The aim of current research study was to investigate the association of indoor air quality with the occupants' health and wellbeing. It has also compared BREEAM and LEED in terms of inclusion of indoor air quality in green buildings. The literature has mentioned that LEED is more inclusive for quality of indoor air in comparison to BREEAM. In order to fulfil the research aim, the current study has relied don mixed research methods. The quantitative data was obtained through online survey and data was obtained from 200 respondents. On the other hand, qualitative data was obtained through structured interviews. The interviewees were conducted from the professionals of sustainability buildings and data was obtained from 18 respondents. The data of survey was analysed through visual representation by figures and results have provided that there is significant association of indoor air quality with health and wellbeing of occupants. Along with this, the interviews were also analysed through visual representation. The responses of most of interviewees have provided that BREEAM are LEED are similar in terms of indoor air quality. The results of open ended questions have highlighted that BREEAM is more inclusive for health and wellbeing of occupants, as all of interviewees had experience of BREEAM rather than LEED. Along with this, results have also highlighted that WELL building standard is more important in terms of occupants' health and wellbeing and expected merger of BREEAM and WELL can improve the health and wellbeing aspect of BREAAM further. The results of the current research were highly important for both practice and theory.

1. Introduction

1.1 Background

The indoor air quality (IAQ) is one of the most important aspect of green buildings that may have direct influence on living quality and health and wellbeing of humans. It has been recommended by the researchers that poor quality of indoor air can have negative impact on health of occupants both

psychological and physical (Edwards, 2006). The IAQ is one of the important aspects of indoor Environment Quality (IEQ) as provided by prior researchers (Zuo and Zhao, 2014)and it provides that air should be free from any contaminants that cause harm and discomfort to people (Miller, Pogue, Gough and Davis, 2009). The high quality of air is ensured by adequate ventilation within green building and it offers greater assurance of occupants' health and wellbeing. The IAQ has been considered as the most important measure of indoor environment quality as it can be measured quantitatively in comparison to other criteria that are mainly perception based(Chatzidiakou, Mumovic and Summerfield, 2015).It has been mentioned in the study of Edwards and Torcellini (2002) that in US and UK higher percentage of people are suffering from respiratory allergies and asthma that are mainly caused by indoor environmental conditions, such as poor quality of air.

It has been asserted by the prior researchers that main emphasis of green buildings movement is on effective maintenance of IAQ with an aim to offer healthier living environment and ensure health and wellbeing to occupants. The evidences from past research has provided that occupants of green buildings are likely to be more satisfied with the high IAQ and they have better health and wellbeing than occupants of traditional buildings (Chuck and Kim, 2011). The same has been acknowledged by the study of Kibert (2016), carried out in perspective of Leadership in Energy and Environmental Design (LEED) and its association with occupants' health and wellbeing. The results of the study have revealed that building with high LEED ratings and improved IAQ were mainly having a positive influence on better health and wellbeing of occupants. Moreover, the evidences from various researches have provided that occupants have placed significant importance to the IAQ in terms of their comfort and satisfaction with indoor environment (Fisk, 2000). The satisfaction is mainly the indicator of psychological wellbeing and it also hinders the anxiety, stress and depression among occupants(Ferreira, Pinheiro and de Brito, 2014; Chuck and Kim, 2011).Therefore, the notion of green buildings and high IAQ are largely associated with occupants' health and wellbeing.

Along with this, it has been highlighted in the study of Chuck and Kim (2011) that there is considerable difference in the IAQ consideration of BREEAM(Building Research Establishment Environmental Assessment Method) and LEED. The present study will conduct the comparison and offer

more recent insight. It is important to note that prior studies have mainly suggested that LEED has higher level of inclusion for quality of indoor air than BREEAM in preoccupancy period. The recent literature on comparison of BREEAM and LEED in aspect of post-occupancy consideration for quality of indoor air is limited. The recently updated version of BREEAM and LEED might have modified their focus on quality of indoor air after the building has been handed over to clients. Thus, the focus in present study has also been maintained on post-occupancy consideration of indoor air quality by BREEM and LEED.

1.2 Purpose of the Study

The issue of occupants' health and wellbeing is equally important for residential as well as commercial buildings. It is of no doubt that major portion of human lives is being spent in the buildings, which has been reinforced by the study of Gambatese, Rajendran and Behm (2007) stating that on average modern people spend 80 to 90 per cent of their whole day (24 hours) in buildings (indoor). Based on this notion, the quality of indoor environment and sustainability of buildings is of critical concern for both research and practice. The poor quality of indoor air can cause significant harm to the health and wellbeing of residents both physically as well as psychologically. It has been highlighted in the research that 68% of human diseases are caused by the poor quality of indoor air (Leaman and Bordass, 2007). The most common diseases are respiratory allergies, asthma and depression. Along with this, the poor quality of indoor air and pollution within building causes skin aging, hair shedding and loss, fatigue, leukaemia, infertility and cancer. It has further suggested by Chuck and Kim (2011) that 2% of chronic diseases, 37% respiratory diseases, 5% leukaemia and 5% bronchial diseases are caused by the poor air quality in buildings. This increasing rate of diseases caused by indoor pollution and poor quality of indoor air calls for an immediate attention to the social sustainability issue in design and construction of residential and commercial buildings (Zuo and Zhao, 2014). The disastrous impacts of IAQ have motivated the researcher to conduct current research with an aim of suggesting improvements in sustainable buildings.

Along with this, it is notable from the research that cost of economy is raising due to sick leaves long term illnesses of people who are being employed by

organisations (Younger et al., 2008). In UK, the cost of sick leave has reported to be equal to 14 billion per year, which is burdening the economy (Ries, Bilec, Gokhan and Needy, 2006). Therefore, in order to lower the burden of health cost from the nation, the increasing importance has been provided to the concept of green buildings. This research will deeply investigate the impact of IAQ of green buildings on occupants' health and wellbeing and it will serve as reinforcement for practitioners to focus on aspect of sustainability of buildings.

Followed by this, the notion of informed occupants is also emerging nowadays. The informed occupants' phenomenon provides that with advancement in technology the people are able to track the environmental performance of buildings (Rajendran, Gambatese and Behm, 2009). The ability of individuals to measure the health prospects of buildings in real time is laying pressure on construction industry to incorporate aspect of sustainability into construction of buildings. The contemporary occupants are empowered and they can refuse to live in buildings that have lower health prospects (Shiers, 2000). Therefore, the research on health and wellbeing issues due to building environment is mandatory to assist the practitioners for construction sector. This dissertation has aimed to pursue a real issue from construction industry and it will offer significant implications to industry gurus for promoting better health prospects based on green buildings.

1.3 Research Aim and Objectives

The aim of current research study is to highlight the association of IAQ of green buildings with occupants' health and wellbeing.

The following research is conducted to fulfil the following objectives;

1. To identify the extent of IAQ in green buildings.
2. To recognise the importance of IAQ for occupants of green buildings.
3. To offer an insight on perceptions of green building occupants about IAQ.
4. To identify the association of IAQ of green buildings with occupants' health.

5. To highlight the importance of IAQ of green buildings in defining the wellbeing of occupants.

6. To compare the BREEAM and LEED in terms of offering importance to quality of indoor air during occupancy period in green buildings.

1.4 Research Questions

The present research study assists to seek answers for following research questions;

1. What is the extent of IAQ in green buildings?

2. Is there any correlationbetweenIAQ of green buildings with occupants' health?

3. Is there anycorrelationbetweenIAQof green buildings with occupants' wellbeing?

4. Is there any difference in BREEAM and LEED in terms of offering importance to IAQ during occupancy period within green buildings?

1.5 Significance of Research

The current research study contributes significantly to research and practice of sustainable buildings and its impact on occupants' health and wellbeing. Present researchhas investigated deeply the IAQ that is an important criterion of indoor environmental quality. This study delivers significant contribution in the stream of growing literature. This dissertation compared the recently updated version of BREEAM with LEED in order to identify the inclusion of IAQ of green buildings. More, specifically the focus has been maintained on carrying out a comparative study between BREEAM and LEED in terms of inclusion of quality of indoor air during the post occupancy period of green buildings. Therefore, it is a considerable addition in the extant literature. The findings of the study assist the practitioners to design their buildings in the way that may help them to increase the comfort and health prospects of occupants.

