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Analysis of a Low Carbon Emission Green Building Using ETABS A Review

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ABSTRACT

Present world is requesting supportable practices in varying backgrounds and development industry isn't unique. The maintainability idea in development industry has made some amazing progress yet there is need for new turns of events and creations. One of the key aspect of sustainable construction is the concept of green buildings. It is the type of buildings that are environment friendly as well as resource efficient. There are several systems for assessing the green building and rating them accordingly. In India, there exist 3 major rating systems but all of these systems only account for very large buildings or small commercial buildings. This exploration center around attempting to oblige a little existing private structure into the structure of one of the rating frameworks SVAGRIHA (Basic Flexible Reasonable Green Rating for Incorporated Living space Evaluation) for changing over the halfway customary structure into green structure. The structure condition was examined and green structure ideas were suggested. A basic expense investigation for the extra works and frameworks were likewise finished to show the efficient part of transformation to green structure. A bunch of suggestion to better the green structure rating frameworks as well with respect to regulatory level were given.

Keywords : ETABS, Structural Analysis, Energy Efficiency, Low Carbon, Building, Environment.

I. INTRODUCTION

India is a fast growing country. Rapid industrialization, increasing population, infrastructure development and destruction of natural resources lead to construction of green building. Green structure is a design that is ecologically mindful and asset effective all through its life cycle. Green structure is likewise known for its maintainability and elite execution. Warm solace concentrates on conventional private structures of India that is known for its utilization of regular and uninvolved strategies for an agreeable indoor climate, are under progress. Detached techniques for accomplishing warm solace inside the structures are the best answer for give a solid and

energy effective indoor climate. This is of preeminent significance for structures in the jungles where mechanical frameworks with high energy utilization are utilized to condition the indoor climate for warm solace. Individuals are compelled to rely upon such frameworks since, larger part of the structures are planned without giving satisfactory significance to detached techniques for controlling the indoor climate. Much of the time, inability to give the expected warm circumstances has brought about distress, chronic sickness and efficiency misfortune. As of now, there is a consistent need to assess the warm states of the indoor conditions to learn further and continue with the exploration in detached plan. Water is a critical and finite resource. It covers over 71% of the Earth's surface and is essential for life, playing a key role in the production of food, human health and sustaining the natural environment. However, water, particularly of drinking water quality, is becoming increasingly scarce in most of the populated regions of the planet. The strain is on to lessen water interest by diminishing wastage, to reuse or reuse however much as could reasonably be expected, and to take a gander at different method for limiting our effect on the water climate. Generally we should be more effective with our water usage. Discarding waste has tremendous ecological effects and can lead to difficult issues. Some waste will ultimately decay, however not all, and in the process it might smell or create methane gas, which is hazardous and adds to the nursery impact. Squander that isn't as expected made due, particularly excreta and other fluid and strong waste from families and the local area, are a serious wellbeing peril and lead to the spread of irresistible infections. Unattended waste lying around draws in flies, rodents, and different animals that thus spread sickness. Typically the wet waste disintegrates and delivers a terrible scent.

II. Literature Review

A. M.Ramírez and N. D. Belie (2023) research paper presented the environmental and economic assessment of eco-concretes using fly ash and blast furnace slag for the design of a house located in Santiago de Cali (Colombia). The environmental and economic impacts are estimated by means of the environmental life cycle assessment (LCA) and life cycle costing (LCC), which are methodologies based on the ISO and ASTM standards implemented in the online software Building for Environmental and Economic Sustainability (BEES), which was selected for the case study.

Results indicate that 40% fly ash concrete or 50% blast furnace slag would be recommended for reducing acidification or global warming potential, respectively. However, considering the existing public policies, the best option for the case study is 50% slag concrete. These results are of significant importance as they allow providing data-based recommendations for designers during the selection of the different eco-concretes. Additionally, these results might help establish a national roadmap to reduce carbon dioxide emissions from the construction sector, which are projected to continue increasing until 2050.

