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Analysis of Carbon-Emitting Processes of Brick-Making: A Case Study from Khyber Pakhtunkhwa, Pakistan

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A B S T R A C T:

The manufacturing of various building materials, including bricks, significantly contributes to the rise in carbon emissions. Consequently, analysis of carbon emissions of the production processes for such materials must be conducted with a view to fostering environmental sustainability in the construction sector. This research, therefore, offers a thorough examination of the carbon-emitting processes involved in brick-making within the brick industry of Khyber Pakhtunkhwa province of Pakistan, specifically focusing on a particular case study in the Nowshera district. The analysis reveals that, within the selected brick manufacturing facility, the firing of bricks in kilns, specifically due to use of coal, generates the highest levels of carbon emissions in comparison to other phases of brick-making. These results highlight the urgent need for a shift towards cleaner energy sources and more fuel-efficient production practices. This analysis serves as a foundation for promoting cleaner production methods, healthier communities, informed policy-making, and improved climate resilience.

Keywords Carbon Emissions, Brick-making, Module A3 of Product Stage

Introduction:

Currently, global warming and climate change are paramount threats to the environment and humans alike. The president of the 27th session of the Conference of Parties to the United Nations Framework Convention on Climate Change, otherwise known as COP 27, termed climate change issue as "humanity's biggest challenge in modern times" as it continues to affect and redefine our world [1]. Climate change is damaging the environment we live in by polluting and damaging the landscapes, water bodies and atmosphere, and harming the animals. It further impacts the lives of humans. Climate changes can lead to formation of disastrous cyclones and typhoons such as cyclone Biparjoy in 2023. Global warming further gives rise to heavy rains and floods such as the flooded streets in UAE in 2024. Pakistan too is a victim of the disastrous effects of climate change issues. About 1700 people died in 2022 floods in Pakistan and the lives of 33 million people were affected in some way [1]. Global Warming also has a detrimental impact on health, especially that of women. Intense heatwaves significantly raise the chances of premature births and reduced birth weights. It is important to highlight that women make up about eighty percent of the climate change refugees [2].

The main driver of climate change is the greenhouse effect due to the emissions of various greenhouse gases (GHG) into the environment [3] and amongst these emissions, carbon dioxide (CO_2) emissions, also known as carbon emissions, are most common [4]. Total CO_2 emissions associated with energy rose by 0.8% in 2024 [5]. The construction sector has emerged as one of the largest contributors to carbon emissions globally, driven by swift urbanization and accelerated economic development [6]. Around 39% of global annual carbon dioxide emissions are attributed to buildings [7]. This is due to utilization of energy, and production and use of various construction materials such as bricks.

The brick kiln industry in the Khyber Pakhtunkhwa (KPK) province of Pakistan is a key component of the local economy, but it also significantly contributes to carbon emissions and hence, climate change and air pollution. There are on average 1200 brick kilns in Khyber Pakhtunkhwa, specifically around Peshawar and Nowshera where there are an estimated 450 brick kilns [8]. Brick making in different regions release varying levels of carbon emissions during the distinct manufacturing phases. In this research, for the analysis of carbon-emitting processes of brick manufacturing in Khyber Pakhtunkhwa, more specifically during the module A3 of the Product stage in a Life Cycle Assessment (LCA), a case study is selected in Azakhel, district Nowshera.

Methodology

The methodology overall incorporates the following major steps:

2.1 Site Selection and Pre-field Planning

The site selected for this research is a brick factory located in Azakhel, district Nowshera, KPK (Figure 1). Once the case study is selected, all aspects of brick-making (after the acquisition of raw materials) are thoroughly comprehended. The brick-making processes, in the context of the selected case study, include extraction of water, mixing of raw materials, brick moulding and firing in kiln. Finally, the necessary data to be collected for analysis is strategically planned.

Figure 1: Brick manufacturing site

2.2 Data Collection

After selection of site and detailed pre-planning, the data is collected from site visit. Any missing data required for analysis is taken from official websites, for instance International Organization for Standardization (ISO) [9], and other research articles such as data about coal used in brick kilns is taken from a research paper [10].

2.3 Analysis

Finally, the data collected is then analyzed to calculate carbon dioxide emissions from the different brick-manufacturing processes that is extraction of water, mixing of raw materials, brick moulding and finally, burning of bricks in kiln. Carbon emissions are determined using the amount and carbon contents or carbon factors of fuels utilized during the various processes of brick manufacturing (Module A3 of LCA). Furthermore, emissions from the various brick-making phases processes are compared.

Results and Discussion:

After calculating the carbon dioxide emissions during the different phases of module A3 of brick production, these emissions are compared. Since in case of the selected brick manufacturing facility, the water pump and mixer are solar powered, therefore, no carbon dioxide is emitted during the extraction of water and mixing of raw materials. Likewise, there are no emissions generated during the process of brick moulding, as hand moulding is employed instead of machine moulding. As a result, firing in kiln produces most carbon emissions among all the brick-making processes, as demonstrated in Figure 2, and this is in accordance with the previous studies. Primarily, the coal utilized in the kiln is the main contributor to the majority of emissions produced during the firing process. The findings, however, pertain specifically to the chosen case study and cannot be extrapolated to all brick manufacturing facilities in KPK. Consequently, it is essential to conduct further detailed case studies.

