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Adaptive Reuse Architecture for Sustainability and Energy Efficiency

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Abstract

In this research article, the facts and data that are accessible are extensively explored. This was accomplished by utilizing simple paperwork that contained references to the surrounding region to illustrate the project's location inside the city limits. The study of the structure's history includes images and blueprints from both periods, as well as portions and other material from both periods of time. In addition, each case study was represented by a virtual model of its own.

Keywords

adaptive reuse, sustainability, energy efficiency

1. Introduction

Climate change and greenhouse gas emissions are hot topics globally. We can save money and cut GHG emissions by using energy more effectively. In Europe, buildings account for 40–45% of total energy use [1].

The UK's long-term carbon reduction ambitions include reducing energy usage. The UK government has set a goal of 80% reduction in GHG emissions by 2050. Several studies show that buildings' energy use may be lowered by 20% to 50% at a reasonable cost. Several nations may have to go farther to meet the 2050 carbon reduction targets.

Non-domestic buildings emit roughly 20% of all carbon emissions in the UK, according to the Carbon Trust [2]. Many older structures have been deemed inefficient due to their high energy usage. So they've become one of the biggest roadblocks to reducing CO2 emissions.

This is especially true for historical structures. Improving the energy efficiency of existing buildings can not only save money and energy, but also create employment and increase the livability of the structures. The world's cost-effective energy efficiency potential [3] requires annual investments of $60–300 billion.

Despite varying estimations, everyone feels there is much space for improvement in energy efficiency. Energy conservation has been utilised for almost 40 years. Governments have just lately given it serious attention. The global financial crisis has made it more vital than ever to minimise energy usage and emissions in buildings. That's why this article emphasises the necessity for further study on historic building conversion energy efficiency. The study is part of a larger initiative to reuse and adapt historic public buildings to save energy. It believes that historic buildings may reduce world energy consumption and CO2 emissions while retaining their distinctive traits.

1.1 Reuse of Existing Building

As buildings age, their usefulness diminishes, prompting the need for repairs to keep them operational. A city's long-term prosperity may depend on the preservation and reuse of historic structures. It is possible to utilise interventions such as refurbishments and remodelling as well as retrofitting and converting buildings from one use to another. In the opinion of Hallegatte [4], adaptation to climate change is a viable option for reducing its negative impacts on the built environment. Low- and even zero-energy structures have been given less focus than low- and zero-energy structures in new construction.

Almost every European city has a big number of ageing structures that may need some attention. Several authors have suggested that improving the long-term durability of these structures by modifying them. According to Notter et al. [5], existing building stock offers the greatest possibility to drastically decrease environmental burdens, and this is supported by the research. Creating demolition is conceivable, but building a new one from start requires a lot more energy in terms of materials, transportation, and construction. Demolition extinguishes embodied energy.

According to Azari and Abbasabadi [6], even if a new building is energy efficient, the operational energy savings would take decades to match the embodied energy. Reusing a building's structure and envelope saves 50% of the embodied energy.

The significance of preserving architectural and historical assets, conserving natural resources, minimising the impact on the environment, and managing waste are just a few of the many reasons why reusing is becoming more popular these days. Keeping existing buildings and all of its components (including the construction) is better for the environment in the long run, particularly if they can be improved in terms of their energy usage during use. It has become an important part of sustainable development and historic preservation to preserve existing architectural components rather than to replace them.

However, many old houses are inefficient and unfriendly to tenants. They also don't satisfy current requirements. Low lighting, inadequate ventilation, sun penetration and glare are some of its environmental issues.