W. Taemthong and N. Chaisaard (2023) research paper presented a method for determining the minimum project costs of green building developments. The processes and steps to be completed in determining such minimum project costs are presented based on a case study of a learning centre building which received LEED platinum certification. An extra investment from traditional building practices was employed to earn a certified level of 0.93%. The cost premiums of silver, gold, and platinum levels are slightly higher than costs involved in traditional building projects at 1.17%, 2.15%, and 8.92%, respectively. The incremental percentages are

higher than Kats et al. (2003)'s results, except in the case of silver certification. However, different countries may have different cost slopes to implement.34

Lalit Srikar et.al (2022) author conducted a detailed comparison between a sustainable office building and a conventional structure. The embodied carbon, cost benefit analysis and operational energy of two theoretical models of conventional and sustainable buildings were analyzed.

The embodied carbon calculation showed that our sustainable building model has a potential of savings of up-to 36.5% annually. This will help greatly reduce the environmental impact of the construction of the building. Using locally sourced materials also help boost local economy. The results show that since, the sustainable building comes with a solar power system, rainwater harvesting, usage of alternative building materials and so on, the cost of building a sustainable building is 43.3% higher than that of a conventional building. Although the initial cost is higher, due to reduced cost in operations, the breakeven period for the building is 6 years. The CO2 released due to operational usage drops by about 73.8% annually for the sustainable building in comparison to the conventional office building. The CO2 released per employee is also down by 64.7% annually 53.

P. Vinoth et.al (2022) objective of the research paper was to present comparison of the results produced from conventional and ETABS software analyses of a G+12 storied building structure. ETABS programme software was used to design and analyze a multi-story G+12 structure with lateral seismic and wind load effects. IS 1893-part2:2002 and IS 456:2000 were used to design this project.

The software analysis stated that the value of reaction force and loads increases gradually from to the roof top floor to the ground floor if it comes down.

Theodoros Chrysanidis et.al (2022) objective of the research paper was to demonstrate whether the cost of construction of a load-bearing body of a reinforced concrete (R/C) building is influenced by the area of an earthquake hazard through a comparative analytical estimation of construction costs. The same building in the three seismic zones in Greece was modeled, analyzed and dimensioned. Then, the construction cost of its structural body was estimated. The building modeling was performed in SAP2000 using frame elements. The analysis of the building was performed by dynamic spectral analysis methods using the design spectrum EC8. A five-story building with a standard rectangular floor plan per floor was used.

Results stated that the rate of increase in construction costs from one zone to another was quite small in relation to the rate of increase in the seismic acceleration in the respective seismic hazard zones. Thus, if an engineer wishes to dimension a construction using the immediately larger seismic zone than the one in which the construction is located for increased safety, they can do so without significantly increasing the cost of materials. The percentage increase in CO2 emissions follows the percentage increase in the reinforcing steel when designing for higher seismic zones to zone I.

LIhua Wei et.al (2021) Based on the experiments of structure underhorizontal low cyclic loading, the aseismatic capacity of the connecting structure of the fiber-reinforced plasterboard and concrete frame was investigated. Excellent aseismatic reliability of the two types connection was showned in this experiment.

Results stated that the lateral deformation resistance and seismic performance of the new green frame structure are sufficient. The new green material connection joints can still work normally when the members yield, which indicates that the seismic capacity of the connection joints is greater than that of the frame structure.

Noel Johnson and Aswathy Soman (2021) in the research paper, G+9 of RCC structure in zone IV are being analyzed by equivalent static method by using ETABS2016 software. In case of RCC structure, all structural members are considered as per IS 456:2000.The basic planning and loading for the RCC structure is kept similar for the investigation.

Results stated that time period for RCC frame structure was more as compared timber structure due higher mass of RCC frame Structure. The Base shear found in RCC framed structure was more as compared to Steel frame structure. Value of base shear obtained for RCC and timber frame structures are 1361.28KN and 349.9 KN respectively. Seismic weight of RCC frame structure was more than Steel Frame structure because of its greater dense crosssection of structural member. It was concluded that RCC and timber combined design, make it a safe choice in seismic zone for greater performance of structure.

