Observation of the Environmental Impact of Brick Manufacturing Process in Greater Dhaka Region, Bangladesh

Submitted By
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Sanjoy Kumar Das

A Thesis Submitted to the Department of Civil Engineering, Daffodil International University in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science in Civil Engineering

Department of Civil Engineering
Daffodil International University

V7

January 2025

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DECLARATION

We hereby declare that, this thesis does not contain any previously authored or published works by other individuals, with the exception of the capstone, which contains the necessary citations.

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This thesis is dedicated to our family, whose unfailing love, support, and encouragement enabled me to complete my trip. Our lecturers and mentors, whose advice and wisdom have been crucial throughout this journey, are also honored in this work.

ABSTRACT

The most popular building material used to create buildings and other structures in Bangladesh is brick. Brickfields have sprung up all throughout the nation to provide brick locally. Brick manufacture has an influence on the environment, society, biology, and seasons. The method of making bricks has a growing negative impact on pollution. Year due to the growing number of brick kilns and brick manufacturing. An study has been conducted to assess the overall effects of brick production process on the environment and public health. We concentrated on the possible burden on the environment, which includes depletion of resources, contamination of the air, water, and soil, as well as negative impacts on agricultural output and human health. Through in-situ observations, questionnaire surveys, and interviews, the brick production stages of 15 brick fields are evaluated. In order to evaluate the safety concerns and poor management, we also concentrated on the Brickfields' management system. We also looked for a relationship between the impact of mismanagement and the environment on the brick-making process. According to the main conclusions of our investigation, a few suggestions are made to lessen the issues. The use of recycled and eco-friendly bricks, kiln systems that have been adapted, alternative fire technologies, training initiatives, and a secure workplace are among the primary recommendations.

ACKNOWLEDGEMENT

First and foremost, we would want to thank Allah for everything. Additionally, we are grateful to **Md. Masud Alom**, **(Assistant professor) Department of Civil Engineering**, **Daffodil International University**. This thesis has benefited from his great passion. We owe him much for his tenacity, advice on academic issues, unwavering support, passionate supervision, insightful criticism, and the countless hours he spent reviewing and revising the course's several drafts. With his unwavering support, we were able to finish this thesis.

We would like to extend our heartfelt appreciation and support to our beloved family for all of their assistance and motivation throughout our stay at the university.

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CHAPTER I

INTRODUCTION

1.1 Background

Brick is an age-old building material that has been used extensively for more than 7,000 years in construction; the first known examples of burnt clay brick date to 4500 BC. The main ingredient in traditional bricks is clay, which has a special mineral makeup that gives them outstanding mechanical, thermal, and physical properties in addition to remarkable longevity. Bricks are appropriate for a variety of purposes, including refractory constructions and conventional buildings, due to their ability to endure a wide range of stresses and weather conditions. In developing countries like Bangladesh, where infrastructure development is a major priority, the need for bricks is growing. With 158.9 million inhabitants, 1,106 people per square kilometer, and a growth rate of 1.37%, Bangladesh is seeing a large amount of migration to metropolitan areas, which is further pushing

Building development is increasing as a result, and the brick sector is expected to increase by 2-3% annually. With a fast increasing demand, Bangladesh now has over 11,100 brickfields functioning, generating about 27 billion bricks annually. According to an earlier study, there would be 50% more brick kilns by 2020 than there were in 2004 (4,500 kilns). The brick industry is a significant contributor to the economy, employing around one million people and manufacturing approximately 120 billion bricks a year. The construction industry is a big energy user and contributor to greenhouse gas emissions. The environmental effects of manufacturing are not the only ones caused by maintenance and refurbishment work. These impacts include decreased vegetation, soil degradation, thinning of the ozone layer, and other issues contributing to global warming. Agricultural productivity has also been negatively affected. Since valuable topsoil is frequently taken for brick-making, agricultural productivity has suffered and overall agricultural output has been greatly impacted, endangering food security. (Islam et al, 2020)

Bangladesh's brick kilns, ineffective manufacturing techniques, inferior materials, and regulatory infractions are causing serious environmental degradation and health hazards. Numerous investigations have assessed the negative consequences that these kilns have on the environment. The Ministry of Environment and Forests has outlawed traditional fixed chimney kilns (FCKs) because of their detrimental effects on the environment. Nevertheless, there have been many difficulties in enforcing this restriction, and the changeover process is still unfinished. Studies reveal that between

0.73% and 1% of cultivable land disappears annually. Because of the fertile alluvial soil on these regions, production is dropping. Furthermore, the yearly use of around 24 million tons of coal for brick fire is a major cause of air pollution. Hazardous gases such carbon dioxide (CO_2), ammonia (NH_3), carbon monoxide (CO), and occasionally chlorine and fluorine are released during the combustion of fuel.

According to several studies, respiratory conditions such persistent phlegm, coughing, and tightness in the chest are exacerbated by manual coal breaking and feeding, high dust concentrations, and kiln ash exposure. The kilns' proximity to the population increases their risk of health problems in comparison to those who live farther away, not simply with regard to the workforce. Similar issues pertaining to brick manufacture are also present in the Dhaka area. (Hossain, et al., 2016)

Many recycled materials and wastes have been examined for their ability to lessen environmental effect by using their energy qualities in the production process, in an effort to alleviate the problems brought on by the construction of bricks. Sustainable practices in the building sector continue to pose a substantial challenge. To limit environmental harm and encourage more sustainable production and consumption, alternative materials are being developed. Studies comparing the life-cycle assessments of alternative and traditional bricks have demonstrated the greater environmental friendliness of the latter.

