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The Impacts of Climatic Features on Residents and Residences: A UK Study

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Abstract: Liveable housing environments face the menace of global climate change. Infrastructure (including buildings and houses) continuously experiences significant impacts exacerbated by natural variability in climate. The study addressed how climate change impacts the resilience of residential buildings, increased maintenance frequency, and the wellbeing and comfort of residents in UK residential buildings. This study used deductive reasoning and an empirical epistemological methodology as a data-collecting basis to evaluate primary information obtained via a questionnaire. Regression analysis was ultimately employed to analyse the collected data. The findings show a significant relationship between climate change and the wellbeing of the occupants of UK residential buildings. Also, the results show that social wellbeing is more important to the occupants than mental and physical wellbeing. It reveals that residential buildings in the UK suffer the cost of maintenance due to continuous reduction in the building fabric's resilience to the impacts of climate change; for instance, a recent increase in rainfall/storms results in unprecedented flooding, which continues to damage the UK residential building fabrics.

Keywords: UK; impacts of climate change; resilience of building fabrics; residential buildings; deterioration of building fabrics; occupants

1. Introduction

Droughts, heavy precipitation, flooding, and rises in temperature are a few examples of climate-induced risks that can endanger human health and the built environment and result in significant financial losses [1]). The urgency of addressing the impacts of climate change is evident globally, reshaping economies, communities, behaviours, and landscapes [2]. [3] emphasises the importance of building resilience through adaptation strategies to oppose climate change's current and future impacts, alongside efforts to reduce greenhouse gas emissions to net zero by 2050. However, the last [4] resolved to accelerate energy transition and emissions reduction before 2030.

Developing a 'liveable' housing environment is a priority of various sectors, especially the construction industry [5]. Housing environments face different challenges that impact liveability, such as climate change and its effects. [6] Moreover, [7] asserted that infrastructure continuously experiences significant impacts exacerbated by natural variability in climate. This impact extends to buildings and houses. Moreover, a recent report by [8] reveals significant evidence to suggest that the climate significantly impacts buildings and houses regarding deterioration and maintainability. This research explores the Impacts of climatic features on residents and residences in the UK.

The preceding overview gave rise to the following research questions.

How does climate change impact the wellbeing and comfort of residential building users (residents)? This was broken down into:

Does climate change have a significant impact on residential building occupants?

Do climate change measures/policies significantly impact residential building occupants?

How does climate change impact the resilience of residential buildings?

Is there any relationship between the impacts of climate change and the deterioration of building fabrics?

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2. Literature review

Liveable housing environments face the menace of global climate change. The main aim of the Building Act 1984 and Building Regulations 2000 in the UK is to ensure health, security, safety and wellbeing, waste reduction, energy and water conservation, and comfort for the occupants or users [9]. Studies have also focused on the impacts of climate change mitigation and energy retrofitting programs adaptation on indoor air quality [10] [11]. House of Common Library also highlighted research areas such as assessing the risks of climate change to building fabric from moisture, wind, and driving rain and health impact from changes in air quality in residential buildings [11].

Even though much has been discovered about how energy systems, emissions, ambient greenhouse gas concentration, and climate change are related, comparatively little research has concentrated on what would happen if climate changed[12]. The quality of the built environments influences the severity of climate change impacts on them [13]; [14]. However, most buildings needed to be constructed considering the impacts of climate change [15]. Future cities strive to be sustainable, liveable and resilient to ensure that their citizens live happily and healthily in affordable homes that are cost-efficient to maintain and are resilient to any future shocks and stresses"[16]. The impacts of climate change are primarily felt in densely populated areas, affecting people's domestic lives such as flooding, drought, heat stress, rainstorms, snowstorms, ice storms, thunderstorms and lightning, windstorms including hurricanes, cyclones, typhoons, tornadoes and whirlwinds, sandstorms, landslides, avalanches, sea level rise, fires and bush fires, overturning of trees, respiratory problems, damage from storms and deterioration of green spaces depending on the location, microclimate; housing type; the climate risk it faces; the socio-economic composition of its residents and their attitudes; resources; and governance conditions [17]; [14]; [18] ; [19].

