participants. The research will be selective of suitable participants who meet the following criteria: give consent for the study to take place, is physically and mentally capable of responding to questions, has occupied the dwelling for a period greater than one month and have mechanical extractor fan fitted to bathrooms.

Although owner occupiers and private rental occupants’ are not expected to make up a significant volume of participants, they will be included in the study ad hoc on the basis they meet the above criteria.

3.3.2 Exclusions

Void properties will be disregarded from the survey, also where ventilation systems are beyond the control of the occupants’ and managed by third parties. This applies to specialist care /sheltered accommodation along with dwellings fitted with whole house ventilation systems which are managed directly by the housing association themselves. Dwellings fitted with positive pressure ventilation will be disregards due to health and safety reasons as the location of the units tend to be above stairwells therefore requiring specialist access equipment to determine if they are working.

This research will focus on occupant behaviour to the use of mechanical extract ventilation installed to bathrooms and kitchens of primarily new and existing domestic social housing stock built from the 1950s.

3.4 Questionnaire design

The questionnaires were designed to satisfy a number of requirements, primarily data capture to enable the aims and objectives of the research to be met. It maintained control by asking questions and providing a number of answers to which the participant can select the most appropriate answer to themselves. However, it was developed so as not to lead the Participants', for example, questions did not begin by identifying the problem i.e. does your home suffer from damp and condensation. The questionnaires were designed to encourage the Participants' to be open and honest, without presenting any bias towards their responses. Additionally it was important the survey was relatively short and easy to understand and complete, so not to confuse or lose the interest of the participant particularly in the case of the online questionnaire. The research questionnaires were structured to allow the participant to believe they were being asked general questions how they use their home, which was true, although the specific interest related to the ventilation and how Participants' responded to it.

To provide a context of value, it was necessary to ask Participants' questions relating to other building components to include windows and doors, heating system, draught proofing in addition to the ventilation system.

To maximise the availability of resources it was necessary to develop the questionnaire into two formats. The first questionnaire involved the researcher collecting specific data concerning the participant and their home during a visit to the participant's home address. The second questionnaire for collected survey data, allowed the Participants' to enter data into the survey the survey using an online software tool. This method allowed Participants' to complete the survey in their own time without the presence of the researcher. Both survey methods of research was discussed and agreed with participating housing association (Valleys to Coast, Bridgend, South Wales). Caution was taken to ensure the aims and objectives of the research are maintained. The two viable options are outlined in below (3.5 & 3.2.3).

3.5 Site visit questionnaire

3.5.1 Ethics

As the survey will cover a number of sensitive topics concerning occupant's behaviour to heating, ventilation and bathing, it is very important to stress to Participants' of the research that their anonymity is paramount and will be maintained throughout the whole process.

As the site visit questionnaire was carried out in conjunction with another service carried out at the Participants' home it's was important the researcher presented a high degree of professionalism, politeness and respect. This was particularly relevant as a number of questions were personal.

Written consent was obtained from the Participants', (a copy of the consent form can be found in appendix 1), to state they are happy to proceed with a questionnaire, prior to the questionnaire taking place. The participant was advised verbally and in writing (a copy of the information leaflet can be found in appendix 1) that all data published or otherwise from the results obtained was anonymized to ensure specific individuals cannot be identified. Participants' were also advise should they wish for their data not to be used they could get in touch with the researcher via email, within a time limit. Should the Participants' wish to make a complaint, the information leaflet also contained contact details of the researcher's university supervisor.

3.5.2 Option 1 – Site visit questionnaire

An interview with participating occupants'' is carried out in conjunction with another service, primarily stock condition surveys and or Energy Assessments. The researcher is employed by a housing association as a stock condition surveyor and accredited Domestic Energy Assessor (DEA) so it's possible whilst visiting stock holders to produce Stock Condition Survey (SCS) and Energy Performance Certificates (EPC)s whilst collecting research data. Production of the SCS and EPC involves a non-intrusive visual inspection of occupant's dwelling, both internal and external. Part of the questionnaire data is collected during this process subject to occupants''' consent. This method reduces the amount questions requiring completion by the dwelling occupants'' and limit their time and effort. The viability of this research method was dependent on the number dwellings available that could be assessed and the consent of the occupants''.

The researcher will make observations to the presence of ventilation systems, along with their status, i.e. whether fans switched on, were the trickle vents open. This evidence will be cross referenced against participants' responses for accuracy.

The primary role of a stock condition/ domestic energy surveyor, is to visit both occupied and un-occupied dwellings within the housing associations portfolio to assess state of repair and that housing stock meets statutory housing requirements. In Wales this is known as the Welsh Housing Quality Standard (WHQS). Additionally as the researcher is a qualified and accredited Domestic Energy Assessor (DEA), EPC's are produced as required during the same visit. The DEA accreditation allows the researcher to carry out EPC's on existing dwellings of any tenure, which allows the researcher to visit owner occupier and private tenanted dwellings.

This work activity also presents an opportunity for the researcher to meet residents in their homes with a potential view to gather data for a dissertation during the visit.

The stock condition and energy survey both consist of a non-intrusive visual inspection of the dwelling. Protocols followed whilst carrying out surveys insure the safety of the researcher and that of the occupants' along with compliance of legislation to include the health and safety at work act, housing act and data protection.

3.5.3 Site Visit procedure:

1. Prior to contacting the tenant the researcher checks for warning codes held on V2C's internal database to establish if it is safe or if the tenant has any special needs or disabilities which may affect communication.
2. Contact the tenant by phone, letter or in person to arrange an appointment.
3. During the appointment prior to entering the dwelling the researcher will show identification confirming name and position within the housing association. The researcher will then explain how the survey is conducted, and confirm if the tenant is wishes to proceed.
4. The researcher then carries out the stock condition survey, a non-intrusive visual inspection of the property, which includes building fabric, components such as heating system, electrical circuit, alarms, windows/ doors and ventilation.
5. The data is captured and entered into apps on a mobile tablet.
6. The researcher would then ask the tenant if they wish to participate in the researcher study, reminding them that the questionnaire is purely voluntary and that they are under no obligation to participate.
7. If the tenant was happy to participate in the survey the researcher will then ask the tenant to sign a consent form allowing for their data to be used for this study. The tenant would then be provided with a brief overview of the study and how to get in

touch with the researcher should they require further information or wish to withdraw their participation (Appendix 3).

8. The researcher would then ask the tenant a series of questions on how they use their home. The researcher would then capture additional observational data relating to the buildings ventilation system.

The stock condition data app has been designed specifically to suit the needs of the housing association. Whereas the energy assessment app known as Reduced Data Standard Assessment Procedure (RdSAP) was designed by an accredited organisation with the approval of the British Research Establishment (BRE).

During the survey the tenant was asked if they would like to take part in a research project about the way we use our homes. The surveyor confirmed that research data would be anonymised and that no person information would be passed onto any third party. The surveyor advised that participation was voluntary and that there was no obligation to take part.

The design of the researcher's questionnaire was to maximise data capture whilst minimizing disruption to the occupants' and the housing association. The method of data capture will be split into 3 groups

1. Utilizing data already captured as part of the researcher's role as stock condition surveyor
2. Visual assessment by the researcher during the visit specific to the dissertation
3. Ask questions to the occupants' about the way they use their home specific to the dissertation.

The questionnaire was created using a mobile survey app provider 'Survey monkey'. This app was added to the researcher's tablet and accessed during the site visit to capture data as stated in items 2 and 3 above. Data from item 1 was added later at the researcher's convenience. To meet ethics criteria all data from items 2 and 3 was only known to the researcher and anonymised before any data is made available to others.

The 'Survey monkey' application uses a cloud-based storage facility, allowing the data captured to be stored securely online. To aid confidentiality no participant identification or contact information was included in the data. Once sufficient data was collected and uploaded the researcher was able to access the data via a computer connected to the Internet. The 'survey monkey' application offered data analytical tools, this was disregarded, survey data

was downloaded in a raw format into an Excel spreadsheet for analysis. Data analysis will be provided to the housing association once the survey is complete.

3.5.4 Questionnaire categories:

- Tenure
- Household population and age band
- Household bathing pattern
- Control of indoor air quality
- Ventilation components
- Importance of building components
- Behaviour towards ventilation components whilst bathing or cooking
- Evidence of poor ventilation
- Costs associated with mechanical extract ventilation

A complete list of site visit questions are available in Appendix 1.

3.5.5: Tools and equipment

The requirement for tools and equipment for this study was limited to a data enabled mobile tablet (iPad air) and a sound level meter (figure 3.2.1). This provided a degree of flexibility to the researcher, as stock condition surveys and EPC's required additional equipment: ladder, clipboard, camera and small tools.

In conjunction with the questions put to Participants' regarding the noise level of their mechanical extract fans, sound level readings were taken of the bathroom and kitchen extractor fan. Readings were taken with the fan off and fan on, at a distance of approximately 1 meter from the fan unit.



Figure 3.5.1: Environment sound level, 4 in 1 Multi meter: Precision Gold N09AQ, Sound operating range: Lo=35dB to 100dB.

Provided by kind permission of the University of Wales Trinity Saint David.

3.5.6 Pilot questionnaire

An initial pilot questionnaire was carried out on a group of Participants' to determine the participant responses provide sufficient information to produce a credible case. The analysis identify short comings such as gaps in data, poor responses or questions that cause confusion. Corrective action can be taken to the questionnaire prior to it being published for the main trial. These include :

- Question asking "How often do you use the extractor fan whilst bathing?" Found a number of Participants' associated bathing with using the bath only, not considering using the shower as bathing.
- A late addition to the questionnaire regarding building component importance was added to establish the context of ventilation in relation to other building components such as doors, windows and heating and hot water system.
- The researcher determined a separate survey with a higher population would provide a general over view of participant opinion with regards to indoor air quality. Whilst it is noted this additional survey supported a different demographic (figure 4.4.1), to the site visit survey (figure 4.2.1), correlations could not be made. That said trends between the two populations did exist.

