Stakeholders' influence on environmental sustainability of reusing religious heritage in the UK: A case of historic churches

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Abstract:
Current global pressures on energy consumption have elevated the objective of energy efficiency both within the scientific and legislative agenda. This is due to increasing scarcity of natural resources and impacts on climate change originating from traditional fossil fuel-based energy generation. However, as the momentum gathers for improving environmental sustainability of buildings, it is inevitable that no aspect of building sector could be left out in meeting the carbon emission reduction target for the building sector. An aspect identified for potential reduction in energy use is religious heritage; especially those currently undergoing reuse for other public uses. Presently, little is achieved with regards to reducing environmental impacts of reusing these buildings. The paper aims is to investigate influence of heritage building stakeholders on strategies to improve environmental sustainability of reusing historic churches. The objective is geared towards improved process and approach for their sustainable reuse. Using a questionnaire survey, this study engaged heritage professionals involved in the refurbishment of religious heritage across the UK. Findings shows that environmental impacts of reusing historic churches have not yet been factored into these projects and that heritage building professionals' influence and perception is vital to reducing environmental impact of these buildings. Further findings suggests other material issues for improved process and/or decision involving reuse of these buildings should include holistic sustainability objectives and agenda for effective energy use management. The paper conclude greater emphasis on energy management and waste reduction would need to be integrated into the strategic and business planning for sustainable reuse of these buildings.
Keywords: *environmental sustainability, religious heritage, stakeholders, influence*

1. Introduction

The significance of the building sector has necessitated the agreement of the key world peer-review assessments, such as the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [**1**], the Global Energy Assessment [2], Energy Technology Perspectives [3] and others on buildings as a priority sector when considering energy security and climate mitigation challenges. Considering its overall significance of climate change, a considerable importance is attached to incorporating energy saving measures to new buildings and concentrated efforts to improving energy efficiency of existing buildings.

Arguably, older buildings especially those with heritage value also have a crucial role in meeting the targets for moving to a low-carbon future. English Heritage [4] and Rowe *et al.*, [5] expressed concern over the replacement of existing building for a new arguing that it would require a considerable investment of 'embodied' energy in materials, transport and construction. In Europe, there are about 500,000 existing religious heritage buildings with a history dating back well over a 1000 years representing a unique and essential part of Europe's cultural heritage with key element of European identity [6].

The religious heritage buildings have stood central to their communities for hundreds of years and had continue to play integral and crucial part for the future survival of their communities. Thus, the importance of religious heritage has been recognised for both cultural and heritage conservation for their community's current and future life. However, due to inevitable change in human society such increasing trend of secularization leading to ongoing redundancy of many religious heritage buildings especially churches; lots of them are coming under threat and therefore have become open for non-religious activities.

In the past, buildings that were structurally secure have been adapted to fit changed needs of the society or new functions. This process of change in function of a building though not always result in changes to the structure or the interior is termed adaptive reuse. Velthuis and Spennemann [7] argued that this process of change requires a certain amount of creativeness and inventiveness, not just from the architects involved in finding a way to fit a new function for the old building, but all those involved in the process.

During the French Revolution, religious buildings were transformed into industrial functions or military uses after they had been confiscated and sold [8] – [9]. Although, these interventions were done in a pragmatic way, however, the driving force behind them was only functional and financial [10]. Meanwhile environmental sustainability aspect of reuse of these buildings is not viewed as a strategic issue and currently still under-researched in the literature most especially reuse of historic churches.

1.1 *Adaptive reuse of historic churches*

A factor driving adaptive reuse of churches especially those with heritage value is redundancy. According to English Heritage [11] redundant buildings are buildings that have reached the end of their original working lives but often have huge potential to be adapted to economically viable new uses. In the UK, majority of heritage buildings affected by redundancy are places of worship converted to alternative use or demolished. Rauti [12] expressed that generally, all denominations have been affected by the increase of the rate of redundancy.