According to [20], the Earth's climate has been relatively stable at about 14 °C since the ice age, which ended 11,000 years ago. However, science has shown that, since 1880, the average temperature has increased by 0.08°C per decade, or one °C, between 1900 and 2021[21]. More also, the Anthropogenic global warming theory predicted that by the year 2100, the Earth's temperature could rise by an additional 30C, which could threaten water availability, agricultural productivity, sustainable development, forest fire risk, drought, and flooding as a result of the rise in sea level[20]. [22] warn that global warming will increase from 1.0C to 1.50C if emissions persist between 2030 and 2052.

According to the [23], the UK's temperature rose by 0.90 degrees Celsius between 2005 and 2014 compared to 1961-1990. [24] the UK temperatures will continue to rise, especially during summer (up to 4°C in the south and 2.5°C in the north by the 2080s); the Warmest year started in 1990. The greenhouse gas emission level will determine the climate change rate and its impact on the environment and housing liveability. Residential buildings emit 15% of CO_2 using fossil fuels for space heating and hot water production [25].[26] further asserted that the comfort or liveable environment is compromised due to the warming climate, hence the focus of UK policymakers on mitigating the adverse effect of climate change by reducing Co_2 emissions by 80% by the year 2050.

2.1. Impacts of climate change

Climate change has resulted in continuous heat waves due to intense global air temperatures affecting residential buildings and the health of occupants, mainly those with limited control capability to manage the temperature, such as the elderly, babies, those that are living alone, sick, or bedbound [1],[2]. Hence, it necessitates the use (energy) of a mechanical cooling system, which also contributes to climate change through greenhouse gas emissions[3]. [4] projected that the increase in the severity of climate change impacts primarily the built environment, threatening both indoor and outdoor activities, leading to occupant discomfort, health, and productivity, and even causing displacement about factors such as population growth, change in building energy usage, and more demand for comfort.[5] further supported that climate change enormously impacts residential buildings from wind, precipitation, and flooding. [6] opined that climate actions such as mitigation and adaptation will go a long way to reduce the consequences of global warming on buildings due to their long lifespan characteristics.

Climate change damage is a global issue, with disastrous events predicted if urgent action is not taken to limit global temperatures to 2°C (Global Commission on the Economy and Climate, 2014). Extreme climate events have resulted in significant human casualties and property losses [8]. The urgency for action is evident, as global warming threatens water availability, agricultural productivity, and the resilience of nations to climate emergencies [9]. The impacts of climate change are already observable, necessitating adaptive measures for both new and existing residential buildings to maintain a healthy indoor environment and occupant comfort ([10]; [11].

According to [8], more than 530,000 people died worldwide between the years 1994 and 2013, and about USD 2.17 trillion of public and private property (PPP) was lost due to the effect of over 15,000 extreme climate events. Besides, over 10,600 people lost their lives in 2014/15 alone because of a lack of sufficient asset integrity in many infrastructures around the globe, exacerbated by adverse weather conditions. The threat continues as it was estimated that 80 million people across 20 states were warned over climate change disasters [12].

2.2. Research gaps

Studies have focused on the impacts of climate change mitigation and energy retrofitting programmes adaptation on indoor air quality ([13]; [14], but the impacts of climate change on the fabrics of buildings still need to be addressed. The House of Common Library has highlighted research areas such as assessing the risks of climate change to building fabric from moisture, wind, and driving rain and the health impact of changes in air quality in residential buildings [14]. Therefore, our research explored the potential impacts of climate change on buildings in the UK, including floods, wind damage, driving rain impact, increases in wildfire, flooding, subsidence, and the internal/external environment of buildings. The study extended to investigating the impacts of climate change on residents of buildings.