Tushar Jadhav et.al (2021) research paper compared the initial cost of major elements such as building envelope, mechanical and electrical systems for conventional and energy efficient building. The effective use of building information modeling (BIM) to understand the cost management aspects was further investigated.

The results indicated that the initial cost of energy efficient building can be significantly lower compared to the conventional building. The study also highlights the effective use of BIM to estimate the major cost drivers associated within the building. The flow chart for comparative initial cost analysis between conventional and energy efficient building can provide significant insights to the different stakeholders in promoting energy efficient buildings.

A. S Ingale (2020) author analyzed the construction and life cycle cost of Conventional building and Green Building based on Life-Cycle Cost Analysis Method. The research was carried out to an existing G+1 story residential building. It was constructed as per the conventional ways using all old non-green materials. The analysis enabled to identify the relationship between sustainable features and its impact on initial cost as well as LCC. Comparison was done between the buildings is for total Energy cost required for the life of 25 years.
B.

From the LCCA of both the buildings, it is clear that the total cost needed for a Green building for 25 years is much less than that of a conventional building. Green Building concept gives Tangible and non-tangible benefits from the stage of conceptualization of the project till the full useful life of the building, through initially in few projects the construction cost is higher than the base cost by approximately 16%, but this can be recovered within 2-3 years of lifecycle of the building by the way of saving in the operation of the green building.

MK Kamaralo et.al (2020) in the research paper, the Life Cycle Cost (LCC) method was used to determine the total cost needed, the optimal cost of the building, the economic age of the building, the number of crew maintenance and the level of energy efficiency. The analysis using the Life Cycle Cost method requires several related costs such as Initial Costs, Maintenance Costs, Energy Costs, Replacement Costs,

and Utility Costs. The analysis was conducted using the Present Worth method within a period of 8 years from the start of building construction. Based on data processing using the Life Cycle Cost method, the optimal cost of a green building concept building was IDR 232,296,615,337 with the economic life of the building being 8 years, the optimal number of maintenance crews was 1 person and the level of energy consumption intensity was very efficient. The intensity of energy consumption in the Green Building case study is 6.68 kWh / m2, which can be said that the intensity of energy consumption in the green building concept is very efficient than conventional buildings.

AlSadi A et.al (2019) objective of the research paper was to design a two-story residential steel moment resisting structure and to compare its construction cost before and after implementing LEED features to the design. One of the significant features of the project was the implementation of green features to the design, such as solar panels, a vegetated roof, permeable paving, highly efficient appliances etc. which transformed the conventional building design to a "green" building making it LEED certified. Total cost of construction rose by 30% by adding LEED features compared to the conventional building cost [24,25]. Considering the savings of $11,548 per year, it will take approximately 15 years to even out the added green feature cost. Overall, this project benefited the group engineers in learning the step by step process of designing a steel frame house and the concept of green building and its importance.

Purushothama.C.T and Harshith H J (2019) research paper aimed to increase lateral stiffness of openings by providing different bracings. Frames considered were – (a) Bare frame, (b) Diagonal bracing, (c) Frame with X bracing, (d) Frame with V bracing, and (e) Frame with Chevron (inverted V) bracing.

Results stated that bracings provided in the frame improves performance of structures, less likely to fail during earthquakes. In green buildings wide openings are unavoidable, openings reduces lateral stiffness of structures. Bracings are the best solution to improve stiffness of structures and to satisfy green buildings requirements. Utmost care should be taken in the design of green building with more openings in the exterior wall by providing stiffeners.

Ammar Qassem Ahdal et.al (2022) in a research paper, it was hypothesized that the mechanical performance of green concrete prepared by substituting cement with Natural Zeolite (NZ) and waste Polyethylene Terephthalate (PET) fibres will yield stronger, cost-effective, and environmentally green concrete for the construction industry. The microstructure, morphology, and surface properties of the locally extracted NZ were characterized using X-ray Diffraction, SEM and BET, respectively. The influence of quantity, shape, orientations, and surface of NZ and PET fibers along with varying curing times, i.e., 28, 90, and 180 days were considered for experimentation.

