International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 01 | Jan 2019 www.irjet.net p-ISSN: 2395-0072

A Review: Impact of Retrofitting in Term of Sustainability Development and Green Building

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Abstract - Building renovation is a present opportunity to solve the current aspect of preliminary energy reduction and global warming. But it is not up to the scale in terms of sustainable development and sustainable retrofitting of buildings. Indirect way residential and commercial buildings are responsible for more than 46% of world global energy used and as much as one-third of global greenhouse gas (GHG) emissions, both in developed and under developing countries. One of the fundamental and crucial problems in global warming is how to reduce collective emission. Retrofitting is the present incorporation of measures to reduce energy consumption in buildings. Therefore improving the living comfort in residential as well as commercial building and repairing or renewing outdated building components is the main reasons for thorough renovation works. In this paper, an attempt has been made to analyze the global impact of retrofitting in term of Sustainability development and green building.

Keywords- Retrofitting, energy reduction, Global warming, greenhouse gas (GHG), sustainability, residential and commercial buildings.

Introduction

To accomplish the target of sustainable development in the area of building renovation, retrofitting technique plays a vital role. Millions of houses are required to be retrofitted in the coming years in order to improve their energy efficiency, reduction of greenhouse gases, better air quality which all leads to good health and a better environment. If we look at the statistic of a substantial share of the building stock across the world, many buildings are older than 50 years with many buildings in use today that are hundreds of years old. More than 40% of our residential buildings have been constructed before the 1960s when energy building regulations were very limited. In Europe 27, countries with the largest components of older buildings include the UK, Denmark, Sweden, France, Czech Republic, and Bulgaria.

The aim of this paper to encourage retrofitting measures to existing buildings to improve their energy, water efficiency and their adaptability to climate change as sustainability development. Support for appropriate domestic scale renewables is also important. A true retrofit require a fact-based, benchmarked, quantitatively oriented energy-efficiency retrofit with a clear pay back analysis on an integrated multi-component effort with performance guarantees.

Significance of Green Building

Green Buildings are designed to reduce the overall impact on human health and the natural environment by:

- Using energy, water and other resources more efficiently.
- Reducing waste, pollution, and environmental degradation
- Increased workforce productivity ultimately holds the greatest potential savings—far greater than energy or water savings. Presently we are facing increasing rents and occupancy rates for green buildings. Once more tenants recognize the potential savings resulting from increased productivity, they will demand new and upgraded green buildings. The building industry is largely a responsive industry, so they will provide the product. (Pogue)
- Recent studies have demonstrated various results in term of financial benefits for green building, but if we take the average and look for statistical significance, we get that three factors highly affect the resident, 1. Air circulation, 2. Lighting system, and 3. Control of the thermal system. (Gatlin)

Essentials of Retrofitting Technique:

- Theoretically, whole-building retrofits presumed as appropriate because that allow to complete the most extensive and expensive task in final step.
- Whole-building retrofit approach help in savings of easy stuff and give the lower payback, annual

savings and good return on investment for the whole project.

- Where the owners have scarcity of capital this technique is considered to be very helpful. In such cases, carry out the proven lower-cost steps first, then change your workforce's behavior, improve training for building managers, and make the best use of the existing equipment. (Pogue)

Need of retrofitting in green building

Studies have shown that deep renovation has the potential to be the preferred solution rather than superficial renovations from ecological and economic point of view. Superficial renovations enhance the risk to miss the climate targets and huge absolute savings to remain untapped. Additional studies have identified the potentials of refurbishment to upgrade the energy efficiency of the building stock and the consequent savings in CO2 emissions. Following are the benefits of applying retrofitting technique in green building:

- Bring Structure design efficiency (secure the building envelope)
- Energy Efficiency
- Water Efficiency
- Materials Efficiency
- Protection of health and indoor environmental quality
- Reinforcement of natural systems
- Waste and toxic reduction

Thaleia Konstantinoua, Ulrich Knaacka This paper presented an integrated approach to the energy upgrade refurbishment that gives specific answers to key parameters of integrated refurbishment. It also determines how improvements in the energy performance can be achieved. In this approach, different options for each parameter are studied, calculated and designed in a level of constructional detail, providing a database of options and solutions. This systematic approach to the strategies, divided into key aspects and different options, can be organized in the form of a "toolbox".