1.2 Study Area

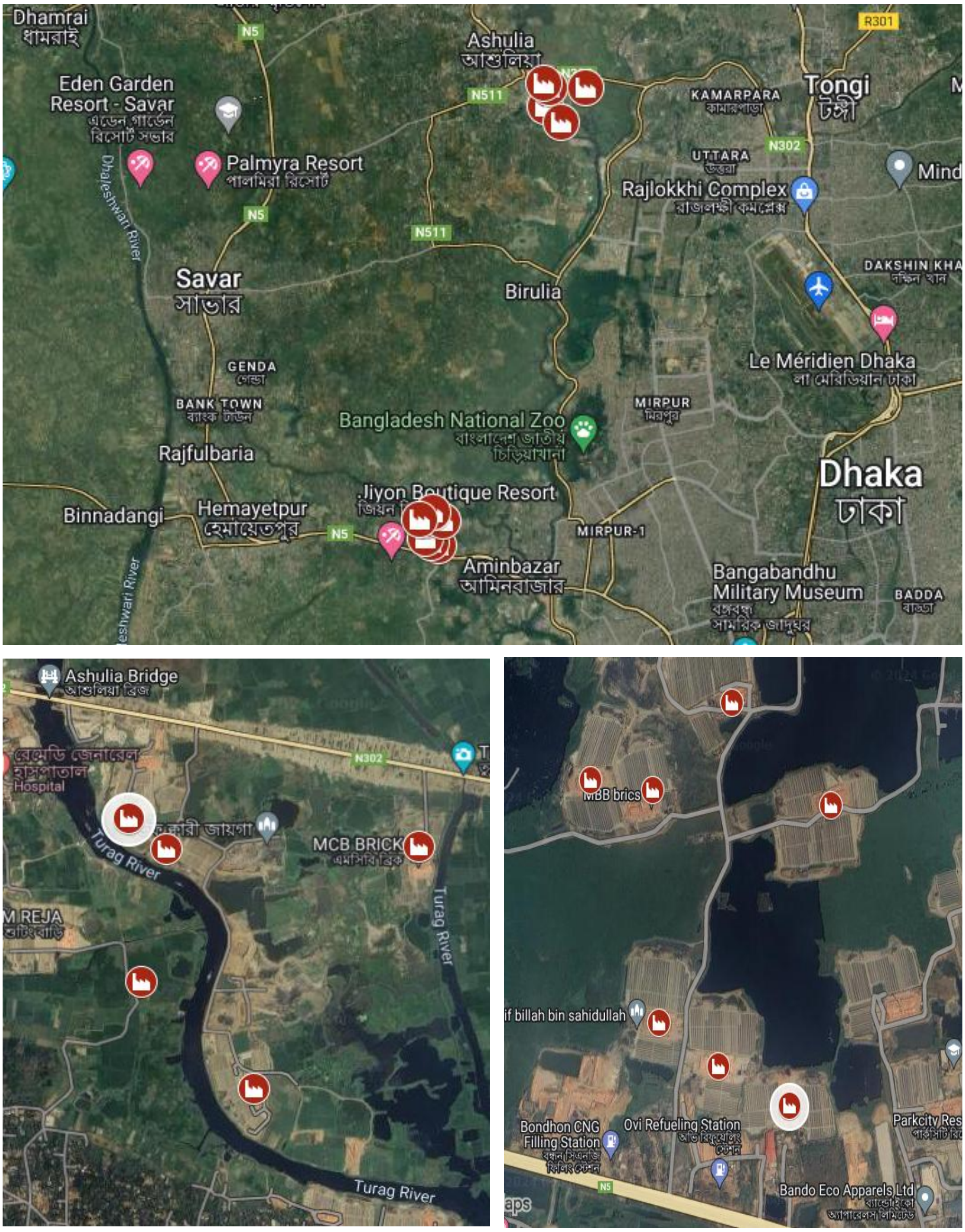

Figure 1.1 Location of the Study Area

1.3 Objective

The major objective of this thesis is as follow:

- To assess the impact of brick manufacturing process on environment (Specially in Greater Dhaka region, Bangladesh)

1.4 Scope of the Thesis

- The main objective of this thesis research was to examine the environmental effects of the brick making process.
- The research will involve both urban and rural areas, accounting for differences in production scale, techniques, and environmental impacts.

1.5 Thesis organization

Chapter	**Topic Contents**
Chapter 1	Introduction
Chapter 2	Literature review
Chapter 3	Methodology
Chapter 4	Result and discussion
Chapter 5	Conclusion and recommendation

CHAPTER II

LITERATURE REVIEW

2.1 General

The production of bricks is a vital component of Dhaka City's construction sector, propelled by the city's fast urbanization and rising need for building supplies (Hossain, et al., 2016). To keep up with the increasing demand, bricks—the fundamental component of many residential, commercial, and industrial projects—are created in huge quantities (Islam et al, 2020). But the conventional ways of making bricks, especially in poor nations like Bangladesh, sometimes depend on antiquated and ineffective technologies that have serious negative effects on the environment (Kabir et al., 2020).

Brick kilns in Dhaka produce a lot of greenhouse gasses, including carbon dioxide (CO_2), methane (CH_4), and black carbon, because they usually burn coal and wood as fuel. Both localized deterioration in air quality and global climate change are caused by these pollutants. The production of bricks causes significant soil degradation in addition to air pollution. Bricks are made from clay, which is taken out of topsoil. This process can cause ecological imbalance, soil erosion, and decreased agricultural output. (Kabir et al., 2020).

Given the concentration of brick kilns in and around the city, many of which operate without adequate pollution control systems, the environmental impact of brick manufacture in Dhaka is exacerbated. The result has been a decline in the quality of the air, especially during the dry season when kiln emissions are at their highest. The local populace is severely at danger for respiratory issues, cardiovascular disorders, and early mortality due to the particulate matter, particularly PM2.5 and PM10, generated by the kilns. (Islam et al, 2020)

The aim of this thesis is to present a thorough examination of the effects brick production has on the environment in Dhaka City. It looks at the industry's present practices, difficulties, and legal framework in addition to the socioeconomic effects on local communities and employees the study will examine the direct and indirect environmental repercussions, with an emphasis on air pollution, land degradation, and water contamination. Furthermore, the study will look into viable sustainable substitutes, like using eco-friendly building materials like fly ash bricks and cleaner technologies like hybrid Hoffman kilns or zigzag kilns, which could drastically lessen the industry's environmental impact. (Hossain, et al., 2016)

This thesis attempts to provide practical solutions and policy recommendations to mitigate the negative environmental effects of traditional brick production while guaranteeing that the brick manufacturing industry can sustainably meet Dhaka's construction needs. It does this by critically evaluating the environmental cost of brick production.