The main findings of the research were that two optimum proportions for the concrete mixtures are obtained: the first one was 10 % NZ while the other one was 2.5 % PET, 15 % NZ, and 1.0 % PET. These optimum mixing ratios were found to enhance the compressive strength of concrete, reduce the production cost, and reuse waste PET bottles effectively, which are key points of this study. Furthermore, the workability of the fresh concrete was improved with higher proportions of PET rather than NZ. Finally, the findings of the current research highlight a pragmatic remedial solution for saving energy, turning non-decomposable waste into useful materials for green concrete, and simultaneously contributing to a cleaner environment.

Emad S. Bakhoum and Yasser M. Mater (2022) research paper aimed to develop an approach using a multicriteria decision-making algorithm based on Analytical Hierarchy Process (AHP), to select the most suitable industrial waste to achieve the desired green concrete properties. The research starts by determining the alternatives including 18 industrial wastes, and the criteria including 14 properties of concrete. An algorithm was developed using a python script to analyze the influence of incorporating each of the industrial waste alternatives on both the mechanical and sustainable properties of concrete. Subsequently, the efficiency of the proposed algorithm is validated using three case studies that present different circumstances of concrete specifications.

Since there is no waste material that can be used to enhance all the concrete properties altogether, the adoption of the proposed methodology in the production of green concrete promotes both the sustainability and mechanical properties of concrete. However, building a larger database incorporating more waste materials and more concrete properties can significantly enhance the decision-making process.

Hritik Bagul et.al (2022) author created a working model of a green society that not only offers residents with an environmentally friendly atmosphere, but also focuses on waste material re-use. CO2 emissions are minimal, electricity usage is low, and there is no discharge. Efficiency in energy use is the way of the future. The world is rapidly approaching energy sustainability. At the same time, humanity is attempting to re-establish its relationship with nature. A home that is energy efficient is a personal step toward renewable energy, environmental protection, and long-term living. Having such a home can help homeowners save money on their costs and is a good investment. Furthermore, energy efficiency equates to a healthier, more pleasant, and environmentally friendly way of life.

Yasser A.S Gama and M.A. Elrazek (2022) research paper focused on the examination of the seismic response demands for the LC by evaluating variety kinds of concrete (LC, HC, and OC). In addition, the combination between them (LC, HC, and OC) in the structural elements is another important factor to be recognized in research. The results include story displacement, story drift, story shear force, and overturning moment.

Results indicate that using LC can cause a better seismic response than other types of concrete. Also, this behavior is caused by the weight of the LC, which is lower than other types [HC, OC]. Hence, it can impact on the earthquake forces. Besides, the design of the structure for story drift and story displacement of the LC model is safer than other types due to the lowering of Young's modulus of LC.

Arundeep Saini et.al (2021) Leadership in Energy and Environmental Design was introduced to provide building owners a concise framework for implementing practical green building design elements. It aims to improve performance across all inflections that hold great importance such as energy savings, water efficiency, and improved indoor environmental quality that leads to higher quality of life. In this undergraduate research, the students have implemented the use environmentally friendly features such as the use of solar panels and rainwater harvesting for landscape to greatly reduce the annual costs. The application of LEED features decreased annual conventional costs by 81% as the cost of the construction increased by 11%. The educational aspect in this research achieved a practical approach to designing a residential building by exploring and developing creative engineering solutions. The group of diverse undergraduate students including first

generation scholars, women in engineering, and multicultural backgrounds benefited regarding learning the constructs of working together. By implementing this student-scholar model, the students have familiarized themselves with engineering modeling and practical construction applications which will be utilized in engineering study and practice.

Lakshmi R (2021) research paper focused on trying to accommodate a small existing residential building into the framework of one of the rating systems SVAGRIHA (Simple Versatile Affordable Green Rating for Integrated Habitat Assessment) for converting the partly conventional building into green building. The building condition was analysed and green building concepts were recommended. A simple cost analysis for the additional works and systems were also done to show the economical aspect of conversion to green building.

The research showed that conversion of small scale existing residential building to a green building is indeed practical and is possible. But there is a lack of accurate rating system that can accommodate such a conversion. The study even though was on a particular case it could be extended to other such buildings as well. More researches in the subject is required and more simplified rating system with guidelines are yet to be developed.