The importance of this approach is to recognize the diversity of each project, as well as the designer freedom to his decisions. For this reason, it doesn't aim to dictate an optimal solution that has to be universally applied to reach the energy demand reduction. With respect to the specific requirements of each case, we assist the designer to make efficient choices.

Francesca Cappellettia, Tiziano Dalla Moraa, Fabio Perona, Piercarlo Romagnonia*, Paolo Ruggeria As per this study the following outline has been made: The definition of a strategy for energy savings and for carbon emission optimization requires that people involved in retrofitting interventions (in the Annex 56 proposals, policy makers and "professional owners") shall address their efforts in a same direction. These Guideline report outlines key drivers for building retrofit and use and the resulting impacts on energy consumption and the policy objectives that should be pursued. The guidelines addresses especially to policy makers and building owners, but the main scope is to show a general overview of the reachable targets for all the actors in renovation of existing buildings.

This study have mentioned the various aspect for reducing greenhouse gas emissions from buildings

- Increase the energy efficiency of new & existing buildings (both the physical envelope, and the operational aspects such as energy systems for heating, ventilation and other appliances);
- Increase the energy efficiency of appliances (white goods, entertainment, personal computers and telecommunication equipment);
- Encourage energy and distribution companies to support emission reductions in the Building Sector;
- Change attitudes and behavior;
- Substitute fossil fuels with renewable energies.

Age is the important factor to consider building for retrofitting and sustainability. Generally 20-60 years buildings have been consider for sustainable development in term of retrofitting. Age of green retrofitted building has been shown in chart 1.1.

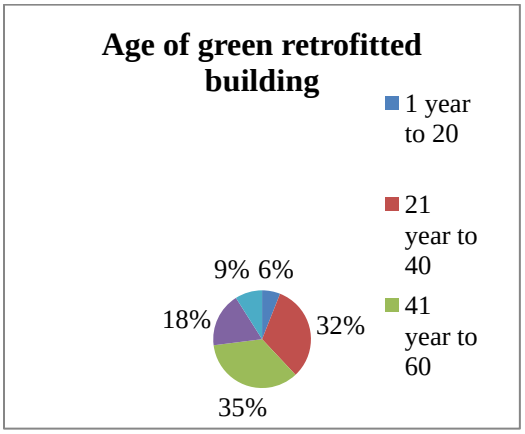

Chart 1.1 **Age of green retrofitted building**

Sophie Trachte and Fritjof Salvesen As per this study Building renovation is a real opportunity to meet current challenges of primary energy reduction and global warming. But it is not sufficient in terms of sustainable development and sustainable retrofitting of buildings. The outcome of this study was (1) Presentation of the theoretical basics necessary to good understanding of physical, hydrothermal, acoustic phenomena in building, (2) Proposals and tools for the evaluation of different problems (or environmental energy) met in the building and for the identification of the origin of these problems, (3) Solutions or recommendations to improve and optimize the envelope, to optimize existing systems and / or implement new systems or measures.

Jeroen Vrijders, Laetitia Delem, The literature review of this study have shown a wide variety of methodological approaches already existing, specifically pertaining to determine cost efficiency and its environmental impact of energetic retrofits of buildings. For the purpose of future forecast data unavailability for evaluation and uncertainty of variables is a crucial problem. In order to make results comparable, there should be uniformity in the methodology.

In the present study researchers have explored below mentioned points regarding sustainable development and green building concept:

- Generally energetic renovation resultant cost efficiency which leads to cost savings in a short run and provide small pay-back period, good return on investment and annual saving.
- Optimal cost curve of individual insulation evaluate runs rather flat which state that many feasible solutions are available nearby the optimum level having similar cost efficiency.