3. Methodology

The study used a quantitative survey approach to address the research questions indicated in the introduction. The quantitative method is widely accepted in social science research and is most suited for quantifying more excellent data [1]. A questionnaire was deemed fit for this study for these reasons:

- To easily pool data from different locations in the West Midlands in the UK
- To ensure confidentiality and promote honest responses due to the sensitivity of the subject matter.
- To moderate the researchers' participation in the survey in order to reduce biases [2].

The choice and use of questionnaires in quantitative research design processes often consider the aim of the study, the kind of data to be collected, and the resources available [3]. The study employed a five-point Likert scale in the questions, which were designed to address the issues related to the impact of wind, rain, rise in temperature, humidity, flooding, drought, and wildfire on residents and residential buildings and to determine how climate change affects the occupants of buildings. However, the questionnaire included some multiple-choice closed-ended questions to get a significant number of responses.

The questionnaire survey was done online using the Poll-fish platform. Before beginning data collection, ethical permission was approved by the Faculty of Science and Engineering Ethics Committee of the University of Wolverhampton. First, a pilot study was conducted where ten responses were received, and the following were observed.

- There were several lengthy and dull questions., and these were corrected.
- A few questions were removed since they did not affect the study's objective.
- Certain questions were asked more than once; these were eliminated.
- Additionally, typographical problems were found and fixed.

Participants were chosen from West Midlands households deemed vulnerable to climate change. Participants were geotargeted using Pollfish, an online platform. Poll-fish is a user-friendly multimedia interface that aids in quick data collection from people anywhere in the world [4]. In

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total, 300 questionnaires were distributed to residential addresses that were perceived to have had some experience with the impacts of climate change. They were randomly selected from the lists of vulnerable homes to the impacts of climate change, as stated by the [5]. In response, 148 questionnaires were returned. Fourteen of these responses were excluded due to incomplete information. A net sample size of 134 was used for this study, representing a response rate of approximately 45%. The following cities have the following sample sizes of correctly filled and returned questionnaires: 70 from Birmingham (52.2% of 134), 19 (14.2%) were from Coventry, 19 (14.25%) from Wolverhampton, 16 (11.9%) from Walsall and 10 (7.5%) from Dudley.

3.1. Demographic information of the respondents

One hundred (74.6%) had insurance,18 (11.9%) had no house insurance, and 18 (13.4%) were not sure. 78 (58.2%) were homeowners. 55 (41%) rented the property, and 1(0.7%) are others. Sixty-nine respondents (51.5%) were male, and 65(48.5%) were female. Most respondents were aged between 25 and 34 years, which is 44 (32.8 %). 35-44 represent 35 (26.1%) of the sample. Nineteen respondents (14.2%) were above 54 years, while (17), 12.7%, were aged 18-24 years, and respondents (2), 1.5 %, were aged 16-17 years. Twenty-eight (20.9%) had two occupants, 27 respondents (20.1%) had 3, 3 respondents (2.2%) had 7, and 34 respondents (25.4%) had 4, and 23 respondents (17.2%) had 5, and 7 respondents (5.2%) had 5, and 12 respondents (9%) had 1. Results indicate that the majority of households had four occupants.

Twenty-one (15.7%) indicated very knowledgeable of the impacts of climate change on residents and residences, 61 (45.5%) had knowledge,44 (32.8%) had low knowledge, and 8 (6%) indicated not knowledgeable. Twenty-eight (20.9%) attended high school, 6 (4.5%) attended middle school, and 21 (15.7%) were postgraduate. 60 (44.8%) attended university, and 19 (14.2%) attended vocational-technical college. The results revealed that the majority of respondents had University degrees. Regarding their type of residence, Thirty (22.4%) indicated detached buildings, 63 (47%) indicate semi-detached houses, 28 (20.9%) indicate Terrace buildings, 6 (4.5 %) indicate a house-end-terraced, and 7 (5.2%) indicate others. On the type of floor of the residence, Eighty-five (63.4%) indicate concrete floors, 34 (25.4%) indicate timber floors, and 15(11.2%) are still determining their building floor type.