Michael Grams et.al (2021) research paper detailed architectural design, consideration, features, structural design, design for sustainability, cost analysis, and LEED certification for an environmentally friendly building. In addition, the study discusses the advantages and features structural design and cost analysis of a LEED certified building and aimed to instil the following virtues and skills, diversity, teamwork, leadership, creativity, innovation, and ethics.

The design process of a green building requires several stages such as the architectural design and structural design stages. In addition, a cost analysis is important to compare the cost of a conventional building to the cost of a LEED certified green to show how a green alternative is beneficial in the long run. In the structural design, several green features are added to the building such as solar panels, rain barrels, and vegetation on the roof. The green features are added to minimize the waste of vital resources such as water and electricity. Although the LEED certified building is a costly alternative, the building's cost will be paid off in eight years and about three thousand dollars will be saved annually after the cost is paid off. Therefore, the green building design is an excellent choice for future projects because the design not only saves vital resources and helps in saving the environment, but also gets paid off in the long run.

Pavithra Rathnasiri et.al (2020) research paper focused to assess the applicability of integrating Green Building Information Modelling for existing green buildings through a practical implementation and identifying the potential challenges. Conducting a comprehensive literature survey first, Green BIM techniques and data requirements of Green BIM were reviewed. A single case study was conducted next, to practically apply the Green BIM technology. The data requirements for Green BIM were identified prior to the selection of case for the study.

Results concluded the possibility of using Green BIM techniques for existing green buildings. Besides, further studies need to be undertaken to identify and evaluate this applicability when the level of data availability is different in green buildings.

Pujan Neupane et.al (2020) objective of the research paper was to identify the costs and potential benefits of green buildings over the life cycle of the project using Cost Benefit Analysis (CBA), which performs an

economic assessment in project appraisal that helps investors and policymakers in better decision making. The study involves a case study of a public office building from Nepal, which is located at Dumre-Bhansar New Town. The existing building is retrofitted with green components such as solar panels and rainwater harvesting for energy efficiency and water efficiency.

The results showed that investing in green buildings reduce the life cycle cost of the project, and therefore generates value for money in public investment in the long run. A policy recommendation on subsidy helps in scaling the project to private sectors especially residential buildings. The most important contribution of this study lies in identifying the costs and benefits of green building and introducing the concept of life cycle cost using CBA, which increases awareness and removes barriers in implementing green technologies

Abhishek Bukhariya and Rahul Satbhaiya (2019) objective of the research paper was to differentiate a simple building and a energy efficient building and determine the stability of RC members after replacing cement by fly-ash cement. The modelling and analysis of the case study was done using analytical application ETABS.

Results stated that bending moment is comparatively more in bare frame, thus green sustainable frame case results in stable structure with less reinforcement requirement. As bending moment is higher in bare frame results thus heavy section is required which will result in less unbalance (shear) force. Conclusion stated that green sustainable structure was comparatively economical than bare frame by 8.4%.

Mirza Mahaboob Baig et.al (2019) author presented comparative study on seismic behaviour of G+15 high-rise building made with structural lightweight concrete (SLWC) and normal weight concrete (NWC) for different soil conditions and different zones, by using SLWC at critical conditions.

Results revealed that maximum bending moment and shear force got reduced by 40% and 34% respectively and maximum member sizes and steel reinforcement got reduced by 31% and 38% respectively, it has also been found that seismic forces on the structure got reduced considerably. Performance of lightweight concrete structure in high seismic zones can be enhanced by providing bracings to the structure.

Chandra Shekhar Singh (2018) objective of the research paper was to highlight how sustainable building material can contribute to lessen the impact of environmental degradation, and generate healthy buildings which can be sustainable to the occupant as well as our environment. As the build account for the 40% of the global carbon emission, the green construction techniques have an unprecedented opportunity to make a major contribution to new global carbon reduction targets. The common carbon metric will be piloted by the green building rating tools.

