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Human-Centric Research in Energy Retrofitting Methodology for Historic Architecture

Abstract

This proposed study investigates the human-centered approach, which emphasizes human experience over technical improvements, of energy retrofitting in historic architecture by examining perspectives from professionals and visitors to retrofitted sites. Humanistic approaches deserve more academic attention in energy retrofitting historic architecture due to the existing research being centered around efficiency-boosting strategies to produce quantitative data rather than qualitative. The proposed study will examine historic buildings in the Davis and Sacramento areas that have undergone energy retrofitting in the past ten years. Through interviews with professionals who worked on the corresponding sites and surveys of site visitors, my proposed research study aims to uncover diverse ideologies among professionals, addressing challenges in balancing energy efficiency goals and historic preservation. The survey intends to provide insights into the perceived impact of retrofits on aesthetics, culture, and visitor experience. The study contributes nuanced perspectives to the discourse on equitable historic architectural preservation, guiding current practices and influencing future policies. The expected findings emphasize the ongoing need for collaborative, human-centered energy retrofitting implementations into historic architecture to keep up with evolving retrofitting technologies and intense desires to preserve architectural history. This study would lay the groundwork for a

holistic approach to sustainable architectural preservation at the intersection of energy efficiency and cultural heritage through the lens of the people who give purpose to these projects.

Introduction

Globally, architecture needs to be adapted to fit modern-day energy-saving standards. Energy-saving standards, such as installing energy-efficient appliances and shifting to renewable energy sources, have been put into place due to the devastating environmental effects of the excessive amounts of energy consumption we have grown accustomed to. Building new, energy-saving structures is not enough. Historic buildings, which account for between 1 and 5% of global building stock, must not be left out in the fight against climate change (Webb, 2017, p. 748). One way to increase energy efficiency for historic buildings is by retrofitting. Energy retrofitting can have a big impact on a building's carbon footprint and lower greenhouse gas emissions.

Foremost, What is meant by a "historic building?" Historic buildings possess these traits: an age of at least 50 years old, having cultural significance, and maintaining the integrity of the original, physical design properties (Webb, 2017, p.748). The literature review will analyze international historic buildings to discuss the current, global trends in energy retrofitting historic architecture.

Energy retrofitting is a crucial step forward in architectural climate resilience. However, historical buildings must maintain the structure's cultural and aesthetic credibility. Technical solutions highlighting specific technologies that result in high energy efficiency outputs offer insight to professionals on what technologies to implement for historic architecture retrofitting projects. However, there are no studies discussing how these drastic changes affect the people inhabiting these buildings regularly. The human perspective must be included.

Literature Review

Extensive research has been conducted regarding energy retrofitting historic structures on an international scale. These studies include literature reviews and case studies that analyze the most effective energy retrofitting techniques for various historic architecture. Some papers offer first-hand data utilizing simulation software to test what retrofitting techniques offer the maximum energy efficiency for these buildings. Modern research offers crucial insight into how to systematically approach an energy retrofit on a historic structure from the perspective of science and engineering. However, further exploration is needed to unveil the humanistic aspect of protruding these significant changes onto fragile, older buildings.

Energy Efficiency

Energy efficiency has become a buzzword because of its contributions to a sustainable built environment. Energy-saving buildings are being constructed every day and older buildings are being retrofitted to fit modern energy standards.

The most challenging part of retrofitting historic architecture is improving its performance while maintaining its aesthetic integrity (Cho, 2020, p.6). Due to these buildings being so dated, modern utilities were not accounted for in building plans. Additionally, because of various country-specific policies that protect historic structures on a governmental level, retrofitting capabilities can be limited. A dichotomy between national energy policy and historic building protection laws is common. Said dichotomies may result in historic structures not gaining access to retrofitting out of the preconditioned fear that the process will interfere heavily with its architecture (Jahed, 2020). Architects and engineers have to find ways around these dilemmas to maximize energy efficiency while staying true to the building's design intent. By combining non-architecturally-compromising insulation methods with other measures like

replacing heating, ventilation, and air conditioning (HVAC) systems, energy efficiency can increase by 43 and 78% in historic residential European buildings (de Place Hansen, 2018, p.30). Smaller-scale changes like simple window replacements could also be considered to improve energy efficiency; these retrofitting strategies have been mentioned repeatedly throughout my research. An in-depth analysis of energy retrofitting strategies is needed to assess possible effects on historic architecture.