4. Analysis and Results

4.1. Reliability analysis

An alpha Cronbach's value of 0.863 for 14 itemised attributes in the questionnaire revealed good internal reliability [1]. In the same light, the reliability statistic yielded an alpha Cronbach's value of 0.739 for 16 itemised attributes, revealing an acceptable internal reliability level, as shown in the table of Cronbach's alpha reliability test values. A weighted index was applied to each degree of agreement: "Strongly agree" was assigned a score of 5, "agree" of 4, "unsure" of 3, "disagree" of 2, and "Strongly disagree" of 1.

Table 1. Overall Response Summary.

Variables	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Residential buildings are now being impacted by climate change in the UK.	23.13% (31)	49.25% (66)	23.88% (32)	2.99% (4)	0.75% (1)
Erosion has an impact on residential	18.66% (25)	52.24% (70)	20.90% (28)	6.72% (9)	1.49% (2)

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buildings in the UK.					
Heatwaves result from climate change.	41.79% (56)	44.03% (59)	9.70% (13)	4.48% (6)	0.00% (0)
A rise in temperature has a negative effect on residential buildings.	31.34% (42)	36.57% (49)	23.88% (32)	7.46% (10)	0.75% (1)
Residential buildings in the UK are experiencing the impacts of drought due to climate change	19.40% (26)	36.57% (49)	29.10% (39)	11.94% (16)	2.99% (4)
Flood causes major damage on residential buildings in the UK.	40.30% (54)	41.04% (55)	9.70% (13)	8.21% (11)	0.75% (1)
Climate change reduces the resilience of residential buildings in the UK.	20.90% (28)	44.03% (59)	29.85% (40)	5.22% (7)	0.00% (0)
Climate change increases the impacts of wildfire.	44.78% (60)	44.03% (59)	5.22% (7)	5.22% (7)	0.75% (1)
Wildfire impacts residential buildings in the UK.	11.19% (15)	42.54% (57)	26.12% (35)	16.42% (22)	3.73% (5)
Climate change influences coastal inundation and impacts residential buildings in	18.66% (25)	48.51% (65)	26.12% (35)	6.72% (9)	0.00% (0)
Climate change causes an increase in windstorms that affect residential buildings	24.63% (33)	41.79% (56)	23.13% (31)	9.70% (13)	0.75% (1)
Climate change causes an increase in	26.12% (35)	47.01% (63)	12.69% (17)	11.19% (15)	2.99% (4)

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extreme cold and affects residential building					
Climate change causes an increase in humidity which impacts residential buildings	28.36% (38)	48.51% (65)	17.91% (24)	2.99% (4)	2.24% (3)
Occupant's neighbours and friends are aware of the dangers that increased wind, rain, a rise in temperature, humidity, flooding, drought, and wildfire can pose to residential buildings	16.42% (22)	40.30% (54)	29.10% (39)	13.43% (18)	0.75% (1)

4.2. Key results

4.2.1. The impacts of climate change on UK residential buildings

Forty points, thirty per cent and 41.03%, respectively, strongly agree and agree that flood causes significant damage to residential buildings in the UK compared to other impacts; this may arguably be due to increased precipitation. 18.66% and 52.24% of the respondents strongly agreed and agreed, respectively, that erosion also impacts UK residential buildings. According to the respondents, 31.34% and 36.57% strongly agreed and agreed that a temperature rise negatively impacts UK residential buildings.

This leads to the buildings suffering from the impacts of heatwaves; as supported by the respondents, 41.79% and 44.03%, respectively, strongly agreed and agreed with that effect. This may be due to a decrease in precipitation. Hence, 20.90% and 44.03% strongly agreed and agreed, respectively, that there is a reduction in the resilience of UK residential buildings. 24.63% and 41.79% strongly agreed and agreed that windstorms resulting from climate change affect UK residential buildings. 28.36% and 48.51% of the responses strongly agreed and agreed, respectively, that humidity due to climate change impacts UK residential buildings, hampering their sustainability. 26.12% and 47.01% strongly agreed and agreed, respectively, that climate change causes an increase in extreme cold, which impacts the quality of residential buildings; the building performance might be reduced.

