Cost-Benefit Analysis of Sustainable Public Housing: A Systematic Review of Literature

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ABSTRACT

This systematic review assesses public housing as an affordable housing scheme across various countries, examining its cost-benefit, environmental sustainability, and affordability. The study was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, and databases from IEEE Xplore, ScienceDirect, JSTOR, ERIC, and Web of Science were utilised for data search and extraction. A total of 145 studies were found based on the inclusion criteria. The study discovered that public housing provides various cost-effective and sustainable housing options that affordable housebuilders can utilise. Regarding the objective, it was found that renters, so long as they take steps to avoid the risk of "economic growth," are likely to gain financially from residing in a green, affordable apartment. It was demonstrated why it would be advantageous for a private corporation to build affordable housing with green features: green homes do not always cost more than conventional structures.

Keywords: Systematic Literature Review, Cost-Benefit Analysis, Public Housing

INTRODUCTION

Global problems, such as economic inequality, housing shortages, resource depletion, and environmental degradation, have emerged due to the economy's rapid growth. Low productivity and mixed quality have been criticised for traditional building as a labour-intensive on-site method (Xue et al., 2017; Low, 2001; Arif & Egbu, 2010; Gann, 1996). To meet the demands for housing quality and quantity, reduce labour costs, and facilitate industrial transformation, the government is making a concerted effort to encourage prefabricated construction techniques in the building sector (Li, 2003; Cao et al., 2015). The model of sustainable development recognises environmental policy integration (EPI) as a crucial planning approach for increasing organisational productivity in policy collaboration and achieving equal strengthening of sectoral and environmental policies (Arif & Egbu, 2010; Gann, 1996).

Empirical studies suggest that green building enhances housing affordability by reducing energy expenditures, which account for a significant portion of the annual income of low-income households (Cao, 2015). In the United States, green energy is often cost-effective. With the help of mandates and incentives that alleviate the fears of bankers, owners, and investors regarding risk and return on investment, housing tends to emerge from a synthesis of public and private sector initiatives. Although there has been general growth in the market share of green buildings since the early 2000s, the adoption of structures with high environmental performance has been gradual. Even in areas where housing is expensive compared to its basic manufacturing costs, there is still a need for more affordable housing (Glaeser & Gyourko, 2003).

The economic viability of green affordable housing is challenging, particularly in smaller urban areas with existing stock (Adelle & Russell, 2013; Jordan & Lenschow, 2010). Currently, green buildings make up fewer than 1% of all buildings and are more prevalent in major cities with higher socioeconomic capabilities. Local

governments require substantial empirical evidence about the viability of the local housing market to perform cost-benefit analyses of different programs and policies and calculate the number of incentives needed to offset the upfront expenditure of green, affordable homes in the residential sector. (Glaeser & Gyourko, 2003; Pearch et al., 2007). Previous studies have primarily focused on leveraging nationally renowned brands to enhance commercial real estate values in major cities, providing limited information on the public and private benefits in the residential sector. Due to the widespread belief that green buildings are expensive to construct and affordable housing is the cause of declining property values, there are no systematic analyses or data on the costs of construction and expense impacts of green affordable housing. This situation could result in irrational underinvestment (Zhao et al., 2007).

The supply of affordable housing has recently become increasingly important, having been largely overlooked for a long time. It is a residential property unit that will either be rented out for at least eight years or sold for less than the market value. Protected tenancies, provided by local public agencies at social rates, and regulated tenancies, provided by both public and private organisations at set rents, are the two main categories of tenancy agreements. A lease might be based on a fixed-term tenancy or, much less frequently, a periodic tenancy. Interest in social housing has grown again due to recent regulatory initiatives, but two key differences from prior eras set it apart. The 1960s and 1970s focused on housing people experiencing poverty, particularly those undergoing internal migration from southern to northern Italy. The broadest definition of the current program's objective is to offer housing for various households and economic levels. The second distinction relates to financing. Government spending had to be reduced due to the sovereign debt crisis. Consequently, a lack of funds presented an opportunity to test creative financing methods (Fuerst, 2014). Therefore, PPP seems to be an unavoidable path to pursue social housing enhancement in the Italian environment, albeit encountering the problems mentioned earlier.