Insulation

Building insulation, used to reduce the flow of thermal energy, comes in many forms. Being a passive form of energy, insulation utilizes ambient forms of energy (Cho, 2020). Internal façade insulation has been deemed to be the most impactful in terms of generating the greatest energy efficiency impact and "can result in no compromise to the building's original façade" (de Place Hansen, 2018, p.22). Insulation methodology is determined by geographic location, materials, and building type. In Denmark, a common retrofitting technique for historic structures is pushing the insulation below the attic floor, allowing for approximately 60 mm of insulation which can reduce thermal energy loss by 55% (de Place Hansen, 2018, p.26). The malleability of insulation can adapt to different cultural architectural traits, making it a standard approach to retrofitting these types of buildings.

HVAC

Replacing outdated HVAC systems with modern, energy-saving ones is a proven effective retrofitting technique for historic buildings. HVAC systems are an active form of energy, meaning they require purchased energy like electricity (Cho, 2020). HVAC replacements are most effective when combined with passive techniques like insulation (Cho, 2020, p.9) due to historic structures usually having inflated average heating needs and higher-than-average

energy bills caused by dated architectural characteristics and legal limitations preventing intervention (Galatioto et al, 2017, p.995). Therefore, combining active and passive forms of energy efficiency improvements leverages better outcomes.

In the case no HVAC system is already installed, some suggest omitting the installation of one entirely due to the potential harm to the building's historic fabric (Webb, 2017, p.752). Also, some historic buildings utilize "inherent energy-efficient features," such as a masonry exterior and porches to provide intentionally designed temperature control (Webb, 2017, p.749). Modernizing historic architecture with efficient HVAC systems can dramatically reduce the building's energy consumption; however, if not already fitted with the necessary equipment, it can be better to rely on the building's inherent energy efficiency capabilities.

Aesthetic

Historic buildings are fundamentally tied to their distinct aesthetic. Though some label them as "draughty, leaky, and inefficient" (Jahed, 2020, p.14), historic structures represent a learning opportunity by offering a glimpse into historic energy-saving problem-solving and serve as architectural time capsules.

Today, building refurbishment and design capitalizes on the Nearly Zero-emission Building (NZEB) approach that prioritizes high energy performance utilizing renewable energy sources (Galatioto et. al., 2017, p.993). This approach brings forth the ethical question of transforming a building's design intent to include energy efficiency when during its construction, no principles existed. Maintaining a historic structure's aesthetic principles while adhering to modern energy standards is a case-specific issue that requires a deep understanding of the architectural and cultural contexts involved (Jahed, 2020, p.14). No one-size-fits-all solution

exists for maintaining a historic structure's aesthetic while energy retrofitting. The aesthetic is deeply tied to culture; culture is deeply tied to humanity.

Culture

The cultural aspects of historic architecture must be taken into account when energy retrofitting. "People's perception of the 'history' and 'heritage' shapes their perception of 'acceptable changes' and the value of the heritage buildings" (Jahed, 2020, p.14). Understanding the cultural components of a historic building takes extensive research and conversations with local people. Understanding culture is not scientific, but humanistic. Organizations, like the Sustainable Traditional Buildings Alliance (STBA), give guidance on how to approach retro fittings for preserving culture. The STBA's mantra is finding a balance between a building's potential for change, its context, and its ongoing maintenance (STBA, 2023). Preserving culture through retrofitting historic architecture geared towards fighting climate change is an up-and-coming industry. The European Union (EU)'s Climate for Culture Project runs hygrothermal simulations and uses regional climate change models to estimate the impact of climate change on historic buildings (Webb, 2017, p.754). The EU's project helps identify structures at a greater risk for deterioration due to the climate crisis (Climate for Culture, 2014). Energy retrofitting historic structures is as much about efficiency as it is about cultural preservation.