4.2.2. Climate change affects the occupants of buildings.

On the impact of climate change has adverse effects on occupants of residential buildings in the UK, 26.12 and 51.49% strongly agreed and agreed respectively. Of which 29.85% and 48.51% strongly agreed and agreed respectively that climate change impacts increase the cost of building maintenance, which arguably maybe as a combination of other factors, such as building age, location, types and so on.

The culture and behaviour of residents are affected as 30.60% and 50% of the respondents strongly agreed and agreed respectively with that point. 25.37% and 41.04 % respondents respectively strongly agreed and agreed that the air quality is getting worse due to climate change, which affects the health and safety of the occupants of the UK residential buildings as opined by 27.61% and 51.49% respondents respectively strongly agreed and agreed. 17.16% and 50%, respectively, strongly agreed and agreed that the impacts of climate change have psychological consequences on the affected residential occupants. Hence, climate change is an essential factor affecting the viability of UK residential buildings, as strongly agreed (20.90%) and 56.72% of respondents. Hence, 40.30 and 52.24% strongly agreed that residential buildings should be more environmentally adapted to support measures to the impacts of climate change. Moreover, new buildings should be designed to improve their resilience to the impacts of climate change strongly agreed (56.72%) and agreed (37.31%) respectively by the respondents.

Hypothesis

H1: Climate change has a significant impact on residential building occupants.

H2: There is a significant impact of climate measures/policy on residential building occupants.

A multiple linear regression analysis was conducted to investigate the relationship between the variables building and measures and the variable occupation.

The dependent variable (building occupants) was regressed on predicting variable climate change impacts and climate policy/measures to test hypotheses H1 and H2. ccbuilding significantly predicted building occupants, *F* (2.131) = 82.26, p < 0.001, which indicates that the ccbuilding and climate measures play a significant role in shaping building occupants (b = 0.64, t=11.324, $p < .001$). The results depict a positive effect of the ccbuilding on the occupants. H2 evaluates if climate measures have a significant effect on the building occupants. The results depict a positive effect of the climate measures on the occupants (b = 0.216, t= 2.710, $p < .008$). Hence H2 was supported, as shown in Table 2.

Table 2. Regression analysis.

			Regression Statistics			
Multiple R	**.747[a]**					
R^2	0.557					
Adjusted R^2	0.551					
Standard Error	0.34661					
Observation						
			ANOVA			
	Sum of Squares	Df	Mean Square	F-value	Significance F	
Regression	19.818	2	9.909	82.26	0.217	
Residual	15.738	131	0.12			
			Coefficients			
	Unstandardized Coefficients	Standardized Coefficients				
Model	B	Beta	Standard error	t	P	Hypothesis supported
(Constant)	0.39		0.31	1.25	0.213	
Ccbuilding-occupants (H_1)	0.64	0.68	0.06	11.3	<.001	Supported
Measures/Policy (H_2)	0.22	0.16	0.08	2.7	0.008	Supported

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Moreover, the *R2* = .557 depicts that the model explains 55.7% of the variance in building occupants. The following regression model is obtained: Occupants = 0.39 +0.64 · ccbuilding +0.22 · policy. When all independent variables are zero, the variable Occupants is 0.39. Through further evaluation, the null hypothesis that the coefficient of *" ccbuilding "* was zero in the population was rejected. Also, the null hypothesis that the coefficient of *" policy "* was zero in the population was rejected. R2: The model explains 55.7% of the variation in building occupants. R-squared adjusted: R2 adjusted is 0.551, showing that the model fits.

The ANOVA test result in Table 2 validates the earlier result indicating whether there is significant difference between the variables that were found to be significant. The table below shows that the characteristics of the regression model are: 35.56 sum of squares, 0.120 mean square, 82.481 F-statistic (.001). The result of the ANOVA test shows that the observed variables were significant at 1% level.

