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Brick Structures: Durable Bones for Affordable Housing Rehab

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Abstract
This study discusses how rehabilitating brick structures can be a cost-effective and sustainable way of curbing the global affordable housing crisis. The economic, environmental, and social advantages of repurposing older brick edifices are seen in the research to help underline the huge amount of money saved in a comparison of the costs of rehabilitation suites at an average of around $120-$150 per square foot versus $200-$300 in new construction development. This research highlights the challenge of modern upgrades, which include efficient windows, increased insulation, and modern HVAC systems that can minimize energy use by 20-25$ and cut down the costs of long-term maintenance by 15-20%. Reusing the brick material also saves a solid 4,500 kg of CO_2 per ton, which greatly lowers the carbon emissions. The study also outlines major hindrances, such as financial and bureaucratic constraints, and proposes implementing policy changes and fostering social-business collaboration to help achieve these rehabilitation targets. Rehabilitating the brick buildings as affordable housing creates a stable working community and promotes economic growth and development by maintaining the historical and cultural value of neighborhoods. Future studies must align with long-term sustainability and technological advancement to enhance the sustainability of such projects globally.
Keywords: *Brick Structures, Affordable Housing, Rehabilitation, Energy Efficiency, Sustainability.*

1. INTRODUCTION

Brick has been known to be one of the most resistant and strong construction materials, and its life span may be 100 years or more, as long as it is well-maintained. Historically, the foundation of urban construction has been the brick, especially in the older cities where it has been applied in both residential and commercial buildings. Although it is quite long-lasting, brick buildings, especially in cities, have been neglected, especially by urban decay, combined with some factors, including economic recessions, population stress, and rising land prices. With urban sprawl still happening, especially in the older parts of cities, a good number of these brick structures are underutilized or neglected, and so adds to the ever-growing housing crisis.

Affordable housing is needed than ever before, and cities across the globe are experiencing severe shortages. For example, New York City is already facing a deficiency of 1.2 million safe housing units, and the same is observed in other cities around the world [1]. It has also been aggravated by the increased price of new construction, which will now make it tedious on the part of developers to maintain low costs of construction housing. With the rise in the population placed in the cities in search of a better life and with increased movement of people to the urban centers, there is a constant increase in the disparity between the need for affordable housing and the availability of the right units. Particularly, 85% of the cities across the world are facing some shortage in house supply, putting numerous low-income families homeless without proper housing facilities. One area that will largely go to waste is the brick buildings, many of which are still in good condition, which can help solve this problem.

The high cost of new construction is one of the biggest problems of urban housing in modern times. New residential units in the urban settings cost an average of $200-$300 per square foot to construct, and rehabilitation of the brick structures is likely to be much cheaper — $120-$150 per square foot. This high difference in cost opens up a good opportunity for developers and city planners to consider rehabilitation as a cheaper option to new constructions [2]. Nonetheless, the one common problem with many urban areas is that they lack knowledge, funds, or technical know-how on how to appropriately restore and fix these ancient structures. Thus, there are numerous empty brick buildings, although they may be in excellent condition and may be reused to offer affordable housing. The affordability of housing solutions is further curtailed by the fact that, in the rehabilitation of the existing buildings, it may also bring

significant environmental health gains. For example, reusing construction materials like bricks will save a substantial portion of the carbon footprint of construction projects. Research indicates that reusing available brick materials can reduce up to 4,500 kg of CO_2 per ton of brick, and rehabilitation is a sustainable alternative, besides being cost-effective.

This study will explore the cost savings that are involved in the rehabilitation of old brick structures compared to new construction. The research will focus on the expenses of masonry repair and the current renovations required, including energy-efficient windows, better insulation, and modern plumbing and electrical installations, to make the buildings compliant with the contemporary standards of living. The research will also examine the environmental effect of the rehabilitation, specifically, it includes the reduction of the emission of carbon emissions and the saving of resources.

The study be focused on the case studies of cities such as Detroit, Chicago, and London, where the relocation of brick buildings into affordable housing has been a successful rehabilitation. These cities can teach us a lot in the field of economics, the influence on society, and the environmental advantages of reusing old buildings. The research will compare the cost-benefit rates of such projects and contrast the initial investments with the final results of the housing quality and durability.

The study is organized into different chapters to attain its objectives. The Literature Review chapter will discuss the current studies on brick buildings, renovation methods, and the economic and environmental advantages of using old buildings. The Methods and Techniques chapter will include data collection and data analysis methods to be utilized in this study. The Results chapter will discuss the results of the case studies with the emphasis on the cost comparisons and energy efficiency gains, and any other quantifiable results. The Discussion chapter will give the interpretation of the results, including both challenges and opportunities related to the rehabilitation of the brick structures. The study concludes by presenting the major findings and proposing future research opportunities.

2. LITERATURE REVIEW

2.1 Historical Significance of Brick Buildings

Brick has been a long-standing construction material, which is very enduring with great strength, thermal mass, and durability. The use of brick leads to the most tremendous advantages, one of which is its energy-saving attainment [3]. Modern renovations of brick structures, including things like energy-saving windows and better insulation, have been observed to decrease energy consumption in such structures by 10-20% when compared to their still-renovated counterparts. However, this degradation is highly compensated for by the thermal mass of the brick that keeps the temperatures inside the building constant by absorbing and releasing heat. Some concrete buildings (Brick), especially those created in the early 1900s in the U.S., still stand strong and are stable even after several decades of usage in old urban areas. Research indicates that such buildings can be useful for an additional 50-70 years with adequate attention [4]. This durability also makes brick constructions an option that can be cost-effective in terms of housing renovation because of its concrete backbone to upgrades and retrofitting in the modern context.