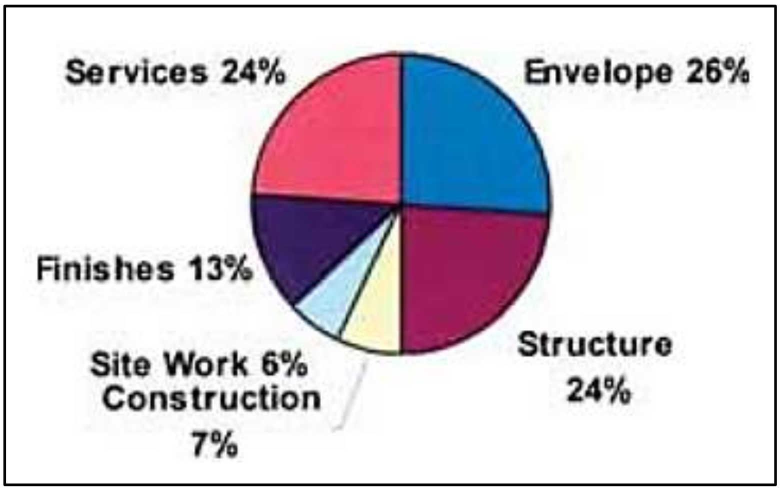

Figure 1: Average embodied energy

1.2 Energy Efficiency in Heritage Building Reuse

It is now essential to work more efficiently with the existing building stock, according to several studies. So as to improve energy efficiency, reduce greenhouse gas emissions, and save resources, increasing research is focusing on modifying existing buildings. In recent years, historic buildings that had been decommissioned for public or private usage have been reused.

As a result, repurposing old structures may be considered a sustainable resource use. Heating and cooling has been a key source of energy usage. Conservation has several challenges in combating climate change and increasing energy efficiency. The EU's Energy Performance of Buildings Directive [7] and its recast encourage efforts to minimise energy usage and expenses. Energy savings in historic buildings may go hand in side with heritage conservation, even if listed structures are exempt from energy efficiency modifications.

Take advantage of chances to increase energy efficiency while refurbishing or converting these structures. As Soares et al. [9] point out, the tremendous potential of historic buildings in Europe necessitates further study into their sustainability and energy efficiency.

1.3 Research Objectives

This aim of this study is to investigate the viability of adaptive augmentation and reuse of existing building with an emphasis on resource optimization and energy efficiency. The following are the objectives of the research:

- To explain the teaching of adaptive reuse architecture studio and theory.
- To study energy efficiency for sustainable reuse of public heritage buildings

2. Literature Review

2.1 Examples of Adaptive Reuse

One of the most prominent instances of adaptive reuse is in London, England. The Tate Modern is the Tate Museum's Gallery of Modern Art. Jacques Herzog and Pierre de Meuron redesigned the structure. Heckendorn Shiles Architects transformed the Ambler Boiler House, a decommissioned Pennsylvania power plant, into contemporary offices.

Many of New England's mills and industries are being converted into residences, including Lowell. Reusing structures like this one is a specialty of Ganek Architects. Open-air museums like Western Massachusetts' Arnold Print Works (1860–1942) have been constructed. It's hard to believe a museum like MassMoCA in North Adams is in Massachusetts.

National Sawdust's performance and design studios are housed in an abandoned Brooklyn sawmill. The Refinery is a five-star luxury hotel in New York's Garment District.

The Albany Grand Cash Market store used to contain the Capital Rep, a 286-seat theatre. The new Pennsylvania Terminal is housed in the James A. Farley Post Office in New York City. Gordon Bunshaft's 1954 Manufacturers Hanover Trust bank is now a trendy New York retail space. This chef-owned 39-seat restaurant in the upper Hudson Valley was previously a petrol station.

More and more people are embracing the concept of adaptive reuse. To preserve memories and protect the environment, it has developed through time. Residents of Lincoln, Nebraska, were reminded of state fairs when the city's 1913 Industrial Arts Building was to be demolished.

A group of neighbourhood members worked tirelessly to convince the new owners to save the building. Although the battle was lost, the outside of the structure was saved because to façadism, a preservation method. An emotional trend to reuse may have begun, but it has already become the standard in the workplace.

The College of Built Environments at the University of Washington in Seattle has featured programmes like the Center for Preservation and Adaptive Reuse. It's a philosophical technique that has grown into a field of study and a company's specialty. Consider collaborating with architectural firms that specialise in repurposing historic structures.

