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IMPLEMENTING BUILDING ENERGY EFFICIENCY RETROFITS (BEER) IN HOTEL BUILDINGS: A CASE STUDY OF SHALLOW RETROFIT

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Abstract

Currently, there is a decisive need around the world to retrofit existing buildings to have higher energy performance. Compared to the significant potential for energy conservation in existing buildings, still the level of implementation of Building Energy Efficiency Retrofits (BEER) is comparatively low. The absence of a clearly defined process for ensuring the delivery of BEER; lack of proactive guidance for project teams to ensure that they make the right decisions to achieve the desired Energy Efficiency (EE) outcomes; and execution of BEER projects in ad hoc basis have been identified as some of the key reasons limiting EE improvements over the long term. Hence, this paper is aimed at developing an initial level decision-making process by incorporating the key decisions to be made and key activities to be performed, during each stage of the BEER decision-making process. The study is limited in its focus to existing hotel buildings, due to their level of energy consumption and potential for conservation. Using a case study, the study derived a total of twelve key decisions to be made and twenty-eight key activities to be performed throughout the decision-making process, based upon which an initial level decision-making process is developed. It is hoped that the findings of this study could facilitate the practitioners in the hotel sector to properly undertake and execute BEER projects.

Keywords: *Building Energy Efficiency Retrofits (BEER); decision-making process; existing hotel buildings.*

1. Introduction

The building stock in the world consumes about 30-40% of the energy (Friege and Chappin, 2014) and releases one third of the total Greenhouse Gas (GHG) emissions (Ruparathna et al., 2016). Since in the building sector, existing buildings encompass the largest segment of the built environment (European Climate Foundation, 2013) and represent the greatest opportunity for Energy Efficiency (EE) improvements (Xing et al., 2011), the enhancement of EE in existing buildings is crucial to attain a timely reduction in global energy usage (Liang et al., 2015; Ma et al., 2012) and GHG emissions (Liang et al., 2015). Within this context, Building Energy Efficiency Retrofits (BEER), provides a useful way to improve the EE of high-energy-consumption buildings (Xu et al., 2015). Simply, BEER are aimed at reducing the operational energy use in buildings through building envelope improvement and mechanical systems upgrades (Xu et al., 2015).

Still existing buildings are slow embrace BEER projects (Friege and Chappin, 2014; Liang et al., 2016), compared to their saving potential (Hendron, 2013). Main reasons for this reduced level of implementation of BEER are: absence of a clearly defined process for ensuring the delivery of BEER, lack of proactive guidance for project teams to ensure that they make the right decisions at the right time to achieve the desired EE outcomes (Gultekin et al., 2014), and execution of BEER projects in ad hoc basis without a systematic decision-making process (Hall, 2014). Hence, it is clear that informed decision-making is crucial for improving the energy performance of existing buildings (Ruparathna et al., 2016) as well as to propagate the benefits of retrofits (Swan and Brown, 2013). In terms of research, however, so far little focus given towards exploring the decision-making aspects of the BEER including the identification of activities to be performed and decisions to be made in the process (Ruparathna et al., 2016). Therefore, this paper is aimed at deriving the key decisions to be made and key activities to be performed in each stage of the BEER projects. The findings are used to propose an initial level decision-making process which could support the effective adoption and implementation of BEER in existing buildings.

Among the existing buildings, this study has limited its focus to hotel buildings due to their level of energy consumption (Sri Lanka Energy Managers Association [SLEMA], 2009; Xu et al., 2013) and saving potential (SLEMA, 2009). Identification of 'lack of personnel and internal expertise' as a key reason for many BEER projects to remain unimplemented in existing hotel buildings (Xu and Chan 2011), has insisted the need for a suitable support tool that can be used by the practitioners in the hotel sector in successful adoption and implementation of BEER. Thus, among the available to approaches to implement BEER projects (i.e. led by in-house team or ESCO) (Ma et al., 2012), in this study the focus was limited to in-house led scenario.