3.5.7 Option 2 – participant online survey questionnaire

Mass market approach to tenants, work colleagues, friends, family members associated with the researcher along with along with friends of family members using a combination of electronic means of communication. This included email, Social media, primarily Facebook and a work based social networking facility. The questionnaire was developed to relatively easy to complete over short duration approximately five minutes. This ensured a high level of completion from Participants' who started the survey. Using social networking facilities provided the highest volume of respondents over the shortest period of time. Although this method did provide an invaluable insight of people's awareness, behaviour and values towards IAQ (4.4 Online results).

3.6.2 Pilot study

A pilot study was produced and tested on participants working for the organisation along with friends and colleagues of the researcher to test the soundness of the questioning and check

that responses provided meaningful answers. A number of questions were adapted to optimise the questionnaire process however number questions were left in but not used in the final analysis.

3.7 Limitations

During the design and implementation of this study a limitations were identified, whilst the number could be managed, others remain. It is therefore necessary for the reader to consider these when reviewing this study. Limitations have been identified as:

1. The site visit questionnaire method of collecting data was that the researcher was an employee of the housing association, and therefore acting on behalf of the employer when visiting tenanted properties to carry out stock condition surveys or the landlord when visiting private rented dwellings to carry out EPC's. Whilst the researcher stressed to Participants' that their responses are confidential and the survey is independent of the landlord or housing association, providing written confirmation. Tenants may believe that their responses may filter back to their landlord. This could have a bearing on the Participants' responses i.e. saying how their landlord expects them to use the ventilation system rather than how they actually use the ventilation system. The cross-referencing participant responses against status of ventilation components minimised this.
2. The site visit appointments were carried out between 8 am and 5 pm (reasonable time of day), to comply with the Landlord and Tenant act 1985 (11, 6). Therefore it was not possible to observe mechanical extract fan, window opening and trickle vent use whilst Participants' were bathing. This study relies on the testimony of Participants' along with the researcher's observations of fan isolation switch, window and trickle vent position at the time of the appointment.
3. As a result of limited time and financial constraints site visit questionnaires within the City and County of Swansea, where the researcher resides along with the workplace being the County Borough of Bridgend, South Wales.
4. Online household profile and age format (question one and two) the participant demographic matches that of the researchers own profile. 30 to 45 age group, homeowner with young children. This data shows that it does not represent a broad cross-section of society only that of similar attributes to that of the researcher.
5. The online questionnaire was completed by Participants' without the presence of the researcher, therefore any data entered into the questionnaire could not be verified. Observation data could not be collected which allowed the researcher to cross-reference the Participants' responses with their home. The data shows 85% (figure 4.4.1), of Participants' were owner occupiers, therefore not associated with the

housing stock provided by the housing association this meant data could not be used to cross-reference or verify quality.

6. The 4-in-1 sound level meter used in this study was not a calibrated instrument readings were taken for an indication in conjunction with Participants' responses. The instrument was limited to readings above 35 dB, although it did pick up readings from 32 dB onwards.

3.8 Statistical Analysis

Questionnaire data was analysed from exported raw data from "surveymonkey" web platform into Microsoft office 365 pro plus Excel software. Statistical analysis was performed using parametric tests, two sample t-test and Chi – square (χ^2). The two sample t-test was used to establish if the variants of data was due to chance alone or due to other influence. t-test distribution was selected assuming the samples belong to a normal distribution.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left[\frac{(n_1 - 1)s^2 + (n_2 - 1)s^2}{n_1 + n_2 - 2} \right] \cdot \left[\frac{n_1 + n_2}{n_1 \cdot n_2} \right]}}$$

Significance was denoted at $p < 0.05$. Graphs were designed using Excel mean $\pm$ S

$$\chi^2 = \sum \left(\frac{(O - E)^2}{E} \right)$$

Chi – square was used to analyse frequency data to determine preferences to particular participant responses was greater than expected.

Data is shown in three formats depending on the level of complexity. Single category data is expressed in the form of a pie chart, multi-category data shown in bar charts this is also used to show comparisons with other datasets, along with tables.

Chapter 4 – Findings

4.1 Site Visit Questionnaire Findings

This section provides results from the researcher visiting Participants' in their homes. The data collected consisted of questions posed to the Participants' along with observational data collected by the researcher whilst surveying the property. The data was entered into an online application accessed via the researcher's mobile tablet. The maximum number of Participants' completing this site visit questionnaire was 41. All questions were answered with the exception of Participants' that did not have mechanical extract fans, they only responded to questions relevant to the components within their home. There was no marketing associated with the site visit questionnaire as occupants' of dwellings were asked if they wish to participate in the questionnaire whilst the researcher was providing another service i.e. producing an Energy Performance Certificate (EPC), for owner occupiers and private rental tenants, and stock condition surveys for social housing tenants.

Owner occupier dwelling



Figure 4.1. 1: Semi-detached 4 bed dwelling constructed 2006 (Francis, 2018).

Whilst owner occupied dwellings account for 70% of housing stock in Wales (figure 2.4.2), they only accounted for 20% (figure 4.2.1), of this study is Participants'. Due to the large variance in property type and limited Participants', it was difficult to draw correlation with other tenured housing stock. However it was noted that Participants' of owner occupied dwelling had no automatic humidistat sensor activated extractor fans, also where mechanical extractor fans were fitted in kitchens they were incorporated into cooker hoods.

Private rented dwelling



Figure 4.1.2: Pre 1900 traditionally constructed mid-terraced one bed ground floor flat (Francis, 2018).

Private rented dwellings shared similarities to owner occupied dwellings, again due to limited Participants' it was difficult to draw correlations between stock types. Although they did tend to be older and less well-maintained. Like owner occupied dwellings no private rented property had automatic humidistat sensor activated extract fans. Only three of the five private rented dwellings had mechanical extractor fans installed.

Social housing dwelling



Figure 4.1.3: 1970's traditionally constructed 3 bed semi-detached dwelling (Francis, 2018).

Social tenured housing stock consisted of 26 existing dwellings (figure 4.2.1) and 2 new dwellings. The existing 26 dwellings consisted of 3 and 2 bed houses and flats, semi detached, terraced and end terrace properties. The existing dwellings were all located in one area Tudor estate, Maesteg. These dwellings were constructed in the early 1970s originally with solid fuel heating systems. All dwellings were retrofitted with mains gas combination boilers (2005 - 15), UPVC double glazed windows and doors (2005), along with external wall insulation (2012-13). 23 of the existing dwellings were fitted with continuous running humidistat mechanical extract fans (table 4.2.3). Two of the existing dwellings did not have mechanical extract fan is fitted in the bathroom or kitchen however they did have positive pressure fan units located in the ceiling above the landing. These were not included in the survey due to access restrictions. The 2 new dwellings (2017), were fitted with traditional manual light switch operated fans. It was found that no fans fitted in social housing stock kitchens were incorporated into to cooker hoods. Fans were wall, ceiling and window mounted (figure 4.1.4.b).

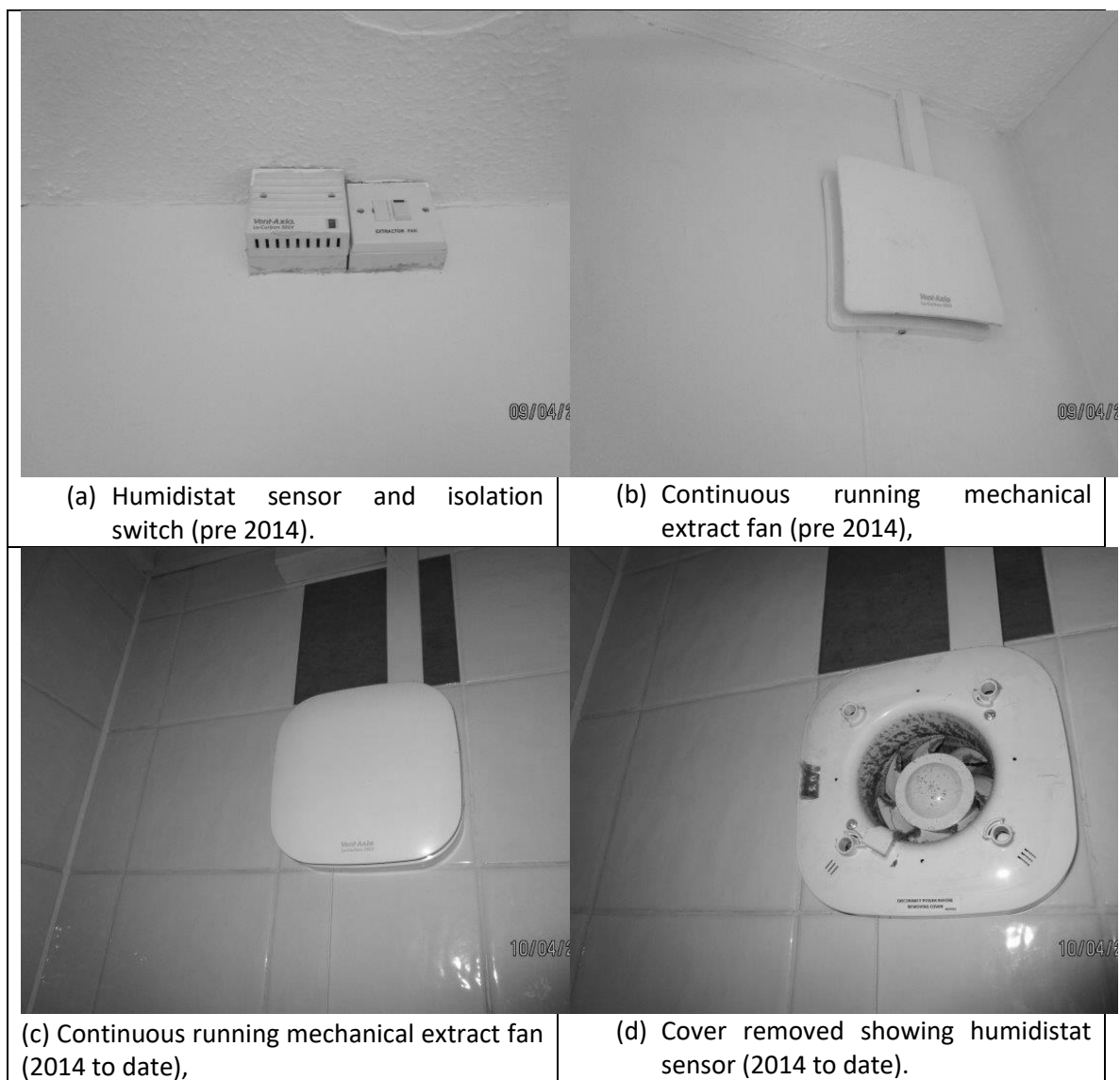


Figure 4.1.4: Continuous running humidistat sensor mechanical extract fans (Francis, 2018).