2.2 Classification of Bricks

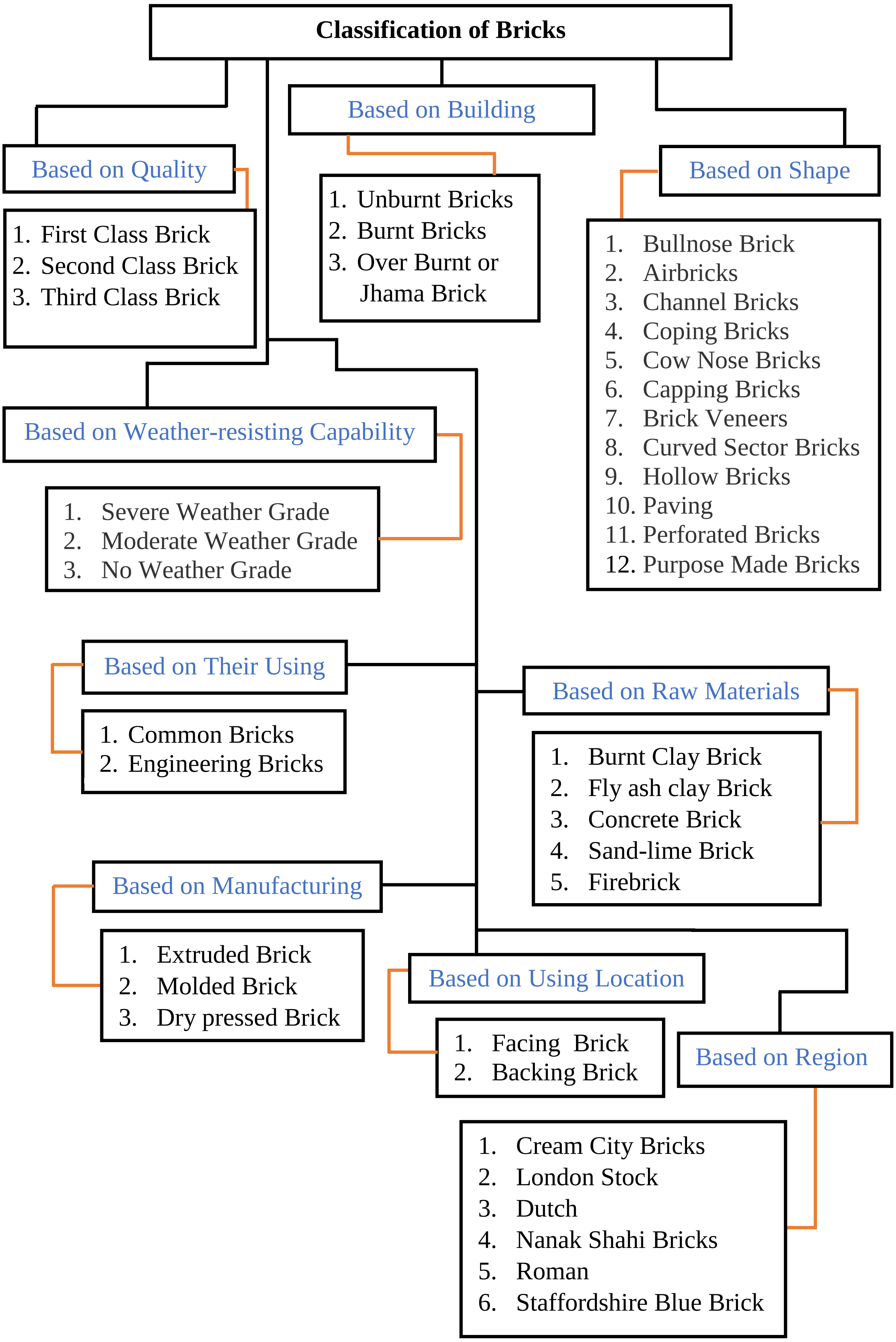

Figure 1.1: Classification of Bricks

1. Based on Quality

First Class Brick: The dimensions are typical. These bricks are all the same color yellow or red. It has a consistent shape, regular texture, and good burn. Less than 10% of the material can be absorbed, and the mean crushing strength is 280 kg/cm2, with a minimum of 245 kg/cm2 (Ghosh, S. 2015). There is no efflorescence in it. When a hammer or another similar brick strikes it, it makes a metallic sound. Even trying to avoid using a thumbnail to make any kind of fingernail expression on the brick surface is difficult enough. There are no stones, gravels, or organic materials present.

It is often utilized-

- Utilized in the construction of long-lasting (about 100 years) structures (Jain et al., 2016).
- Used in buildings that are subjected to corrosive conditions.
- Used to create coarse particles for concrete.

Second Class Brick: The brick has a normal size and is uniformly colored red or yellow. It seems well-burnt, if not somewhat over burned, which is to be expected. It keeps its form consistently, and efflorescence is barely perceptible. Its absorption capacity varies between 10% and 15%. There is a minimum of 154 kg/cm² and an average of 175 kg/cm² for the crushing strength (Kumar, R. 2017). It sounds metallic when hit with a hammer or another brick of a similar kind. It is tough enough to withstand any dents made by a fingernail. When longevity is not a concern, such as in the case of temporary shelters or one-story buildings, these bricks are usually utilized (Patel, N. 2019).

Third Class Brick: The brick is a gentle, light red tint with an uneven form and size. Although a little amount of over burning is acceptable, it is under burnt. The texture is uneven and there is a lot of efflorescence (Sharma, P. 2021). Its 15% to 20% absorption capacity is its range, and is a minimum of 105 kg/cm² and an average crushing strength of 140 kg/cm² (Singh, A. 2020). It sounds blunt or dull when hit with a hammer or another brick. When a thumbnail is rubbed on the surface, it is sufficiently soft to reveal fingernail marks.