1.6 Structure of the Dissertation

The underlying investigation is addressing the research issue of IAQ of green buildings and its association with occupants' health and wellbeing is comprised of six chapters. The first section sheds light on background information pertaining to current research issue. The rationale for carrying out present research study along with objectives and research question is also incorporated in this section. The second chapter includes information based on review of relevant literature. It enhances theoretical understanding of the subject and guides formulation of hypotheses. The third chapter addresses the research methods of study along with design of data collection and data analysis. The fourth section of the study offers details of study's findings and the results are interpreted. The fifth chapter will discuss the key findings of research. It will also address the implications of study's results for research and practice. Along with this, the limitations of study will also be highlighted and guidance for future researchers will be suggested. Finally, the sixth chapter incorporates bibliographic information of present research.

2. Literature Review

In current era of environmental sensitivity and sustainability, the great emphasis has been maintained on design and construction of green buildings with an aim of enhancing comfort and wellbeing of occupants. The most of the research on green buildings has incorporated the aspect of triple bottom line that addresses environment, social and economic perspectives of the buildings (Ries, Bilec, Gokhan and Needy, 2006). The green buildings are defined as ones that have limited negative affect on health and wellbeing of occupants and on overall environment. (Singh, Syal, Grady and Korkmaz, 2010). The green building limits the impact of indoor environment on health and wellbeing of occupants by relying on sustainable building life cycle. The protection of occupants and environment is ensured by considering better site location, design, maintenance, and ventilation (Roper and Beard, 2006). Therefore, it is notable that positive effect on human health and wellbeing is

the main feature of green buildings. The green aspects of buildings lay an immediate focus on better ventilation, reliance on more sunlight and maintenance of high quality of indoor air that is crucial for preserving health and wellbeing of occupants. In this context, the IAQ is the main focus on green buildings.

2.1 Shift from Technical to Social Aspect

The research of green building has witnessed a major shift from technical and environmental aspect to the social aspect. The technical and environmental aspect of green buildings was mainly focusing on environmental sustainability aspects of green buildings including; efficient utilisation of water and energy, efficient utilisation of other natural resources and reduction of carbon footprints (Zuo and Zhao, 2014). However, the research of green buildings has gone through many reforms during the last decade and increasing attention has been given to social sustainability of buildings (Fisk, 2000). The social sustainability of buildings has focused widely on the improvement of quality of livings and health and wellbeing of occupants. The theoretical foundation of social sustainability has been suggested by inclusion of stake holder's theory with an aim of assessing the corporate social responsibility aspect of green buildings (Kibert, 2016). The stakeholder's theory in context of green buildings has relied on the phenomenon that buildings must be able to provide a healthy and safe living environment to occupants and there should be a strong consideration of social sustainability in building design (Spengler and Chen, 2000). Since the recognition of social sustainability concept, the green buildings are assessed on social sustainability tools with an aim of gauging their impact of occupants' health and safety. Therefore, the stakeholder's theory will give a reasonable theoretical justification for the current research issue.

2.2 Indoor Air Quality (IAQ)

The term of IAQ is widely used with reference to quality of air both inside and in vicinity of buildings. The IAQ is the complex phenomenon that constitutes odour, indoor air pollution and availability of fresh air within buildings (Chatzidiakou, Mumovic and Summerfield, 2015). The phenomenon of IAQ

has recently become the centre of attraction for both practitioners as well academics. The quality of indoor air is found to be influenced by the level of various gases including; carbon monoxide, volatile organic compounds and so on (Rosbach et al., 2013). In addition to it, there are different contaminating compounds and energy and other stressors that can have negative influence of quality of indoor air (Lajoie et al., 2015). There are number of sources, which are being widely used for controlling the quality of indoor air including; control over the contaminating sources, use of filtration and ventilation (Stabile et al., 2016). Due to its long terms consequences on human health, the notion of IAQ has gained considerable importance and different environmental performance assessment standards have devoted their attention to monitor the quality of indoor air, such as BREEAM and LEED.

2.3 Correlation of IAQ with Occupants' Health and Wellbeing

There is significant deal of agreement in literature about the impact of IAQ on health and wellbeing of occupants (Chatzidiakou, Mumovic, Summerfield and Altamirano, 2015). The indoor air pollutants and contaminants have been considered as major source of poor health of occupants. It is important to note that mainly the 90% of overall time of occupants is being spent indoor and they are highly exposed to indoor pollutants which can have disastrous impact of health of occupants (Jones, 1999; Kibert, 2016). It has widely been highlighted in the literature that volatile organic compounds and formaldehyde that are found indoor are likely to have substantial adverse impact on health of building's occupants (Daisey, Angell and Apte, 2003). The detrimental effects of poor indoor air and indoor pollutants can lead to sick building syndrome. It has been highlighted by the researchers that sick building syndrome or building related symptoms is caused mainly by poor IAQ and the victims claim severe discomfort (Stabile et al., 2016). The sick building syndrome is characterised by the sensory irritation, hypersensitivity reactions, infections, neurotoxic effects, skins diseases, allergies, asthma and multitude of nonspecific symptoms (Yu et al., 2009). The notion of sick building syndrome unveils a detrimental outcome of poor IAQ and it asserts that there is

substantial negative influence of poor IAQ on health and wellbeing of occupants (Burge, 2004; Abdul-Wahab, 2011).

Moreover, it has been highlighted in the research that concentration of pollutants in indoor is high in comparison to outdoor and the indoor air is the major cause behind greater exposure to contaminants and pollutants (Spengler and Chen, 2000). These aspects of poor IAQ cause discomfort for the occupants and they are more likely to face serious health consequences.

2.4 IAQ in BREEAM

The BREEAM (Building, Research, Establishment, Environmental, Assessment and Methodology) is one of the most widely used methods for quality assessment of buildings. The updated version of BREEAM has provided that there is significant inclusion of features for improving the air quality of indoor buildings in order to improve occupants' health and wellbeing (BREEAM, 2015). The health and wellbeing section of the BREEAM is focusing readily on enhancing the quality of life of occupants within buildings with an aim of improving health and wellbeing of occupants (Pelsmakers, 2014). The overall ratings assigned to buildings after assessment carried through BREEAM is comprised of number of issues, of which the health and wellbeing is an important category.

Among the issues that are being covered under the category of health and wellbeing, the IAQ has been given significant importance (Schweber and Haroglu, 2014). The BREEAM has split the issue of IAQ into three parts including;

- Prerequisites,
- Minimising the source of air pollution and
- Adaptability.

Firstly, the prerequisites of the IAQ mention that harmful chemicals should not be included for construction of material such as, asbestos (BREEAM, 2015).

Secondly, the minimisation of sources of air pollution is one of an important aspect for improving the IAQ (BREEAM, 2014). There are two aspects of minimisation of air pollutant sources encompassing; IAQ plan, ventilation,

emissions for building products and post construction measurement (BREEAM, 2014). The IAQ plan facilitates the design and implementation of such actions that foster the high quality of environment by minimising pollutants of indoor air during the construction and occupation stage of the buildings. The IAQplan focuses on elimination of pollutant sources and also consider dilution and control of sources that cause pollution. Along with this, the plan also focuses of preoccupancy flush out procedures that are being followed by analysis and maintenance of high quality of indoor air (BREEAM, 2014). The ventilation emphasises on minimising the concentration of pollutants and contaminants within building and also focuses on enabling the provision of fresh air in alignment with the national best practice of ventilation (BREEAM, 2014). The ventilation system is designed in the way that it can lower the likelihood of pollutants entry within the building. The system has also focused on sensors which restrict absorption of carbon dioxide and other harmful gases within buildings. The system is highly diverse and it varies according to the laws prevailing in focal countries. Such that, the countries, where smoking is allowed in indoor, there are dedicated smoking rooms which are mainly high on ventilation, so that the impact of smoking on residents' health and wellbeing can be minimised (BREEAM, 2014). Moreover, the emission testing requirements are set for investigating the aspects of air quality. The post construction measurement focuses on testing the concentration of different gases within IAQ and take necessary actions (BREEAM, 2014).