Model Coefficients

Policy and ccbuilding both show significant coefficients (p 0.001 and p = 0.008, respectively). The ccbuilding coefficient is 0.64, implying that a one-unit change in ccbuilding results in a 0.64-unit change in building occupants. The policy coefficient is 0.22, implying that a one-unit change in policy results in a 0.22-unit change in building occupants.

Hypothesis

H0: There is no significant relationship between climate change and the well-being of the occupants of UK residential buildings.

A multiple linear regression analysis similar to Table 2 was performed to examine the influence of the variables: Indoor air quality (Q28), health and safety (Q29)., psychological consequences (Q30)., and disruption of the occupants' family activities (Q31). Viability of residential housing in the UK (Q34). On the variable side, the UK's residential buildings are now impacted by climate change (Q9).

The results show that the independent variables positively affect the dependent variable (ccbuilding). Moreover, the *R2* = .304 depicts that they explained 30.4% of the variance from the variable (ccbuilding), An ANOVA was used to test whether this value was significantly different from zero. Using the present sample, it was found that the effect was significantly different from zero, *F*=11.18, *p* = <.001, *R2* = 0.3. The adjusted R2 is 0.28, indicating that the model may somewhat overfit the data. The standard error of the estimate is 0.69, which is the average distance between the observed and anticipated values.

Hypothesis

H0: There is no significant relationship between climate change and the deterioration of the fabric of a building.

A multiple linear regression analysis similar to Table 2 was performed to examine the influence of the variables, reduced building resilience (15), and cost of maintenance (24) on the variable; Residential buildings in the UK are now being impacted by climate change (9).

H1: There is a significant relationship between climate change and the deterioration of the fabric of buildings. The dependent variable (ccbuilding) was regressed on predicting variables; reduced building resilience (15) and cost of maintenance (24) to test hypothesis H1. Hence, H1 was supported. The ANOVA findings (F=32.71, p.001) revealed that the overall model differs considerably from zero. The results clearly depicted that reduced building resilience (15) and cost of maintenance (24) have a positive effect on ccbuilding.

5. Discussion of Results

5.1. The impact of climate change on the wellbeing and comfort of residents in residential buildings

a) Impacts of climate change on residential building occupants

The impacts of climate change on residential significantly predicted building occupants, F (2.131) = 82.26, p < 0.001, which indicates that the impacts of climate change on residential play a significant role in shaping building occupants, as shown in Table 2. This means that when climate change impacts residential regions, it has a demonstrable impact on building occupancy dynamics.

[2] Rising global temperatures are causing wildfires, extreme heat events, and changes in infectious agents; sea level rise and extreme precipitation events are increasing the frequency and intensity of flood events; and climate change is causing changes to the geophysical system.

The results from the study show that 25.37% and 41.04 % of respondents, respectively, strongly agreed and agreed that the air quality is getting worse due to climate change, negatively affecting the health and safety of the occupants of the UK residential buildings, as opined by 27.61% and 51.49% respondents respectively which strongly agreed and agreed. These climate change effects negatively impact human health, especially those of the most vulnerable groups [2]. The features of climate change impacts on residential buildings that affect the comfort and well-being of the occupants used in this study are wildfire, flooding, temperature rise, humidity, drought, wind, storm and extreme cold, which have a negative impact on the occupant. While the statement emphasises the direct link between climate change impacts and building occupants, it is critical to recognise that other factors may also play a role in the relationship between climate change on the UK residential buildings and its effects on the occupants, such as socio-economic conditions, policy interventions, and individual behaviours.