2. Based on Building Process

Unburnt Bricks: These bricks are weak and yellow-colored, having partially burned (Rani, S. 2020). They are frequently utilized as soil layers beneath RCC footings or basements, as well as surki in lime terracing (Gupta, A. 2019). However, because of their decreased endurance, they shouldn't be exposed to precipitation (Rani, S. 2020).

Burnt Bricks: Bricks are fired in a kiln to create burned bricks (Ghosh, S. 2015). Bricks that have burned include First Class, Second Class, and Third Class bricks, which are divided into groups according to their strength and quality (Jain et al., 2016).

Over Burnt or Jhama Brick: It is the classic sorts of bricks which are manufactured by compressing clay into molds. One of its sleeping surfaces features a deep frog, while the other has a shallow frog (Sharma, P. 2021).

3. Based on Shape

1. Bullnose Brick: The rounded quoins that these bricks, which have rounded angles by default, are used to create, give a polished appearance to angular or curved corners in masonry constructions (Patel, N. 2019).

2. Airbricks The gaps in these bricks allow air to flow. They are used to cavity walls and suspended flooring (Patel, N. 2019).

3. Channel Bricks: They are shaped like a channel or gutter by molding. In sewers, they are employed (Rani, S. 2020).

4. Coping Bricks: Depending on the wall's thickness, they can be angled, saddleback, chamfered, or half round (Sharma, P. 2021).

5. Cow Nose Bricks: Known as "Cow Nose Bricks," these bricks have two bullnoses (Sharma, P. 2021).

6. Capping Bricks: The tops of parapets and freestanding walls are covered with these bricks (Singh, A. 2020).

7. Brick Veneers: These thin bricks are employed as cladding materials (Patel, N. 2019).

8. Curved Sector Bricks: The form of them is curved. In arcs, pavements, etc., they are employed (Rani, S. 2020).

9.Hollow Bricks: These bricks, which are sometimes referred to as cavity or cellular bricks, weigh around one-third less than regular bricks. Because they can be laid more rapidly than conventional bricks, their thickness, which ranges from 20 to 25 mm, allows for speedier building. They are frequently utilized for partitioning (Rani, S. 2020).

10. Paving Bricks: Due to their high iron concentration, these bricks vitrify at lower temperatures. Garden park pavements and floors are frequently used because of their capacity to withstand wear and tear from foot activity, which minimizes slipperiness and increases durability in high-traffic areas (Rani, S. 2020).

11. Perforated Bricks: These bricks, characterized by cylindrical perforations, are notably light and simple to produce, consuming less clay than conventional bricks. Available in diverse forms like round, square, and rectangular, they are often applied in panel construction for lightweight structures and multistory frames. The perforations reduce the brick's thermal mass, contributing to better insulation while also cutting down on the overall dead load of the structure (Kumar, R. 2021).

12. Purpose Made Bricks: These bricks are produced with particular uses in mind. Bricks with splay and cant are made for window and door jambs. Civil engineering projects such as retaining walls, manholes, and sewers need the usage of engineering bricks. Fire bricks are designed for high-temperature environments, including chimneys and structures used for fireworks (Singh, A. 2020). Cornices and corbels are two examples of ornamental embellishments made of ornamental bricks. The building of arches is the exclusive use of arch bricks (Ghosh, S. 2015).

4. Based on Weather-resisting Capability

1. Severe Weather Grade: These bricks are commonly utilized in regions that receive a lot of snow throughout the year. These bricks are resistant to all forms of freeze-thaw activity (Kumar, R. 2021).

2. Moderate Weather Grade: These bricks are commonly utilized in tropical nations. They can resist extremely high temperatures (Sharma, P. 2021).

3. No Weather Grade: These bricks have no weather-resistant properties and are utilized on interior walls (Ghosh, S. 2015).

5. Based on Their Using

Bricks may be used for many different purposes. Bricks can be classified into the following categories based on their intended use:

1. Common Bricks: These bricks are the most commonly used bricks. No special features or requirements are present. Low resistance, low quality, and low compressive strength are characteristic of these bricks. Usually utilized for interior walls (Sharma, P. 2020).

2. Engineering Bricks: These bricks' success has been attributed to a variety of things. It has a high compressive strength and a low absorption capacity. Features include remarkable strength and thickness. It has qualities like chemical resistance, moisture proofing, and exceptional weight bearing capacity. Every brick has the same color, seeming a constant shade of red. Class A is the strongest class while Class B is the most often used. There are three classes in classification: Class A, Class B, and Class C (Kumar, R. 2019). Civil engineering projects main uses are.

- earth works,
- retaining walls,
- damp proof courses,
- manholes, and
- sewers,

6 Based on Manufacturing Method

1. Extruded Brick: It is created by forcing clay and water into a steel die, with a very regular shape and size, then cutting the resulting column into shorter units with wires before firing. It is used in constructions with limited budgets. It has three or four holes constituting up to 25% volume of the brick (Patel, N. 2019).

2. Molded Brick: Instead of being formed by a machine, it is manually sculpted in molds. 50–65mm molded bricks are readily accessible. After the order, more sizes and forms will be available in 6–8 weeks (Ghosh, S. 2017).

3. Dry pressed Brick: The conventional varieties of bricks are created by pressing clay into molds. One of its sleeping surfaces features a deep frog, while the other has a shallow frog (Sharma, P. 2020).

7. Based on Raw Materials

Bricks can be classified into the following types based on their basic materials:

1. Burnt Clay Brick: It is made by squeezing clay into molds, then frying and drying it in kilns. It's the brick that's utilized the most. Plastering is necessary when using it in building projects (Kumar, S. 2018).

2. Fly ash clay Brick: It is produced by molding clay and fly ash at 1000 degrees Celsius. Fly ash has a significant amount of calcium oxide in it. Typically referred to as self-cementing for this reason. When it comes into touch with moisture, it normally expands. Contrary to clay bricks, it is less permeable. It demonstrated a smooth surface, negating the necessity for plastering (Singh, A. 2020).

3. Concrete Brick: It is constructed of concrete. These bricks are the least utilized. Both its quality and compression strength are low. These bricks are employed both above and below the waterproofing layer. Due to their resistance to heat and ability to reduce sound, these bricks may be used for interior brickworks, facades, and fences. It also goes by the name mortar brick. If pigment is applied during the production process, it may have various hues. It's not appropriate to utilize it underground (Patel, N. 2019).