The existing research has proven to be predominantly technical with little mention of the human experience that the built environment is supposedly built around. More research needs to be done regarding how energy retrofitting of historic structures affects the human experience surrounding the buildings. More studies from peoples' perspectives as to how these retrofits affect comfort, usability, and design are needed. Data should be collected highlighting people's

opinions about whether energy retrofits take away from “historic charm” and whether the environmental benefits outweigh any potential damage caused to the historic structure.

Proposed Research Question

The following research question will guide my proposed study: How can energy retrofitting techniques be applied to historic buildings of significance to address the impact of climate change while preserving the historical and cultural aspects of the architecture? How can the success of an energy retrofit on historic architecture be evaluated by a humanistic approach?

Proposed Methods

Context/materials

Data will be collected in Davis and Sacramento. Popular, commonly used historic buildings will be chosen from these two cities that have undergone energy retrofitting procedures in the past ten years. Possible site locations may include Walker Hall, UC Davis campus, The Barn building by the Silo, UC Davis Campus, and the Sacramento Manor Senior Living Complex. Data would be collected around the chosen buildings to attract the appropriate participants who have extensive experience with the building. My research methodology would include incentivizing those with familiarity with the research site to participate in a survey that asks questions pertaining to people’s opinions and experiences with the undergone energy retrofit.

I will be evaluating the architectural plans of the buildings to compare the original drafts to the updated, retrofitted ones. Next, a site visit will be necessary for me to evaluate the structures first-hand. Though personal bias will be involved in the site visit regarding personal aesthetics and opinions regarding different energy-efficient technologies; its purpose is to get a sense of the scale of the project. Once the site visit has concluded, I will interview professionals

involved with the project to gather information about their design philosophy and how the ethical constraints of these projects informed their decisions. Questions outlining their considerations of user experience will be asked. My goal is to understand how much of the energy retrofitting process for historic buildings is developed with human experience in mind. I want to know if human experience is at the forefront of the design process, or an afterthought and how these considerations can be seen in the final project. Inferring from the literature review, the historic building's structural integrity comes before humanistic considerations. I want to evaluate how this assumption translates to the real world. Finally, I will survey frequent visitors to each site to collect data on their experiences reflected by the energy retrofitting. I will ask questions about personal experiences and evaluate the differences in experiences pre and post-retrofit. I am interested in testing civilians' awareness of energy retrofits and how the retrofits have contributed to their comfort and opinions about the site.

Participants

The participants will include architects, civil engineers, and architectural historians who were involved in the energy retrofitting projects this study will analyze. Corresponding professionals will be interviewed to better understand their philosophies behind energy retrofitting techniques for preservation and how they decided what strategies to employ based on their effects on the structure. Ideally, one-to-two professionals for each category–architect, civil engineer, architectural historian–will be interviewed.

Additionally, people who frequently visit the site(s) will be surveyed to collect data on people's experiences and opinions regarding the energy retrofitting project's success in avoiding disrupting the building's historic integrity. A group of people who frequented the building before and after the retrofitting will also be surveyed; offering unique insight into how energy

retrofitting has affected the overall experience. These people will be found by accessing logs of the buildings' employees who have been present through the structure's retrofitting progression and by corresponding with the buildings' managers to identify participants. I will aim to survey at least ten individuals per site. The participants will be a mix of people who have frequented the site after the energy retrofitting and those who have visited the site before and after.

The recruitment of professional participants would take place online after gaining access to the names of professionals involved in the energy retrofitting project from the site's manager or the project's contractor. Emails will be sent out to professionals through their company websites asking them to take place in my study. Professionals could also be found through professional networking sites like Linkedin. I will fact-check LinkedIn credentials by cross-analyzing LinkedIn accomplishments with the companies'/organizations' websites where those accomplishments are listed. Utilizing online resources can aid in determining whether participants are qualified to be a part of the study.