With the long-term goal of achieving a low-carbon economy by 2050 and the short-term target of a 20% reduction in primary energy consumption by 2020, several new publications advise pursuing this goal while leveraging the benefits of the existing EU energy plan. One example outside of declarations of intent found in EU acts or position documents is a funding program established by the European Investment Bank in coordination with the EU Commission (Chegut et al., 2019). Additional examples are Energy Service Companies (ESCo) and Energy Performance Contracting (EPC), which aim to involve private energy suppliers in refurbishing public structures and senior public housing.

The explanations for why the building industry is usually associated with energy efficiency can be summed up by two well-known figures. About 40% of the energy used in cities comes from buildings, which is considerable given that cities are also where greenhouse gas emissions and waste production occur (Chegut et al., 2019). However, very few systematic reviews (SLRs) have been conducted to evaluate public housing as an affordable housing scheme across different countries. In this systematic review, we aimed to assess the cost-benefit, environmental sustainability, and affordability of public housing.

METHODS

Introduction

A recent systematic review was conducted following the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" guidelines (Selcuk, 2019) to fulfil the study's aims, which were to evaluate the cost-effectiveness of public housing as an affordable housing scheme. This report followed a systematic literature review process (SLR). The definition of an SLR is "an evaluation of a specific and measurable topic that main themes and clear techniques to find, select, and critically evaluate related studies, and to analyses and evaluate data of the included studies." Although it establishes a "formal methodology that allows you to pursue a proper literature study on a particular subject," this method is vulnerable to human error. The investigators conducted the entire systematic literature review (SLR) procedure in the same area to minimise this issue and ensure reproducibility. Any discrepancies were, therefore, immediately explained, and everyone worked together to find, remove, and categorise the data accordingly. For a recent systematic review, the extraction, selection, and screening of research articles are illustrated through the PRISMA flowchart (Athikarisamy & Patole, 2021), as shown in Figure 1.

Search Strategy

The recent systematic review followed a search strategy that included data extraction and collection steps related to the title "Systematic Review of Public Housing and its cost-benefit analysis." We used databases for data search and extraction, including IEEE Xplore, ScienceDirect, JSTOR, ERIC, and Web of Science, on November 10, 2022. The MeSH keywords used to search data were "public housing," "cost efficiency," cost-benefit ratio of public housing," "survey-based studies," "outcomes of public housing," and "environment-friendly green housing" among all databases. Only those research articles published from January 2013 to October 2022 have been extracted.