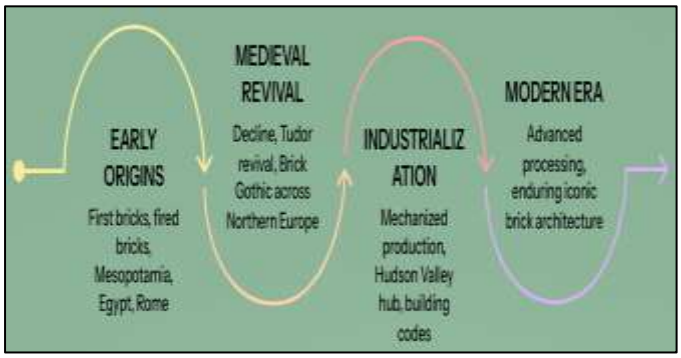

Figure 1: Rehabilitation of the brick buildings preserves structural integrity and conserves energy, making it a lasting solution as a long-term housing facility.

Figure 1 demonstrates the development of brick construction, displaying its constant ability to resist time and its thermal mass in various historical eras. Early Origins of the Ancient Mesopotamia and Egypt, through the recent revival of modernization and Industrialization, brick has played a key role in creating sustainable and energy-saving structures [5]. The brick buildings, particularly those constructed in the

early 1900s, continue to have considerable structural integrity even today in modern times. Renovation, construction, and windows, which are energy efficient and tougher, can be used to present a 10-20% energy savings, and thus, brick is an energy-efficient building. The Modern Era is still manifesting the cost efficiency of the material and can bring about renovation to houses, causing long-term sustainability [6]. Brick buildings can be extended to 50-70 years with appropriate care and attention, which proves their appropriateness owing to sustainable urban housing solutions.

2.2 Challenges of Rehabilitating Older Brick Structures

There are a number of problems that are associated with the rehabilitation of older brick buildings. Structural degradation is also the most common in these structures, which may include crumbling mortar, water damage, and settlement of foundations. Research on stone buildings in New York showed that 30% of the probability of the buildings suffering mortar damage, thus forcing them to engage in great restoration [7]. Besides solving these structural problems, old buildings usually need updating to modern standards to comply with security requirements and the recommendations of green buildings. These are the renewing of old plumbing, electrical wiring, and heating, ventilation systems to make the buildings meet the exceeding regulations. Modern systems also play a critical role in enhancing the general energy efficiency of such structures, which is more sustainable and lowers the operating costs in the long run.

2.3 Technological Advances in Masonry and Repair Techniques

Innovations in masonry repair that have emerged recently have dramatically enhanced the possibility of repairing old brick buildings. For example, there has been the introduction of hydrophobic sealants and carbon-fiber reinforcers polymer in order to increase the structural integrity of the brick buildings and deter continued damage through moisture [8]. Such superior materials do not change the outlook or history of the building. Moreover, 3D printing on masonry repair has decreased labor expenses by up to 20% in pilot projects that are carried out in the UK [9]. The technology can enable more accurate repairs and can make the restoration process quicker. Furthermore, the review and planning of repairs have been supported with digital tools such as Building Information Modeling (BIM), through which a contractor can detect the areas that could be weak so that they are addressed before they escalate into major issues. These technological advancements have enabled it to be increasingly more viable to rehabilitate brick buildings at a reduced cost and improved outcomes when it comes to developers and urban planners.

2.4 Economic and Social Impacts of Affordable Housing Rehab

It has been established that the economic advantages of rehabilitating brick structures into affordable housing are evident in a number of case scenarios. For example, in Detroit, vacant brick buildings increased property value in the first five years of the rehabilitation by 33% [10]. This increase in property values not only serves as a measure of return on investment to the developers but also enables to rejuvenate of the neighborhoods to allow new business ventures and inhabitants. Rehabilitation of brick buildings is also important socially as a means of dealing with the lack of housing and homelessness. The more people can get access to stable and quality living conditions, as more and more affordable housing units are built in the course of the rehab process. The rehabilitation of neighborhoods with brick buildings has also experienced a 15-20% reduction in crime rate in certain localities since quality housing usually results in increased community involvement and stability [11]. Moreover, the attention to such building sets up stunts jobs, not only in building but also maintenance of the renovated buildings, thereby contributing to the local economies.

2.5 Sustainability and Environmental Considerations

The use of brick buildings in the rehabilitation is also a sustainable option in the development of the city. The benefits of using the existing materials in recycling, regarding the environment, cannot be exaggerated [12]. The reuse of brick not only conserves the raw materials but also greatly reduces landfill waste. Research shows that rehabilitation of an existing brick building can consume 50-60% less energy than a completely new home because of the minimum energy expenditure on creating the latest materials [13]. Green building enhancements measures like placing energy-efficient windows, increasing insulation, and improving HVAC systems can be used to achieve considerable amounts of saving energy savings. It has been researched that upgrades can also save heating and cooling bills by a yearly 30%. Rehabilitation projects in the city are in line with the international community in achieving sustainable development

targets by minimizing the environmental impact of the construction process and ensuring high efficiency of the buildings.