The consequences of severe heat episodes regarding illness and death point to climate change as a growing public health concern [3]. According to [4] and [5] prolonged exposure to high temperatures can result in heat exhaustion, heatstroke, dehydration, and kidney and urinary tract infections. Heat is a hazardous environmental factor that can lead to accidents, acute heat sickness, exacerbations of chronic diseases, and unfavourable pregnancy outcomes [4]. Extreme heat events (EHEs) occur when risks are most significant [4]. 17.16% and 50%, respectively, strongly agreed and agreed that the impacts of climate change have psychological consequences on the affected residential occupants. In addition, social isolation has adverse effects on various health outcomes [5]. In the UK, residential building occupants are most affected by floods. According to [6], flooding within the building exposes residents to disease-carrying ticks and Lyme disease. While the impacts of heat waves and heat exposure on health are well established, the consequences of wildfires on health are not as well recognised [7]. However, [8] opined that wildfire smoke reduces air quality and may impair cognitive function.

[9] predicted that the risk of wildfires closer to residential buildings will rise by 30% to 50% due to climate change by 2080. According to existing literature, this study shows that the building occupants feel the impacts of climate change more on the disruption of family activities and effects on the sustainability of their buildings rather than psychological consequences, health and safety, and air quality. Arguably, the impacts of climate change more on the disruption of family activities and effects on the sustainability of their buildings may result in psychological consequences. The evidence gathered for CCRA3 shows that the gap between the level of risk in the UK and the level of adaptation underway has widened: in other words, adaptation action is failing to keep pace with the worsening of climate risks [10]

b) Impacts of climate measures/policy on residential building occupants

The study's results depict a positive effect of the climate measures/policy on the residential building occupants ($b = 0.216$, $t= 2.710$, $p < .008$). Climate measures/policy significantly predicted building occupants. In order to fulfil future energy and climate change objectives, the UK residential sector must now perform better and be more efficient [11]. Upgrading settlements under the direction of the community and local government increases resilience to climate change hazards [12]. There is a contention that policy ought to shift, requiring more sophisticated upgrading methods tailored to individual buildings and users; high-end retrofits can be encouraged where suitable and feasible, but not only for financial benefit[13]. In contrast to the existing literature, this study shows that the building occupants are more concerned about the impacts of climate change on their residential buildings rather than the measures and policies in place. Although they are both significant and essential in addressing the impacts of climate change. For instance, the awareness of the impact of climate change on residential buildings helps integrate climate-resilient strategies into urban planning and policy development, which could positively influence the well-being and safety of building occupants.

5.1.1. The impacts of climate change on the resilience of residential building

Resilience is the ability to recover from the effects of a hazardous event in a timely and efficient manner; it is becoming more attractive in the resilience of cities and communities [12], [14]. The impacts of climate change on residential buildings were regressed on predicting variables and building resilience. The study's results depict a positive effect of the impacts of climate change on residential building resilience ($b = 0.24$, $t= 5.6$, $p < .001$). The significant level P is less than 0.05. Hence, there is a significant relationship between climate change and the deterioration of the fabric of buildings. This means an increase in the impacts of climate change on residential buildings, causing the building's fabrics to deteriorate and thereby reducing its resilience. 20.90% and 44.03% of respondents, respectively, strongly agreed and agreed that climate change reduces the resilience of residential buildings in the UK.

A lot of literature is about building resilience [15][16][17]. However, only some have looked at what and how residential building resilience could be reduced due to the impacts of climate change, hence this study. This study questionnaire results show that climate change reduces the resilience of residential buildings in the UK depending on three main factors: (i) type of building makeup and the risk (vulnerability, Exposure, Hazard building risk as revealed by [12] and the behaviour and awareness of the occupants [18]. The reduction of residential building resilience aligns with conclusions drawn from existing literature and the cost of building maintenance variable debate. As such, this study contributes by defining the extent to which the impacts of climate change are experienced more. It demonstrates that the reduction in residential building resilience by 19% has a higher impact than the cost of building maintenance.

5.1.2. The impacts of climate change on the cost of maintenance of residential buildings

The regression analysis strongly supports Hypothesis 1, showing a significant association between climatic change and building fabric degradation. Building resilience and maintenance costs are essential in influencing climate change's impact on UK residential buildings.

