



CHALLENGES FOR INCORPORATING BIM BASED LCA IN A NEW COMMERCIAL BUILDING PROJECT & CONSTRUCTION FIRM IN PAKISTAN: A REVIEW

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Abstract- This paper presents the gap in current infrastructure development method in Pakistan's construction industry and other. Construction Industry consumes the natural raw material to turn it into usable construction product which release embodied carbon dioxide in environment which has highest percentage in Green House Gases (GHGs), which trap heat in atmosphere. Gradual annual temperature increases per year due to global warming caused by the conventional practice by both developed and developing nations construction industry has sparked an outrage in common people. Hence, environment friendly construction techniques were developed. Building Information Modelling (BIM)-based Life Cycle Assessment Technique (LCA) is critically reviewed for its usage in a developing country. By utilizing BIM based LCA, the environmental load can be reduced, however, lack of resources and data is the biggest hurdle for unlocking its true potential.

Keywords- Building Information Modeling, Commercial Building, Construction Industry, Life Cycle Assessment.

1 Introduction

A Commercial building in real estate sector is defined as income generating property either in form of capital gains or rental income. A Commercial building is ultimately considered economy activity generator of the locality which dictates and forms the living standard of the nearby society. A commercial building can be utilised to present a number of small scale business in the area. The building can be utilised by hospitality management segment, retail outlets, private Small and Medium Enterprise (SMEs) offices, healthcare, multifamily appartments, educational instituites, and large scale industry offices. A Commercial building usually operates on the timely in-flow and out-flow of the payments under certain condition, resulting in wealth rotation in lower and upper segments of the society. In-flow of the cash means to attain rent, operating expense recovery, fees in term of utility provision (security, water supply, electricity), proceeds of any sale made in any portion of building, tax collection and dispursion, tax crediting. Whereas, Out-flow entails intial building construction cost, all operating costs, government taxes on income, costs upon sale and maintenance expenditure. Pakistan is a developing nation in which construction industry and real estate sector plays a major role in its contribution towards Gross Domestic Product (GDP). The business of new building construction in developing countries is flourishing because of its key role in providing work status to the local community, whereas, it also creates more opportunities for exchanging culture and resources [1]. The design of GDP per capita and the commitment of construction industry in the all-out GDP of the nation is generally agreed upon principle, importance in the developing phase of the economy, The GDP increments at a quicker rate, then, at that point, levels off lastly go down at more elevated levels of monetary turn of events. This implies, that it extraordinarily impacts the economy of a nation; while it additionally adds to-wards its current circumstances. The working of other industries is directly influenced by the efficiency and progress of construction development along with its industry. Retarded functioning of this industry can effectively contribute to creating impediments in the growth of the personal lives of a nation.

Building Construction Industry plays a twofold role in providing both food and shelter [2]. For a developing country, the economy is directly related to the construction industry. This relation has been studied by many authors. Similarly, building along with its pre-requisite infrastructure development by the construction industry is linked with the usage of energy by direct or indirect means [3]. In the present day, the ramification of conventional construction industry



performance pattern has brought attention from every walk of life because of harm done to the environment and ecosystem. According to IPCC 2018 report, the increase of 1.5° centigrade per year on average presents a stark image of the drastic changes that occur in environment due to current practices [4]. If the current practices are adopted as same an increase of 2° centigrade on average per year will resultantly wipe the entire eco-system [5]. Gases that trap heat and radiations in Earth's atmosphere are referred to as Green House Gases (GHGs), furthermore, they are a major cause of temperature increment. The construction industry which comprises roads, roads materials, bridges, buildings, building materials, and components are responsible for 40% of Carbon Dioxide (CO₂) emission in the world which is the major constituent of Green House Gases (GHGs) [6].