Materials which are domestically created and sourced which decreases transportation costs and CO2 emissions, they could consist of reused materials, they possess a lower environmental effect, they are thermally effective, they need less energy than conventional materials, they make use of renewable resources, they are lower in harmful emissions and they are economically sustainable. A sustainable building material needs to be used properly and contextually in every community development. The application of sustainable building materials not just minimizes transport costs, carbon emissions, and in most cases materials costs, it also offers employment and skills development opportunities for community members.

Xiaoqiu Ma (2018) research paper investigated the the green building materials management and supply chain system, and builds a green building material management evaluation method based on Building Information Modeling (BIM). BIM can enhance information interaction and sharing in the database, and project parties can optimize and complement the information in a timely manner, reducing the loss of information and management costs. In the green building material supply chain information exchanges based on BIM, all parties of the construction project should form a good trust relationship and reduce unnecessary friction and conflicts, which can greatly reduce costs. BIM central database is the data layer, green building materials basic information model the core layer, aecXML-based network interaction assessment the interactive layer, and design information model, construction information model and operational information model the application layer, which is corresponding to different functional layers, so as to meet the needs of design, construction and the owner.

G.J.Reddy and S.A.Mastan (2017) author proposed the guidelines for the design of fly ash based green concrete of ordinary and standard grade on the basis of quantity and fineness of fly ash, quantity of water and grading of fine aggregate by maintaining water-to-green binder ratio of 0.35, solutionto-fly ash ratio of 0.40, and sodium silicate-to-sodium hydroxide ratio of 1 with concentration of sodium hydroxide as 11M, 13 M, 15M. Heat curing was done at 60°C for duration of 24 h and tested after 1, 3 and 7 days after oven heating.

Experimental results of M30 grades of green concrete mixes using proposed method of mix design shows promising results of workability and compressive strength. So, these guidelines help in design of fly ash based green concrete of Ordinary and Standard Grades as mentioned in IS 456:2000. With the obtained results we can conclude that as the concentration of alkali solution increases the compressive strength of the green concrete blocks increases, and the also with steam curing the solution gets binding property which helps in getting required strength.

Nihar Khalatkar (2017) research paper provided an overview of the present state of affairs of concrete types that have reduced environmental impact, including the use of low energy cement, recycling of crushed concrete as aggregate, the use of fly ash and micro silica, etc. There is a description of among other things the possibilities of using “green” concrete within the existing standards and specifications, research projects about green concrete, life cycle assessments, etc. The potential environmental benefit to society of being able to build with “green” concrete is huge.

The potential environmental benefit to society of being able to build with green concrete is huge. It is realistic to assume that the technology can be developed, which can halve the CO2 emission related to concrete production, and with the large energy consumption of concrete and the following large emission of CO2 this will mean a potential reduction of Denmark’s total CO2 emission by ½ -1%.

Faridah Muhamad Halil et.al (2016) objective of the research paper was to explore the concept of a feasibility study and economic assessment in Green Building Projects. The benefits of preparation of financial feasibility study enable the client to decide with considerable confidence whether or not the project is feasible and worth pursuing.

Conclusion stated that the results of the overall evaluation of market and financial feasibility study provide the information and implication to the clients either to proceed or discontinue of project proposed

for the development. The client ability is to evaluate of the overall evaluation with considerable confidence whether or not the project is feasible and worth pursuing. If the clients decided to proceed, the improvement of the aims and scope of the project is necessary to take account of the modifications that may have appeared at the stage of a feasibility study. In green building project, the cost of construction and market need was depends on the requirement suggested by the Green Building Requirement.

Bakhoum E. S.et.al (2015) research paper presented a comparative study between conventional and eco-friendly building materials using sustainability measures. A prototype of two storeys was constructed using eco- friendly building materials (integrated bricks, rice straw bales, M2 system, plain concrete, and Rockwool sandwich panels). A sustainable decision support system (SDSS) was used to compare between the structural building materials of the two structural systems.

The results showed that the eco-friendly system had better sustainability rank (67%) than the conventional system (56%). In addition, the results of SDSS showed that the Eco-friendly system was better than the conventional system during the three phases of total life cycle assessment (manufacturing, construction and demolition) by 11%, 0.5% and 9%, respectively.