2.2 Teaching Adaptive Reuse Architecture Studio and Theory

Architects have a daunting task when it comes to adapting and recycling ancient buildings. Since it requires a separate set of skills and sensitivities from the beginning, it involves the employment of additional tools to cope with such projects. Herzog and De Meurons' statement on their work on the Tate Modern in London explains the disparity. As a result of this, they suggest that such endeavours need a particular sort of creative energy, which may be expressed in many forms of knowledge and design tools. There are several ways to produce such tools, according to our opinion, including re-creating existing information and dissecting the components of major precedents via an exhaustive analysis.

At the very least, adaptive reuse precursors may be divided into two distinct stages:

- The original design, with its original function intact; and the new structure, with its new purpose, following the adaptive reuse process.
- So the examination of adaptive reuse antecedents differs greatly from the analysis of adaptive reuse precedents.

This leads to three stages of formal inquiry:

- Original building form (original stage);
- Reshaped building form (final stage); and
- The transformation from original stage to final stage in terms of tactics, strategy, and type of intervention.

You must do a comprehensive search utilising multiple classification strategies to learn from architectural design precedents. An architect's name, formal qualities, and so on may all be helpful in narrowing down the scope of the search.

Every category listed above may yield two (or more) sets of data: original function, new function, original architect, original building and new building, etc. The search for relevant precedents for an adaptive reuse project may become extremely difficult, as each of these categories will almost certainly yield two (or more) data sets Adaptive reuse design requires a thorough understanding of how to convert a structure, as well as the techniques and strategy for doing so.

3. Research Methodology

Some argue that sustainable design is antithetical to historical preservation. Because sustainable design necessitates intrusive techniques to install new technologies and treatments, heritage conservation minimalism rejects it. Historic preservation, through protecting intangible cultural assets like historic architecture, is seen as a kind of sustainable development.

However, research and experience show that historic buildings may be the subject of sustainable design initiatives that attain amazing levels of sustainability and energy efficiency without losing authenticity. This long-term preservation is achieved in historic adaptive reuse projects. Thus, repurposing the structure ensures its long-term viability while meeting modern comfort and energy efficiency standards.

Several interventions that may boost the project's energy efficiency while preserving the building will be examined to better understand the structure's history and importance. This study looked at the possible energy savings through double-glazing, shading, natural ventilation, and solar power production using software based on the present adaptive-reuse project. The simulation showed a 36.5 percent reduction in cooling, heating, and lighting energy use, with 74.7 percent of the energy coming from renewable sources.

4. Results and Discussion

4.1 Findings

Historic structures are often subjected to planning restrictions to prevent improper development. Conserving a place's cultural heritage value is defined by the International Council on Monuments and Sites (ICOMOS). ICOMOS also thinks conservation may be achieved with little intervention. The ICOMOS New Zealand Charter states that conservation should involve minimal interference. Compared to building new buildings, renovating existing ones saves money on materials and transportation while reducing pollution and resource consumption. Depending on the amount of the alteration, there is a recommended path for picking the finest intervention in ancient buildings. (Figure 1.5)

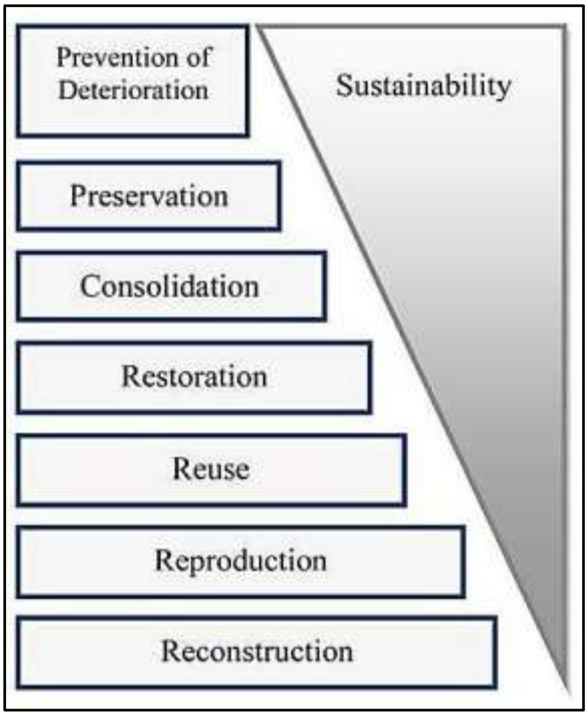

Figure 2: The degrees of intervention and sustainability

However, this is only true when considering embodied energy, cultural, and historic values linked to the historical building itself.