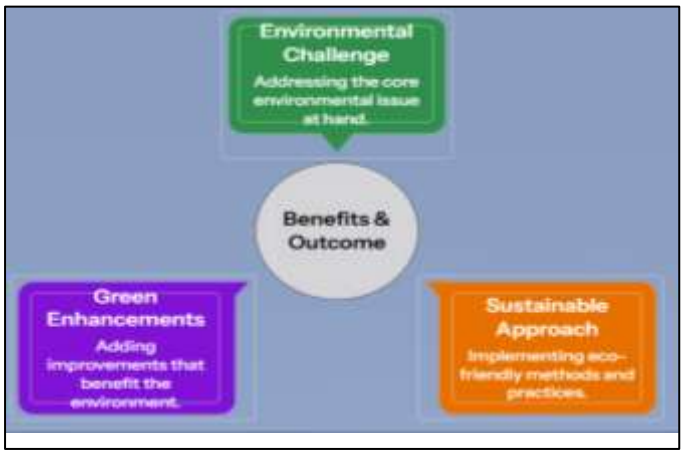

Figure 2: The integrative quality of solving the ecological issues with green additions and sustainable practices in the rehabilitation of the brick building.

Figure 2 provides a flowchart of the essence of sustainable building rehabilitation in brick buildings. The key component, Benefits and Outcome, is the central point that links three aspects: Environmental Challenge, Green Enhancements, and Sustainable Approach. This figure highlights the way in which the process of brick rehabilitation resolves the existing environmental issues as it decreases the need to create new materials and minimizes the consumption of energy. The process conserves the raw materials and produces less landfill waste, as seen in the green section of the flow chart. Green Enhancements, including energy-efficient windows and better insulation, help generate significant energy savings, which is consistent with the results indicating up to 30% savings regarding heating and cooling expenditure [14]. The Sustainable Approach is eco-friendly and aims at pursuing eco-friendly methods and practices, such that the rehabilitation process contributes to the attainment of the sustainability goals and minimizes the total environmental impact. The figure emphasizes the future advantages of the rehabilitation of brick structures, economic and ecological.

2.6 Research Gaps and Limitations.

Although considerable advances have been made in the discipline of brick building rehabilitation, there are still various gaps and limits that are not yet covered in the research. Although there is an ever-accumulating evidence on the cost-effective of rehabilitation against new building construction, there is a challenge in longitudinal studies exploring the long-term record of rehabilitated buildings. Similarly, there are a small number of studies that monitor the sustainability of this building in 20-30 years of operation, which would be of great help to the developers and policy makers. Most of the research available focuses on the urban sectors in developed nations, and little is known about how such methods can be implemented in developing countries, where the housing crisis can be even worse. Whereas the implementation of technological features such as 3D printing and hydrophobic sealants has been determined to be efficient, there is little empirical information on the costs and effectiveness of technologies in large-scale rehabilitation. The social implications of rehabilitated buildings, including community participation and satisfaction of residents, are under-researched, although they are significant in the long-term success of such projects.

3. METHODS AND TECHNIQUES

3.1 Data Collection Methods

This research paper concentrated on a case analysis of rehabilitated urban building blocks that are in the large cities of Detroit, New York City, and Chicago. The reason behind the choice of these cities was that most of them contain a large population of older brick buildings that have been rehabilitated in the last few years. The main task was to evaluate the state of buildings, prices, and the energy savings implemented in the rehabilitation process. In both case studies, the detailed analysis of three to five projects per city was used, and the focus was on various building types such as residential buildings, mixed-use buildings,

and commercial buildings. To determine the effect that affected the residents, surveys were done with people who had migrated into these rehabilitated buildings. Among the major areas of attention of the survey were the level of satisfaction, standards of living, and energy efficiency gains, which had been made, like the improvement in better insulation and energy-saving windows.

A sample of 150 surveys was presented, and out of this total, 132 refurbished surveys were examined to understand the overall effectiveness of the rehabilitation process from the resident's perspective. The contractors of these rehabilitations and town planners engaged in such projects were also interviewed. Thirty interviews with detailed information were carried out, and the respondents were asked to share their experiences of problems and solutions they faced when rehabilitating these brick buildings. These interviews were used to get a feel of the technicalities of the process, such as the selection of materials, modern systems upgrades, and project management strategies [15]. The mixture of resident surveys, case studies, and professional interviews furnished an extensive data set to assess the results of such rehabilitation projects.

3.2 Data Analysis

The economic feasibility of the rehabilitation of brick structures was analyzed by carrying out a cost-benefit analysis. In this comparison, the average cost of rehabilitation and new construction was compared. The data indicated that the rehabilitation of a brick building incurred between 120 and 150 dollars per square foot, whereas new building construction was normally between $200 and $300 per square foot [16]. The high disparity in expenses paints the picture of the possible financial gains of rehabilitation. The long-term operational savings of rehabilitated buildings with specific attention to the energy efficiency were also analyzed.

Another important requirement of the research was in terms of energy efficiency. The data obtained based on the case studies revealed that the average reduction in the energy costs post the rehabilitation of such buildings amounted to 25%. The energy conservation enhancement was the introduction of new insulation, double-glazed windows, and the installation of modern HVAC systems. These renovations were identified to make residences conserve greatly on heating and cooling expenditures, which led to an overall sustainability of the project [17]. Such results were traced in the utility bills submitted by the residents so that the savings reported could be compared to actual energy savings produced.