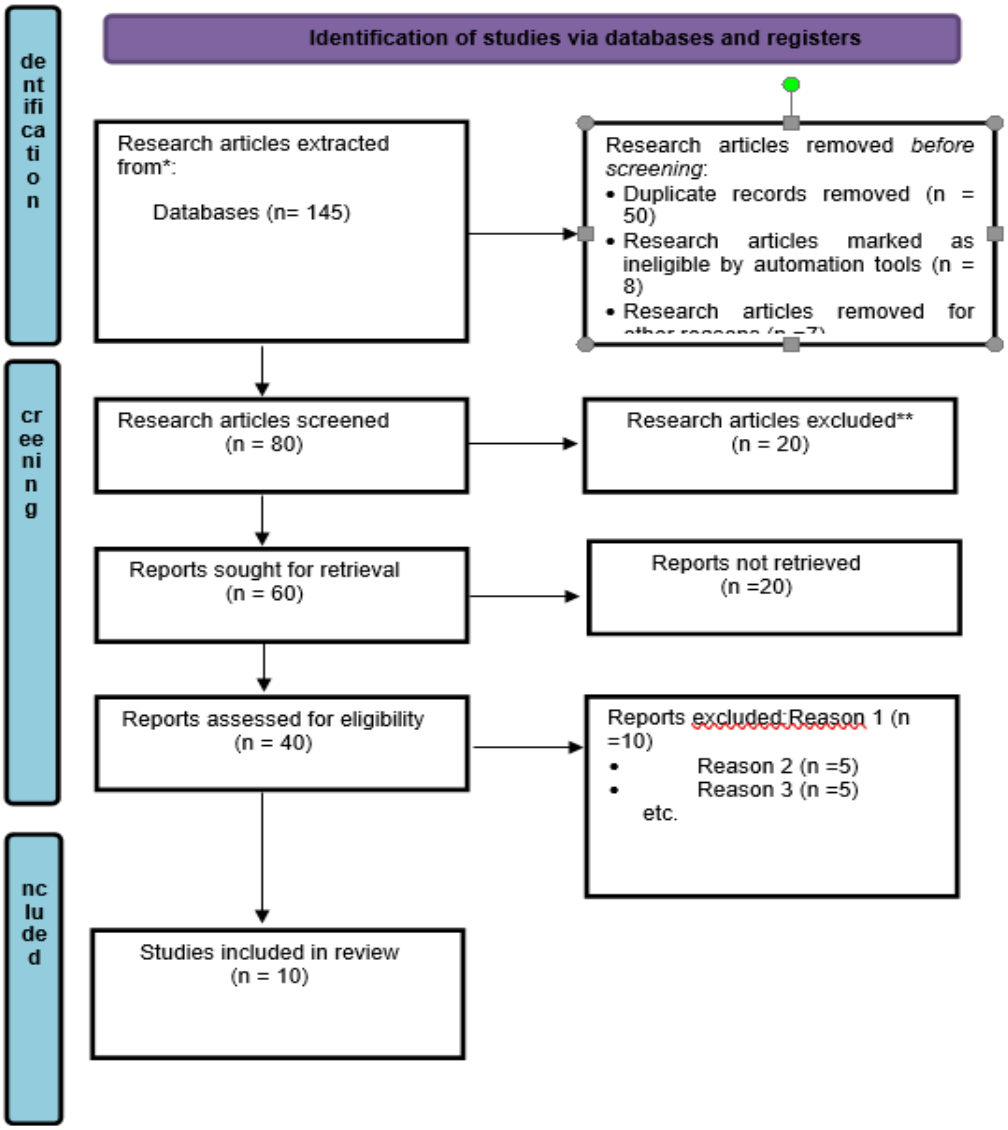

Figure 1: The PRISMA flowchart for screening and selection of standardised Research Articles

Study Selection

Following the collection of the data, the screening and selection processes, which are essential for a systematic review, were conducted using the established inclusion and exclusion criteria. Following PRISMA principles, the collected research publications were screened and chosen. According to the study topic, the selected papers focused on public housing, including its costs, benefits, and effectiveness. The inclusion criteria for selection were (1) survey-based studies, comparative analysis, and cost benefits analysis (2) assessing or evaluating cost-benefit and environment sustainability of public housing (3) The study areas were housing societies, housing projects, and green projects (4) the outcomes of studies should be cost and economic analysis (5) papers written and published in the English language. The exclusion criteria for the recent systematic review were (1) review-based articles, case studies, and already done systematic reviews or meta-analyses, (2) studies

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addressing other schemes or housing strategies, and (3) Research papers published in other languages rather than English.

Data Extraction

After screening and selection, the information related to study type, author, year of publication, research aim, research area, objectives, and findings were extracted, as shown in Table 2. All of these studies were related to

Quality Assessments

We utilised the Mixed Methods Appraisal Tool (MMAT) for quality assessment, which evaluates the quality of survey-based, analysis-based, and comparative studies using 19 items. These 19 items were 19 questions about the title, research questions, study aims, study design, type of participants, source of findings, types of analysis, simulation of results, results, and future recommendations. The MMAT evaluated qualitative and quantitative studies using the same criteria. Three layers of items are considered when evaluating mixed-methods research studies: the overall mixed-methods set, the descriptive set, and a quantitatively assessed set (which can be either randomised clinical trials, non-randomised trials, or descriptive quantitative studies). Every item is evaluated on a scale based on "yes," "no," and "can't tell," and the maximum number of "yes" responses is added up to produce the final score.