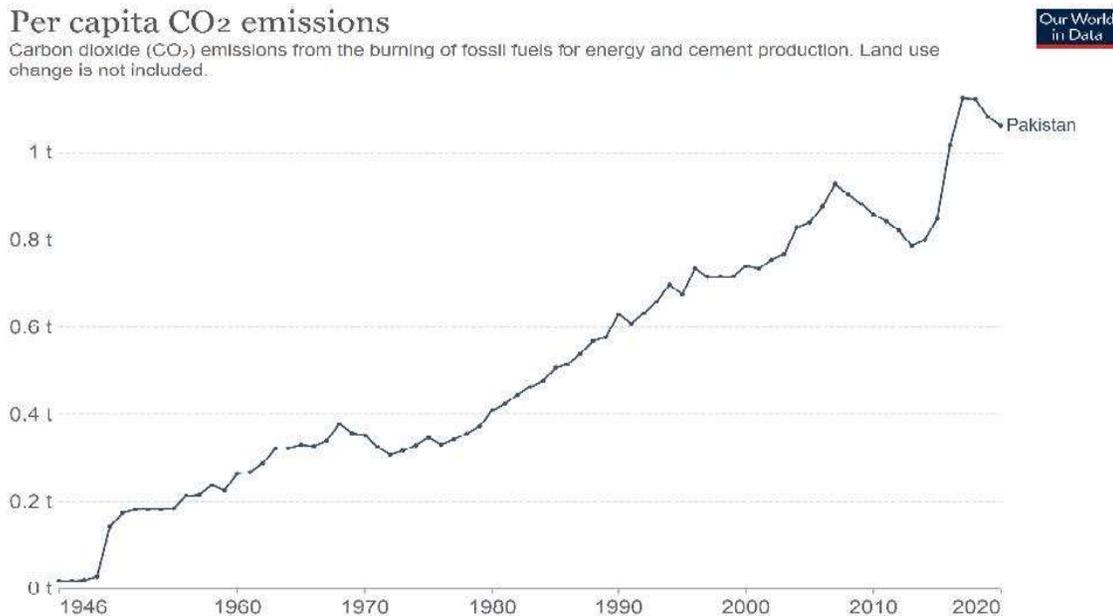


Figure 1: Emissions of Carbon Dioxide (CO₂) per capita by Pakistan over the years [7].

Figure 1 aforementioned shows the upward increment in CO₂ emission per capita over the years by Pakistan. Natural resources of the world are depleting as the population and demand grow. Harm to the natural environment continues to occur with the emission of Green House Gases (GHGs) caused as a result of using natural resources. 65% of Green House Gases (GHGs) consist of Carbon Dioxide (CO₂) which in turn are globally produced due to current construction industry practices [8]. This has resultantly put pressure to find sustainable and environmentally friendly methods to curb carbon emissions. Currently, after effects of climate change are being faced by the people all over world. Every year millions of people relocate in essence to find better opportunities but detrimental effect of climate change is also key element in order to vindicate their relocation [9]. Global warming induce melting of glaciers which rise the sea level, rapid urbanization has put cities on exaggarated path towards unliveable temperatures [10]. Water shortage or water scarcity is also a major challenge for country like Pakistan [11]. Therefore, an existential threat presists on mankind by degradation and current annual temperature rise demographs because of current human practices, which makes it all the more substantial for developing countries like Pakistan to adopt environmentally viable construction techniques. This paper focuses on the applicability of BIM based LCA for countries like Pakistan in order to develop sustain construction practices, techniques and tools based on local resources using modern tools available in market, learn how developed countries have utilized the modern tools and techniques to found environment friendly construction methodologies.

2 Building Construction

Food and shelter are the basic requirement for humans to survive. Literal mean of construction is that it is the science and art of putting objects together in systematic organization. Building construction usually means making and erection of structures used for provision of shelter. It involves phases from intial gathering of financing, planning, design and continues till the time a structure is built and ready to use. Construction also makes up process of repair and maintenance, improve, extend and expand the building from original shape. It concludes at the demolition, decommissioning or dismantling. The idea of having shelter against the harsh weather and animal species developed in Neolithic times or stone age. First huts



and shelters were built from simple tools or by hands [12]. As the time advanced many technological advancements were made in the field of building construction.

In order to find livelihood, people started working in set of teams of to provide shelter to other peoples. Initially, people were dominated by force and only slaves were used to build shelters. As time went on people gained mastery to provide certain skill set in shelter construction therefore, demanding something in return. The prevailing concept of barter system was used to trade shelter for something in return. The idea for building shelters for commercial activity developed in 2000 BCE [12]. In modern times, the concept of commercial building can be predated to 1800s where buildings were used to in order to gain income from them [13].



Figure 2: Conventional method of commercial building construction in Pakistan.

Figure 2 depicted supra shows the conventional method of building construction in Pakistan. Whereas, new techniques are available in the market which would allow for sustainable development to take place. The construction industry pays a lot of Gross Domestic Product in Pakistan so the idea of sustainable construction practices will be instrumental in decreasing the carbon emission as a whole and will allow new market trends based on the positive impact on health, to grow.