4. Sand-lime Brick: Pressure is applied while mixing and molding lime, fly ash, and sand. A chemical reaction occurs to bind the ingredients together during wet mixing. After that, they are put into the molds. Because it provides a somewhat attractive perspective, the color is somewhat gray. Compared to clay bricks, it delivers a smoother surface and more consistent look. Consequently, plastering is not necessary. Because it is so strong, it is employed as a load-bearing element (Ghosh, S. 2015).

5. Firebrick: Refractory bricks is another name for it. It is created using a unique type of earth. It can sustain extremely high temperatures without losing its strength, size, or form after burning. It is utilized for the lining of furnaces and chimneys where extremely high temperatures are typical (Sharma, V. 2018).

8. Based on Using Location

Facing Brick: Facing brick refers to the material used on a building's façade. Bricks with facings have a consistent size, are more durable and stronger than other types of bricks. The color is either red or brown to give the structure a more beautiful appearance. There exist several varieties. Which employ various methods and technologies for facing bricks. Given that they are typically used on the outside wall of structures, facing bricks should be resistant to weather (Patel, A. 2020).

Backing Brick: There are no unique characteristics on these kinds of brick. They serve just as support behind the face brickwork (Sharma, R. 2019).

9. Based on Region

1. Cream City Bricks: Milwaukee, Wisconsin, is where these bricks came from (Thomas, J. 2017).

2. London Stock: London makes use of these bricks (Bennett, D. 2018).

3. Dutch: They originate from the Netherlands (Van der Meer, J. 2016).

4. Nanak Shahi Bricks: They hail from India (Singh, H. 2019).

5. Roman: Roman structures make use of these (Smith, J. 2015).

6. Staffordshire Blue Brick: These originate in England (Johnson, P. 2018).

2.3 Types of Bricks in Bangladesh

Bangladeshi construction has always included bricks as a fundamental component. Affordable, long-lasting, and effective building materials are in high demand in this developing country with an expanding urban population (Hossain & Rahman, 2016). The development revolves around bricks, which are among the most commonly utilized building materials. The industry is dominated by conventional clay bricks (Kabir & Khandaker, 2020), but environmentally conscious consumers and technological improvements in construction are giving rise to alternative bricks including concrete and fly ash bricks, with an emphasis on their qualities, benefits, drawbacks, and implications for sustainable building methods, this literature review attempts to investigate the varieties of bricks used in Bangladesh (Rafique & Iqbal, 2019).

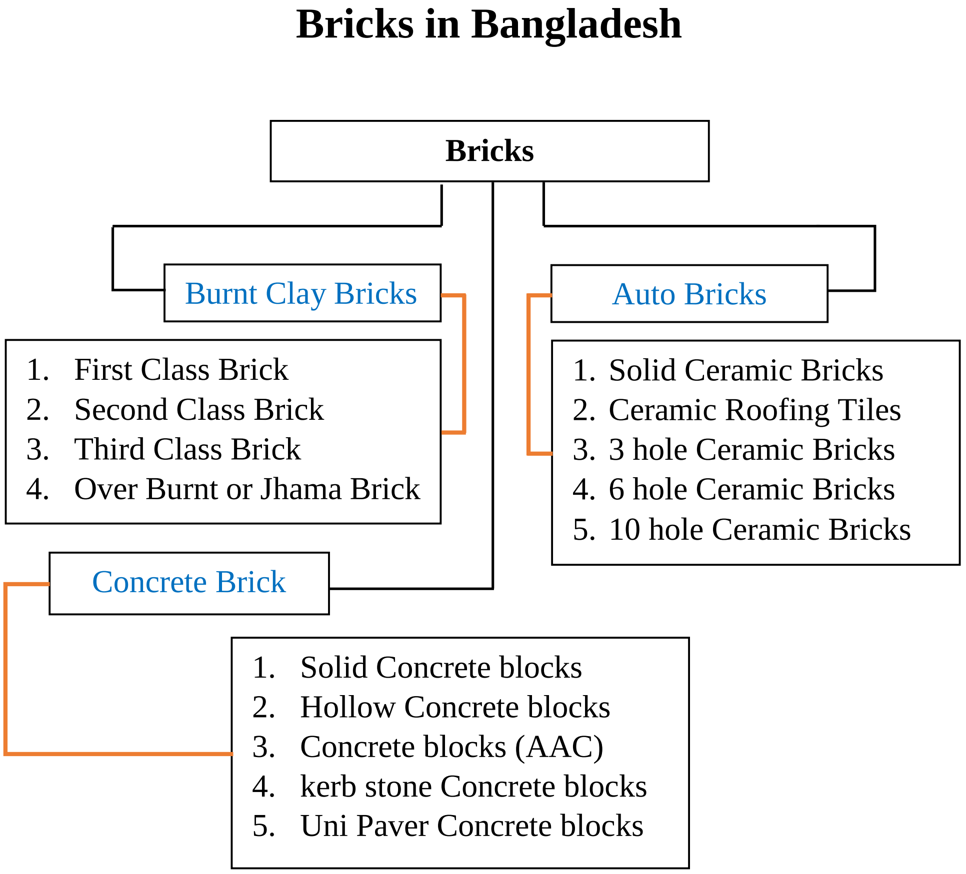

Figure 2.2: Bricks in Bangladesh

2.3.1 Burnt Clay Bricks

The most widely used type of brick in Bangladesh is burned clay, and for a long time, the traditional building landscape has included the production of these bricks (Hossain & Rahman, 2016).Because of their high temperature, which guarantees strength and durability, they are appropriate for load-bearing and structural applications (Rafique & Iqbal, 2019).

1. First Class Bricks

These bricks are perfectly sized, shaped, and colored, and they are of the best quality (Sarkar & Mahmud, 2019). In most cases, their compressive strength is greater than 14.5 MPa (Ahmed, et al., 2018). Fine bricks are perfect for visible masonry projects like walls, facades, and ornamental architecture because they have smooth surfaces and sharp edges (Chowdhury et al., 2020).