Social tenured dwellings were shown to be the only dwellings fitted automatic humidistat mechanical extract fans. These automatic fans required no input from the participants to activate. The sensors detect moisture content of the air and adjust the flow rate accordingly i.e. when the shower is running they will enter a boost mode extracting the air quicker as the moisture content of the room drops so does the speed of the fan rotors. Manual operated fans rely solely on occupants' activating a pull cord or light switch triggering the fan to operate. Most units were Vent-Axia Response. Manual fans have a timer off mode which allows the fan to continue operating up to 15 minutes after the occupant has deactivated the pull cord or switch the light off. Figure a shows the isolation switch for mechanical extract fans located against the ceiling.

4.2 Results – Site Visit

4.2.1 Tenure & Demographic

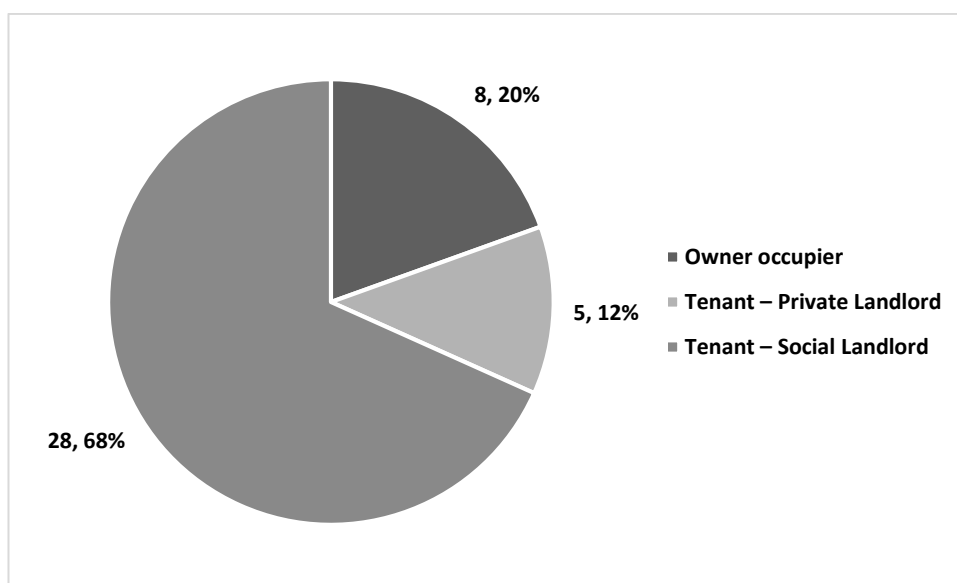


Figure 4.2.1: Number & percentage of tenure for household Participants' (n = 41).

The above pie chart shows the tenure demographic of participants who took part in the site visit survey.

0 - 18 years	18 - 30 years	30 - 45 years	45 - 60 years	60 - 75 years	75 +
43	21	27	11	9	5

Table 4.2.1: Age distribution of household Participants' (n = 41).

The above table shows the age distribution of participant households', which were mainly families.

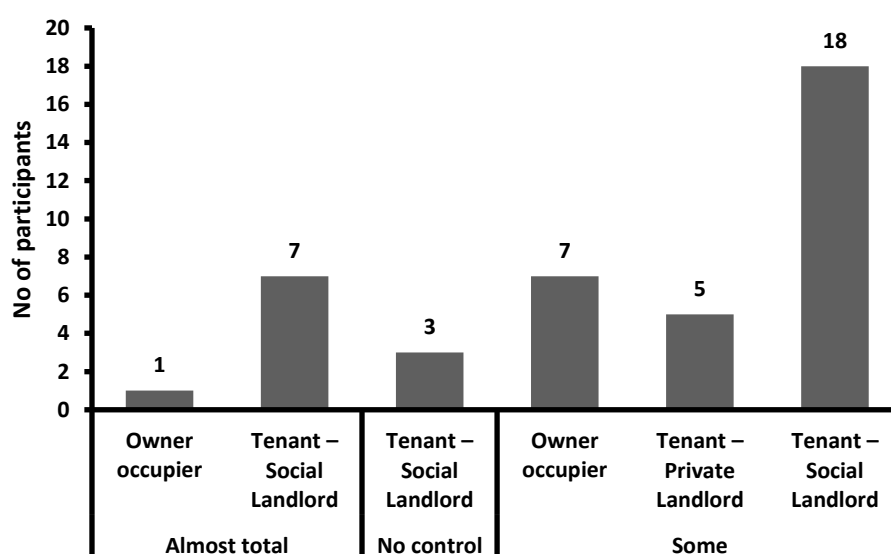


Figure 4.2.2: Participant opinion of control of IAQ, (n = 41)

The above figure shows variants of participant opinion towards IAQ across tenure.

4.2.2 Building components

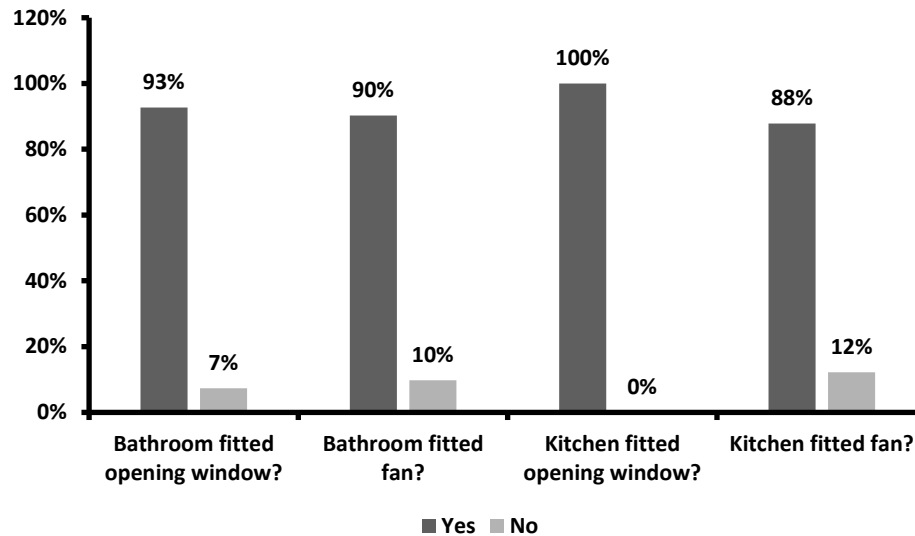


Figure 4.2.3: Ventilation components fitted to Participants' dwellings, (n = 41).

The above figure shows the percentage of dwellings fitted with ventilation components.

4.2.3 Value towards ventilation components fitted to the home

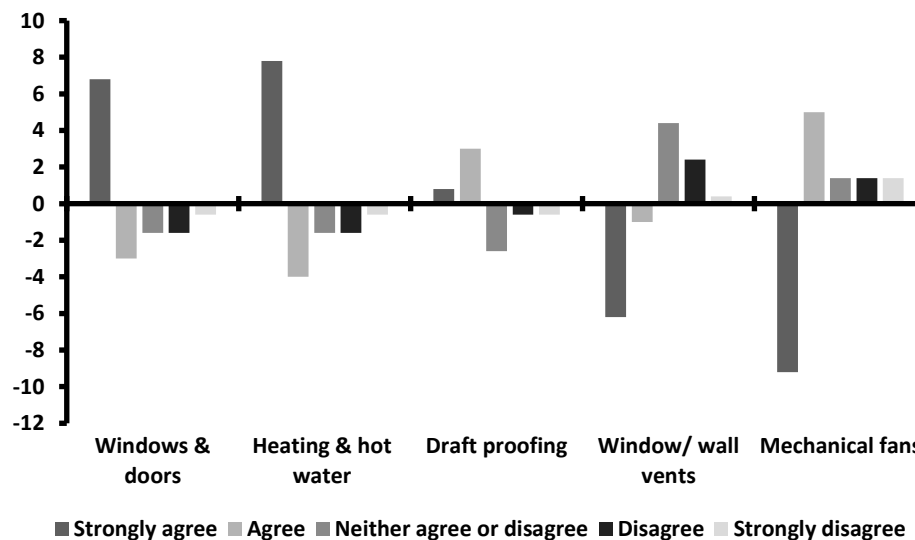


Figure 4.2.4: Observed V expected, participant value placed on building components (n=22).