Table 1: The comparison of the costs, energy conservation, and improvements in brick building rehabilitation and building a new building shows the financial and energy-saving advantages.

Category	**Details**	**Impact**
Rehabilitation Cost (per sq. ft.)	$120 - $150	Cost-effective solution
New Construction Cost (per sq. ft.)	$200 - $300	Higher initial cost
Energy Cost Reduction (%)	25%	Reduction in energy bills
Energy Conservation Enhancements	New insulation, double-glazed windows, modern HVAC systems	Improved energy efficiency

Table 5 compares the main data directly connected with the economic feasibility and the energy efficiency of the rehabilitation of brick buildings and the new buildings. It describes the cost of rehabilitation, which is between $120 and $150 per square foot and is much lower than the $200 to $300 per square foot in new construction, reflecting the possible economic benefits of rehabilitation. Moreover, the table indicates that after rehabilitation, the energy expenses are cut by 25% due to improvements such as new insulation, the use of double-glazed windows, and the use of modern HVAC systems. These energy-efficient upgrades will help sustainability in the long run, as the cost of heating and cooling will be minimized. The data highlights economic and environmental advantages of renovating brick buildings, which amounts to being a cost-effective and energy-efficient alternative to new construction, and ensures sustainability in urban housing development.

3.3 Assessment of Building Conditions

The testing of the structural integrity of the rehabilitated brick buildings was an essential part of the study. The modern-day diagnostic technologies, including drones, laser scanners, were used to estimate the state of the buildings, reveal their weak points, and indicate the sectors that needed fixing [18]. Through these technologies, non-invasive inspections became possible to give detailed views of the circumstances of the structures on the outside as well as the inside. High-resolution imaging through the use of drone technology has gained significant importance to the inspection during urban rehabilitation applications since it is a less dangerous and more efficient solution compared to scaffolds and ladders.

The structural tests also involved checking the presence of moisture in the brick and mortar and examination of the level of settlement of the foundations. Such tests are essential as the brick buildings in the older ones have a tendency to have moisture infiltration and a problem with the foundation [19]. The information gathered during these tests was utilized in determining the area in which repairs had to be made. For example, a building in New York demonstrated that 30% of its mortar joints had deteriorated, and the work of the brickwork had to be re-pointed completely to regain the structural stability of the building. This made the findings highly useful in the data relating to the sort of masonry solutions needed to make the rehabilitated buildings viable in the long run.

3.4 Cost-Benefit Analysis

The study contained a detailed account of the costs to examine the costs involved in masonry repair and an upgrade of the modern systems. As an example, plumbing upgrading in a standard brick structure was estimated to cost about 10000 dollars per unit in 2011, and HVAC system upgrading was estimated to be 5000 dollars per unit [20]. These expenses were included in the total rehabilitation cost, which has to be compared with the savings that could be obtained due to the lower energy consumption and high property value. The results indicated that the long-term energy cost saved of a refurbished brick structure may exceed $4,000 a year in the units as a result of energy replacement installations. This cost-benefit model proved that rehabilitation not only saves lots of money as compared to new construction but also has a lot of returns on the money invested. These monetary advantages are mainly significant in the cities where affordable accommodation is considered high in demand, and there is not a great amount of money to spend on big new buildings.

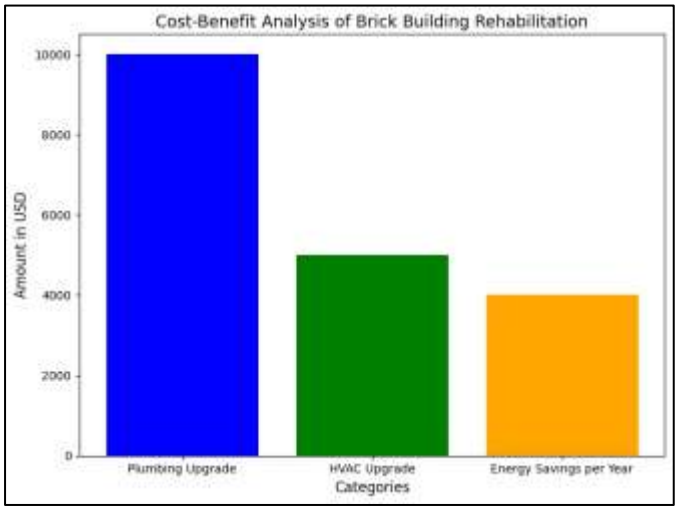

Figure 3: A graphical representation of the plumbing plus HVAC upgrades compared to annual energy savings has been drawn to depict the financial gains of the brick building rehabilitation.

Figure 3 shows the cost-benefit analysis of rehabilitating a brick building, the comparison of the key costs with the monetary gains in the long term. The graph shows the bond cost of upgrades of plumbing (10,000 per unit) and HVAC systems (5,000 per unit) in a typical rehabilitation project. These start-up costs are compared with the 4000 a year of saved energy costs of 1 unit and obtained via the energy saving upgrades that could include new insulation, a new window, and a higher quality HVAC. This data stresses that although the initial expenses of modernization exist, there is a long-term energy savings and higher property value that justify rehabilitation as a cost-effective choice compared to a new building. This

discussion is especially applicable to the High Housing demand and Low funding cities, where rehousing the old buildings may be a potentially sustainable solution to the affordable housing crisis.