2. Decision-making process of BEER

BEER projects should be approached in a systematic manner to achieve maximum benefit out of those projects (Sustainable Energy Authority of Ireland [SEAI], 2015). Despite the existence of large number of BEER decision-making models/tools (Xu et al., 2013), still some authors highlight a lack of systematic process for identifying, determining and implementing BEER projects (Crilly et al., 2012). Similarly, review of literature disclosed that most of the attempts made by the authors so far to derive a systematic approach for BEER projects have resulted in deriving only key stages of the project while only very few have come up with a comprehensive process for BEER projects (for e.g. Ma et al., 2012). This discloses that still there is limited underpinning of decision-making regarding BEER (Friege and Chappin, 2014), which further insist the vitality to come up with decision-making process for the adoption and implementation of BEER projects. Hence, in this level a conceptual decision-making process for BEER projects was developed as shown in Figure 1.

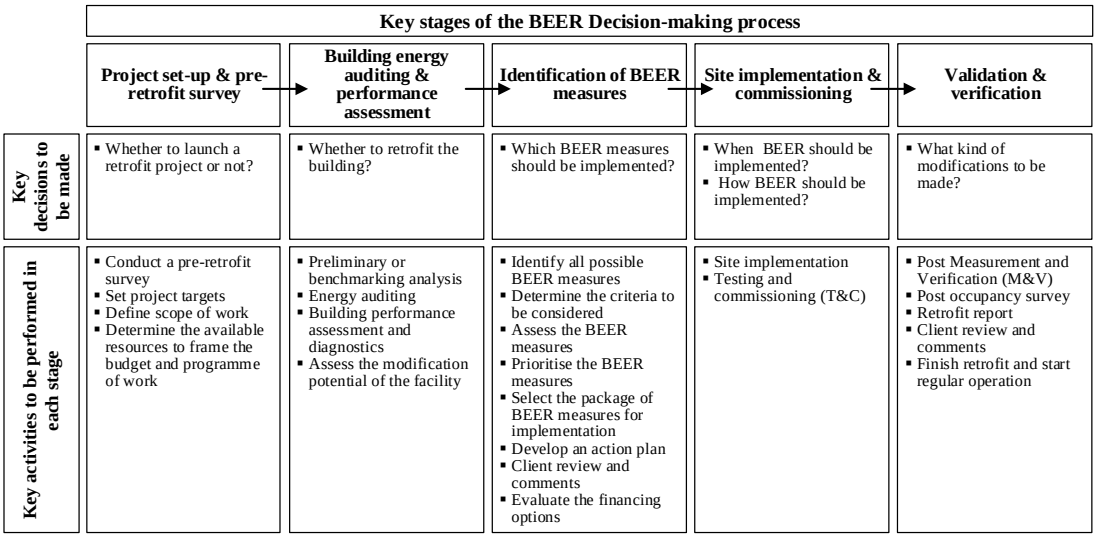

Figure 1: Conceptual decision-making process

Since among the available processes for the adoption and implementation of BEER projects, the process suggested by Ma et al. (2012) appears to cover all the key stages and found to be promising, this same process has been used as the basis for developing the conceptual decision-making process of BEER projects. According to them, the overall process of a building retrofit comprises of five major stages: namely, project setup and pre-retrofit survey; building energy auditing and performance assessment; identify possible retrofit measures or options; site implementation and commissioning; and validation and verification, as depicted in Figure 1.

In the decision-making process of BEER projects, several vital decisions to be made (Zundel and Stieß, 2011) and various activities to be performed (Mondrup et al., 2014). Similarly, the developed conceptual decision-making illustrates both key decisions to be made and key activities to be performed in each of the aforementioned five stages. The activities to be performed under each stage of the BEER project as illustrated in Figure 1 were derived mainly based on the findings of Ma et al. (2012), Hendron (2013), and Mohammadpour et al. (2016), while the decisions to be performed under each stage were elicited

by compiling the findings from Liang et al. (2016), Duah et al. (2014), Ma et al. (2012), and Hendron (2013).