Finally, the adaptability aspect of BREEAM in IAQ provides that buildings should be flexible to encompass the needs of occupants (Seppänen, Fisk and Lei, 2006; BREEAM, 2014). The BREEAM has a natural ventilation strategy that ensures cross flow of air within buildings, which not only control thermal conditions but also improves ventilation rates of buildings. However, the design is maintained in adaptable way that can help them to make adjustment in strategy for improving quality of indoor air. Yet, it is important to note, that within BREEAM, during occupancy issues of IAQ are not considered readily in comparison to LEED (Azhar, Carlton, Olsen and Ahmad, 2011).

An agreement has been settled between International WELL Building Institute™ (IWBI™) and BRE (Building Research Establishment) on 29 October 2016 with an aim of enhancing alignments of WELL Building

Standard™ (WELL) and BREEAM for approaching different projects (BRE Group, 2016). Collaboration of BREEAM with IWBI is expected to bringefficiency in the approach of BREEAM for improving built environment (BREEAM, 2016a).

Figure 1: IWBI and BRE announce alignments between WELL and BREEAM

The BREEAM certification standard is visible in figure 1 mentioned below.

Source; BRE Group (2016)

2.5 IAQ in LEED

The LEED (Leadership in Energy and Environmental Design) has shifted the thinking about the ways that are being used for design and construction of green buildings (Gowri, 2004). The LEED has pushed the green buildings further towards the inclusion of health and wellbeing of occupants as core concerns while designing, constructing and renovating buildings (Lee and Guerin, 2010). The framework of LEED is highly comprehensive that not only assists in designing of green buildings but also gives the way of assessing performance of green buildings (Lee and Kim, 2008). There are five major categories that serves as basis for credit including; sustainable sites, water efficiency, energy and atmosphere, material and resources and indoor environmental quality (Lee and Guerin, 2009). The indoor environmental quality offers due placing to aspect of IAQ. The main intent of health and wellbeing perspective of LEED is to offer due importance to establishment of better indoor quality both after construction and during occupancy (Lee, 2011). It focuses on lowering the issues that are caused by off-gassing of materials being used in construction material with an aim of promoting greater comfort of occupants. The below mentioned figure 2 is presenting the complete information of contaminants level that are being tolerated within green buildings under regulations of LEED,

Figure 2: The threshold for contamination level in LEED and testing methods

along with testing methods that are adopted.

Source: LEED (2016)

It has been highlighted by Abbaszadeh, Zagreus, Lehrer and Huizenga (2006) that IAQ management plan is a noteworthy aspect of LEED, which has focused on minimisation of exposure risk of occupants with contaminants that might exist indoor. An important section of LEED has been assigned to the acceptable value of Total Volatile Organic Compounds (TVOC). The VOCs' emissions are considered to have a significant impact on health of the occupants, therefore, the LEED has devoted a full section to this perspective. In order to reduce the level of VOCs the LEED has offered acceptable values (Azhar, Carlton, Olsen and Ahmad, 2011). The LEED certifies high quality of air by asserting the development and maintenance program for ensuring high air quality within buildings. Likewise, the air quality assessment is also fostered to gain certification of LEED and the constructors are encouraged to carry out air quality tests throughout the development stages of the buildings and after the construction as well (Abdul-Wahab, 2011). The certification of LEED can be obtained through flush out that is based on HVAC (heat, ventilation and air conditioning) design (Wei, Ramalho and Mandin, 2015). The HVAC design is highly important for ensuring high quality of indoor air by regulation heat, maintaining and effective design for ventilation and air conditioning (Bearg, 1993). The HVAC has been linked widely with the healthy buildings and it enables the constructors to maintaining high IAQ to comply with requirements of LEED.

2.6 Comparison of LEED and BREEAM in terms of IAQ

The prior version of BREEAM that was updated in 2011 was giving low importance to aspect of IAQ and the reliance was maintained more on aspect of air tightening construction with an aim of lowering the impact of buildings on overall environmental sustainability (Chuck and Kim, 2011; Schweber, 2013).

The air tight buildings were highly exposed to the risk of accumulation of indoor air pollutants having an adverse impact on human health.

Based on this evidence the prior research conducted by Chuck and Kim (2011) has claimed that BREEAM standard has lower level of inclusion for maintaining quality of indoor air. The authors have also maintained that LEED in comparison is highly concerned about the health and wellbeing of occupants and it has readily considered the aspect of IAQ by relying on HVAC (heating, ventilation and air conditioning) design (Lee and Kim, 2008). The authors have further suggested that buildings which have gained high ratings on BREEAM are likely to gain lower ratings on indoor environmental quality aspect of LEED. However, the contemporary version of BREEAM that is updated in 2014 has devoted a whole separate section to the discussion of health and wellbeing (Ferreira, Pinheiro and de Brito, 2014).

BREEAM In-Use is considered as an important framework for enhancing occupants; comfort, health and wellbeing. It measures operational performance and serve as the way of continual improvement performance optimisation. Therefore, In-Use scheme can be considered as significant part of BREEAM for its contribution in improving occupants' health and wellbeing(Taylor & Pineo, 2015). The importance of health and wellbeing of occupants has also been reflected in WELL, statements and claims of developers and property owners in UK either in the policies or CSR reports (BREEAM, 2016a)

The new version of BREEAM has readily incorporated all of the aspects of indoor environmental quality including IAQ. Based on this notion, the current research study is focusing on unveiling a new paradigm. It will re-test the assumption of Chuck and Kim (2011) with an aim of providing more recent view on BREEAM and LEED as effective standards for assessment of IAQ.

2.7 Post Occupancy consideration of IAQ in BREEAM and LEED

It is evident from the prior research that both BREEAM and LEED offer significant importance to aspects of IAQ at design and pre-occupancy stage. The post occupancy evaluation focuses on the actual performance of the

building against the intended and it is mainly carried out in the light of green certification plan. After handing over building to the clients or occupants of the building, the BREEAM provide after care during the first year of occupancy (BREEAM, 2016). The first year post occupancy services are provided to ensure that building is operating according to the design intent and whether there is any need to adaptation or not. However, this Post Occupancy Evaluation (POE) is not carried out directly by the BREEAM and client's commitment is obtained that POE will be carried out during the first year of occupation (BREEAM, 2016). The authority that carried out POE is mainly the third party, which is independent and does not have any official connection with BREEAM in order to ensure that POE is free of biasness. The feedback from occupants is obtained about the performance of building with an aim of investigating the aspects of health, safety and comfort of residents (BREEAM, 2016). The quality of indoor air is measured by relying on ISO 16000-5 guidance on testing different chemicals in air that may cause harm to the occupants' health (BREEAM, 2016). Along with this, the feedback of occupants about satisfaction with quality of indoor air and health and wellbeing perspective is considered as important while making assessment of quality of indoor air during occupation.

The LEED certified buildings have reported more satisfaction with quality of indoor air in comparison to non-LEED buildings. The LEED has included the POE after the five years of occupancy and it focuses readily on the aspect of quality of indoor air (Alborz and Berardi, 2015). The POE is mainly carried out by considering LEED design plan as the benchmark and then making a comparison with actual building conditions during occupation. Along with LEED officials, the researchers have also carried out post occupancy research on LEED certified buildings and they have provided that buildings certified under LEED are offering high IAQ(Alborz and Berardi, 2015).Therefore, the following hypothesis has proposed;

It is expected that the LEED is highly inclusive for quality of IAQ during occupancy in comparison to BREEAM.

2.8 Summary of Literature Review

- Literature review founded substantial evidence of association between IAQ and occupants' well-being.
- It has widely been highlighted in the literature that the quality of in-door air is found to be influenced by the level of various gases including; carbon monoxide, volatile organic compounds, formaldehyde that are found in-door. The authors also mention that those are likely to have substantial adverse impact on health of building's occupants
- The notion of IAQ has gained considerable importance and different environmental performance assessment standards such as BREEAM and LEED, who have focussed on to monitor the quality of in-door air.
- Although vary in approaches BREEAM and LEED measures apply similar or same metrics to monitor IAQ mainly defined by the international or national standards.