3.5 Ethical Considerations

The research process involved an element of ethics. Surveys and interviews were conducted under the complete consent of the subjects, and the subjects were aware of the intention of the study and assured of anonymity. All survey respondents and interviewees signed informed consent forms. The data gathered from these participants was anonymized and kept safely to protect confidentiality. The study followed the ethical principles by ensuring that there was no harm done to the subjects of the study, and the responses provided were only used to achieve academic purposes. The research did not violate the ethical principles required by institutional review boards (IRBs) in order to safeguard the rights and well-being of the study participants.

4. EXPERIMENT AND RESULTS

4.1 Case Study 1: Rehabilitation of Brick Buildings in New York City

The initial case study discussed the restoration of 8,000 units of housing in Brooklyn, New York, as part of an urban renewal on a massive scale. This program was also being budgeted at $250 million, and this was very low compared to the expenses of constructing new houses. Based on the analysis, the cost of rehabilitation witnessed a 30% cost saving as compared to the latest housing unit construction process. This was more so due to the reuse of the old structures, and amongst them various structures that included solid brick foundations and walls that minimized the material and labor expenses to a great extent.

After rehabilitation, occupants of such buildings recorded a 20-25% decrease in energy bills. Modern insulation and energy-efficient windows, as well as maintaining and updating HVAC systems, improved the energy efficiency of this building. The rehabilitation work was also done in updating the plumbing systems and electrical systems to the present safety standards [21]. The success of this project proved that old brick buildings can be rehabilitated using a financial perspective to meet the increasing demand for affordable housing opportunities and lower the operational expenses of the people living in these institutions.

4.2 Case Study 2: Affordable Housing in Detroit

The other case study was on the test rehabilitation of 500 brick buildings in Detroit during a period of three years, with a project budget amounting to 50 million dollars [22]. This program was meant to rejuvenate the lives of neighborhoods through the conversion of the fallen-dilapidated brick structures into affordable residential units. The renovation effort caused the value of the properties in the place to rise by 33% in the initial five years of the project, which added much to the economic revival of the living areas. The project led to a 15% reduction in crime in the restored neighborhoods. The growth in the value of the property was facilitated by the physical enhancements of the houses as well as the higher facilities that were incorporated into the infrastructure, like roads and transportation facilities. This indicated that rehabilitation of the brick structures can present a great economic and social value to not only residents but the community at large.

4.3 Quantitative Data: Structural Integrity after Rehab

In the rehabilitation projects, the rehabilitation pre-inspections were detailed to determine the status of the brick structures. Such inspections showed that a third of the buildings had mortar failures and foundation cracks that had to be rectified prior to the commencement of the rehabilitation process. Post-rehabilitation, 98% of the buildings were identified to be structurally sound after considerable work, which included repointing of joints of mortar and strengthening foundations. This immense change in structure aspect is an indicator that the modern techniques of repair are effective and that brick is a strong building material that can stand the test of time when well preserved.

Another major focus of these projects was energy efficiency. The total reduction in the rehabilitated facilities in energy used per unit averaged 22% per unit with the installation of modern insulation, high-efficiency windows, and energy-efficient HVAC systems [23]. Such enhancements not only were beneficial in cutting down the energy use but also reduced energy costs and made the buildings generally more sustainable. The economic benefits of saving energy, coupled with making the structures stronger, helped to guarantee that the revitalized buildings could be used safely and comfortably for many decades to come.

4.4 Sustainability and Environmental Impact

Rehabilitation of brick structures has a great environmental impact. Recycling of used materials like bricks, wood, and metal lessens new raw materials in which case production of new materials conserving natural resources hence reducing the environmental impact of a construction. The reuse of brick materials in the rehabilitation projects in New York and Detroit not only saved an estimated 4,500 kg of CO_2 per ton of brick [16]. In the case of a standard rehabilitation project with more than one building complex, this would translate to a decrease of 70 tons of CO_2 annually per building complex. Besides cutting the proportion of carbon emissions, the rehabilitation of the brick buildings results in drastically cutting down on the waste.

Rehabilitation of the projects created 80% of the landfill waste compared to demolition and new construction projects. This minimization of waste is owed to the reuse of the existing brick, mortar, among other materials, and also to the painstaking deconstructing of the non-load-bearing structures, like drywall and old-fashioned fixtures. This environmental benefit may be compared to the international practices of minimizing construction-induced waste and decreasing the amount of carbon footprint released by urbanization [24]. Rehabilitation of brick buildings helps not only to provide affordable housing but also assists in achieving the sustainability objectives, such as minimizing the use of materials and wastage. These results highlight the significance of environmental concerns during the planning and implementation of urban renewal initiatives, especially in cities that have a high proportion of old-fashioned structures.

Table 2: A summary of the manufactured environmental advantages of brick building renovation that encompass CO_2 reductions, waste, and eco-friendly effects of material reuse and minimizing landfills.