The above figure shows the variance of observed data versus expected, the category for strongly agree shows the greatest variants across all building components using chi-square test.

Analysis of frequency data using Chi-square

$p = 0.05$	Degrees of freedom	Chi-square critical	χ^2
Component variance	16	26.30	58.94

The null hypothesis is rejected as 58.94 is greater than 26.3.

Bath fan switch position	n	Automatic		Manual		No fan
		Off	On	Off	On	
Owner occupier	8			5	3	
Tenant – Private Landlord	5			3		2
Tenant – Social Landlord	28	11	12	2	1	2

Table 4.2.2: Method of mechanical extractor fan activation (n = 41).

The above table shows observed data by the researcher during the site visit of the position of the bathroom fan activation switch for automatic humidistat fans and manually operated fans.

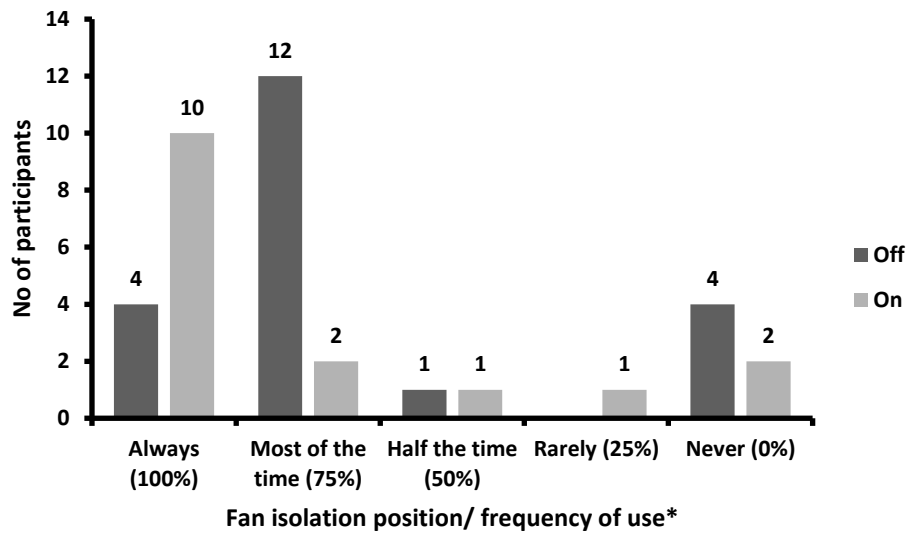


Figure 4.2. 5: Relationship of bathroom fan use against activation, percentages shown only for context to Participants' (n=22).

The above figure cross-references participants' responses of the question how often they use the bathroom extractor fan whilst bathing against the observation made by the researcher of the extractor fan isolation switch.

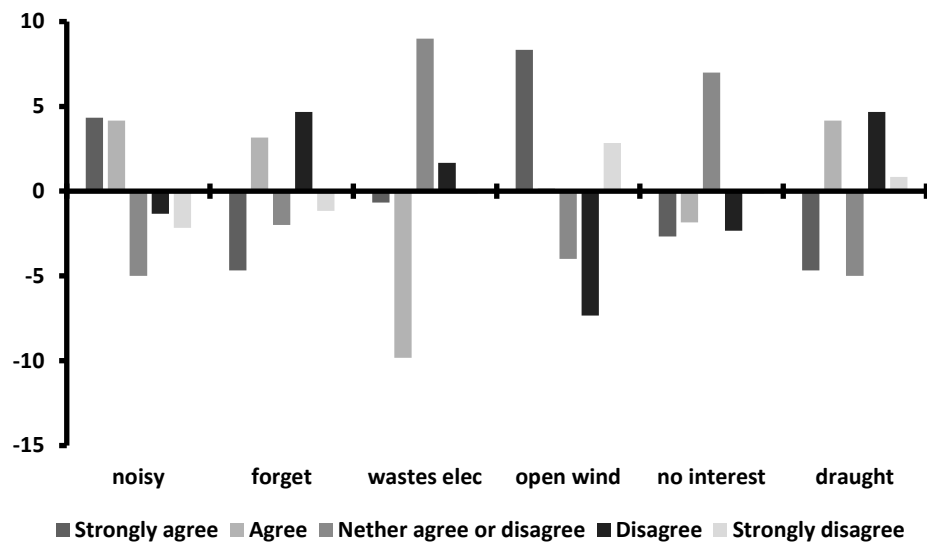


Figure 4.2.6: Observed V expected, participants' opinion of why they do not use the bathroom fan (n = 37).

The above figure shows the variance of observed data versus expected, the category for strongly agree shows the greatest variants across all building components using chi-square test.

Analysis of frequency data using Chi-square

$p = 0.05$	Degrees of freedom	Chi-square Crit	χ^2
Component variance	20	31.41	82.85

The null hypothesis is rejected as 82.85 is greater than 31.41.

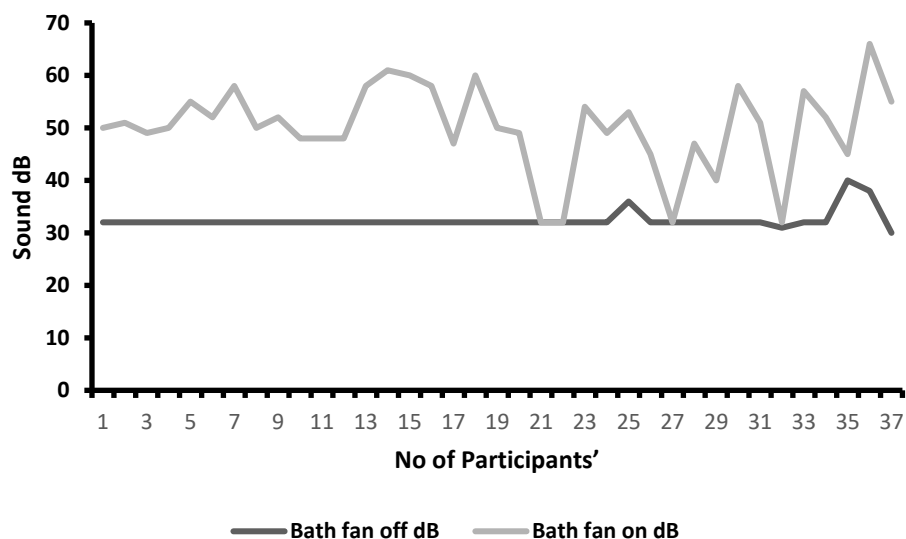


Figure 4.2. 7: Bathroom extractor fan sound off and on, minimum instrument reading (32db).

The above figure showing sound recording in the bathroom with the fan off and on. Automatic continuous running fans had no impact on the meter reading when operating in normal trickle speed of between 6 and 8 litre/ second.

	Population = n	Mean = $\bar{x}$	Standard deviation = s	Standard Error Mean
Bath fan on	37	50.11	8.25	1.36

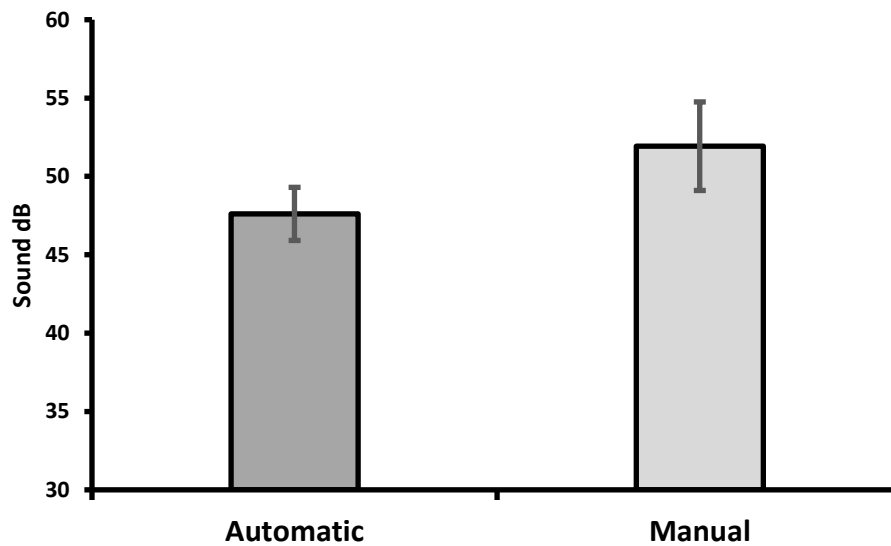


Figure 4.2.8: Comparison of automatic / manual, extractor bathroom fan noise (n as shown).

	Population = n	Mean = $\bar{x}$	Standard deviation = s	Standard Error Mean
Automatic	23	47.61	8.13	1.69
Manual	14	51.93	10.57	2.83

Statistical relationship using t – test (two tailed), $p = 0.05$.

Relationship	Degrees of freedom	t critical	t
Automatic/ Manual	35	2.03	1.40

The above figure shows a comparison of noise between automatic and manual operated fans using a t-test

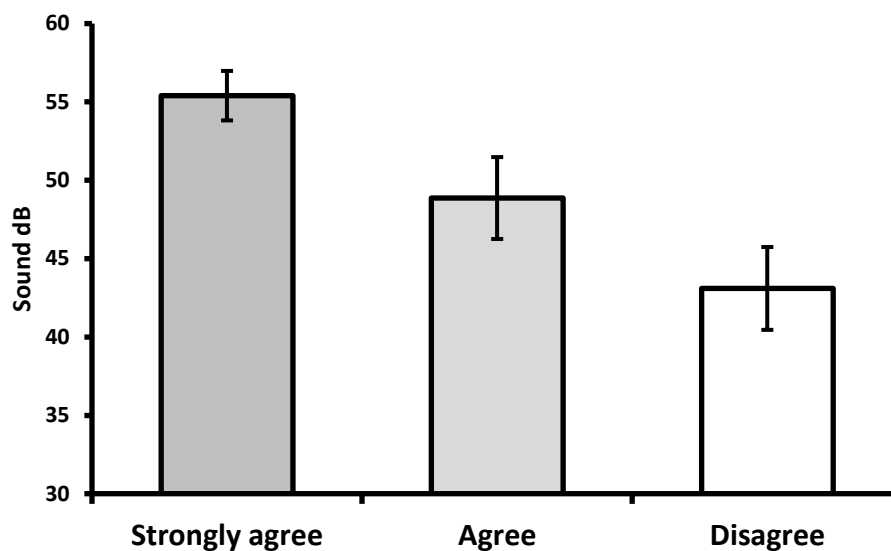


Figure 4.2. 9: Participant opinion to whether bathroom fan is noisy.