Despite the development of this conceptual decision-making process, still a gap remains as to practicality of this developed process i.e. how these decisions and activities are carried out in practice in the hotel sector, which will be elicited in this study via empirical investigation from an in-house led scenario's perspective.

3. Research methodology

Case study strategy is being selected for this study, wherein the study focused on conducting a single case study, by realising the vitality to spend sufficient time in investigating the decision-making aspects i.e. what decisions were made, and what activities were performed in each stage of the project. During case selection priority was given for the BEER projects that have received the Sri Lanka National Energy Efficiency Awards by believing that such cases would facilitate in deriving the best practices followed by the organisations while retrofitting the facilities.

The selected BEER project for this study was a shallow retrofit project, focused on fine-tuning or improving the management of building's energy systems (i.e. installed VSDs for pumps, motors, blowers in AHU etc., replaced magnetic ballasts with electronic ballasts, replaced incandescent or conventional fluorescent lamps with CFL and LED), and was resulted in energy cost reduction of around 700 – 800 kWh per day.

In total six (06) semi-structured interviews were conducted with the respondents selected on the basis of their level of involvement in the decision-making process of the selected BEER project, which provided good insights into the decisions to be made and activities to be performed in each stage of the process. The details of the respondents are presented in Table 1.

The structure of the interviews intended to facilitate the respondents to specify any details that they considered relevant. Code based content analysis using NVivo computer software was used to analyse the qualitative data collected through semi-structured interviews. During data analysis, each of the interviews were individually coded and analysed under the principles of grounded theory to ensure that the emergent nature of the research was retained.

Table 1: Details of the respondent

Respondent code	Profile of the respondent	Roles played	Years of experience
R1	Chief Engineer	Facilities Manager, Energy Auditor	30
R2	Senior Foreman	Electrical Engineer	36
R3	Foreman	Electrical Engineer	15
R4	Cost Controller	QS/Cost Consultant	08
R5	Chief Technical Advisor- Energy	Industry Institution	25
R6	Assistant Manager	Supplier	05

Findings from the case study analysis are discussed below.

4. Case study analysis

Case study analysis disclosed several key decisions to be made and key activities to be performed in a BEER project led by in-house team. These derived decisions and activities could be fitted within the five stages of BEER decision-making process identified by Ma et al. (2012). Figure 2 presents the proposed initial level decision-making process developed based on case study findings, clearly illustrating: in the first level, twelve (12) key decisions to be made; and in the second level, twenty-eight (28) key activities to be performed during each stage of the process. It is necessary to point out that in

Figure 2, the activities to be performed are presented in the chronological sequence in relation to each stage. The key findings are further discussed in the following sections.

4.1. PROJECT SET-UP AND PRE-RETROFIT SURVEY

This is the initial stage of a BEER project and includes all the activities to be performed in a BEER project to initiate the project. In this case, at first the need of retrofitting was realised by the Facilities Manager (FM) through the routine performance assessment process where energy consumption of the hotel is monitored and evaluated over the past consumption data. This has led him (i.e. FM) to decide 'whether to launch a retrofit project or not'. Then, the project targets were set based on FM's rough understanding of the hotel's saving potential. Afterwards, the parties to be involved in the project were pre-determined along with rough idea on roles that should be performed, as it was perceived that this would be useful in setting up the project team in the subsequent stage.

4.2. BUILDING ENERGY AUDITING AND PERFORMANCE ASSESSMENT

This is the second stage of the process which is focused on clearly identifying the saving potential of the facility with the intention of selecting the suitable systems for retrofitting. In this stage, initially an in-depth audit was conducted by the FM with the intention of clearly identifying the saving potential of the facility. Then by presenting the audit findings, FM has made the top management aware of the need of retrofitting.