In the UK, there are approximately 45,000 churches with Church of England (CoE) alone having about 16,200 churches of which more than 12,200 are heritage listed with some 52% being listed as either Grade I or Grade II* [13]. Whilst most the churches remain in use for worship, however, some 1,626 have been declared redundant between 1969 and 2004; a trend predicted to continue at a rate of 30 buildings per year [14]. Thus, the adaptive reuse of church buildings becomes significant in conservation fostered by the economic benefits associated with tourism they could generate [15] – [17].

Velthuis and Spennemann [7] observed that demolition affects about one fifth of the redundant churches predicting that about 60% of all redundant churches could end up in demolition. In addition, to challenges of reuse of historic churches, some are observed to be ill adapted to meet the needs of modern society. However, to effectively safeguard and reduce the vulnerability of these important heritage assets to be lost, improving their environmental sustainability in an innovative way would be needed not just at the European level but also at various national level if their remarkable patrimony is to be handed to future generations.

2. The case for environmental sustainability in adaptive reuse of historic churches

Rising energy costs with its associated environmental impact has driven the quest for development of new ideas and solutions to achieve sustainable adaptation of heritage buildings. Ellison *et al.* [18] asserted that the rising trend in energy prices will drive property investors to improve the energy efficiency of buildings so as to sustain market demand and rental growth. Therefore, greater attention is directed to updating existing buildings to improving their environmental sustainability standard and to potentially making them more economical to operate; thus giving them longer life span.

Cooper [19] specifically posited that upgrading the performance of existing buildings stock (i.e. adaption) is the most critical aspect of improving sustainability of the built environment. Steemers [20] however argued that for a building to be truly sustaining, it needs to endure and adapt to climate change incrementally over time. Douglas [21] in line with this view drew attention to adaption has an opportunity to implement sustainability into buildings thus making its environmental argument strong.

Brown [22] and Bruhns *et al.*, [23] extended these views stating that operational energy in non-domestic buildings has risen drastically within the last four decades and such necessitated energy improvements in re-using existing buildings. This has the potential to provide substantial cost savings for owners and occupiers. While the case for environmental sustainability and the numerous potential benefits of reusing heritage buildings for other purposes has been acknowledged and highlighted, however, current approaches have only tended to give more recognition to the significance of these buildings as community cultural identity [24] – [25].

Meanwhile available sources omit the influence, practices and perception of heritage building stakeholders neither seek to develop theory nor any framework for practice. For instance, conservation professionals' focus and decisions appear to be principally based on their perception of conserving the features and the identity of the buildings. Meanwhile, little is mentioned with regard to the implications of the energy use in adaptive reuse of these buildings. Most striking is the lack of attention given to influences from project stakeholders.

English Heritage [26] while responding to the challenges of climate change recommends that sustainability appraisal of historic building stock should put into consideration the whole-life energy costs allowing for strategies to increase its sustainability in terms of energy and materials in mitigating climate change effects. Arguably, when historic churches are converted to another use, the indoor temperature, the level of comfort required for the users and energy consumption of the building would change. This would require some degree of caution and care by the design professionals as ill-designed interior space and systems can result to adverse effects on the users and the fabric of the building [27]. This could lead to draughts, thermal stratification, condensation, and deterioration of historic artefacts and possible elevated energy consumption [28]. This underscores the need to adapt and retrofit them to optimal energy performance standard for their new operation.

Currently, the Church of England (CoE) emits about 330,656 tonnes of CO_2 in its operations, yearly [29]. According to Figure 1, the major source of energy consumption of the churches are shown to be mainly due to heating (36%) and lighting (31%). Although limited scope of their energy refurbishment options exists due of their historic value, however, savings of up to 25% are assumed could be achievable through routine energy saving strategies and utilising energy efficient equipment [29. However, conversion of some of these churches to other uses could offer great opportunity to achieve part of the aim to achieve 80% reductions of churches' carbon emissions by 2050.This necessitate the need for greater understanding of the potential environmental savings that can be achieved by reusing these religious heritage.