Data Analysis

The recent systematic review was based on a qualitative analysis, in which we developed themes following the research aims. A technique for assessing the descriptive method is thematic analysis. It is typically used with a collection of data, like transcripts from an interview or other sources. The researcher thoroughly examines the data to identify recurrent themes, subjects, ideas, and meanings. Through thematic analysis, we discussed each aspect of the study, including the cost-benefit ratio, environmental sustainability, and affordability of public housing, as presented in the included articles. Table 1 outlines the themes of a recent systematic review, including:

Table 1: Themes of recent systematic review

Themes	**Sub-themes**
Cost benefits	Cost of houses Economically fair Range of Average customer
Environmental Sustainability	Greenhouses Co2 emissions Less pollution causing
Affordability	Affordability for contractors Balanced investments
Energy efficiency	Energy independent Fossil fuel dependent

Ethical Considerations

In a recent systematic review, ethical approval is not required because we are extracting data from previously published studies. Among the publishers of those studies, informed consent was obtained by the research owners, who have been retrieved and analysed.

Summary

From data collection to screening and selection, all steps of the recent study were performed following PRISMA guidelines. After extraction, the MMAT tool assessed the quality of the included studies.

RESULTS

Identified Studies

From the current systematic review, 145 studies were collected based on the analysis of the affordability and cost benefits of public housing schemes, which were searched in the already mentioned databases. Based on the inclusion criteria, 40 papers were deemed relevant and reliable concerning the study's objectives. Due to redundancy, 30 study papers were deleted from 40 investigations using exclusion criteria. Only 10 of the remaining papers matched the standards and the aforementioned requirements.

Descriptive analysis of identified Studies

Among the nine selected studies, the public housing trends of approximately seven different countries were analysed to evaluate the cost benefits. Those ten studies were survey-based, cost-benefit analyses conducted in Australia, the USA, Virginia, Italy, Mexico, and China, representing different world regions with high, low, and moderate economies.

Table 2: The characteristics of included and selected studies

Authors, year	Study location	Study population	Study design	Objective	Findings
Jacobs, et al., 2010 [16]	Australia	UK and Australian post-war housing	Critical analysis	To develop a baseline regarding the long-term development of public housing in Australia	Public housing reduces government costs and environmental consequences.
Chegut, et al., 2016 [17]	Netherlands	Dutch construction models	Comparative analysis	To categorise public housing as an enhanced form of energy-efficient housing,	Energy-efficient public housing has a higher chance of being sold than low-efficiency housing.
Jeddi et al., 2019 [18]	Virginia.	Low-Income Housing Tax Credit (LIHTC)	Cross-sectional study	By examining building costs, trade costs, and the economic consequences of green certificates and accessible public housing units, this study analyses volume reward alternatives for green affordable housing.	The size of the social advantages of green building supports the local establishment of a voluntary program for environmentally friendly affordable homes.
Di turi, et al., 2015 [19]	Italy	Public residential buildings of Bari	Analysis based study	to assess the energy requirements of a city's public housing and choose potential energy planning methods.	The findings revealed that the execution of power policies that promote the efficient use of energy and solve environmental issues and public housing is crucial.