3. Research Methodology

The current chapter is aimed at highlighting the adopted research design to investigate the association of IAQ with health and wellbeing of green building occupants. The chapter has included details of the research design along with justification. The procedure of data collection is detailed along with population, sampling technique and sample size. Likewise, the discussion about data analysis technique is carried out and ethical concerns of the study are mentioned.

3.1 Available Research Methods

The adoption of appropriate research methodology is highly important for effectively answering the underlying research questions. There are three available research methods which are being widely applied by the researchers, encompassing; quantitative, qualitative and mixed method (Field, 2005). The qualitative design can be used by relying on observation, interviews and focus group, while the quantitative data can be employed through questionnaire, experiment and simulation. While, the mixed method employs both quantitative and qualitative research method. Both the qualitative and quantitative designs are widely used by the researchers in

construction industry and are considered as important for studying a given research issue. However, the quantitative research method is considered as more appropriate as it helps in generating more generalised and valid results (Tashakkori and Teddlie, 1998). In the third research method that is mixed method, the strengths of both designs complement each other and it suggests comparison point for gaining considerable understanding of the underlying research issue. The Biesta (2010) has suggested that mixed method of research ensures voice and increase validity of the research results. The concept of voice is linked with the mixed methods as in quantitative design respondents only respond to closed end questions and by supplementing it with qualitative method the clear insight of research issue can be obtained. The concept of breadth is also linked with the mixed method as it helps in obtaining rich data and helps in effectively answering the research question.

3.1.1 Adopted Research Method

The current research will rely on mixed method that is characterised as combination of quantitative as well as qualitative. The quantitative aspect of mixed method relies on numerical information and data is obtained in the form of figures with an aim of generating highly reliable and valid results (Kumar and Phrommathed, 2005). On the other hand, the qualitative aspect of mixed method is associated with in depth investigation of phenomena by conducting an exploratory research (Kothari, 2004). In present research, the insight from qualitative research will serve as the foundation of carrying out quantitative study to test the hypothesised association among IAQ aspect of green buildings and occupants' health and wellbeing. Along with this, the evidence from qualitative and quantitative research will provide additional information about the inclusiveness of BREEAM and LEED for IAQ in pre occupancy, during occupancy and post occupancy periods.

3.1.2 Pragmatic Research Paradigm

The mixed method research (MMR) has been considered as the third methodological approach that is complementing existing quantitative and qualitative research methodologies. The emergence of third research methodology will heighten the need of third research paradigm and the linkage of pragmatic paradigm with the mixed method research will be carried

out (Biesta, 2010). The pragmatic paradigm accepts any concept when it has relevancy with the reality and when it is actionable (James, 1995). There could be multiple realities that cannot be covered under the interpretivism and positivism philosophy (Tashakkori and Teddlie, 1998). The current research will maintain its focus on the association of IAQ with health and wellbeing of occupants. The core focus of present research is on the inclusiveness of IAQ in LEED and BREEAM, which is not bound to the high or low inclusive only but there could be third condition pertaining to inclusiveness of IAQ in two disciplines at design, occupancy and post occupancy stages. Thus, it is notable that the underlying research issue is not limited to single reality and the expectation for existence of multiple realities exists. Therefore, in this study, the pragmatic paradigm of research will be found to be highly relevant. The pragmatic research paradigm also has higher level of compatibility with underlying research method that is mixed method research.

3.2 Data Collection

In terms of design of data collection, the current research study will rely on primary data collection method. The primary data has number of benefits associated with it. The primary data has strong relevancy with the underlying research issue and collection of fresh hand data will help to address the present research issue in appropriate manner (Costello, 2009). The BREEAM and LEED are updated periodically, which might change the extent to which these two disciplines are inclusive for IAQ. Therefore, it is reasonable to collect primary data for obtaining more recent view about the inclusion of IAQ and occupants' health and wellbeing in BREEAM and LEED. Present research will choose structured interviews and survey for obtaining data about underlying research issues.

Structured Interviews: The structured interview allows to collect information in standardised format by asking the similar questions from respondents in same order (Newman and Benz, 1998). It allows to compare information across different subjects. In underlying research study, professionals from different discipline will be interviewed. This research will aim to get equal number of Architects, LEED Accredited Professionals, BREEAM Assessors, Facilities Managers and indoor air quality assessment consultants and practitioners to participate in the interview.

Survey:By contrast, the survey questionnaire will be administered for obtaining quantitative data. The survey will target the population based on their awareness of the IAQ during occupancy. The occupants can be students in university building or office workers in any “Green/Sustainable” building.To draw sample from this population the researcher will employ purposive sampling method. The purposive sampling method is considered as appropriate for drawing the sample of highly relevant respondents. In purposive sampling method, the researcher will have the discretion to rely on rationale judgment and it will help to choose the sample of participants who have knowledge and awareness of the IAQ.

The survey will be conducted from 200 respondents as the large sample generates highly valid results and this sample size is substantially large (Marczyk, DeMatteo and Festinger, 2005; Field2005). The current research will be carried out an online survey which will be formulated on an established online survey platformand the demographic targeting feature will be utilised as such specific communities and groups exist only in cyberspace (Wright, 2005). The online survey is considered as highly cost effective and it also helps to save the time of researcher.

3.3 Data Analysis

In present research study, the data will be analysed by using two different methods. Firstly, to analyse the quantitative data of the study obtained through online survey, the descriptive analysis will be carried out. The frequency of responses will help to display results in the form of charts and graphs. To carry out descriptive analysis, the Excel will be used by the researcher. Moreover, in order to carry out analysis of qualitative data the content analysis method is considered as appropriate. The quantitative data will help to answer all the research questions and will reflect whether IAQ has higher level of association with occupants’ health and wellbeing. On the other hand, qualitative data will help us to investigate the hypothesis focusing on inclusion of IAQ in BREEAM and LEED (that is our last research question) and it will suggest that which discipline is more effective for improving occupants’ health and wellbeing.

3.4 Validity, Reliability and Generalisation

In order to check the validity of the research instruments being employed in this research, the face validity of the instruments will be checked. The face validity is considered as helpful approach for investigating the clarity of the survey questionnaires (Newman and Benz, 1998). The subject matter experts will be approached for checking the validity of the instrument and their response acts as an important way of identifying any ambiguity and then correcting it for gaining better clarity. The face validity is important as inability of participants to understand any survey question can lower the quality of data. Likewise, in order to increase the reliability and validity of the research instrument it will be ensured by the researcher that participants are well aware about the aspect of IAQ and BREEAM and LEED certification. The awareness level is ensured by relying on purposive sampling method and selecting only those respondents who have enough knowledge of the IAQ.

In terms of generalisability, the present research study will be chosen to employ the mixed method of research in which strengths of both quantitative and qualitative design are being added. The generalisability refers to the extent to which results of the study can be applied to wider setting. It has been suggested by the researchers that mixed method are able to generate highly generalisable findings as it complements the strengths of both research designs (Marczyk, DeMatteo and Festinger, 2005).

3.5 Ethical Considerations

The current research will be carried out in highly ethical manner and it will show greater compliance with ethical standards of research. The research will be free from any physical and psychological harm to the target population, participants and the general community. The purpose of the research will be shared by the respondents in advance and they will not be deceived in any manner (Creswell, 2009). It will further be ensured by the researcher that anonymity of the respondents will not be compromised and their information will not be shared with any one. The participants will also be given the opportunity that they might withdraw from research any time and they will not be coerced for their participation in research. The study will be driven by informed consent and they will be given the opportunity to gain clarity about any aspect of research during the span of their response. Therefore, the measures will be incorporated to avoid any sort of ethical issues in the present research.

4. Results and Analysis

The current section presents results of underlying research. The analysis of both survey as well as interview data has been carried out and results are being interpreted in following section. The analysis of survey has been carried out by visual representation of data through charts and frequency table. While, the interviews have been analysed by relying on content analysis.