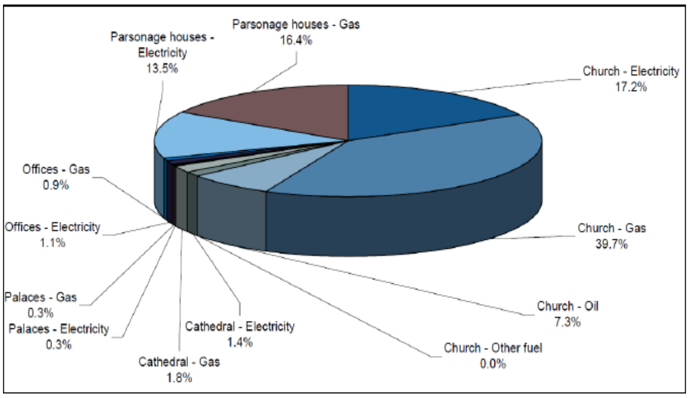

Figure 1: CoE's CO_2 emissions by source
Source: Church of England [29]

This study investigates the perception and influence of heritage building stakeholders on strategies to improve environmental sustainability of reusing religious heritage with particular reference to reuse of historic church buildings. The objective of the study is twofold:

- To determine the pragmatic impact of the influence of the stakeholders on improving environmental sustainability of reusing religious heritage buildings;
- To determine the most sustainable and compatible approach adopted by different stakeholders to reuse of religious heritage as perceived by the stakeholders.

This research is intended to serve as a resource for policymakers, building owners, designers and heritage preservation advocacy groups. To this end, the study identifies key environmental considerations and challenges related to retrofits and reuse of religious heritage.

3. Research methodology

Very few if any studies on investigating stakeholders' perception of environmental sustainability of reusing religious heritage exists in the literature. As part of the a doctoral research on energy management for sustainable reuse of public heritage buildings; the author developed a questionnaire instrument to lay a foundation for developing a tool to aid decision making for environmental sustainability of reuse of religious heritage buildings. The use of questionnaire survey was considered appropriate to reach a large numbers of stakeholders concerned and as an objective method to obtain opinions on the issues to be investigated.

A similar approach was adopted by Elmualim *et al.* [30] to investigate the perceptions of respondents in other UK's industries. Gaps identified in the literature relating to the perspectives of stakeholders were used to develop an online questionnaires survey. The survey was piloted, discussed and accepted among selected group of stakeholders as an appropriate instrument to collect the required data. The online survey instrument was sent via email to the professionals in the UK's industry within a period of two months between May to July 2013. The respondents involved in this study were architects, engineers, surveyors, planning and conservation officers.

The questionnaire contained 19 questions however, the aspect consider for this paper only comprises of Part C - the construct of perception on energy use (PEU) reduction and Part E and F – the construct of perception on sustainable approach (PSA). The dimensions of stakeholders' influence and perception (i.e. PEU and PSA) variables measured in the survey were rated on a scale ranging from 1 to 5 from "Highest" to "Lowest." The scores indicated the stakeholders' influence and perception on sustainability consideration in the project.

4 Results and findings

A total of 211 responded to the survey. Therefore, the sample size is considered adequate. Cronbach's Alpha value was employed to determine the level of reliability of the internal consistency of each item. The result shows that the stakeholders' perception on PEU dimensions achieved Alpha value level exceeding 0.60 (Alpha = 0.76) indicating a good reliability value. The corrected item-total correlation to all items is found to be greater than 0.3 indicating the degree at which each item correlates with the total score [31]. There are 29.8% (63) architects, 30% (64) conservation officers, 9.5% (20) energy consultants, 13% (28) engineers, 8% (16) planning and development control officers, 4.7% (10) regulatory officers and 4% (8) surveyors and 1% (2) others who participated in this study.

4.1Consideration of energy use reduction for church conversion projects

Table 6.13 present the respondents rating on sustainable considerations for church conversion projects. The overall ranking, in ascending order is: conservation policies; users comfort; low energy operating cost; and low energy installation cost. The results show that conservation policies are consistently held in high consideration by the respondents in every project. Meanwhile, low energy consideration trails in the third and the least considered in the projects. The ranking of conservation policy as the most important is not unexpected as policymaker's greatest obligation for any heritage building project is to ensure compliance with conservation policies.