	Key stages of the BEER Decision-making process				
	Project set-up & pre-retrofit survey →	**Building energy auditing & performance assessment** →	**Identification of BEER measures** →	**Site implementation & commissioning** →	**Validation & verification**
Key decisions to be made in each stage	▪ Whether to launch the retrofit project or not	▪ Whether to provide permission to proceed with the project or not ▪ Who were parties to be involved and what were the roles to be performed ▪ What system or systems should be retrofitted	▪ Which retrofit measures should be used to retrofit the selected system ▪ Whether to approve the project proposal or not ▪ Whether to fund the project or not ▪ How much money should be spent on the project	▪ When to begin with the implementation of the selected retrofit measures ▪ How to do the installation of the selected retrofit measures	▪ Whether any modifications to be made to the retrofitted system ▪ What kinf of modifications to be made
Key activities to be performed in each stage	▪ Identify the need of retrofitting ▪ Set targets ▪ Pre-determine the parties to be involved in the project along with rough idea on roles that should be performed	▪ Conduct an in-depth energy audit ▪ Identify the areas with saving potential ▪ Make the top management aware of the need of retrofitting and get their approval ▪ Refine and modify the set targets for the project ▪ Define the scope of work for the project ▪ Determine the parties to be involved in this project along with their roles ▪ Select the most suitable system for retrofitting	▪ Identify all possible BEER measures ▪ Determine the criteria to be considered ▪ Assess BEER measures ▪ Assess the modification potential of the facility ▪ Select the most suitable BEER measures ▪ Refine and expand the previously defined scope of work ▪ Develop the project proposal, submit it to the top management and get their approval to proceed with the project ▪ Determine the most suitable financing option ▪ Request certain suppliers in the market to provide the quotations ▪ Select the most suitable supplier and place the orders	▪ Demonstrate the way of doing the installations ▪ Implement the selected retrofit measures ▪ Perform the testing and commissioning	▪ Observe the operation condition of the retrofitted system ▪ Perform the post measurement and verification ▪ Identify the areas which need further improvements ▪ Develop and submit the retrofit report ▪ Review the retrofit report and formally close the project

Figure 2: Proposed initial level decision-making process

Findings disclosed that the key decision the top management had to make, mainly after making them aware of the need of retrofitting was 'whether to provide permission to proceed with the project or not'. Since in this case, a clear saving potential was visible through the audit findings, the top management had granted the approval to proceed with the project. Afterwards, in this case based on the findings of the audit, the set targets were refined and modified. Then the scope of work of the project was defined, based upon which the parties to be involved in the BEER project along with their roles were clearly determined. Respondent R1 had disclosed that 'who were parties to be involved and what were the roles to be performed' is a key decision to be made in this stage mainly after defining the scope of work as it facilitates to avoid the ambiguity in the functions to be performed as well as ensure the proper execution

of the tasks. Following this, the parties involved in the project had to finalise their decision with regard to the systems that should be retrofitted. Thus, by considering the level of efficiency of each system in terms energy consumption, each system's contribution to electricity cost, amount of energy cost reduction that could be gained through retrofitting, and impact of each system's operation on guests' comfort, the most suitable system for retrofitting was selected.

4.3. IDENTIFICATION OF BEER MEASURES

This case had the practice of identifying all the possible retrofit measures after selecting the most suitable system for retrofitting. Then these identified retrofit measures were assessed in terms of different criteria i.e. attainable energy saving, needed potential investment cost, payback period, ROI, uncertainty in achieving the predicted level of saving, and time needed for implementation, based on which the most suitable retrofit measures were selected. Afterwards, in this case, the previously defined scope of work was refined and expanded to suit the selected retrofit measures. Then a project proposal was developed mainly including, inter alia, the selected retrofit measures, refined scope work, total budgeted cost for the project, and the key benefits that could be gained through the implementation of selected retrofit measures (i.e. potential saving, emission reduction etc.).

This developed project proposal was then submitted to the top management to obtain their approval wherein the top management had to decide 'whether to approve the project proposal or not', 'whether to fund or not', if yes, 'how much money should be spent on the project' as evident from the case study analysis. Since in this case the top management was very much satisfied with the submitted project proposal mainly the project payback, they had decided to fund the project using internal funds. Afterwards, this case had to select the most suitable supplier for the project for which they have requested the certain suppliers in the market to provide quotations. This was necessitated in this case due to their lack of enough knowledge on the level of credibility of the suppliers. Finally, the orders were placed in a timely manner to avoid project delays.