There is a significant relationship between climate change and the deterioration of the fabric of buildings. This means an increase in the impacts of climate change on residential buildings causes the building fabrics to deteriorate, thereby increasing the maintenance cost of residential buildings. 29.85% and 48.51%, respectively, strongly agreed and agreed that Climate change impacts residential buildings by increasing the cost of maintenance as well [19].

Research conducted by [20] opposes this position by indicating other factors that architectural design deficiencies (unavailability of certain construction materials on the market and challenging access to the building part that needs maintenance) have the most impact on increasing maintenance cost. It can be argued that the impacts of climate change, such as the impacts of wildfire, rise in temperature, drought, humidity, wind, storm, and flooding, will reduce the building material capacity, thereby increasing the frequency of maintenance and, thereby, more cost accrued [21].

The life of the building depends on the integrity of the material used during construction; hence, the durability of materials can influence maintenance costs. According to [22], the choice of building materials may result in high maintenance costs. Materials used can deteriorate quickly due to the impacts of climate change.

[23] Moreover, [20] opined that due to the impacts of climate change, building elements deteriorate faster than they should, thereby increasing the maintenance cost. For instance, continuous extreme weather events such as storms increases in temperature, and flooding can weaken building foundations and cause damage to roofing and cladding.

The positive coefficients for both reduced building resilience and maintenance cost indicate that, in the examined context, both decreased resilience and higher maintenance costs are related to more significant degradation of building fabric. These findings may have ramifications for urban planning and maintenance decision-makers, architects, and lawmakers. It emphasizes the need to consider the trade-offs between resilience and maintenance costs in building fabric.

6. Summary of new findings

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This study demonstrates that the reduction in residential building resilience by 19% has a higher impact than the cost of building maintenance. In contrast to the existing literature, this study shows that the building occupants are more concerned about the impacts of climate change on their residential buildings rather than the measures and policies in place: However, they are both significant and essential in addressing the impacts of climate change. For instance, the awareness of the impact of climate change on residential buildings helps integrate climate-resilient strategies into urban planning and policy development, which could positively influence the well-being and safety of building occupants. It shows that the building occupants feel the impacts of climate change more on the disruption of their family activities and effects on the sustainability of their buildings rather than psychological consequences, health and safety, and air quality.

7. Conclusions

Findings from testing the hypotheses imply that the impacts of climate change on residential buildings affect the occupants significantly. It can be argued that climate impacts such as heatwaves, rise in temperature, drought, flood, wildfire, windstorms, coastal inundation, humidity, and extreme cold affect negatively affect the occupants, distraught the way residents live in their houses, impacts the health and safety, reduces air quality, affects the occupant's mental well-being.

The findings show that there is a significant relationship between climate change and the well-being of the occupants of UK residential buildings. However, the results show that social well-being is more important to the occupants than mental and physical well-being. The results show a significant relationship between climate change and the deterioration of the fabric of buildings. It indicates that residential buildings in the UK will suffer the cost of maintenance due to continuous reduction in the building fabric resilience to the impacts of climate change.

In summary, the urgency of this study is underscored by the increasing risks associated with climate-related events, demanding a comprehensive understanding and effective adaptation strategies and resilience measures for the built environment. As a result, the research's conclusion on the reduction of residential building resilience aligns with conclusions drawn from existing literature and the cost of building maintenance variable debate. As such, this study contributes by defining the extent to which the impacts of

climate change are experienced more. This study contributes to the body of knowledge and practice of minimising the impacts of climate change by providing empirical evidence on factors influencing climate impacts resilience reduction and strategies for mitigating them. This study's data has important implications for policymakers, urban planners, and other stakeholders working to create resilient and sustainable environments in the face of climate problems.

8. Limitations

Data collection was restricted to the West Midlands;. Due to the quantitative approach of this study, the results may need to be investigated deeper through interviews to understand the concerns of specific respondents. However, the study’s findings may be embraced and used as a benchmark to guide future decisions on climate change’s impacts on residents and residential buildings in other parts of the world.

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