3 Incorporation of BIM based LCA to reduce embodied carbon footprint emissions

Embodied Carbon emissions are referred as those carbon emissions which take place in materials and construction processes throughout the whole lifecycle of the infrastructure. Therefore, it includes the material extraction, transportation to manufacturer or production plant, during manufacturing or production, transportation to site for use, while application in construction phase, transportation to end of life facilities and beyond the life cycle of the product [5]. Transportation infrastructure helps in mass mobility of people and goods from one place to another. The continuous construction of infrastructure cause large sum of material extraction, production, and utilization, therefore, releasing a huge sum of Green House Gases (GHGs) [14]. Building infrastructure is essential for human development which in turn arises sustainability challenge to cater for. Overall, the construction sector and carbon emission are directly proportional to each other [3]. To achieve sustainable environmental infrastructure without causing any further environmental degradation is an arduous task for policy makers.

In addition, demand-driven innovation policies coupled with booming GDP growth in developing countries have improved energy efficiency. Macro-level economic policy serves as a productive primary tool for managing the structure of market demand and supply. In the current situation, manufacturers are benefiting from meeting potential demand by launching new and improved products as barriers to entry for new companies have been removed. , has supported a high-price strategy to stimulate innovation activity for demand-driven policy innovation. Many developing and emerging economies are



striving to implement demand-side innovation policies in consumer policy, government procurement, and key market reforms to highlight social needs and market failures. Developed for function and energy saving. Building on existing theory and research, many empirical articles examine the dynamic links between innovation and environment in different economies and regions., [15].

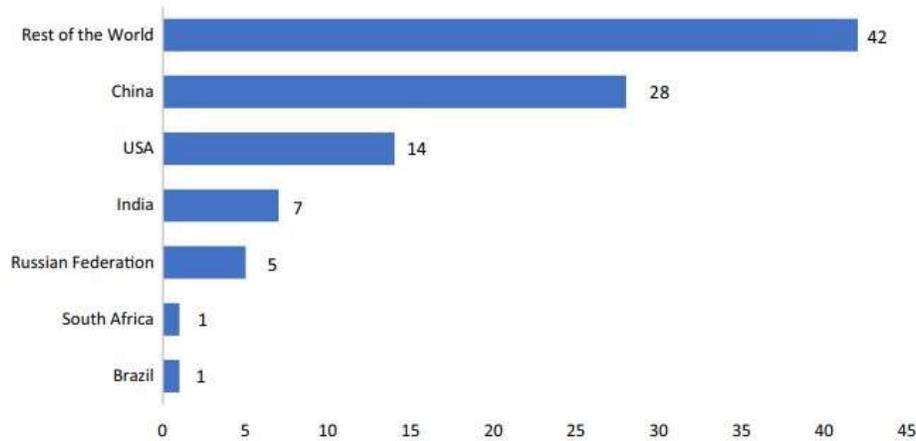


Figure 3: Global CO₂E Emitting Economies in year 2020 [15]

Figure 3 illustrated above shows that the of conventional practices of carbon intensive industries is still a problem even in developed countries. Whereas, Fundamental initiatives are being undertaken worldwide by scholars to find alternative, cost efficient, and environment friendly practices needed today to maintain the overall functionality of the building facility.

Literature suggest that there are many techniques utilized now a days to hamper the on-going environmental degradtaion. Building Information Modeling is a new technology which help policy makers in applying environmentally viable, socially acceptable and economically feasible materials or practices from the line design stage to completion including maintenance and operational phase of the infrastructure which also includes immediate service restoration in case of break down. [16]. It is a new roboust method to calculate environmental load of buildings which are either constructed or in construction phase. It is desirable to use the BIM tool in early stage of construction however, due to lack of information, resource and data available the usage of BIM is restricted and limited. A bidirectional path is required to transfer information in order to successfully execute Life Cycle Assessment for the project under consideration. This tool allows one to practically integrate building-related environmental sustainability requirements into BIM projects and carry out desired changes to reduce its environmental impact.

4 Literature Review

Various scholars have researched on making building construction environmentally viable and make future living condition better for all humanity. A summary of their working is explained in table 1.

Table 1 Literature Review for Limiting Embodied Carbon Footprint by BIM Based LCA

Authors	Study Area	Year	Summary of Using BIM based LCA for Limiting Embodied Carbon Emission.
Dauletbek and Zhou [17]	China	2022	It was concluded that BIM-based life cycle assessment is a powerful tool for assessing homes in operation and maintenance phase as it



			comprehensively evaluates the environment, energy efficiency and economics.
LLatas, et al. [18]	Spain	2022	A data driven BIM based LCA was proposed for the locality, which indicated most CO _{2E} emitting materials for which alternatives can be worked out.
Cheng, et al. [19]	China	2022	It was concluded that steel, timber and bricks were the top most contributing factors, whereas, interior alternatives and carbon sinks can be worked out to balance the negative output.
Maierhofer, et al. [20]	Austria	2022	It was found out that 68% of the building GHGs release to the environment was related operational integration system and BIM based LCA can hamper down the negative impact if applied in design phase. This is now a regulation under the European Union standard building procedure.
Ansah, et al. [21]	China	2021	Under consideration study proved that the BIM based LCA provides a systematic and detailed assessment of the building project and by adopting real local data driven BIM based LCA, we can improve the design robustness and performance of building environmentally.