4.4. SITE IMPLEMENTATION AND COMMISSIONING

In this stage, initially this particular case has made two main decisions i.e. 'when to begin with the implementation' and 'how to do the installations', mainly with the intention of minimising the interruptions caused to the hotel operation or guests. Since the selected BEER project for this study was a shallow retrofit project, adopting measures that are relatively easy to install and have low upfront cost, the respective stakeholders of this case had decided to proceed with the implementation of this project using in-house staff. Since some of the in-house employees did not have enough skills and experience with the implementation of similar systems, the assistance of equipment supplier was obtained where he was involved in demonstrating the way of doing installations to in-house staff.

Then the in-house staff were involved in implementing the selected retrofit measures and subsequently did the Testing and Commissioning (T&C) to ensure the proper functioning of the retrofitted systems.

4.5. VALIDATION AND VERIFICATION

After the successful implementation and commissioning, the FM of the property was involved in observing the operation condition of the retrofitted system to reassure the proper functioning of the retrofitted systems mainly with the intention of minimising the guest complaints. Then, the post Measurement and Verification (M&V) was conducted wherein the project team was involved in: observing the current energy consumption pattern against the previous consumption data; reviewing the project results other than energy conservation and thus determined the level of success of the project. Subsequently, the FM had to decide 'whether any alterations to be made to the retrofitted system' to enhance the performance of the system based on his involvement during the post M&V, and was involved in identifying the areas that need further improvements. Finally, a retrofit report was developed incorporating the project findings, which was in turn reviewed by the top management, and took measures to close the project.

5. Discussion of the findings

Though conducting a pre-retrofit survey to identify the operational problems of the facility is identified as an activity to be performed in the stage of project set-up and pre-retrofit survey (Ma et al., 2012), the analysis disclosed that this activity was not being performed during this particular project as they had a very good understanding on the operational issues of the facility.

Findings revealed that setting targets for the project during this stage was similar to the view of Mohammadpour et al. (2016). Though defining scope of the work is identified as an important activity to be performed in the stage of project set-up and pre-retrofit survey (Ma et al. 2012), in this case the scope of work was defined in the stage of building energy auditing and performance assessment. In literature, determining available resources to frame the budget and programme of work was highlighted (for e.g. Ma et al., 2012), while in practice only the availability of needed manpower to proceed with project was pre-determined in this stage.

Although 'whether the building should be retrofitted or not' is highlighted as a decision to be made in the stage of building energy auditing and performance (Liang et al., 2016; Ma et al., 2012), this decision was not performed by this case, as they had strong commitment and desire to proceed with this project. Hendron (2013) has highlighted that doing a preliminary analysis before an audit, would provide an indication of the total saving potential. However, this was not needed under this case, as they had already realised the saving potential via the routine performance assessment process.

In this case, FM had decided to directly do an in-depth audit rather than doing a walkthrough audit, as he already had a rough understanding on the saving potential and wanted to better capture energy conservation opportunities of the facility in detail. This appears to be align with those of Ma et al. (2012) who disclosed that for a particular retrofit project, the most suitable type of energy audit should be selected based on the amount of details and level of accuracy required.

Though conducting building performance assessment and assessing the modification potential of the facility were identified as activities to be performed in the stage of building energy auditing and performance assessment (Ma et al., 2012), this selected case did not perform these activities. This was because, the chief engineer of the hotel had obtained the required information relating to the performance of the facility through both routine performance assessment process and energy audit which did not necessitated to conduct a building performance assessment. Conversely, it was not required to assess the modification potential as it was a shallow retrofit project and aimed at doing only minor alterations to the existing systems. However, respondent R5 had highlighted the vitality of performing this activity in the attempt of deriving the most suitable retrofit measures. Hence, this was incorporated in the proposed decision-making process (Refer Figure 2).