Ashish Kumar Parashar and Rinku Parashar (2012) research paper investigated the effect of green plantation on inclined roof to the indoor temperature on any building in Chhattisgarh climate. The research work emphasizes on use of the Rat trap bond wall technique with insulated cavity wall and room with inclined roof approach having green cover for a residential building. The cavity in wall was filled with wooden powder as insulating material and the outer surface of the wall protected from temperature and rainfall with tile covering. Observations were recorded in two conditions i.e., room with green roof and room with bare roof.

The experiment showed a promising result where by the average indoor temperature dropped between 0.6°C to 2.7°C as recorded during the observation for bare roof, while average indoor surface temperatures dropped between 4.8°C to 6.9° C with green roof during daytime.

The green impact on housing price

The majority of the publications that address this topic of the price effects of green buildings concentrate on commercial properties. Hedonic regression was employed by Eichholtz et al. (2010a, 2010b) to examine the price premium and discovered that certified buildings got 16.8% premiums. A certified building could increase sales price by 1.8%, 4.7%, and 13.3%, according to further studies on sustainability and dynamic analysis. Dermissi (2009) shown that LEED-certified buildings have the potential to increase sales prices by 18%; Eich-Holtz et al. (2013) demonstrated that both Energy Star and LEED have positive effects on sales price, however the effects of the two certification programmes are very minor. Their empirical research showed that a building with an Energy Star certification might increase its sales price by 12.9%, while those without a label indicated that the Energy Star labelled building could raise its sales price at 12.9%, while those labelled with LEED are at 11.1%.Though Wiley et al. (2010), Fuerst and McAl- lister (2010) and Eicholtz et al. (2010b) found out those labelled with LEED gain the sales price pre- miums are $130/sqm, 25% and 11%, while those labelled with Energy Star gain $30/sqm, 18% and 13%. It's obvious to see that Energy Star performs better then LEED if we only take the price premium into account. For such dual-labelled buildings, the effect on rent or sales price is

significantly more favourable. Fuerst and McAllister (2010) reported a 28–29% sales premium for those dual-labelled structures; Fuerst et al. (2012) showed an 11% premium. There are studies from other green certificate schemes besides those that concentrate on Energy Star and LEED. Chegut et al. (2012) discovered that the BREEAM label in the UK carries a pre-mium of 38% on the sales price. Furthermore, Fuerst et al. (2012) noted that if the building receives the EPC from the EU, it might perform better and earn a premium. Aroul and Hanzs (2012) discovered that green buildings earn a 2% premium for residential structures. Then when.[35]

Brounen and Kok (2011) showed that the premium predicted for buildings rated A, B, and C is 10%, 5.5%, and 2.5% accordingly, compared to those rated D. Additionally, the expected discounts are 0.5%, 2.5%, and 5%, respectively, for homes with ratings of E, F, and G. Kok and Kahn (2012) discovered that the Energy Star certification had a favourable effect on home prices. However, LEED has little of an influence. Miller et al. (2008) further demonstrate that there is no discernible premium on sales price for green buildings. The primary barrier to promoting green building is the high initial cost. Additionally, developers that lack relevant experience in green construction are less knowledgeable about the risk, cost, benefit, and value of green building. It might have a detrimental effect on the sales price.[36]

Leopoldsberger (2011) found that there is a significant negative correlation between maintenance and energy costs and rent. 2011 study by Forests and McAllister looked at how EPC rating affected the market value of 708 commercial properties.

McAllister (2013) conducted a review of 29 green building literatures. Hedonic regression is frequently used to examine how going green affects price, with commercial property serving as the major focus. Chen (2011) conducted an interview with 120 Taiwanese appraisers and found that 87% of them agreed that green label would theoretically have a positive impact on the sales price, 66% believed the impact would be visible on the market, and the majority believed the impact would be in the range of 10% of the price. Due to a dearth of empirical research on this topic in Taiwan [37].

III.CONCLUSION

Here different authors concluded variations in study

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