The above chart shows the relationship between the mean fan noise participant response to questions answering multiple-choice questions to whether they agree or disagree that they bathroom fan is noisy.

	Population = n	Mean = $\bar{x}$	Standard deviation = s	Standard Error Mean
Strongly agree	10	55.40	4.99	1.58
Agree	15	48.87	10.12	2.61
Disagree	10	43.10	8.36	2.64

Statistical relationship using t – test (two tailed), $p = 0.05$.

Relationship	Degrees of freedom	t critical	t
Strongly agree/ Agree	23	2.07	1.88
Strongly agree, Agree/ Disagree	33	2.03	2.55

Kitchen

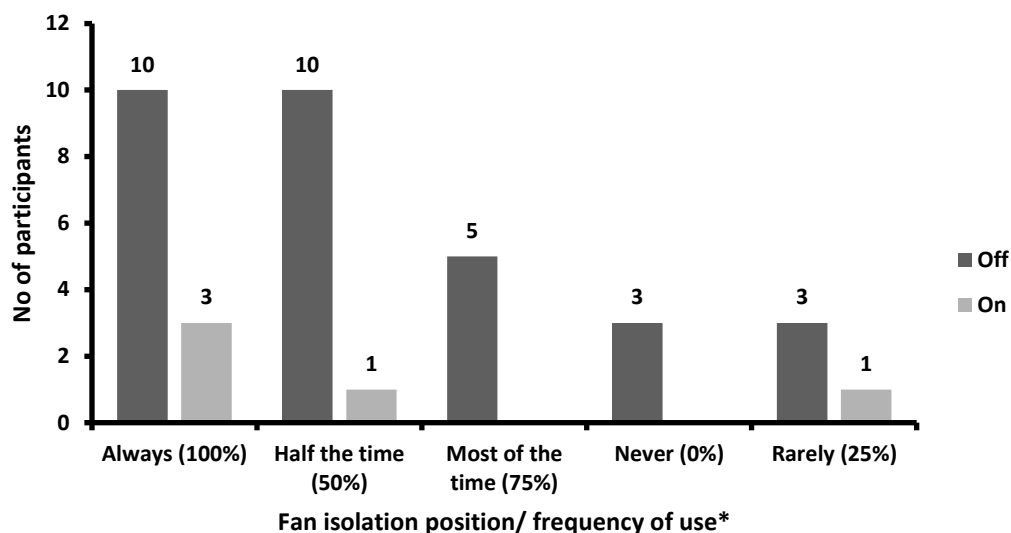


Figure 4.2. 10: Relationship of kitchen fan use against activation (n = 36).

The above figure cross-references participants' responses of the question how often they use the kitchen extractor fan whilst bathing against the observation made by the researcher of the extractor fan isolation switch.

How often do you use the extractor fan whilst cooking?	No fan	Off	On
Always (100%)		10	3
Half the time (50%)		10	1
Most of the time (75%)		5	
Never (0%)		3	
No fan	5		
Rarely (25%)		3	1

Table 4.2.3: Participant behaviour to use of mechanical extractor fan whilst bathing (n = 36).

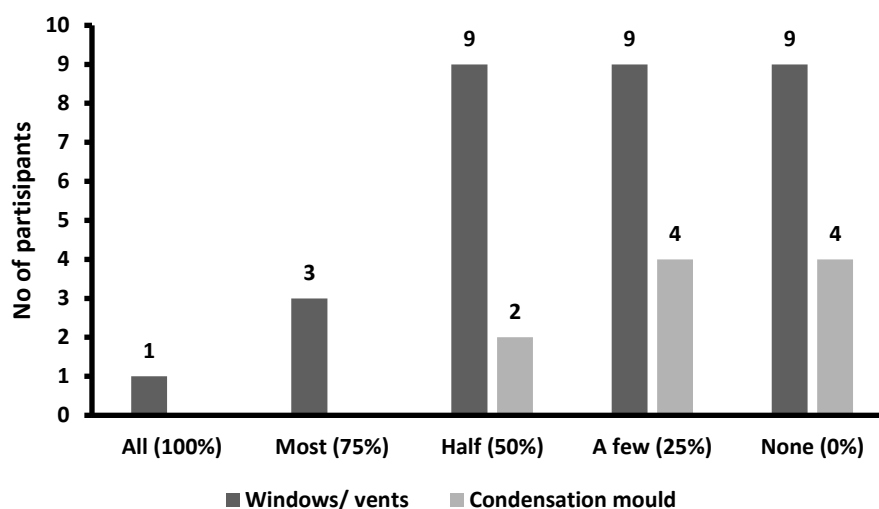


Figure 4.2. 11: Showing participant behaviour to use of windows and trickle vents (n = 41).

The above figure cross-references researcher's observations' of percentage of window and trickle vent positions' against evidence of condensation mould.

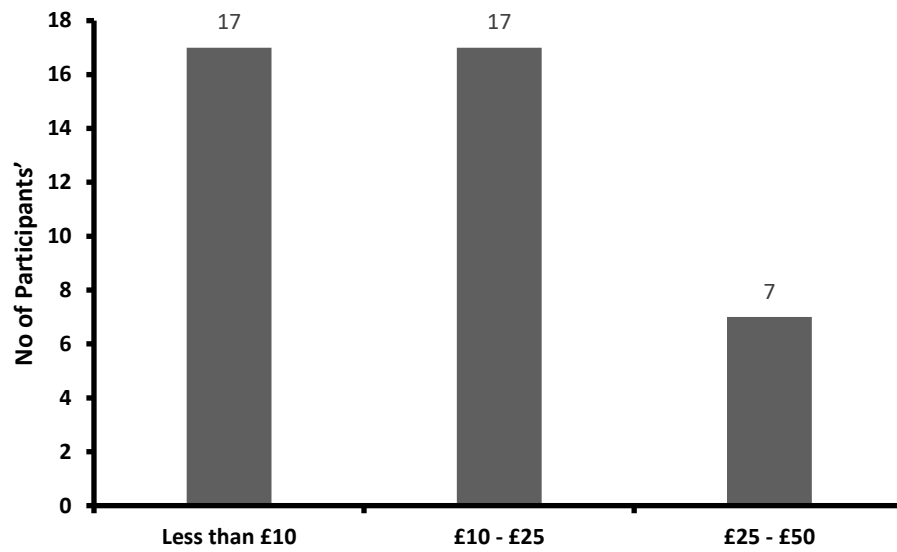


Figure 4.2. 12: Showing perceived extractor fan running costs per year (n = 41).

The above figure shows participants perception of extractor fan annual running costs.

4.3 Online Questionnaire Findings

This section provides results from Participants' completing the online questionnaire. The questionnaire was produced using 'survey monkey' an online questionnaire development platform. This survey commenced on 15 March 2008 and completed on 16 April 2008. The maximum number of Participants' completing this questionnaire was 141. Not all questions were answered, this is shown in the corresponding result sets (below). Each result set shows number of Participants' (n). Marketing for the online questionnaire was through direct email, and social media using Facebook and Yammer. Participants' accessed the questionnaire by clicking on a link attached to the email or an image within their social media account.

Participants' completing this questionnaire consisted of friends and family members of the researcher along with friends of friends and family members using 'Facebook' social media. Marketing using 'Yammer' a work based social media at the housing association (V2C), allowed work colleagues of the researcher to complete the questionnaire.

4.4 Results – Online Questionnaire

4.4.1 Tenure & Demographic

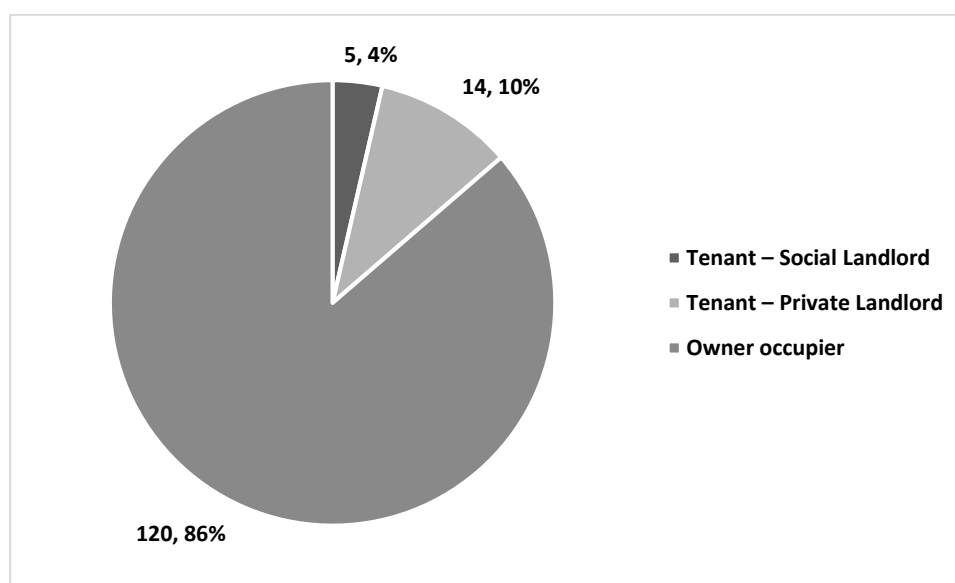


Figure 4.4.1: Number & percentage of tenure for household Participants' (n = 141).