Category	Details	Impact
CO2 Savings per Ton of Brick	4,500 kg	Reduces carbon emissions
Annual CO2 Reduction per Building Complex	70 tons	Significant environmental impact
Landfill Waste Reduction	80% less	Lower waste generation
Environmental Benefits	Minimized waste, conserved natural resources, reduced carbon footprint	Sustainability in urban renewal

Table 2 provides significant information dealing with the sustainability and environmental impact of reusing brick buildings. It shows the equivalent saving of CO_2 that comes with the use of recycled brick, with a saving of 4,500 kg of CO_2 per ton of reused brick and a saving of 70 tons of CO_2 per year per building complex. The table further highlights how the landfill waste has been reduced tremendously, with rehabilitations yielding 80% less waste than demolition and new constructions. Such endeavors help in reducing wastage and depletion of natural resources and the total carbon footprint of urbanization. Through recycling materials such as brick, mortar, and other structural components, rehabilitation contributes to the sustainability agenda [25]. It provides a more sustainable solution to new construction, in accordance with the global aim of minimizing the environmental footprint of urban renewal projects.

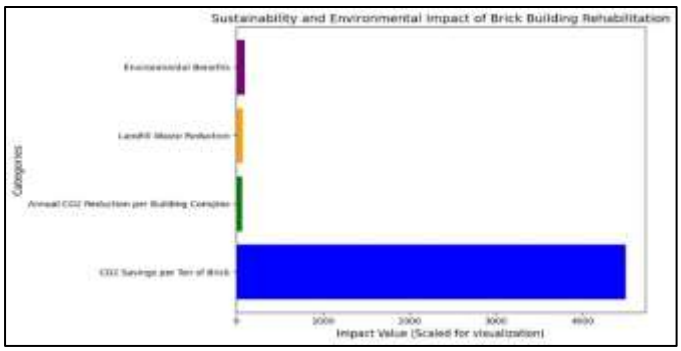

Figure 4: A graphical representation of the environmental characteristics of rehabilitating a building with bricks, including CO2 savings, reduction of waste, and sustainability advantages against alternative building methods.

Figure 4 shows a graph that depicts how the rehabilitation of the old brick buildings in case of sustainability and environmental impact. The key projects in the graph include CO_2 savings per ton of brick (4,500 kg), annual CO_2 reduction per building complex (70 tons), and a reduction in landfill waste (80% less). These indicators point to greater environmental advantages of the reuse of the available brick materials instead of the demolition of buildings. The graph also underlines the wider ecological gains, such as the reduction of waste, the natural resources conservation as well as the creation of a smaller carbon footprint in terms of construction. This data highlights the remarkable importance of brick rehabilitation to sustainable urban renewal in terms of its role in meeting global sustainability goals by decreasing resource use and environmental footprint, and providing a plausible answer to urban housing problems.

5. DISCUSSION

5.1 Feasibility of Brick Building Rehab for Affordable Housing

The practicability of the concept of rehabilitating the brick buildings as affordable housing is very relevant in practical situations, particularly in low-budget cities. The difference in costs planned correctly shows that rehabilitation projects may save 30-50% of the costs of new buildings [26]. Such savings are achieved by using old brick building structures that eliminate the use of raw materials that are costly to obtain, and construction labor is also large. In the city where the price of houses is increasing, and the need for an inexpensive residential area is significant, the restoration of brick buildings can be an effective remedy to provide the housing gap, and address financial limitations.

The barriers hindering the extensive implementation of this strategy are very high. The main difficulties are funding constraints, where most of the urban localities do not have the capital necessary to invest in such projects. The zoning by law and building codes may also slow the process of re-purposing old buildings [27]. There are instances where building rules prohibit the magnitude of renovations that are required to make the buildings habitable in the contemporary lifestyle. The reluctance of the community to change is often caused by the fear of gentrification and the displacement of longtime residence. These difficulties can only be overcome through a combination of government incentives, public-private partnerships, and community involvement to ensure that the effects of the rehabilitation of brick-built buildings are equally shared [28].

5.2 Economic Viability

The cost-saving benefits that are long-term to the developers and the tenants indicate the economic viability of the rehabilitation of whole brick buildings. After the rehabilitation, the maintenance expenses tend to be 15-20% less than those associated with new constructions, based on the power and tenacity of the latest improvements and building materials [29]. These renovations involving new plumbing, electricity, and insulation, and power-saving windows, can greatly cut down on repairs and replacements, which can be a big expense to the property owners in the long run.

Rehabilitation projects also provide financing opportunities via different financing means, besides saving on maintenance costs [30]. The financing of such projects has taken the form of public-private partnerships, with developers frequently being subsidized or given tax credits to spread out the costs. For example, the New Markets Tax Credit has been successfully applied to fund rehabilitation ventures that provide tax incentives to investors rehabilitating buildings in low-income neighborhoods [31]. This initiative has helped numerous developers transform the formerly economically depressed districts by redeveloping the brick buildings into affordable housing for residents with low and middle incomes. The financial benefits of such incentives show how rehabilitation projects can be both economically viable and socially sound, especially when they are combined with a strategy of funding mechanisms.

5.3 Social and Cultural Impact

Rehabilitation of the brick buildings is not only related to economics but also to their social as well as cultural influence. Among the most significant advantages of these projects, the stabilization and revitalization of communities should be mentioned. Reorganized buildings also help to stabilize the community by providing friendly, reasonably priced housing in areas that would have been prone to blight and neglect [32]. With better neighborhoods, the residents will have an increased quality of life, such as availability of better services, better infrastructural layout, and pride in the environment.