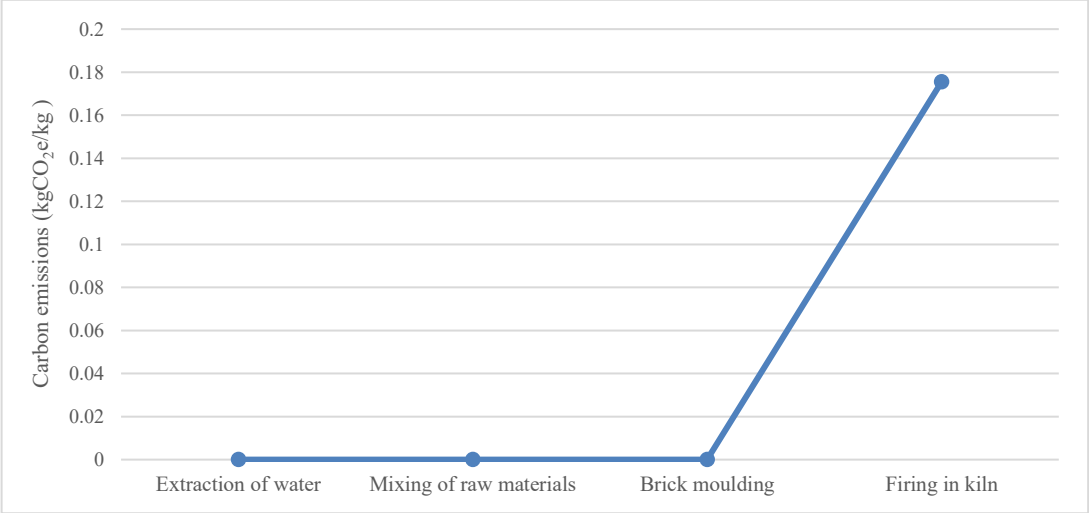

Figure 2: Comparison of carbon emissions during the various processes of brick-making

The findings, however, pertain specifically to the chosen case study and cannot be extrapolated to all of the brick manufacturing facilities in Khyber Pakhtunkhwa. Consequently, it is essential to conduct further detailed case studies. Furthermore, with the advancements in brick production methods, carbon emissions may vary, hence, studies must be conducted in future in order to revise the amount of carbon dioxide emissions from brick manufacturing.

Conclusion

- This study successfully assessed the carbon dioxide emissions throughout the various phases of brick-making.
- In addition, it is concluded that regarding the selected brick-manufacturing facility, the firing of bricks in the kiln is responsible for the majority of carbon dioxide emissions when compared to all other processes involved in brick manufacturing within module A3 of the Product Stage.
- This research further demonstrates that coal, which is a high-carbon intensive material, employed in the brick firing process within kilns results in the greatest carbon emissions.
- Moreover, the adoption of solar power and hand moulding reduces overall carbon emissions during brick production.

REFERENCES

[1] "All in One Annual Magazine for 2023," *Jahangir's World Times (JWT)*, vol. 14, pp. 113–114, 2023.

[2] "The News International." 2023. Accessed: Aug. 09, 2024. [Online]. Available: https://www.thenews.com.pk/print/1103106-climate-through-a-gender-lens

[3] "Causes of Climate Change." European Commission. Accessed: Aug. 09, 2024. [Online]. Available: https://climate.ec.europa.eu/climate-change/causes-climate-change_en

[4] T. Lützkendorf and M. Balouktsi, "Embodied carbon emissions in buildings: Explanations, interpretations, recommendations," *Build. Cities*, vol. 3, no. 1, 2022.

[5] "CO2 Emissions." International Energy Agency, 2025. Accessed: Jun. 02, 2025. [Online]. Available: https://www.iea.org/reports/global-energy-review-2025/co2-emissions

[6] N. Zainordin and D. B. F. Zahra, "Factors contributing to carbon emission in construction activity," presented at the Third International Conference on Separation Technology 2020 (ICoST 2020), Atlantis Press, 2020, pp. 176–182.

[7] "World Energy Statistics and Balances (Database)." IEA, 2019. Accessed: May 31, 2025. [Online]. Available: www.iea.org/statistics

[8] "Survey of Brick Kilns in District Peshawar and Nowshera of Khyber Pakhtunkhwa Province." International Labour Organization, 2024.

[9] *The International Organization for Standardization*. Accessed: Jun. 02, 2025. [Online]. Available: https://www.iso.org/home.html

[10] A. Abbas *et al.*, "Assessment of long-term energy and environmental impacts of the cleaner technologies for brick production," *Energy Rep.*, vol. 7, pp. 7157–7169, 2021.