Applications

Utilized in load-bearing walls, pavements, and facades for both structural and decorative reasons (Miah et al., 2018).

Advantages

- High strength, high water absorption, and resistance to weathering. They are appropriate for big, enduring projects like multistoried buildings (Rahman et al., 2017).

Disadvantages

- High price because to the production method and material quality (Ahmed et al., 2018).

Figure 2.3: First class Brick

2. Second Class Bricks

These bricks are not as smooth on the surface as first-class bricks, and they contain minor flaws in size and shape. They are less durable because they are burned at a lower temperature. They have strengths of 7.5 and 14 MPa (Hossain et al., 2017).

Applications

Extensively utilized in basic construction and interior wall applications when aesthetics is not a priority (Ahmed et al., 2018).

Advantages

- More affordable than premium bricks and appropriate for construction projects with no apparent results (Sarkar et al., 2019).

Disadvantages

- Not as strong and with a worse finish as premium bricks (Chowdhury et al., 2020).

Figure 2.4: Second class Bricks

3. Third Class Bricks

These are irregularly shaped, sized, and texture bricks that were badly burned. They are often weaker than 7.5 MPa, with a much lower strength (Rahman et al., 2019).

Applications

Used in low-cost housing or temporary constructions where strength and endurance are not the main concerns (Haque et al., 2018).

Advantages

- Affordable and easily accessible (Sarkar et al., 2019).

Disadvantages

- Poor resilience and toughness; unsuitable for permanent building (Chowdhury et al., 2020).

Figure 2.5: Third class Bricks

4. Over-Burnt (Jhama) Bricks

Because the bricks are overfired, their surfaces have glossy, irregular forms. Since they have been exposed to too much heat, over-burnt bricks are often highly rigid and fragile (Hossain et al., 2017).

Applications

Utilized as fill material, aggregate, or for walls that are not load-bearing in the construction of roads (Ahmed et al., 2018).

Advantages

- They are not appropriate for use in structural applications due to their high strength and uneven form (Rahman et al., 2019).

Disadvantages

- Their fragile structure and irregular forms render them unsuitable for accurate masonry construction (Islam et al., 2018).

Environmental Concerns

In Bangladesh, deforestation and air pollution are further exacerbated by the manufacture of burnt clay bricks. Carbon dioxide and other particulates are released into the atmosphere by traditional kilns when they burn significant volumes of coal or wood. Due to its negative effects on the environment, brick-making methods have been called for to be updated, and more environmentally friendly materials have been used (Nabi et al., 2022).

Figure 2.6: Over burnt Bricks

2.3.2 Auto Bricks

In contrast to conventional brick-making techniques, auto bricks are machine-made, eco-friendly bricks built with automated technology, frequently in energy-efficient kilns, to boost production efficiency and lower emissions.

1. Solid Ceramic Bricks

Bricks made of solid ceramic are dense and consistent in size and shape. Their smooth surface and great compressive strength are the consequence of using premium clay and firing it at a high temperature. They may be used in a variety of environmental settings due to their minimal water absorption. (Sarkar et al., 2019).

Applications

As foundations, load-bearing walls, and structural elements for commercial, industrial, and residential structures, solid ceramic bricks are widely utilized. In addition, they can be used in landscaping and pavement. (Ahmed et al., 2018).

Advantages:

Solid ceramic bricks offer several advantages, including:

- Long lifespan, resistance to weathering, fire, and pests.
- Good thermal insulation, which aids in maintaining acceptable indoor temperatures.
- Excellent compressive strength, which qualifies them for load-bearing applications.
- Their polished or painted surface may be treated to improve visual attractiveness and accommodate a variety of architectural ideas.

Disadvantages

- Compared to hollow or lightweight alternatives, solid ceramic bricks are heavier, which might result in higher labor and transportation expenses.
- The cost of manufacture may cause them to be more expensive than other kinds of bricks, which might affect the total cost of the project.
- The ideal solution for non-load-bearing walls, where lighter choices are desirable due to strength and weight, might not be provided by these materials.

2. Three-Hole Ceramic Bricks

These bricks are lightweight yet retain structural strength because to their three holes, or perforations. When insulation and weight reduction are crucial, they are usually utilized in walls. (Sarkar et al., 2019).

Applications

Non-load-bearing walls are widely constructed both outside and inside of homes and businesses using lightweight materials that are easy to handle and install. These materials are perfect for creating divisions. When insulation is needed without adding too much weight, utilized as filler materials in framed constructions. (Ahmed et al., 2018).

Advantages

- They may be transported and handled more easily on-site because to their less weight than solid bricks, which can result in cheaper labor expenses.

- Lightweight and uniform in size, they allow for faster construction and less labor-intensive installation

- Generally, less expensive than solid bricks, so they are a good option for budget-conscious construction projects.

- The holes improve the thermal performance of the bricks, helping to regulate indoor temperatures and reduce energy consumption.

Disadvantages:

- Since load-bearing applications are not suitable for 3-hole bricks due to their lower compressive strength compared to solid bricks, their use in such applications should be avoided.

- Because of the increased sensitivity to water absorption caused by the holes, appropriate waterproofing measures are required to avoid moisture-related problems.

- Maybe not as visually pleasing as solid bricks, which is something to take into account in clearly visible building locations

3. Six-Hole Ceramic Bricks

Similar to 3-hole bricks, 6-hole ceramic bricks are characterized by six perforations, which further reduce weight and improve insulation. Uniformity in size and shape is ensured during the manufacturing process. (Chowdhury et al., 2020).

Applications:

Non-load-bearing walls are heavily constructed both outside and inside of homes and businesses. Due to the small weight, which makes carrying and installation easier, these materials are considered perfect for making partitions and room dividers. In framed buildings, these materials are often utilized where considerable weight gain is required but thermal insulation is not needed. (Ahmed et al., 2018).