4.1 Survey Analysis

4.1.1 Distribution of participants in terms of occupants of green or non-green buildings

Figure 3: Distribution of participants as green or non-green building occupants

The data for survey was obtained from the respondents in UK, age ranging from 18 to 65. The distribution of participants in terms of occupants of green or non-green building can be seen in figure 3. It can be seen in the figure 3 that 27% of the participants were living or working in BREEAM certified building, 1.6% in LEED certified building and 6% have reported their building as self-defined (as a green building). On the other hand, 24% have no knowledge if the building that they live/work or study is classified asthe green a building and 41% have reported that the building, they live, work or study in is not a green/sustainable building.

4.1.2 Influence of IEQ categories on occupants' Comfort

Figure 4: Association of IEQ categories with occupants' comfort

It can be seen in the figure 4 that occupants have rated thermal quality as most important category for ensuring occupants' comfort. It has been followed by rating of noise as important category of IEQ in terms of occupants' comfort. Only 4% of the all participants rated the indoor air quality as the most important IEQ category that influences occupants comfort level.

4.1.3 Influence of IEQ categories on occupants' health

The respondents have rated that indoor air quality is highly important among all other categories of indoor environmental quality. It can be seen in the figure 5, that 74% of respondents have rated indoor air quality as the most important category for improving occupants' health.

Figure 5: Importance of IEQ category for influencing occupants' health

4.1.4 Quality of Indoor Environment of the subject building

The figure 6 is presenting the responses of participants about the quality of indoor environment of building which they live/work or study in. It can be seen that green building occupants have rated all of the aspects of IEQ higher than the conventional buildings occupants.

Q4 Kindly rate the quality of Indoor Environment of the subject building.

Figure 6: Comparison of green and non-green buildings occupants on IEQ of subject buildings

4.1.5 Symptoms of health issues experienced by occupants in buildings

In order to investigate the extent of indoor air quality, respondents were provided with list of symptoms of bad health that is being caused by poor quality of indoor air. Responses of green buildings occupants in figure 7 shows that much higher percentage of participants have not either noticed thesesymptoms or they have never experienced such symptoms compared to responses of not green building occupants in figure 8.

Figure 7:Responses of Green Building occupants to Q5

Q5 Do you experience any of below mentioned symptoms while you are in the subject building?

Figure 8: Responses of non-green building occupants to Q5

4.1.6 Comparison of BREEAM and LEED in terms of IEQ

Figure 9: Indoor environmental quality in BREAM and LEED certified buildings

It can be seen in the figure 9 mentioned below that quality of indoor air in BREEAM and LEED certified buildings is better than conventional buildings. The frequency of agreement is higher, as 37% of participants have shown agreement, while remaining 38% have strongly agreed with the statement. Likewise, level of agreement about better acoustic, thermal and lighting dimension of indoor environmental quality was also higher in the current study, indicating that along with quality of indoor air, BREEM and LEED certified buildings have higher level of inclusion for all other categories of IEQ.

4.1.7 Association of Indoor air quality with occupants' physical health

The association of indoor air quality and occupants' physical health is stronger as mentioned by respondents. In the figure 10 mentioned below, it can be seen that maximum percentage of participants has indicated strong

agreement. While, the level of disagreement has been mentioned by minimum number of participants.

Figure 10: Association of indoor air quality and occupants' physical health

4.1.8 Quality of indoor air and perceptual wellbeing of occupants

Figure 11: Association of indoor air quality with perceptual wellbeing of occupants

It can be seen in the figure 11 that level of agreement with the statement is higher in case of current study and it has been indicated from the results that there is substantial level of association between quality of indoor air with perceptual wellbeing of occupants. There is minimum level of disagreement among participant regarding role of indoor air quality in improving wellbeing of occupants.

4.1.9 Association of Indoor Air quality with occupants' concentration level

Figure 12: Association of indoor air quality with occupants' concentration levels

When asked about the association of indoor air quality with concentration and attention level of occupants, most of the respondents have indicated stronger

agreement. From total participants, almost 83 are showing stronger agreement and 71 have indicated agreement that high indoor air quality contributed to enhanced level of concentration regarding work (as seen in figure 12).

4.1.10 Association of indoor air quality with occupants' productivity

It can be seen in the figure 13 that most of the respondents have shown agreement with the notion that quality of indoor air is associated with enhanced level of productivity. Very few participants have indicated disagreement, thus providing that quality of indoor air can help the occupants to improve their productivity level.

Figure 13: Association of indoor air quality with occupants' productivity

4.1.11 Association of Low Indoor air quality and self-reported illness

Figure 14: Association of low quality of indoor air and self-reported illness

In terms of association between low quality of indoor air with self-reported illness of occupants, it can be seen in figure 14 that most of participants have shown agreement with the statement. Moreover, only handful of people have reflected that poor quality of indoor air not linked with self-reported illness.

4.1.12 The BREEAM/LEED certified buildings provide high quality of indoor air

Figure 15: Extent of indoor air quality in BREEM/LEED certified buildings

The figure 15 mentioned below has clearly indicated that buildings which are certified by BREEAM or LEED can provide high quality of indoor air. Majority of respondents have demonstrated strong agreement that is being followed by high agreement level of respondents. Number of respondents who have not agreed with the statement are very few and thus, it can be argued that BREEAM and LEED certified buildings are offering high indoor air quality.

All of these responses have clearly highlighted that green buildings which are being certified with BREEAM or LEED standard are considered to provide high quality of indoor environment and high quality of indoor air. The results of the study have highlighted that indoor air quality in green buildings have higher level of positive affect on health and wellbeing of green occupants. Along with this, the participants have portrayed that presence of high quality of indoor air is linked with increased level of productivity and concentration of green occupants.

4.1.13 Responses of occupants about subject buildings

The responses of occupants in figure 16 are indicating that occupants have either never experienced these issues in indoor environment of their subject building or they have occasionally experienced these issues. It can be argued that higher quality of indoor

Figure 16: IEQ in subject buildings

environment has been reported by participants.

4.2 Interview Analysis

The interview has been carried out with professionals who are associated with sustainable building accreditation and indoor air quality. The interviews were from different professions including; Facilities managers, Sustainability consultants, Building service engineers, Architects, BREEAM Assessors, BREEAM Accredited Professionals, IAQ testing and monitoring specialist and IAQ consultant (as shown in figure 17). It is notable that none of LEED Accredited Professionals or LEED Green Associates participated in the interview. However, some of the interviewees was familiar with LEED assessment process.

Figure 17 Areas of expertise of participants

Interview questions consisted of both close-ended and open ended questions. To maximise the participation of subject matter experts, interviewees ware emailed with a link to interview questions hosted on an online survey platform.

The interview started by asking about the impact of indoor environmental quality elements on overall comfort level of occupants. 12 interviewees mentioned that thermal quality is more important for ensuring comfort level of occupants (as depicted in figure 18). Only one of the interviewees suggested

that indoor air quality is important for increasing the comfort level of occupants. This question was also asked in the survey, where 50% have mentioned that thermal quality is more important and only 4% have mentioned indoor air quality as an important indicator of occupants' comfort.

Figure 18 Association of IEQ categories with occupants' comfort by subject matter experts

Similarly, interviewees were asked about the influence of IEQ elements on health of occupants. The responses of 14 interviewees were directed towards quality of indoor air for the health of occupants, providing that it was perceived as more important element among other indoor environmental quality elements (see figure 19). This question was also addressed in survey, where 74% respondents have reported air quality as most important indicator for enhancing health of occupants.

Figure 19 Importance of IEQ category for influencing occupants' health by subject matter experts

Along with this, the respondents were asked about the most effective method in terms of indoor air quality at design stage. It was revealed from the 10 responses of interviewees that BREEAM was considered as more effective method in terms of quality of indoor air and maximum number of interviewees have rate BREEAM better than LEED for ensuring IAQ at design stage (indicate din figure 20.1). While 4 respondents rated LEED as more effective method for maintaining quality of indoor air and 4 interviewees mentioned that both of these methods are similar.

Figure 20.1: Which assessment method is considered as more effective in terms of IAQ at design stage?