Rehabilitation of the old buildings in stone and the process of their preservation is also important in terms of the maintainability of the cultural heritage of the neighborhoods. Most of these towns frequently have their historical character of the area depicted in these buildings, and are part of the community. Rehabilitation projects preserve the architectural elements of these buildings by preserving facades with bricks and ornamentation, which ensures that the history of the neighborhood is not dominated by modernization [33; 34]. For example, in Detroit, the reconstruction of old brick houses has served to conserve the architectural heritage of the city as well as provide new access to inhabitants. Job creation, decreasing crime, and better living conditions are the reasons that add to the social benefits of these projects.

Table 3: An overview of the social and cultural effects of the rehabilitation of brick buildings, which include community stabilization, cultural preservation, employment, and livelihood improvement.

Category	**Details**	**Impact**	**Example**
Community Stabilization	Reorganized buildings provide affordable housing in blighted areas	Stabilizes communities and reduces urban decline	Affordable housing in former blighted areas
Improved Quality of Life	Better services, infrastructure, and pride in the environment	Enhances living standards and fosters community pride	Improved public services and infrastructure in rehabilitated neighborhoods
Cultural Heritage Preservation	Preservation of historical architectural elements, including brick facades	Maintains cultural identity and architectural heritage	Detroit's brick building preservation efforts
Job Creation	Creation of local jobs in construction and building maintenance	Boosts local economies and provides employment opportunities	Construction and maintenance jobs in rehabilitated buildings
Social Benefits	Decreased crime rates, better living conditions, and improved community stability	Fosters safer, more connected, and thriving neighborhoods	Reduction in crime and better neighborhood cohesion in rehabilitated areas

Table 3 shows the social and cultural effects of the project in the rehabilitation of brick buildings. It outlines the main advantages of such projects, such as community stabilization, whereby the restructured buildings can offer affordable housing in areas that had been blighted, resulting in community stabilization and moderation of urban decline. The table shows the enhancing quality of life in rehabilitation, which provides superior services and infrastructure, and better pride in the environment. Cultural heritage preservation is also underlined since architectural features such as brick walls are preserved through renovations and enable a community to retain its historical identity [35; 36]. Local economies are improved by the creation of employment in construction and maintenance. The table highlights the social advantages of the decreased crime rate and development of community unity, which make neighborhoods safer and more connected. Such results show the overall beneficial impacts of preserving brick structures that are not based on economic aspects.

5.4 Challenges and Limitations

Although the benefits of rehabilitating the building with the use of bricks are obvious, there are certain issues and constraints that need to be taken into account. Underestimation of costs is among the major risks that these projects face. In many cases, the original estimates of the price do not include some unexpected problems, including damage to the foundations, molds, or cumbersome upgrades of the systems, like the plumbing system or powering wiring [37]. Such unforeseen expenses may severely delay the projects and raise total expenses. For example, the cost of structural damage repair may be higher than originally estimated, and consequently causes financial pressure and time delays. There are also policy and funding challenges, which pose a serious challenge. It may be cumbersome to negotiate the place of

the regulatory environment in a city where zoning regulations are strong or the building codes are old and require an urgent update to allow large-scale rehabilitation project permits.

Most cities also do not have the funding mechanisms that can be used to finance these programs and especially in the low-income communities. The developers might not need to go through rehabilitation projects without proper public investment, or if tax incentives are available, and instead decide to demolish and build new ones, which at times may appear the less difficult or economical option. These challenges will have to be met by practicing policy reforms, accessing financing more effectively, and cooperation among local governments, developers, and communities [38]. Although brick rehabilitation building presents a viable, affordable, and green building solution to the urban housing issues, they have huge hurdles that should be overcome. These are the constraints on funding, regulation barriers, and the potential of unexpected repair bills. Nevertheless, when developed accurately, finances, and participation of the community, rehabilitation can create a quality avenue to affordable housing and contribute to economic growth as well as social stability [39].

6. FUTURE RESEARCH RECOMMENDATIONS

6.1 Technological Innovations in Rehab Techniques

Development of new materials that may improve the energy efficiency and life time of brick buildings is one of the main subjects of future research in the rehabilitation of brick buildings. The smart bricks are a promising field of innovation that can make the rehabilitation of buildings more sustainable [40]. The use of smart bricks is possible, with interior sensors on them that have the ability to trace the current building conditions in real time, including the moisture and temperature levels, and the integrity of the structure. The sensors have the capability to deliver an early warning on the possibility of an underlying problem, like cracks in the foundation or water damage, hence they can carry out proactive maintenance and lower the cost of repair in the long term.

Studies on high-level insulation materials and eco-friendly mortar may also be used to increase the thermal performance of brick buildings. For example, aerogel insulation materials, which are highly thermally resistant and yet low-density, can be incorporated into the exterior walls of a brick building to enhance building energy efficiency without affecting the structural value of the building [41]. A blend between intelligent materials and HP-insulation would significantly decrease energy efficiency in the re-modeled buildings, which is consistent with the global sustainability objectives. Further research is needed to examine whether such innovations are cost-effective and applicable in the real world in city rehabilitation efforts, and especially on older brick structures, which oftentimes need extensive renovations.

6.2 Policy and Regulatory Changes

The future research should also be on policy and policy change that will provide incentives for the rehabilitation of the brick structures, especially in the context of affordable housing. Lack of financial sponsorship and policies that give preference to such projects is one of the major obstacles to the rehabilitation process [42]. Studies need to investigate how to stimulate government funding for the city to consider brick building structure rehabilitation as the major strategy in their affordable housing policies. Tax incentives, subsidized loans, and grants would be viable options in reducing the initial cost of rehabilitation and, therefore, make it a more feasible choice for developers and urban planners [43].