- In many cases, optimum U-value lies far away than the minimum legislative requirements. Optimum solution in terms of cost efficiency in projects is a 'Low Energy' renovation or even a passive house renovation because it depends upon what methodology and data used and surrounding conditions example, tax deduction, energy pricing etc.
- A recent Flemish study (3E, PHL, KUL, 2008) states that the most insulation measures have very low payback period i.e.couple of years, maximum 15 years, except window replacement. Optimal U-values for components lies between 0.25 and 0.3 W/m²K for each opaque part of the envelope.
- In terms of environmental impact, energetic renovation measures have a positive impact due to lower energy consumption. However, this is not always valid, if there is a greater use of electricity (e.g. installation of a heat pump).
- Renovation is always considered to be more efficient in terms of environmental & financial sustainability rather than demolition and reconstruction of building if thorough retrofit is technically possible.

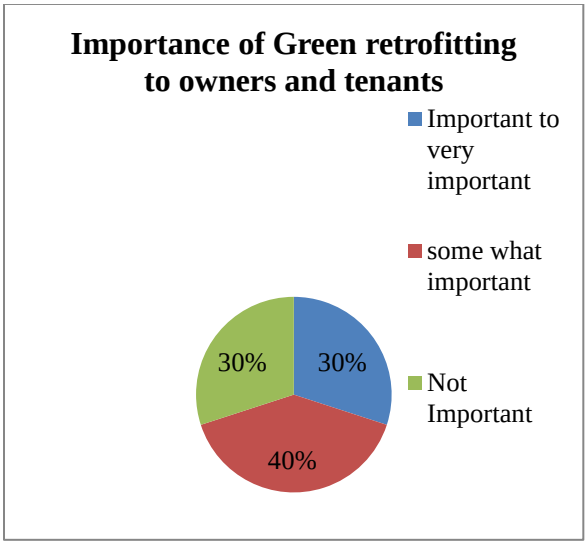

Chart 1.2 % of importance of Green retrofitting to owners and tenants

Jonathan Pilbeam and Jordan Green, UWE, The aim of this study was to introduce about the sustainable construction and retrofitting option for typical houses. The following points has been made in term of sustainable construction-

- While setting new buildings, there is an opportunity to orient them to:
  - Maximize natural daylight and sunlight into the building.
  - Ensure that the largest part of the roof's surface is facing South or at least SSE/SSW so that any solar panels on the roof have maximum access to the sun.
  - Maximize the roof pitch angle to be PV ready in future
  - South facing elevations could utilize naturally ventilated conservatories and sun lobbies to control solar gain within dwellings.

- Consider the topography of the land and character of the place together with solar orientation when siting and laying out your new building. The Building for Life Tool on the Design Council website can help with this.
- Space can be left around the main buildings to allow for rain water collection and the use of Sustainable Urban Drainage Systems or SUDS in the landscaping around dwellings.

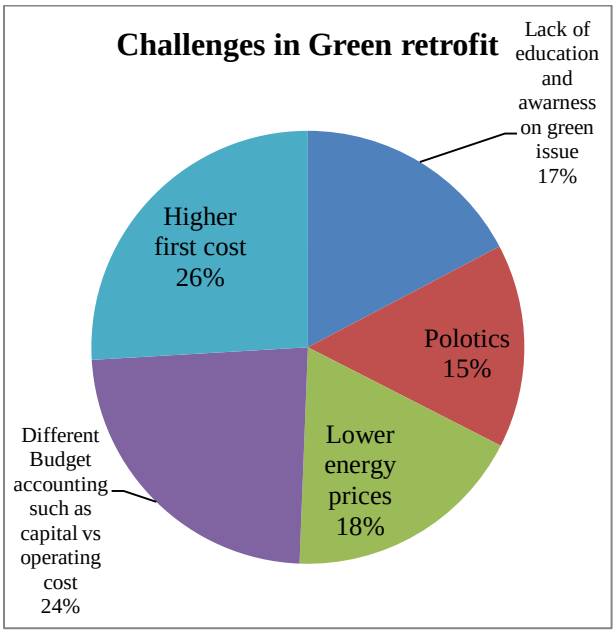

Chart 1.3 Challenges in Green retrofit

McGraw-HIII According to this study-Green retrofit market opportunity- The market opportunity for building has grown dramatically in both new and existing building. By 2022, the green building market share of all retrofit, alternation and renovation activity expected to 25-40%.