The above pie chart shows the tenure demographic of participants who took part in the online survey.

0 - 18 years	18 - 30 years	30 - 45 years	45 - 60 years	60 - 75 years	75 +
156	47	148	67	27	2

Table 4.4.1: Age distribution of household Participants' (n = 141).

The above table shows the age distribution of participant households', which were mainly families.

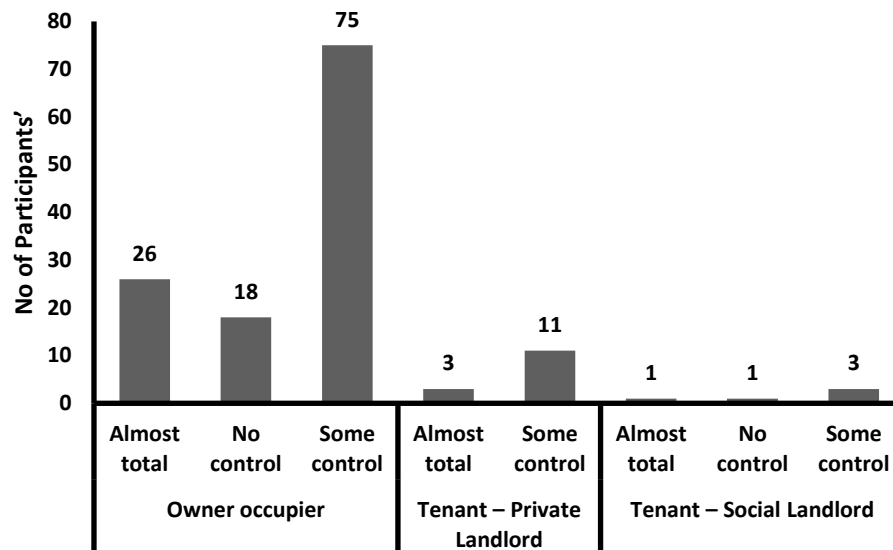


Figure 4.4.2: Participant opinion of control of IAQ, (n = 138).

The above figure shows variants of participant opinion towards IAQ across tenure.

4.4.2 Building components

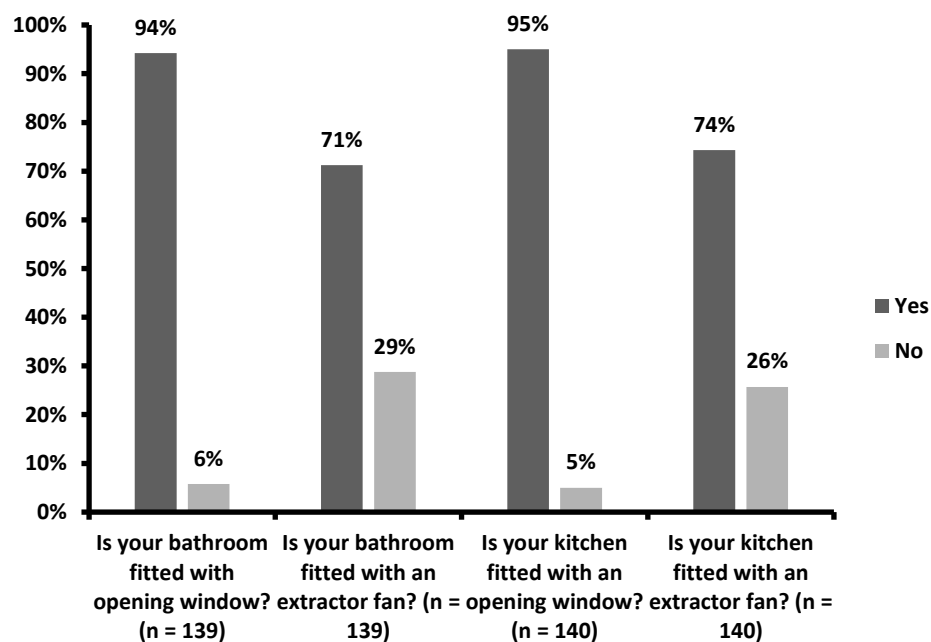


Figure 4.4.3: Ventilation components fitted to Participants' dwellings, (n = as shown).

The above figure shows the percentage of dwellings fitted with ventilation components

4.4.3 Value towards ventilation components fitted to the home

Please rate the following components fitted to your home in order of importance. (n = 141)	Very important	Important	Neither important or unimportant	Unimportant	Very unimportant
Windows and doors	86%	13%	1%	1%	0%
Heating & hot water system	81%	19%	0%	0%	0%
Draft proofing	45%	47%	8%	1%	0%
Window or wall vents	16%	55%	22%	6%	1%
Mechanical extract fans	10%	45%	30%	11%	5%

Table 4.4. 2: Participant value of importance placed on building components (n = 141).

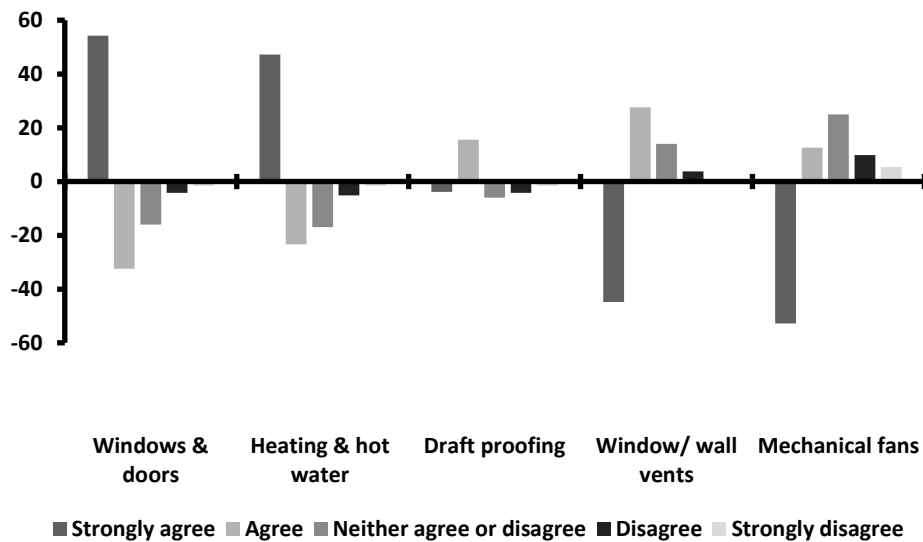


Figure 4.4. 4: Observed V expected, participant value placed on building components (n=141).

The above figure shows the variance of observed data versus expected, the category for strongly agree shows the greatest variants across all building components using chi-square test.

Analysis of frequency data using Chi-square

$p = 0.05$	Degrees of freedom	Chi-square critical	χ^2
Component variance	16	26.30	343.06

The null hypothesis is rejected as 343.06 is greater than 26.30.

Have you been provided with instruction and guidance by the: landlord/Installer/Previous owner, on how to correctly use the following components fitted?	Windows/ doors	Heating & hot water	Windows/ wall vents	Extract fans
Yes	45%	54%	21%	22%
No	43%	38%	58%	50%
N/A	6%	7%	11%	20%
Don't know	6%	1%	11%	9%
n =	139	138	139	123

Table 4.4. 3: Participant knowledge of instruction on building components.

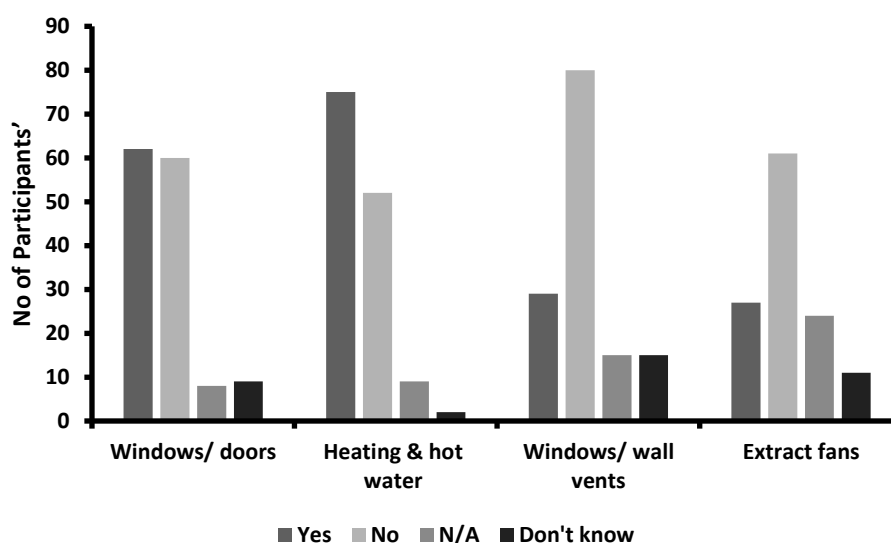


Figure 4.4. 5: Provision of instruction on how to use building components (n = ref table: 4.4.3).

The above table shows participants response as to whether they have received instruction and guidance from the installer, landlord or previous owner on building components.

How you ventilate your bathroom when bathing?	No.	%
Open window	54	38.3%
Use mechanical extractor fan	45	31.9%
Open window and use mechanical extractor fan	30	21.3%
Open bathroom door	6	4.3%
Other	6	4.3%

Table 4.4. 4: Participants' method of ventilating bathroom (n = 141).