As per Duah et al. (2014), the most suitable retrofit measures for a BEER project should be determined based on the results of both building performance assessment and energy auditing. Nonetheless, this particular case had selected the most suitable system for retrofitting based on audit results, and afterwards only focus was given towards identifying the suitable retrofit measures.

Though prioritising the BEER measures based on the relevant energy-related and non-energy-related factors (Ma et al., 2012) was identified as an activity to be performed to derive the most suitable BEER measures, no any efforts were taken in this case to perform this activity.

Ma et al. (2012) have put emphasis on the development of an action plan to notify the client about the selected BEER measures. Equally, this particular case had developed a project proposal after determining the suitable BEER measures as well as refining the previously defined scope of work, in which the latter is a novel activity derived through case study analysis. According to Hendron (2013), prior to move on with the implementation of the selected BEER measures, the available sources of financing should be evaluated to determine the most suitable financing option, which was not needed under this case, as it was internally funded.
As has been highlighted by Ma et al. (2012), this case had implemented the selected retrofit measures and had performed the T&C during the stage of site implementation and commissioning. Besides, in

this case prior to begin with the implementation, FM had taken efforts to demonstrate the way of doing the installation to the staff by involving the supplier and thereby disclosed that if an organisation decides to proceed with project implementation using its in-house team, necessary efforts should be taken to provide the required training for the in-house employees by conducting demonstration programmes.

During the validation and verification stage, this case was involved in deciding 'whether any modifications to be made to the retrofitted system', and if yes 'what kind of modifications to be made' in which the latter was similar to the findings of Hendron (2013).

As per Ma et al. (2012), after the implementation and commissioning, it is crucial to verify the saving from the project by conducting post M&V. Similarly, this activity was performed in this case as well. Analysis disclosed that in this case the FM's involvement during the performance of post M&V had facilitated him in identifying the areas that may need further improvements, which is parallel to the view of Panthi et al. (2017).

Though the performance of a post occupancy survey is highlighted as a crucial activity in terms of assessing the level of satisfaction of the stakeholders (Ma et al., 2012), no such survey was conducted in this case. As per the authors, after conducting an occupancy survey, a formal report (referred to as retrofit report) should be developed including the key findings of the project that is to be reviewed by the client in turn. Similarly, this particular case was also involved in developing a retrofit report.

As a whole from the above discussions, it is clear that among the derived decisions and activities, some are consistent with the literature findings with varying extent (completely or to some extent), while some are newly derived through the analysis. Besides, some activities highlighted in the literature are not performed in the actual project context (Refer Figure 1 and 2).

6. Conclusions

Aim of this study was to develop an initial level decision-making process to support the effective adoption and implementation of BEER in existing hotel buildings. The research was carried out through the combination of a critical literature review and execution of a case study. Using literature findings, initially a conceptual decision-making process was developed, which was in turn refined based on empirical findings. By employing single in-depth case study, this study derived twelve (12) key decisions to be made and twenty-eight (28) key activities to be performed during each stage of the shallow retrofit project under in-house led scenario (Refer Figure 2). It is hoped that the findings of this study would facilitate the practitioners in effective adoption and implementation of BEER in existing hotel buildings in way an expert might. Further research could be focused on deriving a comprehensive decision-making process for the adoption and implementation of BEER project, by using this developed decision-making process as a basis. Besides, this developed initial decision-making process could also be refined and validated by another case study as a further work.

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8. References

Crilly, M., Lemon, M., Wright, A. J., Cook, M. B. and Shaw, D. 2012, *Retrofitting Homes for Energy Efficiency: An Integrated Approach to Innovation in the Low-Carbon Overhaul of UK Social Housing*, Energy & Environment, 23(6-7), 1027-1055

Duah, D. Y., Ford, K. and Syal, M. 2014, *Expert knowledge elicitation for decision-making in home energy retrofits*, Structural Survey, 32(5), 377-395

European Climate Foundation. 2013, *Assessing Europe's Building Stock*, Available from: https://europeanclimate.org/bpie/

Friege, J. and Chappin, E. 2014, *Modelling decisions on energy-efficient renovations: A review*, Renewable and Sustainable Energy Reviews, 39, 196-208

Gultekin, P., J. Anumba, C. and M. Leicht, R. 2014, *Case study of integrated decision-making for deep energy-efficient retrofits*, International Journal of Energy Sector Management, 8(4), 434-455

Hall, S. 2014, *Development and initial trial of a tool to enable improved energy & human performance in existing commercial buildings*, Renewable Energy, 67, 109-118.