The recruitment of the civilians would be on-site. I would set up a booth near the entrance of the historic building to inform passers-by about my study. Recruiting on-site reassures me that my sample will be diverse and easily accessible. I will offer incentives to those who choose to participate in the form of an entry to a raffle to win a $50 Visa gift card. This will entice multiple people to take my survey.

A balance between professional and visitor experiences is necessary to effectively evaluate a humanistic approach to energy retrofitting historic architecture. A range of three–six professionals will be interviewed and at least ten civilians who've either experienced the site pre-and-post-retrofit or only post-retrofit will be surveyed for each site.

Data collection methods

I would collect data in the form of interviews and surveys.

The interview of professionals who have worked on the chosen site would include questions like:

1. What is your philosophy when it comes to energy retrofitting of historic architecture without disrupting its historical characteristics?
2. How do you balance the need for energy efficiency with the preservation of the historical integrity of a building?
3. Can you share a specific example of a successful aspect of this energy retrofit project on a historic site and how historic characteristics were preserved?
4. What challenges do you face in balancing design priorities for people and for the environment?

A qualitative approach allows professionals to share nuanced details about their decision-making processes, challenges faced, and successful strategies employed in energy retrofitting historic architecture. This study would compose a humanistic narrative to complement existing quantitative research and offer a first-hand perspective translating the intricacies described in existing research but applied in real life.

The survey for civilians who frequent the chosen site would include questions like:

1. How often do you visit historic architectural sites?
2. Did you notice any changes in the site's appearance or atmosphere after energy retrofitting?
3. Rate the impact of energy retrofits on your overall experience with the historic site.

4. Do you believe that the energy retrofits have positively or negatively affected the architectural aesthetics and historical ambiance of the site?
5. Would you recommend energy-retrofitted historic sites to others?

The data from surveying civilians would be beneficial to the energy retrofitting sector. The surveys would produce valuable feedback that can inform future energy retrofits for historic buildings. Allowing for the visitor's perspective to be heard, which is often ignored, is critical. Using these surveys as qualitative measurements of success can then be used in conjunction with the professional interview results to cross-verify the findings from the interviews and evaluate how effectively the professionals' intentions translated to real life.

Data analysis methods

The data from the interview will be collected through transcribed audio recordings that I have recorded with consent. The answers to the questions will then be categorized into major themes and then divided into categories based on the scale of the professionals' consideration of visitors' experience. Emerging themes will then be implemented into a thematic framework that will relate the themes to existing literature regarding energy retrofitting on historic architecture.

The data from the survey will first be tallied based on the frequency of certain responses. Means and medians will be calculated. The findings will then be organized based on first-time visitors and frequent visitors. Demographics from the surveys will be taken into account to explore the relationship between different demographics and how they react to the space. Sufficient data found from the surveys will then be extracted into a table that puts together all these factors and organizes all the data into an easily legible format to spot patterns.

The data from the interviews and surveys will be cross-referenced to compare the professionals' intentions and visitor experience.

Anticipated Results

From the professional perspective, I anticipate finding a diverse set of philosophies that inform the professionals' decisions regarding energy retrofitting historic buildings. I expect that some professionals will value energy efficiency over historic preservation and vice versa. As "energy retrofits are increasingly viewed as a protection tool" to save historic buildings from demolishments, I expect both those who value historic preservation and efficiency to be passionate about the need for energy retrofitting historic buildings. (Webb, 2017, p.749). Some architects have expressed concerns for historic preservation arguing that "at no other point in history have people wanted to stop time [through historic preservation]" and argue that builders in the past "weren't concerned about conservation," implying that historic buildings can be poorly constructed beyond feasible repair (Yarrow, 2016, p.346). Ideological discrepancies could create tensions between professionals' views and could potentially determine the direction an energy retrofitting project would take.