Also the % of importance of Green retrofitting for owners and tenants has been shown in chart 1.2. Crucial challenges in green retrofitting building have been shown in chart 1.3.

Cetin Sahin This research work will introduce about earthquake resistant design and the methodology about seismic evaluation and rehabilitation of existing structures. It also gives computer software modeling against seismic loads and shows the necessity of seismic upgrading in a steel moment-frame building. According to this study, the structural retrofit improved the seismic resistance of the building and it can be considered in the retrofit of moment frame structures to prevent the risk of structural collapse under the design load with much more confidence. This study shows how the pushover analysis may be used in order to estimate the seismic resistance of existing or retrofitted structures as well as how the linear analysis may be followed by a detailed nonlinear analysis of part of the structure.

Kirtika Gupta[1], Abhishek Kumar[2], Mohd. Afaque Khan[3] In this review paper many guidelines for the retrofitting have been reviewed specially for seismic effect building in concrete frame. The conclusion part of this study has shown to have the further detail investigation for seismic effected buildings.

Magnus Bonde The overall aim of this research project is to study green/energy-efficient real estate from an economic perspective and retrofits.

The main focus of this paper was:-

- "Do green buildings have a superior indoor environment?",
- "Does energy efficiency add value?", and
- "What prevents profitable energy-efficiency measures from being undertaken?"

In this paper the targeted study was on tenants that how tenants perceive the indoor environment in green-rated premises, and to compare these results with tenants' perception of a conventional building's indoor environment. Here two case studies have been done, firstly on LEED-certified building and secondly on conventional building. The studies concluded that the tenants are more satisfy in the green building than the conventional buildings.

The main focus of paper is to study green/energy-efficient buildings and retrofits. The target of this paper was not to elaborate any new research methodologies, but instead to use already established approaches and theories to study a specific research area, with a focus on the Swedish real-estate sector.

In the summary part of paper says that, users are most oriented towards indoor environment in green buildings, at least in terms of thermal comfort and air quality. According to this paper still are some economic barriers toward a more sustainable built environment.

The main barriers are-

- First, a premium for improved energy efficiency exists.
- Second, it is problematic to alter existing leases.
- Third, even if the incentives are appropriate, it still can be rational to postpone refurbishments, as better investments can be made in the future.

As a result, profitable green/energy-efficiency retrofits might not be undertaken.

Jian Zuoa, Zhen-Yu Zhaob This paper have shown the deep review about green building globally. The result part of this paper concluded in three basic categories as following-

- The definition and scope of green buildings;
- Benefits and costs of green buildings; and
- Ways to achieve green building.

According to the literature part of this paper most of the studies focus on environmental aspects of sustainability such as energy consumption, water efficiency and greenhouse gas emission together with the technical solutions. Still there is lack of further studies on social and economic factors even number of research studies shown their importance in this field. The life cycle evaluation methodology, have been taken into consideration in case of environmental and technical aspects of green building, will be a useful tool for social sustainability as well.

Rafik Itani and Xin Liao, The conclusion part of this study shows that retrofit strategies of reinforced concrete bridges can be optimized to achieve the performance goals of a given structure. As a result, considerable economic savings can be realized in retrofitting applications also it will give impact on sustainability by reducing the consumption of natural materials.

SHARACHCHANDRA M. LELE, as per the introduction part of this paper**,** recent few years have shown the drastic change in transformation in the environment-development debate. The question being asked is no longer "Do development and environmental concerns contradict each other?" but "How can sustain- able development be achieved?" All of a sudden the phrase Sustainable Development (SD) has become pervasive.

In case of SD the finding of this paper was- More specifically, proponents and analysts of SD need to:

- clearly reject the attempts (and temptation) to focus on economic growth as a means to poverty removal and/or environmental sustainability;
- Recognize the internal inconsistencies and inadequacies in the theory and practice of neoclassical economics, particularly as it relets to environmental and distributional issues.
- accept the existence of structural, technological and cultural causes of both poverty and environmental degradation:
- understand the multiple dimensions of sustainability, and attempt to develop measures, criteria and principles for them;
- Explore what patterns and levels of re- source demand and use would be compatible with different forms or levels of ecological and social sustainability, and with different notions of equity and social justice.