Advantages:

- The increased number of holes improves thermal performance, helping to maintain comfortable indoor temperatures and reduce energy consumption for heating and cooling.
- Generally, more affordable than solid bricks, making them an attractive option for budget-conscious construction projects while still meeting performance requirements.
- Compared to solid bricks, 6-hole ceramic bricks are lighter, making them easier to transport and handle, resulting in lower labor costs and faster installation.
- Faster and easier installation is facilitated by their consistent dimensions and lightweight design, saving labor hours and boosting project efficiency.

Disadvantages

- Higher surface area may result in increased moisture penetration and decreased durability.
- Lower load-bearing capability relative to solid bricks makes them less appropriate for massive buildings.
- The perforations' ability to let air circulate may reduce thermal efficiency.
- Drilling into or firmly fixing items is difficult and requires specialized effort.
- The cost of building might go up if more insulation or plastering is required.

- The gaps may let noise through, which lessens their soundproofing ability.

4. Ten-Hole Ceramic Bricks

Perforated with ten uniformly spaced holes, 10-hole ceramic bricks are designed to be lightweight while maintaining sufficient structural integrity. Their lightweight nature allows for easier handling, movement, and installation. Typically, available in standard dimensions that align with established construction practices, they can be easily integrated into building projects. While the porous ceramic material provides modest thermal insulation properties, it may absorb moisture if not properly sealed. (Chowdhury et al., 2020).

Applications

These bricks are frequently used to create non-load-bearing walls, including internal partitions in low-rise or residential buildings, when a great degree of structural strength is not necessary. Additionally, they may be used to split and partition spaces, offering a portable and effective way to divide rooms. In order to improve the structure's beauty and energy efficiency, 10-hole ceramic bricks are also frequently utilized as façade cladding on building exteriors, particularly when an extra layer of insulation or aesthetic treatment is added.(Patel, N. 2019).

Advantages

- In temperate climes, the perforations assist preserve internal temperatures better than solid bricks, and they are easier to handle and transport, which lowers labor costs and building time.
- Because they require less material during manufacture, they are less expensive than solid bricks.
- Suitable for many kinds of construction, particularly internal partitioning and non-load-bearing uses.
- In regions where soil conditions are limited, the reduced weight lessens the total stress on building foundations.
- Requires less energy and raw materials to manufacture, which makes them a more ecologically friendly choice than conventional solid bricks.

Disadvantages

- Reduced durability in wet situations due to increased moisture penetration
- Airflow via holes can impair insulating characteristics;
- Less load-bearing capacity than solid bricks, making them unsuitable for big constructions.
- Drilling into it is challenging, and correct installation calls for specialized workers.
- The necessity for additional insulation or plastering raises expenses.
- Noise transmission from holes can lower acoustic performance.

6. Solid Concrete blocks

Building materials composed entirely of concrete, solid concrete blocks are known for their sturdiness and thickness. Exceptional fire resistance and durability are offered, along with a high compressive strength that frequently exceeds 15 MPa. The large thermal mass contributes to energy efficiency by assisting in the regulation of interior temperatures. (Chowdhury et al., 2020)

Applications

These blocks are considered perfect for both residential and commercial constructions due to frequent utilization in foundation walls and load-bearing walls. Sound transmission is significantly reduced when used as acoustic barriers and in retaining walls. The usefulness for fire-rated walls is further enhanced by fire-resistant qualities.

(Ahmed et al., 2018).

Advantages

- Solid concrete blocks are appropriate for load-bearing buildings due to their exceptional compressive strength.
- Buildings made with these blocks have a longer lifespan due to their high resilience and resistance to adverse weather.
- By keeping flames contained and safeguarding the structural integrity of buildings, non-combustibility and fire resistance improve safety.

- Solid concrete blocks' ability to absorb and release heat helps control interior temperature and boost energy efficiency.
- Good sound insulation is provided by dense buildings, which lessens noise transfer between spaces.
- Solid concrete blocks are an affordable option since they require less upkeep over time.

Disadvantages

- Higher labor and shipping expenses can result from the weight of solid concrete blocks, placing additional stress on foundations and necessitating careful structural design.
- Despite a large thermal mass, heat transmission can lead to energy loss if not well insulated under extreme cold.
- A lack of aesthetic appeal may require additional finishing or cladding, driving up project costs.
- Cracking can occur due to stiffness and susceptibility to temperature fluctuations from improper installation or exposure to extreme ground movement.

Figure 2.7: Solid Concrete Bricks

2.3.3 Hollow Concrete Blocks

Precast masonry components with voids that save weight without sacrificing strength are called hollow concrete blocks. Typically sized 390 mm by 190 mm by 190 mm, they provide strong compressive strength (sometimes exceeding 10 MPa) and improved acoustic and thermal insulation because of their hollow cores. (Chowdhury et al., 2020).

Applications

These blocks are frequently used for partition and non-load-bearing walls in residential and commercial construction. Frequently utilized in industrial applications, such as fire-resistant and sound-barrier walls, these blocks have insulating qualities that make them appropriate for external walls. (Patel, N. 2019).

Advantages

- Lightweight, which lowers labor and shipping expenses.
- Improved thermal insulation aids in controlling interior temperature.
- Economical because of the manufacturing's efficiency.
- Faster construction since it is easier to handle and install.
- Offers effective sound absorption.

Disadvantages

- Limited use for load-bearing applications due to lower structural strength as compared to solid blocks.
- The ability to absorb moisture if improperly sealed.
- Extra finishing can be necessary for visual appeal
- Susceptible to cracking if improperly installed.
- Not as fire resistant as concrete blocks that are solid.

Figure 2.8: Hallow Concrete Blocks

1. Concrete blocks (AAC)

Made of cement, lime, sand, water, and aluminum powder, Autoclaved Aerated Concrete (AAC) blocks are a lightweight precast masonry material. They have a density of 600–800 kg/m³ and are typically 600 mm by 200 mm by 100 mm in dimension. With a compressive strength that often exceeds 3 MPa, their cellular structure, which has small air pockets, improves sound absorption and thermal insulation.

Applications

Both load-bearing and non-load-bearing walls made with AAC blocks are often utilized in both residential and commercial construction. They are perfect for energy-efficient buildings because to their superior thermal insulation, and their lightweight design makes handling and installation simpler. To further promote sustainable building methods, they are also utilized for roofing systems, facades, and partition walls. (Patel, N. 2019).