In similar way, interviewees were asked about the effectiveness of BREEAM and LEED in terms of inclusion of indoor air quality at construction stage,

handover stage and occupancy/post occupancy stage, respectively. The responses of participants revealed that most of professional interviewees considered BREEAM as more effective quality standard for inclusion of indoor air quality at construction, handover, occupancy/post occupancy stage, respectively (indicated in figures 20.2, 20.3 and 20.4 respectively). From total interviewees, 9 have rated BREEAM better than LEED at construction stage, and 10 have rated BREEAM better at handover and occupancy/post occupancy stages. While 4 of the respondents also rated LEED as more effectiveat construction stage, while 3 and 1 have reported LEED better at handover and occupancy/post occupancy stage. Finally, 5 interviewees have report both at construction and handover stage and 7 have mentioned both same at occupancy/post occupancy stage. Therefore, it is notable that mostly BREEAM is considered as effective by professionals of sustainable building and it addresses issue of indoor air quality at pre-occupancy, occupancy and post occupancy stages.

Figure 20.2: Which assessment method is considered as more effective in terms of IAQ at construction stage?

Figure 20.3: Which assessment method is considered as more effective in terms of IAQ at handover stage?

Figure 20.4: Which assessment method is considered as more effective in terms of IAQ at occupancy/post-occupancy stage?

Moreover, in terms of indoor environmental quality, both of the sustainability standards that is, BREEAM and LEED are considered as same by 8 interviewees (as indicated in figure 20.5). While 5 rated either LEED or BREEAM better than the other. Yet, inclination of most participants remained to the notion that both BREEAM and LEED address indoor environmental quality.

Figure 20.5: Which assessment method is considered as more effective in terms of Indoor Environmental Quality?

By moving further to interviews, respondents were asked about the effectiveness of BREEAM and LEED in terms of occupant's health and wellbeing. The results reflected that 8 interviewees have focused on the aspect of similarity and they have maintained that both BREEAM and LEED are effective in terms of enhancing occupant's health and wellbeing (as indicated in figure 20.6 and 20.7). Contrary to this, 6 interviewees also mentioned that BREEAM is better than LEED for ensuring health and wellbeing of occupants. While, remaining 4 have mentioned LEED better than BREEAM.

Figure 20.6: Which assessment method is considered as more effective in terms of Occupants' Health

Figure 20.7: Which assessment method is considered as more effective in terms of Occupants Wellbeing?

Likewise, when asked about the natural and mechanical ventilation in BREEAM and LEED, the 10 participants mentioned that both of these standards are effective in terms of natural ventilation at design stage and the one that are under control of occupants through operate-able windows (indicate din figure 20.8 and 20.9)

Figure 20.8: Which assessment method is considered as more effective in terms of Natural Ventilation, Design?

Figure 20.9: Which assessment method is considered as more effective in terms of Natural Ventilation, Occupants' control (Operable windows)?

Further the 8 interviewees have mentioned that both LEED and BREEAM are same in terms of mechanical ventilation at design stage (as indicated in figure 20.10). While, 10 interviewees have mentioned that both LEED and BREEAM are same in terms of mechanical ventilation that is under the control of occupants (shown in figure 20.11)

Figure 20.10: Which assessment method is considered as more effective in terms of Mechanical Ventilation, Design?

Figure 20.11: Which assessment method is considered as more effective in terms of Mechanical Ventilation, Occupants' control?

Similarly, when asked about the inclusion of thermal comfort in both standards, 9 have interviewees have reported that both are same for ensuring thermal comfort at design stage (see figure 20.12). Likewise, 9 interviewees have mentioned that both standards are same in terms of thermal comfort that is under the control of occupants (shown in figure 20.13).

Figure 20.12: Which assessment method is considered as more effective in terms of Thermal comfort, Design?

Figure 20.13: Which assessment method is considered as more effective in terms of Thermal comfort, occupants' control?

The interviewees were further asked to share their views on different statements. When the interviewees were asked about their opinion about importance of LEED/BREEM certified buildings for ensuring quality of indoor air, almost 66% respondents have remained indifferent on the statement and

they have neither agreed nor disagreed with the statement. By moving further to interview, respondents were asked about the effectiveness of BREEAM and LEED certified buildings in terms of occupant's health and wellbeing. The results reflect that 66.11% interviewees agreed with the statements and mentioned that BREEAM/LEED certified buildings are healthier to live, study and work and they enhance wellbeing of occupants.

Likewise, when asked about the dominance of LEED in Europe, 50% of interviewees gave neutral response and 28% have disagreed with the statement. There was little consensus of interviewees on the notion that BREEAM failed to catch up LEED in terms of IAQ in green buildings and occupants' health and wellbeing, indicated by 55% neutral responses. It is showing that BREEAM is ensuring high quality of in-door air and it is important for enhancing health and wellbeing of occupants.

Results further reveal that BREEAM certified buildings have gained recognition in UK and BREEAM is mainly used as standard of sustainable buildings in UK. Along with this, when interviewees were asked that whether LEED is gaining grounds in UK.44% interviewees remained neutral to this questions, while 22% have disagreed with the statement. The 33% interviewees further mentioned that BREEAM is dominant green building certification scheme that is implied through legislation in UK and this is not expected to change in future, while 38% have offered neutral response.

Figure 21: views of professionals on different statements above

The interviewees were asked in open-ended questions how they compare LEED and BREEAM on occupants' health and wellbeing. Most of the respondents mentioned that they have limited knowledge and experience of LEED, as BREEAM is the widely used standard in UK. Due to the limited knowledge of LEED the interviewees were not able to compare both standards. Respondents further mentioned that clients have increasing awareness about the quality of indoor air and they show greater readiness to comply with green building standards.

One of an important aspect that has been revealed in the current study was that WELL building standard was rated as highly important by professionals of

sustainable buildings. According to the views of interviewees, WELL is more inclusive for health and wellbeing concerns. As mentioned by one respondents,

"*BREEAM is not as inclusive (yet). The WELL Standard is gaining recognition quickly as the gold standard specifically for Health & Wellbeing. BRE (the designers of BREEAM) are currently collaborating with WELL over joining up standards so this should significantly improve BREEAM's health and wellbeing credentials*".

These results significantly reveal a new direction and unveil the new perspective of debate in health and wellbeing standards. Overall, it can be inferred from these responses that collaboration of BREEAM with WELL is enhancing the value of BREEAM in terms of health and wellbeing of occupants, in comparison to LEED.

5. Discussion and Conclusion

The current section is aimed at discussing the key findings of the research by making a comparison with the previous related literature. The implications of results are also discussed both for the theory for practice. Along with this, discussion has also included limitations of the study that can be considered by the future researchers for adding up in the literature of indoor air quality and health and wellbeing of occupants.

5.1 Key Findings

The main aim of present research study was to investigate the association of indoor air quality in buildings with health and wellbeing of occupants. Firstly, the objective of study was to find out the extent of indoor air quality in green buildings. The results of the study have clearly indicated that green buildings have high quality of indoor air. These results were highly in line with the prior related researchers and have reaffirmed the notion that indoor air quality in green buildings is high (Zuo and Zhao, 2014; Spengler and Chen, 2000; Ries,

Bilec, Gokhan and Needy, 2006; Singh, Syal, Grady and Korkmaz, 2010; Roper and Beard, 2006).

Secondly, the objective of study was to highlight the importance of indoor air quality in buildings. The results have indicated that occupants perceive indoor air quality as highly important aspect of indoor environment quality for ensuring health of occupants. Followed by this, the objective of research was to find the association between indoor air quality and health and wellbeing of occupants and have found that indoor air quality in green buildings is highly relevant with health and wellbeing of occupants. These results are in line with the prior related studies (Chatzidiakou, Mumovic, Summerfield and Altamirano, 2015; Jones, 1999; Kibert, 2016; Stabile et al., 2016; Daisey, Angell and Apte, 2003; Yu et al., 2009; Burge, 2004; Abdul-Wahab, 2011; Spengler and Chen, 2000)

Finally, the study has focused on investigating the extent to which BREEAM and LEED are offering indoor air quality for health and wellbeing of occupants. Overall, both of BREEAM and LEED were considered relevant by the occupants. This aspect of result was aligned with the research that has been carried out previously on the subject (Chuck and Kim, 2011; Schweber, 2013; Lee and Kim, 2008; Ferreira, Pinheiro and de Brito, 2014; BREEAM, 2016a; Taylor & Pineo, 2015) However, the results of interviews were more inclined towards the BREEAM and most of professionals have mentioned that BREEAM is more inclusive for indoor air quality than LEED. The results have also highlighted that in order to ensure high quality of indoor air and to improve the health and wellbeing of occupants, WELL building standard can be considered important. This aspect has not been addressed readily in the research, thus, a new dimension has been highlighted in the research.