Table 1: Energy use reduction as sustainable consideration factor and ranking

Considerations for Church conversion	Frequency - Respondents' ranking of the factors							
	1	2	3	4	5	SD	Mean	Rank
Low energy installation costs	16	37	42	21	7	1.074	2.724	4
Low energy operational cost	16	18	42	37	10	1.140	3.057	3
Users comfort/productivity	6	13	43	46	15	0.999	3.415	2
Strict compliance to conservation Policies	0	5	25	40	52	0.884	4.139	1

The Spearman's Rank Correlation Coefficient test performed on respondents' sustainable consideration factor for church conversion projects yielded the following results: Conservation policies (R-value = 0.218, $\rho = 0.016$); Users' comfort (R-value = -0.422, $\rho = < 0.01$); Low energy operating cost (R value = -0.472, $\rho = < 0.01$); Low energy installation cost (R-value = -0.39, $\rho = < 0.01$). This indicates that there is significant difference between the policy makers and the professionals in their perception (Table 2). To investigate the influence of the respondents' PEU as it impact their strategies adopted in practice for energy use reduction; binary logistic regression analysis was used to determine the ability to predict the adoption of a given strategies adopted by the respondents as indicated in the survey. A dummy-coded 0 was adopted for non-adoption of a strategy while 1 was dummy-coded for adoption of a strategy. In terms of adopting improvements of the building fabric to reduce U-value, it can be seen from Table 3 that the Wald statistic obtained in the test was 12.04 at the significance value of 0.001. It can be seen that the value fails to attain the 0.05 threshold. Since the value fails to attain the 0.05 threshold it can be concluded from the finding that respondent's choice of adopting the improvement of the building fabric to reduce U-value, is influenced by their perception. However, to confirm this, the -2 log likelihood value is presented as 255.468 in Table 3. This is fairly high and in accordance with the recommendations of Fields [32] caution needs to be taken in concluding that the model might not be good in the prediction of this strategy from the respondents' perception.

Table 2: Spearman's rank Correlation Coefficient test result on energy use reduction for projects

Considerations for Church conversion	Mean		Spearman's Correlations	
	Professionals	Policymakers	R-value	Sig (ρ)
Low energy installation costs	3.088	2.273	-0.39	<0.01
Low energy operational cost	3.529	2.473	-0.472	<0.01
Users comfort/productivity	3.809	2.927	-0.422	<0.01
Strict compliance to conservation Policies	3.985	4.327	0.218	0.016

In order to represent the overall model fit, the Cox and Snell R^2 and the Nagelkerke R^2 values categorized as pseudo R^2 are indicated in Table 3. The Cox and Snell R^2 and the Nagelkerke R^2 values are interpreted to reflect the amount of variation accounted for by the logistic regression model, with 1.0 indicating perfect model fit [33]. According to Table 3, the Nagelkerke R^2 value is 0.084, meaning that a significant relationship of 8.4% can be found between the respondents' perception and their adoption of improving building fabric to reduce U-value as a strategy for energy use reduction.

Table 3: Influence of stakeholders on strategies for energy use reduction in the projects

Strategies Adopted	Model Summary			Variables in the Equation						
	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2	Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Q 18_1 (Improving building fabric to reduce U value)	255.468	.063	.084	Perception	0.029	.008	12.040	1	.001	1.029
				Constant	-1.191	.457	6.796	1	.009	0.304
Q18_2 (Building services upgrade)	256.671	.047	.063	Perception	0.025	.008	9.087	1	.003	1.025
				Constant	-.911	.450	4.105	1	.043	.402
Q18_3 (Energy management system)	244.788	.011	.015	Perception	.013	.009	2.080	1	.149	1.013
				Constant	-1.425	.496	8.256	1	.004	.241
Q18_4 (Smart lighting control)	259.988	.009	.012	Perception	.011	.008	1.757	1	.185	1.011
				Constant	-1.068	.466	5.243	1	.022	.344
Q18_5 (Smart metering)	180.661	.033	.054	Perception	.029	.012	5.924	1	.015	1.029
				Constant	-3.090	.711	18.869	1	.000	.045
Q18_6 (Renewables installations e.g. Solar, Geothermal, Biomass etc.)	261.756	.005	.007	Perception	.008	.008	.963	1	.326	1.008
				Constant	-.890	.459	3.750	1	.053	.411
Q18_7 (Operational energy management policy and awareness)	245.240	.043	.059	Perception	.026	.009	8.005	1	.005	1.026
				Constant	-2.020	.524	14.884	1	.000	.133