Renewable energy technology and resource efficiency methods must be employed to increase the building's environmental sustainability. Social sustainability may be increased by allowing the structure to operate according to modern norms and technological improvements. intrusive additions or alterations to the building's fabric are not authorised (prevention of degradation, preservation, consolidation, and restoration).

Thus, these intervention techniques may only be used during the reuse phase. Furthermore, subsequent conservation intervention methods (reproduction and rebuilding) focus on the building's historical and symbolic qualities rather than its practical worth (since the structure is already partly or destroyed). As a result, the reuse approach is the best option for including sustainable interventions and ensuring that the building meets contemporary green design requirements.

4.2 Energy-efficient Designing Methods in Building Phase

In a structure, the utilisation process consumes the greatest energy. According to a research by the World Business Council for Sustainable Development (WBCSD) [8], buildings use 88 percent of the energy necessary to run and maintain the structure. The energy-efficient applications recommended during the design phase will pay for themselves in the long term. These tools, which are all listed below, may help you conserve energy over time.

Supporting multipurpose development: Housing settlements, commercial zones, offices, and retail spaces are all advocated for in sustainable development. As a result, individuals may be able to reside close to their places of employment and shopping. As a consequence, the expansion of a community differs from the growth of standard suburban projects. It is also safer as a consequence of the property's24-hour accessibility.

Bringing design and public transit together: To improve public transportation, sustainable design should be applied at the local level. The daily arrival and departure of tens of thousands of automobiles pollutes the air and generates traffic congestion, necessitating the construction of parking lots.

Making use of energy-efficient lights and appliances: One of the most energy-efficient and rapidly increasing lighting technologies today is the light-emitting diode (LED).

Lighting controls: The design of a building determines its lighting needs. The size and location of windows and structures are important elements in daylight illumination. The requirement for lighting is reduced through automatic adjustments depending on the orientation of building windows, daylight availability, and room utilisation.

Heating, ventilation, and air conditioning (HVAC) equipment with high efficiency: HVAC systems have a large influence on a building's energy utilisation. HVAC systems may be reduced by using more efficient building envelopes, according to the link between building standards and HVAC systems. In well-designed and well-built buildings, HVAC systems may be kept to a minimum. Improvements to HVAC system efficiency have the potential to save a lot of money.

The overall amount of heating or cooling produced by a heating boiler or air conditioner determines how much money is saved over time. In well-insulated buildings, heating and cooling systems require less energy. By partitioning a building in the proper manner to produce thermal zones of acceptable proportions, heating, cooling, and ventilation needs may be decreased.

5. Conclusion and Future Scope

Sustainable building is seen as a solution for the construction sector to preserve the environment. Promoting sustainable construction practises strives to achieve a balance of economic, social, and environmental performance. That building is crucial economically, but also has significant environmental and social effects, becomes obvious. Globally, building specialists are becoming more aware of this problem. Sustainable building construction methods have been promoted to promote economic development while protecting the environment. Three ideas emerge to reduce construction's negative environmental impacts and achieve industrial sustainability: resource efficiency, economic efficiency, and human adaptability. They set forth a framework for incorporating sustainability into building projects from the start.

The framework may help the building sector better understand and execute sustainability. It summarises sustainability ideas, methodologies, and processes, emphasising the necessity to incorporate sustainability into construction projects holistically. Its goal is to improve the quality and comparability of building environmental performance assessment methods. It emphasises and analyses aspects to consider when applying environmental performance assessment methodologies for new or existing building assets. It is meant to be used in combination with and as a supplement to current evaluation methods like BREEAM, BEES, LEED, and others. The sustainability criteria are connected to varying degrees.

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