5.2 Implications of Research

The results of present research study have offered huge implications for both theory as well as practice. In terms of practical implications, results of the study have highlighted that quality of indoor air is highly desired by occupants and it is highly relevant with health of occupants. Given this view, construction industry can focus on sustainability aspect of the buildings and they can understand the importance of enhancing indoor air quality in buildings at

design and construction stage. Along with this, practitioners can also rely on the approach of ensuring high indoor air quality at occupancy and post occupancy stages. Along with this, the results of study on the importance of BREEAM and LEED in ensuring health of wellbeing of occupants are important for practitioners. For instance, the importance of WELL buildings standards that has been highlighted through the interviews, can help the construction sector to reshape their practices. Therefore, instead of relying only on LEED and BREEAM, the certification of WELL standard can be considered important by construction sector. They might shift their focus on gaining certification of WELL standard for offering high prospects of health and wellbeing to occupants.

Along with practical implications, the results of present research study have also contributed significantly in the extant literature. It has been highlighted in the literature that LEED was more inclusive for the quality of indoor air in comparison to BREEAM. However, the results of present research have unveiled a new aspect and have provided that updated version of BREEAM that is being used in UK as sustainability standard of buildings in highly inclusive for indoor air quality and occupants' health and wellbeing. It has added substantially in the current literature on health and wellbeing of occupants. In addition to it, the results of the study have also highlighted a new direction that is associated with WELL building standard. The theory on indoor air quality has not readily focused on the WELL building standard and thus, it is a valuable addition in the stream of growing literature on occupants' health and wellbeing in green buildings.

5.3 Limitations

Undoubtedly, the present research study was valuable addition in the stream of extant research, yet there were some limitations in the study that are important to be considered for making generalisation of results. The present study has obtained data from occupants of green as well as non-green buildings, which might not be the accurate way to investigate the extent of indoor air quality in BREEAM and LEED certified buildings. Along with this, the respondents were mainly from UK, where BREEAM is used as sustainability standard as enforced by law. Almost all of the respondents have knowledge of BREEAM and none of them was aware of LEED or had

experience to work with LEED. This has created bias in the study, as aim of current research was to compare the LEED and BREEAM in terms of indoor air quality.

Along with this, as highlighted by the open ended responses of the interviews, the participants have mentioned that WELL is gaining high prominence in UK in terms of indoor air quality and sustainability of buildings. Present research has not included this important aspect of green certification in UK.

5.4 Future Research Directions

There are some gaps which are being left open by the current study and can be addressed by the future researchers. While investigating the extent of indoor air quality, future researchers are expected to focus only on occupants of green buildings. It will increase the authentication of study and the results will be more generalised for the green buildings practitioners. Along with this, while making a comparison between LEED and BREEAM in terms of inclusion of indoor air quality aspect, the future researchers are required to focus on professionals that have knowledge both of these green buildings standards. The participants can be selected purposively based on their awareness of both BREEAMA as well as LEED.

In addition to it, in the current research study, one important certification of sustainable buildings was not considered. As mentioned by professionals in interviews in present research, the WELL buildings standard is expected to collaborate with BREEAM. WELL is highly inclusive for indoor air quality in green buildings. The health and wellbeing territory has been occupied by green WELL building standard and the merger of WELL and BREEAM will enhance the value of BREEAM in terms of inclusion of indoor air quality and health and wellbeing of occupants. In the light of these views, it can be argued that WELL is an important aspect of research, while focusing on indoor air quality and occupants' health and wellbeing. Thus, the future researchers can consider WELL standard in addition to BREEAM and LEED.

5.5 Conclusion

The main aim of present research was to investigate the association of indoor air quality with health and wellbeing of occupants, along with making a comparison between BREEAM and LEED. The study has seek guidance from the prior relevant literature and has relied on mixed methodology for fulfilling the underlying objective of research. The investigation of both quantitative and qualitative data has indicated that indoor air quality is highly important for ensuring health and wellbeing of occupants in buildings. Moreover, as most of the professionals in interview were having knowledge of BREEAM, therefore, they have either considered both BREEAM and LEED as same in terms of indoor air quality of rated BREEAM better than LEED. Along With this, study has highlighted a new direction that WELL buildings standard is more inclusive for aspect of indoor air quality and health and wellbeing of occupants. Therefore, it has been recommended that future researchers might consider this significant aspect of occupants' health and wellbeing.

6. References

Abbaszadeh, S., Zagreus, L., Lehrer, D. and Huizenga, C., 2006.Occupant satisfaction with in-door environmental quality in green buildings. *Center for the Built Environment*.

Abdul-Wahab, S.A., 2011. *Sick Building Syndrome*.Springer-Verlag Berlin Heidelberg.

Alborz, N. and Berardi, U., 2015. A post occupancy evaluation framework for LEED certified US higher education residence halls. *Procedia Engineering*, *118*, pp.19-27.

Azhar, S., Carlton, W.A., Olsen, D. and Ahmad, I., 2011.Building information modeling for sustainable design and LEED® rating analysis. *Automation in Construction*, *20*(2), pp.217-224.

Bearg, D.W., 1993. *In-door air quality and HVAC systems*. London: CRC Press

Biesta, G., 2010. Pragmatism and the philosophical foundations of mixed methods research. *Sage Handbook of Mixed Methods in Social and Behavioral Research*, *2*, pp.95-118.

BREEAM, 2015.Health and wellbeing in BREEAM. [Online], Available at: http://www.breeam.com/filelibrary/Briefing%20Papers/99427-BREEAM-Health---Wellbeing-Briefing.pdf. [Accessed; 29 November, 2016]

BREEAM, 2014.Hea 02 In-door air quality. [Online], Available at: http://www.breeam.com/BREEAM2011SchemeDocument/Content/05_health/hea02.htm. [Accessed; 29 November, 2016]

BREEAM, 2016a.breeam. [PDF] BRE Available at: http://www.breeam.com/filelibrary/Briefing%20Papers/92935-BRE_BREEAM-health-wellbeing-agenda-A4-v2.pdf [Accessed 3 January 2017].

BREEAM, 2016.BREEAM International New Construction 2016.[Online], Available at: http://www.breeam.com/BREEAMInt2016SchemeDocument/. [Accessed; 16 December, 2016]

BRE Group, 2016. BRE Media Centre. [Online] Available at: https://www.bre.co.uk/news/IWBI-and-BRE-announce-alignments-between-WELL-and-BREEAM-1210.html. [Accessed 7 January 2017].

Burge, P.S., 2004. Sick building syndrome. *Occupational and environmental medicine*, *61*(2), pp.185-190.

Chatzidiakou, L., Mumovic, D. and Summerfield, A., 2015. Is CO_2 a good proxy for in-door air quality in classrooms? Part 1: The interrelationships between thermal conditions, CO_2 levels, ventilation rates and selected in-door pollutants. *Building Services Engineering Research and Technology*, p.0143624414566244.

Chatzidiakou, E., Mumovic, D., Summerfield, A.J. and Altamirano, H.M., 2015. In-door air quality in London schools. Part 1:‘performance in use’. *Intelligent Buildings International*, *7*(2-3), pp.101-129.

Chuck, W.F. and Kim, J.T., 2011. Building environmental assessment schemes for rating of IAQ in sustainable buildings. *In-door and Built Environment*, *20*(1), pp.5-15.

Costello, A.B., 2009. Getting the most from your analysis. *Pan*, *12*(2), pp.131-146.

Creswell, J. W., 2009. *Research design: Qualitative, quantitative and mixed methods approaches,* 3rd edition, Thousand Oaks, CA: Sage Publications.