Guardigli, et al., 2018 [20]	Italy	Housing Society of Bologna	Analysis based study	To evaluate the cost-effectiveness of the energy-efficient public housing schemes	Public housing with minimum CO2 emission provides the best cost-effectiveness for citizens.
Preciado-Pérez, et al., 2017 [21]	Northwest Mexico	Housing Society of Northwest Mexico	Cost Benefit Analysis	to assess the energy requirements of a city's public housing and choose potential energy planning methods.	Regarding decreased power consumption, investing in low-energy designs or energy-efficiency upgrades is always beneficial, but the accounting rate of return varies depending on the type and source of funding.
Trachtenberg, et al., 2016 [22]	Virginia	Atlanta, GA, and the Virginia Center for Housing Research (VCHR)	Cost-benefit Analysis	To examine the cost efficacy of green building affordable housing by comparing it to non-green multifamily affordable housing in the Southeast	Regarding building and development expenses, power efficiency, and utility prices, as well as pleasure, green developments generally exceed those of non-green developments.
Hoye, 2013 [23]	Wisconsin USA	Housing green society	random survey	to determine how homeowners view renewable energy sources and to identify the reasons why they are reluctant to incorporate them into affordable homes.	A shift in mentality toward green, sustainable living offers advantages for survival, including access to affordable housing, improved health, and greater overall satisfaction.
Ge, J et al., 2020 [24]	China	Green affordable housing	Cost-benefit analysis	to implement environmental building technology in order to increase building performance (GBT)in public housing	The findings of this study offer precise recommendations for selecting GBTs and affordable housing during the planning and construction phases.

Key Results

The term "public housing" refers to the engineering and architectural implications and requirements for constructing dwelling units. A well-designed home satisfies people's demands, is safe and sound, offers superior efficiency and human engagement within a compact form factor, and delivers ease tailored to occupants' hobbies, lifestyles, and environments. Additionally, the architectural and engineering requirements for housing, including components and energy supplies, must be practical and durable. Numerous economic, ecological, and social issues are related to housing construction. Ecologically and affordably designed homes must be optimised to maximise citizen satisfaction and minimise detrimental consequences for the local industry, community, and environment.

Cost Benefit

According to the studies presented, increasing the availability of affordable housing for low-income

households will result in significant cost reductions for the state, as well as benefits for both individual households and the community as a whole. These studies elucidate the concept of cost-benefit analysis (CBA) (Chegut et al., 2016; Yeganeh et al., 2019; Trachtenberg et al., 2016) and the challenges associated with quantifying the public benefits resulting from specific forms of social spending. This research explored methods for quantifying and monetising certain non-governmental advantages while acknowledging that many of the benefits derived cannot or should not be monetised.

Affordability

In the search for a stable public housing society worldwide, acute housing inequality and low house prices among households with low-to-moderate incomes are becoming impediments. Global housing policy has focused on increasing subsidised housing and promoting investment in affordable homes. The included studies examine the relationship between the availability of public amenities, such as primary and secondary schools, clinics, and public transportation, and the home budget for suitable housing. Economical and comfortable accommodation is analysed based on special data on qualified households and affordable housing projects. Public housing effectively made housing available and inexpensive for as long as eligible families were concerned (Yeganeh et al., 2019; Hoye, 2013; Guardigli et al., 2018). The study highlights the implications of housing policy formation for the financial and social well-being of the intended communities.

Environmental Sustainability

One of the significant economic areas is housing development, which assures the success of urban growth and sustainability. Numerous issues with the quality of accommodation and resident satisfaction were raised by the diversity of design options and the use of cutting-edge technologies, as reported in the included studies. A building that is energy-efficient, suitable for occupation, has an effective waste disposal system, and uses alternative energy sources is referred to as environmentally sustainable housing (Preciado-Pérez & Fotios, 2017; Zhao et al., 2020; Chegut et al., 2016)

DISCUSSION

Public housing is a relatively fresh and growing field that has recently attracted more attention from academics, professionals, and policymakers over time due to the social, environmental, and economic advantages of such a program. As a developing body of knowledge, it is first necessary to define innovative, sustainable, and affordable public housing within the corpus of construction knowledge to identify the critical success factors (CSFs) cluster for creating public housing. According to studies, public housing refers to the development of sustainable and inexpensive housing using cutting-edge techniques, procedures, materials, and technology (Ahmed, 2017).

This benefited the study because a systematic literature review and bibliometric analysis were employed to gather and analyse the data. The Web of Science and Scopus databases were searched for peer-reviewed publications that addressed the four study objectives: low-cost housing, sustainable housing, sustainable and reasonable housing, and unique housing. These sources were used to identify critical success factors (CSFs), combine them, and cluster them (Al Shawabke et al., 2020). This study highlights the diverse range of critical success factors (CSFs) for public housing, as well as their interrelationships. The public housing CSF paradigm revealed that the house's architecture, elements, manufacturing processes, and technology are the primary factors to evaluate, given that they encompass the most features and reflect the most beneficial public housing CSFs that have been extensively explored by scholars (Al-Momani, 2000).