The above table shows participant responses to behaviour when bathing.

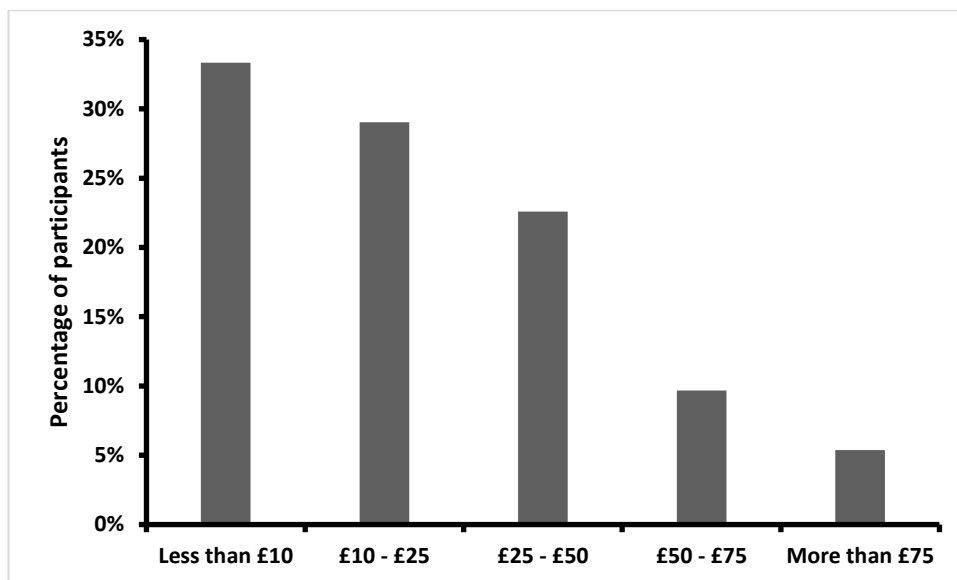


Figure 4.4. 6: Perceived extractor fan running costs per year, (n = 92).

The above figure shows participants perception of extractor fan annual running costs.

4.5 Discussion

In this study set out to evaluate the level of understanding, behaviour, and value occupants' place upon the ventilation of their homes. In this section we discuss the outcomes of our findings and results. We then compare comparisons or contrasts with other studies to enable conclusions to be drawn.

Tenure and demographic

The predominant Participants' for this study were found to be social housing tenants 68%, owner occupiers accounted for 20% and private housing tenants accounted for 12% (figure 4.2.1), Participants' tended to be parents of young families, age bands were highest in the 0 to 18 years and 30 to 45 age bands (table 4.2.1).

When questioned regarding the indoor air quality of their homes, Participants' were given the option of: almost total control, some control and no control. Whilst it was difficult to draw conclusions how each tenure responded our study showed 73% of all tenures stated they had some control of the air quality (figure 4.2.2).

Ventilation components

All of the Participants' dwellings in this study had some form of ventilation components built into their homes. Opening windows in kitchens accounted for 100%, and opening bathroom windows accounted for 93%. Not all dwellings had a mechanical extractor fan is fitted bathrooms accounted for 90% in kitchens accounted for 80% (figure 4.2.3).

Value

Participants' were asked to rate building components in order of importance ranging from very important, important, neither important or unimportant, unimportant and very unimportant. It's noteworthy that this question was introduced during the study period hence the low participant numbers ($n = 22$). These components consisted of: windows and doors, heating and hot water system, draft proofing, window or wall vents, and mechanical extract fans.

Statistical analysis carried out using the chi square test found χ^2 variance in response to building components was greater than a null hypothesis would expect. For this question chi-square was 58.94 whereas Chi square critical was 26.3. The data shows Participants' who strongly agree that building components such as windows/ doors and heating /hot water system are important were greater than expected. However Participants' who strongly agree that building components such as window/wall vent and mechanical fans were less than expected (figure 4.2.4). This question shares similar trends to the online survey (figure 4.4.4), when comparing these two figures the data suggests that participants with a greater social housing tenure agree mechanical fans are more important when compared with participants of a mainly owner occupier tenure.

Behaviour

Participants' were asked a multiple choice question which allowed them to select how often they use the extractor fan in the bathroom whilst bathing, the options were: always (100%), most of the time (75%), half the time (50%), rarely (25%) and never (0%). The percentage figure was purely added to give the participant a sense of context. The responses from the Participants' were then cross-referenced against the isolation switch position for the bathroom fan. The fan isolation switch is usually located against the ceiling, out of reach to prevent casual use, (figure 4.1.4.a). 14 of the Participants' who responded always (100%), the isolation switch was observed to be in the "on" position for 10 households' and "off" for 4 households'. Interestingly it was noted of the 14 Participants' who responded most of the time (75%), the isolation switch was observed to be in the "off" position and only 2 in the "on" position.

This would indicate that Participants' were being optimistic with their statement of using the fan most of the time (75%). At the other end of the scale it was noted that 4 of the Participants' who stated they never (0%) use the bathroom fan the isolation switch was found in the "on" position. This would indicate that these Participants' were unaware there bathroom fan was operating.

A similar question was posed concerning the extractor fan in the kitchen, however 31 of the 36 Participants' used the kitchen fan as a manual operation regardless of whether it was automatic, (table 4.2.12).

This was primarily as the isolation switch was conveniently accessible. It was therefore not possible to determine Participants' behaviour against observations in this case.

Of the 41 dwellings studied, it was noted 37 were fitted with mechanical extractor fans. It was observed that 21 of these fans were isolated from the power supply, consisting of 10 manually operated fans and 11 automatic fans (table 4.2.3). The data showed that owner occupied dwellings and private rented dwellings were fitted with only manually operated fans.

Data from (table 4.2.3) shows 23 of the 28 mechanical extract fan fitted to social tenure dwellings were continuously running humidistat sensor activation. A discussion with Raymonde De-Schoolmeester, Electrical Works Supervisor for Valleys to Coast Housing association stated.

"Whilst humidistat extractor fans are more expensive to purchase than standard manual activated units, we've found because they were quieter, tenants were more inclined to use them". "Traditional manual stop start fans need to remove a high volume of moist air in a short space of time, less than 15 minutes usually before they cut out, this meant they could be noisy due to the fan rotors running faster". "Continuous running fans move air at lower volume, therefore cheaper to run and quieter".

Current Building Regulations required intermittent running mechanical extract fans to have a minimum flow rate in wet zones (bathroom/shower room), of 15 litres per second whereas continuous running fans operate up to 13 Litres per second. Building regulations only require noise restrictions on continuous running mechanical extract fans 35 dB for bathrooms (MHCLG, 2010). This would appear to be the case in this study, lower automatic fan operating noise was assessed using the noise meter (figure 3.5.1/4.2.8). Whilst the mean sound of bathroom automatic fans 47.61 dB, is lower than the mean sound of the bathroom manual fans 51.93 dB, no significant statistical difference was found using a two-tailed t-test. The results show t of 1.40 remains within 95% of a normal distribution. The null hypothesis would expect there to be a statistical difference between automatic and manual fan noise, however this appears not to be the case in this study. However this study found that of the 23 automatic fans studied 11 of the 12 were switched off (table 4.2.3). Subsequent review of the manufacturer's installation instructions for "Vent-Axia, Response", the most common extract fan assessed during this study, found this model runs through a 15 minute calibration routine when powered on from an isolation switch. During this time the fan runs at higher speeds than during normal operating conditions along with an LED display showing flowrate and system

pressure. The sound measurement of these fans was taken within this 15 minute period. This information may suggest why these fans were louder than anticipated.

This oversight by the researcher may be shared by Participants' who equally have limited knowledge of how these fans operate. This may suggest similarly to other studies (Dongen, 2007), why almost half these fans were switched off.

This study found on 4 occasions continuous running bathroom extract fans did not show an increase in sound level over the ambient measurement of the instrument being 32dB (figure 4.2.6).

Statistical analysis using the two-tailed t-test was used to compare bathroom fan noise measured with a sound meter against Participants' responses as to whether they thought their bathroom fan was noisy (figure 4.2.9). No significant difference was found between Participants' who strongly agreed and those who agreed that their bathroom fan was noisy, t 1.88 was found within the 95% normal distribution, t -critical was 2.07. However significant difference was found between Participants' who strongly agreed and agreed with Participants' who disagreed their fan was noisy, t 2.55 was outside the 95% normal distribution as t critical 2.03.

Observation

During the researcher's study of the 41 dwellings it was observed (figure 4.2.11), that only one had all trickle vents open, three had most of them open, the remaining 37 dwellings had between half and none open. It was observed that 2 of the 9 dwellings that had half the windows/ vents open, showed evidence of condensation mould. 4 of the 9 dwellings that had a few windows/ vents open showed evidence of condensation mould, a similar observation was made of the dwellings with no window/ vents open. Although this is a small sample, the data does with recent studies (Guerra Santin & Itard, 2010) & (Howieson, et al., 2014), indicate the less well ventilated the dwelling the greater the risk of condensation.

Running costs of mechanical ventilation

The researcher posed the question to participants what the typical annual running cost for their mechanical ventilation, a common initial response was "I have no idea" however when presented with multiple choice options: less than £10, £10-£25, £25-£50, £50-£75 and £75 +. 17 of the 41 participants selected less than £10 (figure 4.2.12).

Online Survey Questionnaire

Whilst it's accepted the online survey questionnaire was not used for analysis due to verification and demographic of participants a number of trends shared common traits with that of the site visited participants.

Participants' for this online study were found to be owner occupiers 86%, private housing tenants accounted for 10% and social housing tenants accounted for 4% (figure 4.4.1). However like the site visit survey participants' tended to be parents of young families, age bands were highest in the 0 to 18 years and 30 to 45 age bands (table 4.4.1).