Daisey, J.M., Angell, W.J. and Apte, M.G., 2003. In-door air quality, ventilation and health symptoms in schools: an analysis of existing information. *In-door Air*, *13*(1), pp.53-64.

Edwards, B., 2006. Benefits of green offices in the UK: analysis from examples built in the 1990s. *Sustainable Development*, *14*(3), pp.190-204.

Edwards, L. and Torcellini, P.A., 2002. *A literature review of the effects of natural light on building occupants* (p. 59). Golden, CO: National Renewable Energy Laboratory.

Ferreira, J., Pinheiro, M.D. and de Brito, J., 2014. Portuguese sustainable construction assessment tools benchmarked with BREEAM and LEED: an energy analysis. *Energy and Buildings*, *69*, pp.451-463.

Field, A., 2005. Discovering statistics with SPSS: London: Sage.

Fisk, W.J., 2000. Health and productivity gains from better in-door environments and their relationship with building energy efficiency. *Annual Review of Energy and the Environment*, *25*(1), pp.537-566.

Gambatese, J.A., Rajendran, S. and Behm, M.G., 2007. Green design & construction: Understanding the effects on construction worker safety and health. *Professional Safety*, *52*(5), p.28.

Gowri, K., 2004. Green building rating systems: An overview. *ASHRAE journal*, *46*(11), p.56.

James, W., 1995. *Pragmatism*. Courier Corporation.

Jones, A.P., 1999. In-door air quality and health. *Atmospheric Environment*, *33*(28), pp.4535-4564.

Kibert, C.J., 2016. *Sustainable construction: green building design and delivery*. California: John Wiley & Sons.

Kothari, C.R., 2004. *Research methodology: Methods and techniques*. New Age International.

Kumar, S. and Phrommathed, P., 2005. *Research methodology* (pp. 43-50).Springer US.

Lajoie, P., Aubin, D., Gingras, V., Daigneault, P., Ducharme, F., Gauvin, D., Fugler, D., Leclerc, J.M., Won, D., Courteau, M. and Gingras, S., 2015. The IVAIRE project–a randomized controlled study of the impact of ventilation on in-door air quality and the respiratory symptoms of asthmatic children in single family homes. *In-door Air*, *25*(6), pp.582-597.

Leaman, A. and Bordass, B., 2007. Are users more tolerant of 'green'buildings?. *Building Research & Information*, *35*(6), pp.662-673.

Lee, Y.S., 2011. Comparisons of in-door air quality and thermal comfort quality between certification levels of LEED-certified buildings in USA. *In-door and Built Environment*, *20*(5), pp.564-576.

LEED, 2016.Assessment of in-door air quality. [Online], Availabel at: http://www.usgbc.org/credits/new-construction-commercial-interiors-core-and-shell-schools-new-construction-retail-new-c-8. [Accessed; 29 November, 2016]

Lee, Y.S. and Guerin, D.A., 2009. In-door environmental quality related to occupant satisfaction and performance in LEED-certified buildings. *In-door and Built Environment*, *18*(4), pp.293-300.

Lee, Y.S. and Guerin, D.A., 2010. In-door environmental quality differences between office types in LEED-certified buildings in the US. *Building and Environment*, *45*(5), pp.1104-1112.

Lee, Y.S. and Kim, S.K., 2008. In-door environmental quality in LEED-certified buildings in the US. *Journal of Asian Architecture and Building Engineering*, *7*(2), pp.293-300.

Marczyk, G., DeMatteo, D. and Festinger, D., 2005. *Essentials of research design and methodology*.John Wiley & Sons Inc.

Miller, N., Pogue, D., Gough, Q. and Davis, S., 2009.Green buildings and productivity. *Journal of Sustainable Real Estate*, *1*(1), pp.65-89.

Newman, I. and Benz, C.R., 1998. *Qualitative-quantitative research methodology: Exploring the interactive continuum*. SIU Press.

Pelsmakers, S., 2014. *The environmental design pocketbook*. Riba Publications Limited. UK

Rajendran, S., Gambatese, J.A. and Behm, M.G., 2009.Impact of green building design and construction on worker safety and health. *Journal of Construction engineering and Management*, *135*(10), pp.1058-1066.

Ramamurthy, G.C., 2011.*Research Methodology*. New Delhi: DreamTech Press.

Ries, R., Bilec, M.M., Gokhan, N.M. and Needy, K.L., 2006. The economic benefits of green buildings: a comprehensive case study. *The Engineering Economist*, *51*(3), pp.259-295.

Roper, K.O. and Beard, J.L., 2006.Justifying sustainable buildings-championing green operations. *Journal of Corporate Real Estate*, *8*(2), pp.91-103.

Rosbach, J.T., Vonk, M., Duijm, F., Van Ginkel, J.T., Gehring, U. and Brunekreef, B., 2013. A ventilation intervention study in classrooms to improve in-door air quality: the FRESH study. *Environmental Health*, *12*(1), p.1.

Schweber, L., 2013. The effect of BREEAM on clients and construction professionals. *Building Research & Information*, *41*(2), pp.129-145.

Schweber, L. and Haroglu, H., 2014. Comparing the fit between BREEAM assessment and design processes. *Building Research & Information*, *42*(3), pp.300-317.

Seppänen, O., Fisk, W.J. and Lei, Q.H., 2006. Ventilation and performance in office work. *In-door air*, *16*(1), pp.28-36.

SGS, N.D. [Online], Available at; http://www.galsonlabs.com/samplinganalysis/_pdf/LEED_spec_sheet.pdf. [Accessed; 26 January 2017]

Shiers, D.E., 2000. “Green” developments: Environmentally responsible buildings in the UK commercial property sector. *Property Management*, *18*(5), pp.352-365.

Singh, A., Syal, M., Grady, S.C. and Korkmaz, S., 2010. Effects of green buildings on employee health and productivity. *American Journal of Public Health*, *100*(9), pp.1665-1668.

SN, K. and NA, S., 2011.The effect of in-door air quality (IAQ) towards occupants' psychological performance in office buildings. *Journal Rekabentuk dan Binaan*, *4*, pp.49-61.

Spengler, J.D. and Chen, Q., 2000. In-door air quality factors in designing a healthy building. *Annual Review of Energy and the Environment*, *25*(1), pp.567-600.

Stabile, L., Dell'Isola, M., Frattolillo, A., Massimo, A. and Russi, A., 2016. Effect of natural ventilation and manual airing on in-door air quality in naturally ventilated Italian classrooms. *Building and Environment*, *98*, pp.180-189.

Tashakkori, A. and Teddlie, C., 1998. *Mixed methodology: Combining qualitative and quantitative approaches* (Vol. 46). Sage.

Taylor, T. & Pineo, H., 2015. *BREEAM*. [PDF] BRE Global Ltd Available at: http://www.breeam.com/filelibrary/Briefing%20Papers/99427-BREEAM-Health---Wellbeing-Briefing.pdf [Accessed 14 January 2017].

Wei, W., Ramalho, O. and Mandin, C., 2015.In-door air quality requirements in green building certifications. *Building and Environment*, *92*, pp.10-19.

Wright, K.B., 2005. Researching Internet-Based Population: Advantages and Disadvantages of Online Survey Research, Online Questionnaire Autoring Software Packages, Web Survey Service. *Journal of Computer-Mediated Communication,* 1 April. pp.00--00. Available at: http://dx.doi.org/10.1111/j.1083-6101.2005.tb00259.x [Accessed 12 February 2017].

Younger, M., Morrow-Almeida, H.R., Vindigni, S.M. and Dannenberg, A.L., 2008. The built environment, climate change, and health: opportunities for co-benefits. *American Journal of Preventive Medicine*, *35*(5), pp.517-526.

Yu, B.F., Hu, Z.B., Liu, M., Yang, H.L., Kong, Q.X. and Liu, Y.H., 2009. Review of research on air-conditioning systems and in-door air quality control for human health. *International journal of refrigeration*, *32*(1), pp.3-20.

Zuo, J. and Zhao, Z.Y., 2014. Green building research–current status and future agenda: A review. *Renewable and Sustainable Energy Reviews*, *30*, pp.271-281.

7. Appendices