In addition, it can be seen from Table 3 that the odds ratio as expressed by Exp (B) = 1.029 and since it surpasses the threshold of 1.00; it can be deduced that any increase in the respondents' PEU will increase the odds of adoption of improving building fabric to reduce U-value. This interpretation also goes for the choice of other strategies such as building services upgrade, smart metering and operational energy management policy and awareness. For other strategies such as energy management system, smart lighting control and renewable installations, it can be seen from the table that the significance value of the Wald statistic obtained was greater than 0.05. Since the value surpasses the 0.05 threshold, it is notable from the results that respondents' choice of adopting these strategies was not influenced by their perception. It could be observed that the -2 log likelihood value were also very high and in accordance with the recommendations of Fields [32], it can be concluded that the model would not be sufficient to predict the strategies adopted from the respondents' perception.

Furthermore, it could be seen that the Nagelkerke R^2 value were also low, meaning that there were very mild or no relationship between the respondents' perception and their adoption of the stated strategies for energy use reduction. However, the odds ratios as expressed by Exp (B), were all greater than 1.00. Since the odds ratio surpasses the threshold of 1.00, it can be concluded that any increase in the respondents' PEU will increase the odds of adoption of the stated strategies for energy use reduction. To determine the source of the difference in the respondents' PEU reduction, the respondents' scores were subjected to One Way Analysis of Variance (ANOVA). The differentiating variables used includes the following: respondents' status such as profession and/or role in heritage industry, geographical location, years of working experience on heritage building projects and the number of heritage refurbishment projects they have been directly involved. The result on the test of difference on the basis of the respondents' profession and/or role in the heritage industry is presented in Table 4. The F-ratio in the results is used to determine the statistical significance. The result show the F-value obtained to be 2.740 at a ρ-value of 0.010. Since the ρ-value is less than 0.05, it can therefore be concluded that the respondents differs in their PEU reduction on the basis of their profession and/or role in heritage industry.

Table 4: Test of difference in the perception of the stakeholders based on their profession

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6008.071	7	858.296	2.740	.010
Within Groups	59209.574	189	313.278		
Total	65217.645	196			

Similar test carried out for other differentiating variables yielded the following result: location (F-value = 1.822, ρ-value = 0.059); years of working experience (F-value = 0.342, ρ-value = 0.887) and number of heritage building refurbishment projects (F-value = 1.740, ρ-value = 0.127). It could be observed that ρ -value is greater than 0.05 for other differentiating variables; therefore be concluded that the respondents do not differ in their PEU reduction in on the basis of the other variables. Meanwhile, since the F-value is significant for the respondents' professional status, the source of the significance difference was investigated through a post-hoc multiple comparison tests conducted via Tukey HSD (Honestly Significant Difference). The results as presented in Table 5 show that there is a mean difference in the group professional status. The result of the mean difference (MD) indicate that engineers seem to have the best perception and gives higher priority and values to environmental sustainability to the projects among the respondents. Their perception was significantly better than those of the energy consultants (MD = 16.74) and conservation officers (MD = 15.38). Although, conservation officers were also found to possess a good (MD = 1.37), the difference was not found to be significant. Further findings shows that other stakeholders were not found to be significantly different in their perception regarding environmental sustainability of reusing historic churches.