Every key public housing CSF cluster network demonstrated recurrent CSFs, including the requirement for energy-efficient systems and fittings to be used, secure tenure, a healthy and comfortable indoor environment, and housing costs in proportion to earnings. The CSFs related to building components demand that durability, lifecycle costs, and improved resource utilisation be considered. The processes used to produce housing must minimise waste, maximise energy efficiency, and uphold high-quality standards. When discussing the technology element, the CSFs that were most frequently mentioned included reducing waste output, reducing water and energy use, and improving residents' living standards. In this study, the three dimensions mentioned

above, along with the technical aspects of public housing, form the foundation for a comprehensive, clustered Community Sustainability Framework (CSF) paradigm of sustainable, affordable housing development. (Ahmed, 2017; Ali, 2010).

It draws attention to the critical success factors (CSFs) that should be utilised to create public housing, facilitating not only affordable homes that are sustainably constructed from a social, economic, and environmental standpoint but also houses that are innovative and intelligent in comparison to traditional public housing (Alobaidi & Rahim, 2015). The envisioned public housing CSF paradigm is a precursor to developing a dynamic evaluation model for assessing the impact of incorporating novel technologies and practices on achieving the public housing's critical success factors. Additionally, it provides practitioners and academics with a shared language to recognise and understand what constitutes a sustainable, creative, and reasonably priced home (Anderson, 2016). As a result, the paradigm for public housing Community Sustainability Factors (CSFs) developed in this project can serve as the foundation for creating public housing and assessing the affordability, sustainability, and novelty of low-income homes. Even as research on public housing has garnered more attention over time, many questions remain unanswered. The specific findings of this study shed light on research opportunities and gaps in literature, notably in the area of housing technology. Future studies could utilise this paradigm to assess the weight and significance of each CSF in creating public housing. Researchers might consider evaluating the effects of building public housing on the comprehensive environmental, social, and economic aspects of the entire housing project (Awadh, 2017).

The HOPE VI Urban Revitalization Demonstration Program64, the social and physical program of the federal government's reinvigoration of troubled public housing, places a strong emphasis on mixing income, demonstrating the significance of housing policy that seeks to establish neighbourhood poverty while giving low-income people access to affordable housing (Buys & Miller, 2012). Such a focus starkly contrasts the public housing program's track record of centring poverty by regularly building developments in underdeveloped areas and securing units for the poorest households. These practices are primarily to blame for many of the most well-known failures of public housing, including violent environments, substance misuse, government dependence, teenage pregnancy, unemployment, and lower educational attainment among youth. Research linking the social and physical characteristics of communities and family housing to specific changes in health status has emerged in the field of public health due to growing interest in multilayer health determinants, including individual, biological, and environmental factors (Chan & Adabre, 2019). We can invest in interventions that yield the best results and mitigate enduring health inequities related to income, ethnicity, race, and social class by better understanding the connections between neighbourhood, housing conditions, and public health outcomes. Implementing the recommendation, public health organisations and local housing authorities may leverage the Task Force's suggestion for tenant-based rental assistance programs to demonstrate to policymakers how effectively these initiatives enhance family safety in the neighbourhood.

CONCLUSION

This article evaluated the cost-benefit analyses of public housing and affordable housing to encourage private researchers to consider the advantages of building green public housing. In achieving its goal, the study discovered that public housing provides various cost-effective and sustainable housing options that affordable housebuilders can utilise. Regarding the objective, it was found that renters, so long as they take steps to avoid the risk of "economic growth," are likely to gain financially from residing in a green, affordable apartment. It was demonstrated why it would be advantageous for a private corporation to build affordable housing with green features: green homes do not always cost more than conventional structures.

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