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Estimation of Embodied Carbons using Machine Learning

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A B S T R A C T

The earlier time the percentage of the embodied carbons from buildings was very high in environment which is very harmful to the sustainability. So, for resolving the emission of carbon from the buildings the several authors have done so much research on embodied carbons of construction materials in different countries. It provides a systematic approach to quantifying and evaluating the environmental impact of embodied carbon throughout the life cycle of buildings. The research focuses on the assessment of embodied carbon in sustainable building practices. It addresses the limited availability of data in existing case studies and the complex methodologies employed for assessing embodied carbon. The paper highlights the need for a machine learning model, as well as standardized protocols and guidelines in this field. The aim of the study to provides a standardized protocols and guidelines for this area of research contribute to the understanding of the environmental impact of construction practices and facilitate informed decision-making for sustainable building design and construction in the future. The objective is to contribute to the field of embodied carbon assessment and provide a foundation for further research in this area. The result of the study is by validating the Indian models to the different countries to establish a new sustainable building to promote a sustainable environment impact.

Keywords: Building information modelling(BIM) ,Machine learning(ML),Embodied carbons.

1. INTRODUCTION

The paper proposes a machine learning model for estimating the environmental impacts of embodied carbon in buildings. The model is validated to assess its accuracy, revealing average percentage errors across different countries. The research aims to establish a dynamic model and standardized protocols and guidelines for conducting embodied carbon life cycle assessments in buildings. The main objective of the paper is to address the issue of embodied carbon in buildings and propose a machine learning model for its assessment, along with standardized protocols and guidelines. A machine learning model is proposed, leveraging authentic databases and supervised learning techniques to estimate the environmental impacts of embodied carbon throughout the building life cycle.

The estimated carbons give a clear idea about the how much carbons evaluated from the building. And according to the percentage of evaluated carbons we can conclude that required suggestions to the building. The machine learning helps to predict the values accurately by using different algorithms and it can predict the future values accurately.

By developing a supersized model according to the material used in building and transportation emissions by putting the model in the LCA software which is cradle-to-gate we can conclude that the tones of carbons from a building and electricity production is acting a major role for producing the carbons from a country by using the python codes we developed the best equations for calculating the percentage error in the electricity production compared with the different countries we know the clear difference. The evaluated carbons create more impact on the environment so we need to minimize the evaluated carbons.

Emissions in buildings occur across various life cycle stages, including material extraction, construction, operation, and end of life, with transportation emissions playing a crucial role. While operational impacts have seen improvements, embodied impacts lack consistent methodologies and data, posing a challenge for mitigation efforts. Without enhanced building efficiency, GHG emissions from construction could double in the next 20 years due to urban sprawl.

1. LITARATURE REVIEW

- Hamza El Hafdaoui ET AL (2022) reported that; The model utilizes authentic databases and supervised learning techniques to estimate the environmental impacts of embodied carbon throughout the building life cycle The model was validated and showed average percentage errors of approximately 15.71% across different countries. The study introduces a standardized algorithmic protocol and guidelines for assessing embodied carbon, demonstrated through a case study in Morocco. The aim of the study to provides a standardized protocols and guidelines

for this area of research contribute to the understanding of the environmental impact of construction practices and facilitate informed decision-making for sustainable building design and construction in the future

- Tianzhen Hong ET AL (2020) reported that; The aim of the paper is to identify the trends and challenges in the field of machine learning for buildings. It also aims to pinpoint research and application gaps in this area. The paper provides a comprehensive literature review that summarizes the applications of machine learning across different stages of the building life cycle. The findings of the review can inform future research on machine learning to improve occupant well-being, energy efficiency, flexibility, and resilience of buildings. The paper also emphasizes the need for more mature and encouraging applications of machine learning in the building sector. It suggests that future research should focus on improving occupant comfort, energy efficiency, demand flexibility, and resilience of buildings.
- Ping Hong ET AL (2019) reported that; To estimate missing HC50 (hazardous concentration 50%) and eco toxicity characterization factors for chemicals in USE to x using a data-driven approach. The authors propose building machine learning models based on the physical-chemical properties of chemicals and their mode of action classification to estimate the HC50 values. These values are then used to determine the eco toxicity characterization factors. The paper also evaluates the performance of these models compared to traditional QSAR (quantitative structure-activity relationship) models. The paper also evaluates the performance of these models compared to traditional QSAR (quantitative structure-activity relationship) models.
- Mohamed A.Abadelaal ET AL (2023) reported that ; To assess the sustainability of concrete structures using the Building Information Modeling and Life Cycle Assessment (BIM-LCA) integrated approach. The research focuses on evaluating the environmental impacts, energy consumption, waste, and cost of different types of concrete mixes. The paper also explores the use of Analytical Hierarchy Process (AHP) to compare and select the most sustainable concrete alternative based on criteria such as CO2 emissions, embodied energy, and cost. The ultimate goal is to provide engineers with computerized models and guidelines that improve the sustainability of construction projects.
- Alexander Hollberg ET AL (2019) reported that; The study finds that embodied GWP during the design phase is twice as high as for the completed building, mainly due to the use of placeholder materials refined later. The paper discusses three alternatives to automatic quantity take-off to improve the accuracy of BIM-based environmental assessments. BIM-based approaches offer advantages in quantifying embodied environmental impacts, such as global warming potential (GWP), throughout the building lifecycle.BIM has been utilized for conducting Life Cycle Assessments (LCAs) of buildings, allowing for the evaluation of various environmental impacts such as energy consumption and material usage.

2. CONCLUSION

By using the research papers, we calculated the embodied carbons of Indian residential buildings. The results obtained for the two story buildings in India and the study introduces a machine learning model and standardized algorithmic protocols for assessing embodied carbon in buildings, aiming to improve accuracy and consistency in assessments. By using the country data bases (energy website) and supervised learning model we get the approximate error of 18.79%.

By using theoretical calculations, in these calculations by multiplying the volume of the material, Density and the emission factors we get the embodied carbons of different materials used in buildings. All the materials used in the components are divided into four types they are building structure, building envelope, openings, floors. In building structure footings, connecting beams, columns, beams, stairs. The overall percentage of building structure is 21%. Second building envelop includes the walls and finishes having the percentage of embodied carbons from the building is 12%. third openings including the glazing, frames, interior doors, exterior doors. Having the percentage of carbons are 4%. And finally the floors include the concrete of 1inch layer, damp proof course, concrete layer of 5inch layer, insulations, ceramic tiles, PVC supply. Having the percentage of 63%.the findings helps to develop the strategies for reducing the embodied carbons from a building especially in India. Recommendations include incorporating additional databases, considering transportation emissions and primary material sources, and training the model for different life cycle stages to enhance accuracy in embodied carbon assessments.

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