4.2 Stakeholders' perception on environmental sustainability construct

To validate the construct on PSA exploratory factor analysis (EFA) using SPSS software was carried out on items on section B and D in the survey. This allows for the exploration of factors perceived by the respondents for sustainable approach to reducing environmental impacts in reusing historic churches. Starting with the original data matrix and using multiple correlations as the estimates of communalities, principal factors were extracted after interacting of communalities. Factors with eigenvalue greater than 1 were retained for rotation. The procedure yielded two factors seven factors components. The factors were extracted and identified using the features of the items loaded and labelled according to their groupings as follows: Energy management (1); Design decision (2); Government regulations (3); Limited resources and

Table 5: Post-hoc multiple comparison test on difference between the respondents' perception

(I) Profession/role in heritage industry	(J) Profession/role in heritage industry	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Architects	Conservation Officers	5.57701	3.25924	.680	-4.4132	15.5673
	Energy Consultants	6.94192	4.67864	.815	-7.3991	21.2829
	Engineers	-9.80077	4.12362	.259	-22.4405	2.8390
	Planning/Development Control Officers	5.18534	4.99812	.968	-10.1349	20.5056
	Regulatory Bodies Officers (e.g. English Heritage)	2.18534	6.67541	1.000	-18.2762	22.6468
	Surveyors (e.g. Building Surveyor, Quantity Surveyor etc.)	5.73892	7.08205	.992	-15.9690	27.4468
	Others	-14.68966	12.72951	.944	-53.7082	24.3289
Conservation Officers	Architects	-5.57701	3.25924	.680	-15.5673	4.4132
	Energy Consultants	**1.36491**	4.65936	1.000	-12.9170	15.6468
	Engineers	**-15.37778***	4.10173	**.006**	-27.9504	-2.8051
	Planning/Development Control Officers	-.39167	4.98008	1.000	-15.6566	14.8733
	Regulatory Bodies Officers (e.g. English Heritage)	-3.39167	6.66191	1.000	-23.8118	17.0285
	Surveyors (e.g. Building Surveyor, Quantity Surveyor etc.)	.16190	7.06932	1.000	-21.5070	21.8308
	Others	-20.26667	12.72244	.754	-59.2635	18.7302
Energy Consultants	Architects	-6.94192	4.67864	.815	-21.2829	7.3991
	Conservation Officers	-1.36491	4.65936	1.000	-15.6468	12.9170
	Engineers	**-16.74269***	5.30012	**.038**	-32.9886	-.4968
	Planning/Development Control Officers	-1.75658	6.00568	1.000	-20.1652	16.6521
	Regulatory Bodies Officers (e.g. English Heritage)	-4.75658	7.45977	.998	-27.6223	18.1091
	Surveyors (e.g. Building Surveyor, Quantity Surveyor etc.)	-1.20301	7.82575	1.000	-25.1905	22.7845
	Others	-21.63158	13.15779	.723	-61.9629	18.6997
Engineers (e.g. Mechanical, Electrical etc.)	Architects	9.80077	4.12362	.259	-2.8390	22.4405
	Conservation Officers	**15.37778***	4.10173	**.006**	2.8051	27.9504
	Energy Consultants	**16.74269***	5.30012	**.038**	.4968	32.9886
	Planning/Development Control Officers	14.98611	5.58415	.134	-2.1305	32.1027
	Regulatory Bodies Officer (e.g. English Heritage)	11.98611	7.12479	.699	-9.8528	33.8251
	Surveyors (e.g. Building Surveyor, Quantity Surveyor etc.)	15.53968	7.50712	.438	-7.4712	38.5506
	Others	-4.88889	12.97081	1.000	-44.6471	34.8693
Planning/ Development Control Officers	Architects	-5.18534	4.99812	.968	-20.5056	10.1349
	Conservation Officers	.39167	4.98008	1.000	-14.8733	15.6566
	Energy Consultants	1.75658	6.00568	1.000	-16.6521	20.1652
	Engineers (e.g. Mechanical, Electrical etc.)	-14.98611	5.58415	.134	-32.1027	2.1305
	Regulatory Bodies Officer (e.g. English Heritage)	-3.00000	7.66418	1.000	-26.4923	20.4923
	Surveyors (e.g. Building Surveyor, Quantity Surveyor etc.)	.55357	8.02084	1.000	-24.0320	25.1391
	Others	-19.87500	13.27475	.808	-60.5648	20.8148
Regulatory Bodies Officers (e.g. English Heritage etc.)	Architects	-2.18534	6.67541	1.000	-22.6468	18.2762
	Conservation Officers	3.39167	6.66191	1.000	-17.0285	23.8118
	Energy Consultants	4.75658	7.45977	.998	-18.1091	27.6223
	Engineers (e.g. Mechanical, Electrical etc.)	-11.98611	7.12479	.699	-33.8251	9.8528
	Planning/Development Control Officers	3.00000	7.66418	1.000	-20.4923	26.4923
	Surveyors (e.g. Building Surveyor, Quantity Surveyor etc.)	3.55357	9.16045	1.000	-24.5251	31.6322
	Others	-16.87500	13.99281	.929	-59.7658	26.0158
Surveyors (e.g. Building Surveyor, Quantity Surveyor etc.)	Architects	-5.73892	7.08205	.992	-27.4468	15.9690
	Conservation Officers	-.16190	7.06932	1.000	-21.8308	21.5070
	Energy Consultants	1.20301	7.82575	1.000	-22.7845	25.1905
	Engineers (e.g. Mechanical, Electrical etc.)	-15.53968	7.50712	.438	-38.5506	7.4712
	Planning/Development Control Officers	-.55357	8.02084	1.000	-25.1391	24.0320
	Regulatory Bodies Officer (e.g. English Heritage)	-3.55357	9.16045	1.000	-31.6322	24.5251
	Others	-20.42857	14.19130	.838	-63.9278	23.0707
Others	Architects	14.68966	12.72951	.944	-24.3289	53.7082
	Conservation Officers	20.26667	12.72244	.754	-18.7302	59.2635
	Energy Consultants	21.63158	13.15779	.723	-18.6997	61.9629
	Engineers (e.g. Mechanical, Electrical etc.)	4.88889	12.97081	1.000	-34.8693	44.6471
	Planning/Development Control Officers	19.87500	13.27475	.808	-20.8148	60.5648
	Regulatory Bodies Officers (e.g. English Heritage etc.)	16.87500	13.99281	.929	-26.0158	59.7658
	Surveyors (e.g. Building Surveyor, Quantity Surveyor etc.)	20.42857	14.19130	.838	-23.0707	63.9278