As for professionals' considerations of the human experience, I believe this will vary by person, not by discipline. Considerations of human experience in built environment fields are necessary, but the value each architect, engineer, etc. is willing to put on human experience is variable. Societal trends in ideal human experiences shift frequently as "the uses of cultural heritage and the consequent demand for energy services are..not constant, but highly dependent on conventions and expectations that are constantly changing within society." (Leijonhufvud and Broström, 2011, p.75). Choosing projects that have undergone energy retrofits in the past ten years will allow for an easier identification of energy and preservation trends that have influenced professionals' decisions for human experience. I expect professionals to express the challenging nature of historic architecture energy retrofitting projects. Implementing energy

technologies while considering the “preservation of historic buildings requires broad and long-term compromises between social, economic and environmental aspects” (Leijonhufvud and Broström, 2011, p.72). I want to compile data that clearly outlines these considerations, giving future energy retrofitting projects more insight into how their peers approach these projects.

From the visitor’s perspective, I anticipate finding a range of responses about the effects of energy retrofitting historic buildings. However, I think most people would value historic preservation over energy efficiency. A study found that contemporary architects resist architectural preservation and that architectural preservation fields are more closely related to social/behavioral sciences where research considers “the impact of changes to buildings and places on the human environment” (Wells, 2018, p.463). This suggests that historic architectural preservation has proven to have positive outputs on human experience. While energy systems can be replaced, history can not; people value that.

There is a somewhat radical culture surrounding historic preservation, especially in modern society where historic architecture is like candy to bulldozers. I believe that people rely on historic architecture to bring a sense of nostalgia and rely on historic conservation societies, like the National Trust, which in 2022 earned an income of £643.3m made up of subscriptions and donations (Hargrave, 2022), to provide the nostalgia. There is a rising, global market for historic architectural preservation, proving its intrinsic value. I believe that older age groups will be less accepting of modern technologies as opposed to younger generations who stereotypically seem to value the environment more. Older generations “show greater skepticism than other age groups” concerning climate change and are also skeptical about climate policy’s ability to “lead to innovation” (Albalate et al., 2023,p.13).

I believe the correlation between the answers of professionals and visitors, will vary based on visitors' ideals. Visitors who value energy efficiency and thermal comfort may align mostly with the intentions of civil engineers as they are in charge of constructing and maintaining energy infrastructure. Visitors who value historical accuracy may align mostly with the intentions of architectural historians who have more specialized knowledge about historical details than traditional architects. I expect to find that each professional designs for a certain type of person- one that is most aligned with their values. Designers design based on "value systems, worldviews, and aspirations" that define design intent (Wahl and Baxter, 2008, p.73). One's design process can not be unbiased, which is why collaboration is key for successful projects.

From my anticipated results, I conclude that to successfully defeat all of the challenges of energy retrofitting historic architecture, diverse groups of professionals must work together with diverse groups of civilians in the design and planning process to avoid biased approaches that result in pleasing the minority. This study is integral to the field of energy retrofitting historic architecture because of the value it places on professionals' decision-making and its impact on the everyday person. Humanistic-centered studies need to be implemented in traditional energy retrofitting research, especially in the context of historic buildings. A human-centric approach centralizes the challenging aspects of these projects around a scope everyone can relate to, the human experience.

Conclusion

In conclusion, this study aims to explore the human-centered side of energy retrofitting in historic architecture, considering both the perspectives of professionals in the field and the experiences of visitors to retrofitted sites. Through a qualitative approach involving interviews

with professionals and surveys of site visitors, I intend to gain valuable insights into the complex interplay between energy efficiency goals and the preservation of historical characteristics.

While other methods provide a strong foundation for understanding the dynamics at play, it is important to acknowledge certain limitations. The use of surveys, while allowing for a large and diverse sample of visitors, may be constrained by self-reporting biases. Additionally, the depth of comprehending the interviews may be limited by the subjective nature of participants' responses. The study's generalizability may also be influenced by the specific characteristics of the selected historic sites and participants.

Despite these limitations, the study holds immense importance. By merging insights from professionals and visitors, the study contributes to an often neglected, nuanced understanding of energy retrofitting in historic architecture. The anticipated results will not only inform current practices but may also guide future projects. The study's contribution to existing literature lies in its exploration of the philosophical contexts of professionals, the varied experiences of visitors, and the synthesis of these perspectives to enhance the overall discourse on equitable historic preservation.

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