Hendron, B. 2013, *Advanced Energy Retrofit Guide Practical Ways to Improve Energy Performance - Grocery stores*. Available from National Renewable Energy Laboratory (NREL) web site: https://www.nrel.gov/docs/fy13osti/54243.pdf

Liang, X., Peng, Y. and Shen, G. Q. 2016, *A game theory based analysis of decision making for green retrofit under different occupancy types*, Journal of Cleaner Production, 137, 1300-1312

Liang, X., Shen, G. and Guo, L. 2015, *Improving Management of Green Retrofits from a Stakeholder Perspective: A Case Study in China*, International Journal of Environmental Research and Public Health, 12(11), 13823-13842

Ma, Z., Cooper, P., Daly, D. and Ledo, L. 2012, *Existing building retrofits: Methodology and state-of-the-art*, Energy and Buildings, 55, 889-902

Mohammadpour, A., Anumba, C. J. and Messner, J. I. 2016, *Integrated Framework for Patient Safety and Energy Efficiency in Healthcare Facilities Retrofit Projects*, Health Environments Research & Design Journal, 9(4), 68-85

Mondrup, T. F., Karlshøj, J. and Vestergaard, F. 2014, *Building Performance Simulation tools for planning of energy efficiency retrofits in* 10th Nordic Symposium on Building PhysicsNordic Symposium on Building Physics, Lund University

Panthi, K., Das, K. and Abdel-Salam, T. 2017, *Sustainability and cost assessment of coastal vacation homes for energy retrofits*, Built Environment Project and Asset Management, 7(2), 185-198

Ruparathna, R., Hewage, K. and Sadiq, R. 2016, *Improving the energy efficiency of the existing building stock: A critical review of commercial and institutional buildings*, Renewable and Sustainable Energy Reviews, 53, 1032-1045

Sri Lanka Energy Managers Association (SLEMA). 2009, *Energy management guide*, Sri Lanka Sustainable Energy Authority

Sustainable Energy Authority of Ireland (SEAI). June 2015, *Unlocking the Energy Efficiency Opportunity*, Available from https://www.seai.ie/resources/publications/Unlocking-the-Energy-Efficiency-Opportunity-Summary-for-Policymakers.pdf

Swan, W. and Brown, P. 2013, *Retrofitting the Built Environment*, Salford: Wiley

Xing, Y., Hewitt, N. and Griffiths, P. 2011, *Zero carbon buildings refurbishment––A Hierarchical pathway*, Renewable and Sustainable Energy Reviews, 15(6), 3229-3236

Xu, P. & Chan, E. H. 2011, June, *Barriers to implementing energy performance contracting (EPC) mechanism into hotel buildings retrofit in china in* Management and Innovation for a Sustainable Built Environment MISBE 2011, Amsterdam, The Netherlands, June 20-23, 2011. CIB, Working Commissions W55, W65, W89, W112; ENHR and AESP

Xu, P., Chan, E. H. and Lam, P. T. 2013, *A conceptual framework for delivering sustainable building energy efficiency retrofit using the energy performance contracting (EPC) in China*, Journal of Green Building, 8(1), 177-190

Xu, P., Chan, E. H., Visscher, H. J., Zhang, X. and Wu, Z. 2015, *Sustainable building energy efficiency retrofit for hotel buildings using EPC mechanism in China: analytic Network Process (ANP) approach*, Journal of Cleaner Production, 107, 378-388

Zundel, S. and Stieß, I. 2011, *Beyond profitability of energy-saving measures—attitudes towards energy saving*, Journal of Consumer Policy, 34(1), 91-105