*. The mean difference is significant at the 0.05 level.

grants (4); Risks of condensation and building complexity (5); Heritage visual impact and secondary glazing (6) and Fabric U-value (7). The labelled factors indicate the critical factors to be addressed to achieve energy use reduction for sustainable reuse of PHBs (Table 6).

5. Discussion

The stakeholders influence and perception on environmental sustainability of reusing religious heritage have been examined through the study. It can be said that the respondents differs in their PEU especially on the basis of their profession. The professionals among the respondents have better perception than the policymakers. This difference could perhaps be possibly due to the perception among the policymakers that there is little room for improving the environmental sustainability of historic churches. Partly, because of the way historic churches are built hundreds of years ago and more importantly because of the impulse to protect their delicate fabric which pose limitations to common 'easy wins' of energy efficiency. It implies that the policymakers would need to develop more proactive inclination to incorporating environmental measures to buildings that are more likely to be adapted and to understand what the potential is for those buildings for environmental upgrading. It is notable that some professionals are influenced by their perception to adopt strategies to improve the building fabric by reducing the U-value of the buildings. Possible explanations as to why some professionals are prone to adopt this strategies could be that they perceived it as the most sustainable way of improving the environmental sustainability of the buildings. Other compelling explanations could be that this strategy give greater comfort during the winter season; and poorly insulated walls in humid buildings in winter period are likely to show signs of mold at cold spots (thermal bridges). In addition, adding insulation could be part of the overall strategy to reduce air