Ventilation components

Unlike the ventilation components fitted to dwellings of the site visit survey (figure 4.2.3), the online survey of predominantly owner occupier tenure participants (figure 4.4.3) shows dwellings less likely to be fitted with bathroom or kitchen extractor fans. It's important to note that social housing tenants would not influence the requirement for a mechanical fan to be fitted to their homes, as this would be driven by the housing associations requirement to meet housing quality standards. This chart also shows kitchens are more likely to be fitted with extractor fans and bathrooms.

With regards to knowledge of building components the online questionnaire showed a trend where participants showed a greater awareness of instruction and guidance on how to use the heating and hot water system (figure 4.4.5), but not the window vents and extract fans.

The results have shown a trend towards a similar study of new California homes (Price & Sherman, 2006) and how occupants' behave and interact with their homes (Sharpe, et al., 2015), although both these studies focus on new dwellings the research provides a good insight how occupants' of existing home which have had energy efficient improvements added.

Chapter 5 – Conclusion

Regarding the hypothesis above there should be a holistic approach to energy efficiency, ventilation and occupancy behaviour. The data suggests occupants' of dwellings have little understanding awareness or value of ventilation components fitted to their homes. This study has shown even after the housing association has gone above what is required for building regulation compliance to provide automated humidistat ventilation fans tenants still switch them off.

The lack of awareness of how these components correctly function has shown little benefit to improving indoor air quality.

The data in this study has shown that because of running mechanical extract fans is not a driver for switching them off but a lack of awareness of how they correctly operate.

A campaign of raising awareness amongst tenants how to correctly use their ventilation systems could be seen as a way of improving indoor air quality and improving occupants' health and well-being. Stock holders may need to develop a strategy that ensures occupants' maintain their property to a standard that's not detrimental to the buildings fabric or the occupants' health. This will incentivise stock holders to develop a campaign to raise awareness of ventilation and healthy occupation, will develop a strategy that provides a balanced approach to heating and ventilation, will develop a ventilation strategy not detrimental to people living in fuel poverty, and will introduce energy efficient low tech retro fit passive ventilation with restricted occupant controls.

This research would benefit from further study looking at behaviour patterns of participants after a programme of education highlighting the correct use of fans to determine if this would see an increase in their use. Additional research looking at the installation and commissioned of the mechanical fans to determine they function to suit the needs of the occupiers.

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Chapter 7 – Appendices

Appendix 1 – Site visit Questionnaire

Q1. Property tenure?

Q2. Number of occupants', 0 – 18 years, 18 – 30 years, 30 – 45 years, 45 – 60 years, 60 – 75 years and 75+

Q3. Household show usage per week?

Q4. Please take one of the following statements which is most appropriate to you:

- a) I have no control of the air quality in my home
- b) I have some control of the air quality in my home
- c) I have almost total control of the air quality in my home

Q5. Bathroom/ kitchen fitted with opening window

- a) Yes
- b) No

Q6. Bathroom/ Kitchen extractor fan isolation switch position at time of survey

- a) On
- b) Off

Q7. Bath /shower room / kitchen extractor fan activation

- a) Continuously on or automatic (humidistat sensor)
- b) Manual fire light switch on and time off
- c) Unable to determine

Q8. How often do you use the extractor fan whilst bathing / cooking?

- a) Always (100%),
- b) Most of the time (75%),
- c) Half the time (50%),
- d) Rarely (25%)
- e) Never (0%)

Q9. If you don't use the fan please rate following reasons why ranging from strongly agree, agree, neither agree or disagree, disagree and strongly disagree

- a) too noisy
- b) forget to switch it on
- c) wastes electricity
- d) open the window instead
- e) not interested
- f) draft from outside

Note: this question initially applied to both the bathroom fan and kitchen fan, however during the pilot study it was found that participants gave the same responses. It was therefore only asked once.

Q10. Ambient bathroom/ kitchen sound (dB), sound with mechanical extract fan running (dB)

Q 11. Visual evidence of mould caused by condensation

- a) Yes
- b) No

Q12. Window or window vents open at time of survey

- a) All (100%)
- b) Most (75%)
- c) Half (50%)
- d) A few (25%)
- e) None (0%)

Q 13. Windows fitted with trickle vents

- a) Yes
- b) No

Q 14. How much do you believe running your mechanical extract funds cost per year

- a) Less than £10
- b) £10 - £25
- c) £25 - £50
- d) £50 - £75
- e) More than £75

Appendix 2 - Online Questionnaire Summary

Q1. Property tenure?

Q2. Number of occupants', 0 – 18 years, 18 – 30 years, 30 – 45 years, 45 – 60 years, 60 – 75 years and 75+

Q3. Household shower/ bath usage per week?

Q5. Please rate the following components fitted to your home in order of importance: very important, important, neither important or unimportant, and important and very unimportant

- a) Windows and doors
- b) Heating and hot water system
- c) Draught proofing
- d) Window or wall vents
- e) Mechanical extract fans

Q6. Have you been provided with instruction and guidance by the landlord /installer or previous owner on how to correctly use the following components fitted to your home?

- a) Windows and doors
- b) Heating and hot water system
- c) Window and or wall vents
- d) Mechanical extract fans

Response choice was: Yes, No, Don't know, N/a.

Q7. Please take one of the following statements which is most appropriate to you:

- a) I have no control of the air quality in my home
- b) I have some control of the air quality in my home
- c) I have almost total control of the air quality in my home

Q8. Bathroom/ kitchen fitted with opening window

- a) Yes
- b) No

Q9. Is your bathroom fitted with an extractor fan?

- a) Yes
- b) No

Q10. How do you ventilate your bathroom when using the bath or shower?

- a) Open window
- b) Use mechanical extractor fan
- c) Open window and use mechanical extractor fan
- d) Open bathroom door
- e) Other

Q11. How do you activate your bathroom / shower room fan?

- a) Continuously on or automatic (humidistat sensor)
- b) Manual fire light switch on and time off
- c) Unable to determine

This question was added late in the survey process

Q12. How often do you use the extractor fan whilst bathing / cooking?

- f) Always (100%),
- g) Most of the time (75%),
- h) Half the time (50%),
- i) Rarely (25%)
- j) Never (0%)

Q13. If you don't use the fan please rate following reasons why ranging from strongly agree, agree, neither agree or disagree, disagree and strongly disagree

- g) too noisy
- h) forget to switch it on
- i) wastes electricity
- j) open the window instead
- k) not interested
- l) draft from outside

Note: this question initially applied to both the bathroom fan and kitchen fan, however during the pilot study it was found that participants gave the same responses. It was therefore only asked once.

Q14. How much do you believe running your mechanical extract funds cost per year

- f) Less than £10
- g) £10 - £25
- h) £25 - £50
- i) £50 - £75
- j) More than £75

Q15. How do you ventilate the lounge and bedrooms in your home?

- a) Open windows occasionally
- b) open windows continuously
- c) Open trickle vents occasionally
- d) Open trickle vents continuously
- e) other (please specify)

Appendix 3 – Participant information sheet & consent form

Investigating the way we use our homes.

Information Sheet

Dear Participant

I am a post graduate student studying a master's degree at the University of Wales Trinity Saint David (Swansea) Campus. I would like to invite you to take part in this research study on the way we use our homes. Before participating it is important you understand why the research is being done and what it would involve for you. Please take time to read the following information carefully.

The study aims to explore occupant behaviour characteristics and perceptions of components and systems incorporated in domestic dwellings. The study will be in the form of mobile tablet based app questionnaire, completed by the surveyor during the appointment. Data will be procured in three forms which consist of :

- Asset data from housing association stock condition survey
- Observation data gathered during the survey
- Questions posed to occupants' during the survey.

In total, this questionnaire should take around five minutes to complete.

Please remember that your participation is entirely voluntary, there is no obligation on you to take part and you have the right to withdraw at any given time during the survey. However, if you want to withdraw after you've completed the study this can only be carried out if I'm contacted within one week after completion. Please note all information will be kept confidential, data will not be analysed individually, but looking at as trends and groups. All data will be anonymized by the researcher, therefore **no** information will be released which will enable the reader to identify you personally, including the housing association.

The study is designed to gather your own personal thoughts and feelings, there are no right or wrong answers. This project has been approved in accordance with the University of Wales Trinity Saint David (UWTSD), Research Ethics Policy. If you have any further questions on the information regarding the study, or that you wish to make a complaint please contact Wayne Francis (wfrancis.148428@student.uwtsd.ac.uk) or course supervisor Juan Ferriz-Papi (juan.ferriz-papi@uwtsd.ac.uk).

Please remember all information will be kept private and if you wish to withdraw your data this can only be issued if I'm contacted within one week after completion (wfrancis.148428@student.uwtsd.ac.uk). You can request a summary of the project contacting me using this email address above between May and June 2018.

Please read the Consent Form below, and sign the form if you are satisfied that you have been fully informed about the procedure of the study and your ethical rights as a research participant.

Thank you for your time, I hope that you find the study interesting and enjoyable.

Yours faithfully

Consent Form

Investigating the way we use our homes.

PLEASE READ THE FOLLOWING INFORMATION CAREFULLY

Reference no.....(*Completed by researcher only*)

Tick here

1	I am over the age of 18	
2	I have read and understand the information sheet for this research project. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
3	I understand that my participation in the activity is voluntary and that I am therefore free to withdraw my involvement at any stage, without giving a reason.	
4	I am aware of the timescales in which I can withdraw my data (as indicated on the Information Sheet)	
5	I understand that all information will be anonymised, kept confidential and that my personal information will not be released to any third parties	
6	By ticking this box, I agree to participate in this study under the condition of fully understanding the terms above.	

Print Name.....

Signature

Date.....