Usman Aminu Umar, M. F. Khamidi, and Hassan Tukur, The aim of this paper was to introduce the sustainable materials for vast developing construction industries. As per this paper SBM are materials which are locally developed which directly reduce transportation cost and CO2 emissions, it may part of recycled materials, which has following positive factors for GB- (1) lower environmental effect, (2) thermally effective, (3) less energy than conventional materials, (4) renewable resources,(5) lower in harmful emissions (6) economically sustainable. Further they have concluded that sustainable building material needs to be used properly and contextually in every community development.

Enver Aydın Kolukisa, Nihal Baloglu Ugurlu, This paper emphasize that sustainable development is a milestone in environmental theory. According to this paper SD as a new concept came up in the 1970's directly proportional with the increasing industrialization. The report known as "Collective Future" published by the World Environment and Development Commission in 1987, the concept of SD, which has the principle of increasing development in consideration with the environment, attracted a lot of attention (Ercoşkun, 2005).

The outcome of this paper is "education for sustainable development develops and strengthens the capacity of individuals, groups, communities, organizations and countries to make judgments and choices in favour of sustainable development (UN, 2005)".

Annette Schavan, MP, The summary part of this paper emphasized that vital change is required in society for that there is need of change to each

individual person. Therefore we have to take this social dimension right from beginning to enable the transfer of research results to everyday life.

Yang Lu, in this paper main finding were desirable qualifications of green concrete for sustainability. The main points is following-

- Long service life and performance
- Maximized recycling materials usage and minimized environmental impact.
- Minimized transportation cost.

The noticeable figure of this paper is construction industry consumes 40% of the total energy and about one-half of the world's major resources. Hence, it is imperative to regulate the use of green materials and less energy consumption in construction industry.

Conclusion

From this literature survey, it has been observed that building renovation using green retrofitting is a real opportunity to meet current challenges of primary energy reduction and global warming. Generally the age of retrofitted building was 20-60 years at globally; also almost 70% green retrofitted building were proved important for owners and tenants. In coming decade, the green building market share of all retrofit, alternation and renovation activity expected to 25-40%. The main cause for green retrofitting, were lack of awareness on green issue, politics, lower energy prices and different budget accounting such as capital vs operating cost.

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BIOGRAPHIES

Dr. Vijay S. Rawat was awarded a Ph.D. in Civil Engineering from Pacific University, India at 2018 and authored a research thesis titled "Re-analysis and Re-design of G+3 residential Building by retrofitting techniques with cost comparison in seismic Zone-III, Mumbai.". In 2014, he was awarded M.Tech (Construction Engineering) from Bhagwant University, passed with CGPA 7.30 and B.Tech in Civil Engineering Rajasthan Technical University, Kota, India. Presently He has more than 6 years of teaching and industrial experience. He published and presented his research in many National as well as International conferences and also peer-reviewed journals. Totally he has published 2 books and more than 9 papers, maximum peer-reviewed journal papers. His current area of research is the analysis and design of the residential building by retrofitting techniques in term of sustainability.

Dr.R.Divahar was awarded a Ph.D in Civil Engineering (Structural Engineering Specialization) from Hindustan University, India at 2015 and authored a research thesis titled "Behaviour of Cold-Formed Steel Beam with Concrete Encased Trapezoidally Corrugated web". In 2011, he was awarded M.E (Structural Engineering) from Hindustan University, passed with CGPA 9.15 and achieved University 2nd rank and B.E in Civil Engineering from Jerusalem College of Engineering, India (Affiliated by Anna University at May 2008. Presently He is have more than 8 years of teaching and industrial experience, around 5 years he worked as a Head of the Department in St.Joseph College of Engineering, Sriperumbudur, Chennai, India. His inventions are patented and published in India at Jan 2018. He published and presented his research in many National as well as International conferences and also peer reviewed journals. Totally he published more than 25th papers, maximum peer reviewed journal papers was indexed by Scopus, Elsevier, Springer & Science Citation Indexed. His current area of research is Cold-Formed Steel Structure, Concrete and Composite Structure and Finite Element Analysis.