Table 6: Extracted factors ordered and grouped according to their size

S/N	Size	LFC	Factor Description
Factor 1: Energy management			
1	0.848	F2	Adaptation to upgrade building energy efficiency
2	0.831	F1	Importance of energy use reduction in conversion as modern buildings
3	0.619	F3	Importance of energy monitoring and analysis after conversion to other uses
4	0.540	F4	Use of technologies to minimise energy consumption after conversion
5	-0.429	F22	Listed churches are complex buildings with limiting features on energy efficiency
Factor 2: Design decision			
1	0.864	F18	Low consideration given to minimising energy consumption
2	0.808	F16	Low priority for energy efficiency in conversion projects
Factor 3: Government regulations			
1	0.798	F24	Government policies, regulations and requirements (e.g. FiTs, VAT, etc.)
2	0.626	F23	Influence of grade listing on possible energy efficiency improvements
3	0.554	F25	Inadequate operational energy management policy and awareness
Factor 4: Limited resources and grants			
1	0.800	F28	Inadequate resources and grants to encourage energy efficiency measures
2	0.669	F27	Inadequate energy efficiency framework disseminating effective strategies
Factor 5: Risks of condensation and building complexity			
1	0.783	F19	Most sustainable options in practice are limited in application to heritage buildings
2	0.733	F21	Risks of insulation and interstitial condensation in the walls or roof
3	0.510	F22	Listed churches are complex buildings with limiting features on energy efficiency
Factor 6: Heritage visual impact & secondary glazing			
1	0.475	F4	Use of technologies to minimise energy consumption after conversion
2	0.867	F5	With minimum visual impact secondary glazing should be allowed
Factor 7: Conflict over fabric U-value			
1	0.809	F6	Significant energy use reduction could only be achieved by reducing the U - value
2	0.566	F7	Energy saving measures only make sense if payback is less than 10 years

S/N = Serial No, LFC = Loaded Factor Code

infiltration that are common to historic churches. However, the potential and effectiveness of adopting this strategy cannot be predicted as a sustainable approach for historic churches as the outcome of the model is not sufficient to base the prediction. Meanwhile others who do not adopt the strategy might perhaps perceived the strategy to be more intrinsically risky for the buildings because of their heritage value. This findings is in line with the reports of other researchers [34] – [37] who pointed out that motivation or adoption of strategies to reduce energy consumption in buildings will vary with the individual inclinations or perception.

On the other hand it can be said that increase in the respondents' PEU could result to the consideration of other strategies such as building services upgrade, smart metering, operational energy management policy and awareness becoming higher priority over fabric improvement. Further findings from this study suggest that improving environmental sustainability of historic churches could be achieved with improved process and/or appropriate decision that include holistic sustainability objectives and agenda for effective energy use management. Other material issues to be considered include making financial resources and grants available, avoiding measures with potential risks of condensation and adequate consideration for the visual impact the measures could have on the building. Strategies such as energy management system, smart lighting control and renewable installations are also potential measures for consideration to make reuse of historic churches sustainable. There is need for the stakeholders to place greater priority and values to environmental sustainability of religious heritage buildings first to increase their future value and to contribute positively to the climate change agenda.

6. Conclusions

This study brings to the fore that that one of many reasons for poor energy performance of heritage building projects could partly be attributed to low perception of the need to improve their energy performance at the decision stage and lack of consensus and commitment to environmental sustainability among heritage stakeholders. The study underscores the need for positive change in perception and attitudes, more enlightenment, training, integrated teamwork and collaboration among heritage professionals to successfully deliver environmentally sustainable reuse of historic building projects. It is recommended that when looking to install energy efficient solutions to religious heritage, it is important to focus on the key important factors in order to safeguard the building from unintended consequences. It is recommended that any technological approach to reuse of religious heritage should align with conservation principles and should be: unobtrusive; non-disruptive; and flexible. In addition, maintaining the fabric and integrity of the building are vitally important.

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