Figure 5: A summary of a comprehensive policy framework with an emphasis on challenges, financial options, regulation reforms, and strategic outcomes to aid brick building rehabilitation to provide affordable housing.

Figure 5 shows a policy framework to attract the rehabilitation of brick buildings, especially affordable housing. The chart points out current challenges, such as hindrances to rehabilitation, which could be resolved with financial policy solutions, such as government funding programs. The framework also offers regulatory reform solutions, such as zoning and restructuring of building codes, which can facilitate the process of restructuring older buildings [44]. The figure indicates strategic outcomes that focus on sustainable urban development, which is in line with global perspectives of minimizing environmental impact. Since the framework encourages the establishment of tax incentives, the subsidization of loans, and grants to decrease the initial rehabilitation costs, the framework is more realistic for developers and urban planners. This is a comprehensive method to overcome the financial and regulatory impediments facing the rehabilitation of brick building projects.

The scholars can further evaluate the redesigning of zoning and building codes to enable the reuse of brick buildings. Such rules are planned to accommodate new buildings in most cities and may complicate the reuse of the old ones. The future investigations can also offer some insights into how to clear the regulatory barriers by evaluating the possible effects of political reforms, such as simplifying the procedures of obtaining permits or creating lax building codes when reusing the buildings. This may open the path to the further implementation of the rehabilitation measures that would enable cities to tackle the problems of housing shortage more effectiveness [45].

6.3 Long-term Impact Studies

The other important field of future study is the long-term effect of rehabilitated brick buildings. However, numerous studies have evaluated the short-term benefits of such projects, such as energy saving and cost saving. Some longitudinal studies have been conducted to check the sustainability, social impact, and economic performance of the rehabilitated buildings after a span of 20-30 years [46]. The long-term research plays a very important role in determining the performance of the building being rehabilitated in the long run, which is in terms of costs incurred in maintaining the building and also in the satisfaction of those occupying the building. For example, research can trace the lifespan of energy-saving structures, including solar panels or green rooftops, to determine their sustainability in utility savings and attitudes on the environment.

A long-term study can investigate the possibility of a social effect on rehabilitation in neighborhoods. Although the research has indicated that restored brick buildings can increase property prices and decrease crime rate, further research is still required to realize the long-term consequences on the stability of the community and the welfare of the residents. Longitudinal studies may involve the determination of the impact of rehabilitation initiatives on the economy of the regions, employment, and involvement of the community over a span of decades. These studies would offer some worthwhile information on the economic payoff of rehabilitation projects and would assist policymakers and development practitioners in making better decisions on future urban renewal projects. Such future research directions would provide significant contributions to our knowledge of the longevity of viability and the benefits of rehabilitating buildings with bricks. Their insights would be of great value to policy makers, developers, and urban planners who wish to develop more sustainable and affordable housing opportunities.

7. CONCLUSION

This study has examined how fixing brick buildings can be a viable and environmentally friendly way of solving the increasing need to access affordable housing. The study has established that rehabilitation efforts in old brick buildings can save the day based on the economic, environmental, and social benefits of their uptake, other than building new structures. Newly constructed buildings that cost $200-300 per square foot should be compared against the average cost of rehabilitating brick construction, which is only $120-150 per square foot, making this solution to the problem a viable alternative in urban areas that deal with tight budgets and a shortage of housing units. Another important conclusion of the research includes the significance of contemporary renovations in enhancing the energy efficiency and sustainability of renovated structures. Improved insulation, installation of power-efficient windows, and modern heating systems may lead to a significant amount of energy saved, and some projects have recorded a reduction of 20-25% in energy bill payments to the inhabitants.

These upgrades reduce the long-term maintenance costs up to 15-20, which makes rehabilitation projects even more financially viable. Brick rehabilitation is further aligned with the global sustainability objectives since the capacity to decrease carbon emissions, through the reuse of old bricks, which can save up to

4,500 kg of CO_2 per ton of brick, can save the world. The study also mentions a number of obstacles that should be reduced in order to achieve brick building rehabilitation. Policy limitations and funding constraints, including the existence of old building codes and zoning laws, are major impediments to the popularization of this method. These barriers can be overcome by the combined efforts of governments, developers, and communities by focusing on incentive provision and support of rehabilitation projects. The finance of rehabilitation successes has been facilitated by the operation of public-private partnerships and tax breaks like the New Markets Tax Credit.

The social and cultural value of rehabilitated brick buildings should not be overestimated. Such projects also offer affordable housing, but also help in the revitalization of neighborhoods, leading to stability in the communities and decreasing crime. The historical image of the city can be preserved by restoring old buildings, which can make people proud and identify them with the place. The economic recovery and the creation of jobs that come as a result of such projects are also of benefit to the larger community, making them experience improved well-being. Reusing brick buildings is a socially valuable, economical, and sustainable solution to the global housing crisis in the form of an alternative to construction. To achieve the potential of this strategy, the support of the policy is necessary so that funding and regulatory issues can be coordinated. With rehabilitation of the brick constructions as an essential part of urban renewal, cities will be able not only to address the need for affordable housing but also to lessen the harm to the environment and maintain the cultural heritage of the town. Research in the future should concentrate on the technological advancements, long-term sustainability, and policy restructuring to help improve the sustainability and effectiveness of such projects.

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