Decision-makers on the national level should set out a solid policy for setting targets for carbon dioxide emission reduction. National-level policy devised keeping in mind the sustainable development is based upon three main challenges, in essence, interpretation of the development work keeping in mind the future use, information structuring to maintain a defined level of service while catering influencing need. As Pakistan is developing, sustainability-oriented strategies must involve all environmental, social, and economic parameters so that due input is taken from stakeholders. Developing a national-level strategy would mainly depend upon the contribution from the private sector. For that purpose, the policymakers, should initially roll out plans for helping the local sector to couple up to the advanced stage, then only, discourage the conventional practices. Afterward, the system of incentives and restrictions should be imposed to ascertain and enforce the policy in true letter and spirit.

Unavailability of data and lack of reliable data results in over designing of structure to ensure the smooth operation of the public or private facility. Efficiency and reliability in testing results should ensure the proper designing of public infrastructure. This would result in the reduction of material wastage inherently reducing the embodied carbon emission.



Alternative materials should be incorporated resulting in better environmental performance as compared to simple design. Building Information Modeling also helps a great deal in this regard to keep track of the development work completed. This will not only help inefficient operation but significantly reduce the wastage of resources in repair and maintenance. The exact quantities can be calculated and end of life recycling or refurbishment can be planned

5 Discussion

The growing human need for infrastructure provision is a massive challenge while keeping in mind the prospects of that human livelihood and standard of living. The construction industry provides the infrastructure for daily activity by mankind in the movement of goods and people, however, conventional methods of construction are causing a detrimental effect on the environment [22]. The rapid increase of population results in massive building infrastructure needs for survival therefore, the development of building projects is occurring on a massive scale. Natural fossil fuels are the key elements of the construction industry whereas, blatant use of these resources results in Carbon Dioxide (CO₂) emissions both directly and indirectly [23]. Pakistan is currently amongst the countries with the lowest carbon emissions rating, however, developing countries will suffer the most from climate change [24]. Therefore, it is imperative for developing countries like Pakistan to develop policy frameworks, adopt sustainable practices, adopt material alternatives, improve processes and develop national strategies from now so that corrective actions taken beforehand will resultantly allow new markets and trends to flourish which will be sustainable in the long run and provide better living condition to future generations. Adopting BIM based LCA will be a step in right direction in order to provide the desired level of service to the client whereas, promoting sustainability criteria for future construction in the locality. This opens up new market trend to flourish, which initially increases the boost of construction sector in country's GDP, Furthermore, allowing more environment friendly construction to take place.

6 Conclusions & Recommendations

Following conclusions can be drawn based on literature review: -

1. Developing Countries like Pakistan emit the least amount of embodied carbon footprint in environment, whereas, will be bearing the major consequences.
2. Building Information Modelling (BIM) is a new tool that has been introduced by Autodesk in Architecture, Engineering and Construction domain. Though, there is a resource deficiency for expertise in this new software tool, there has been a lot of effort to gain maximum utility of this software; Which has proven it to be worthy.
3. BIM based Life Cycle Assessment is a new technique that is being adopted by developed countries and that has performed in excellent manner in order to reduce the embodied carbon emission of the new infrastructure construction.
4. The versatility of technique can be enhanced much further by utilizing local area based carbon emission factors data and by utilizing the technique from initial design phase till completion.
5. Locally available environment friendly material alternatives should be accessed and factored in so that building performance can be judged as a whole.

Following are the recommendations that should be adopted to counter the effect of carbonised environment :-

1. National Coordinated effort to develop a policy framework and road map to modern tool usage solutions.
2. Roadmap to convert existing infrastructure towards environment friendly alternatives. Government policy to strictly achieve zero carbon emission in new building projects.
3. All developers to committ to relevant industry roadmap and require disclose of supply chain data.
4. All manufactures to comply and committ to road map developed to achieve environment friendly materials.
5. Future curriculum must include the harmful impact of unregulated construction practices.



6. Upcoming research should be focused on improving energy efficiency of existing infrastructures, private buildings, public buildings and new construction of any facility using BIM based LCA in operational and maintenance phase as well.

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