Advantages

- Lowers shipping and labor expenses.
- Improves energy efficiency by preserving a constant interior temperature.
- It is non-flammable, which increases building safety.
- Minimal energy usage in the production process and in the utilization of repurposed resources.
- This effectively lessens the transmission of sound.
- Easy Cutting and Shaping: This allows for quicker building.

Disadvantages

- Prevents usage in some applications that need bearing loads.
- To avoid problems, appropriate sealing is necessary.
- Could raise labor expenses and complexity.
- It could not be extensively accessible in every area.
- May fracture during construction if not protected.

- Extra finishing may be necessary for visual appeal.

Figure 2.9: Concrete blocks (AAC)

2. Kerb stone Concrete blocks

Precast concrete products known as "kerb stone concrete blocks," or "concrete kerbs," are used to mark the boundaries of roads and give walkways and pavements a firm edge. They are often available in conventional sizes, which include 1 meter in length, 200 mm in width, and 100 mm in height. Their compressive strength is strong, frequently surpassing 25 MPa. These blocks feature a sturdy construction, assuring endurance and resistance to traffic stresses and corrosion. Additionally, kerb stones are meant to ease water drainage and can be polished in various textures and colors to improve visual appeal. (Chowdhury et al., 2020)

Applications

In urban infrastructure, kerb stone concrete blocks are often used to define borders for flower beds and landscaped areas, keep soil erosion at bay, and separate walkways from roads. They are also utilized to give outdoor spaces a defined boundary and improve their aesthetic appeal in driveways, parking lots, and residential areas. These blocks are also used in drainage systems to efficiently guide water runoff. (Patel, N. 2019).

Advantages

- Excellent strength and durability, making it appropriate for high activity areas
- Effective in stopping soil erosion and preserving the aesthetic integrity of landscaping
- Low maintenance needs owing to weather resilience.
- Ample design possibilities that enable aesthetic customization.
- Simple alignment and installation that reduces labor expenses and time.

Disadvantages

- Kerb stone blocks can be heavy to move and install, requiring labor-intensive work.
- If not fitted correctly, it may crack in extremely cold or hot temperatures or under large loads.
- Limited design freedom as a result of uniform forms and sizes.

Figure 2.10: Kerb Concrete Blocks

3. Uni Paver Concrete blocks

Concrete blocks for paving applications, sometimes referred to as interlocking concrete pavers or uni paver concrete blocks, are precast masonry components. These are textured blocks with a better traction surface and a visually appealing appearance. They are often available in many shapes and sizes, such as 200 mm x 100 mm x 60 mm. For stability and to reduce movement during installation, interlocking mechanisms are incorporated into their design. High traffic areas may be assured of longevity since uni pavers have compressive strengths that often surpass 30 MPa. (Chowdhury et al., 2020)

Applications

Uni paver concrete blocks are frequently used for parking lots, driveways, walks, and patios in both residential and commercial settings. They are appropriate for high-traffic areas because of their interlocking construction, which facilitates fast installation. They are also used to provide a strong and aesthetically pleasing surface in public areas like parks, plazas, and roads. Uni pavers also assist to good storm water management due to its permeability, enabling for water drainage and lowering runoff.

Advantages

- Available in a variety of colors, shapes, and textures, uni pavers can improve the aesthetic appeal of outdoor spaces.
- Their interlocking design allows for quick installation and simple repairs; as individual pavers can be replaced without disturbing the surrounding area.
- High compressive strength makes uni pavers suitable for heavy loads and high-traffic areas.
- Uni pavers' longevity and low maintenance requirements make them a more cost-effective choice in the long run when compared to other paving materials.

Disadvantages

- If the interlocking mechanism is not fitted correctly, shifting or uneven surfaces may occur over time.
- Uni paver blocks might have greater upfront prices when compared to alternative paving materials.
- If gaps between pavers are not kept up, they may encourage the growth of weeds.
- Some configurations might not be appropriate for situations requiring specialist handling of very large loads.

Table 2.1: Details of Brick production process

Categories	**Bricks Field**	**Concrete Bricks Factory**
Types	1. First Class Brick 2. Second Class Brick 3. Third Class Brick 4. Over Burnt or Jhama Brick	1. Solid Concrete blocks 2. Hollow Concrete blocks 3. Concrete blocks (AAC) 4. kerb stone Concrete blocks 5. Uni Paver Concrete blocks
Row Materials	1. Clay 2. A small amount of sand 3. water	4. Cement 5. Sand 6. Crushed stone 7. water
Drying Process	1. Dry in the open field	2. Dry in the open field
Waste Generate	1. Fly Ash 2. Coal 3. Coal Ash (Rabbish) 4. Broken bricks 5. Unused clay 6. Polythene 7. Cardboard	1. Unused Concrete 2. Rejected Concrete Products 3. Broken Concrete Products 4. Cracked Concrete Products 5. Plastic 6. paper 7. cardboard 8. Dust from Aggregates
Waste Management	1. Burying the soil by making a hole 2. The soil is piled up	1. Material Recycling 2. Water Recycling: 3. Dust Control 4. Raw Material Efficiency 5. Reduce Packaging Waste: 6. Dispose of expired admixtures according to regulations.

2.4 Types of Kilns in Bangladesh

A range of kiln methods are employed in the production of bricks, particularly in Bangladesh. Regarding cost, environmental effect, and efficiency, each variety offers unique benefits. The primary kiln types utilized in Bangladesh are as follows:

1. Fixed Chimney Bull's Trench Kiln (FCBTK)

Structure: In Bangladesh, this is one of the most prevalent kinds of kilns. It is an oval or circular trench kiln that is continuous and has a permanent chimney. A pit is filled with bricks, which are then burned. Green bricks are loaded, burnt, and cooled in various areas of the trench. The emissions can be vented through the fixed chimney. Moderate, yet pollutant and energy-intensive. FCBTKs are notoriously polluting, adding to greenhouse gas emissions and air pollution.

2. Zigzag Kiln

Structure: The airflow within this kiln travels in a zigzag pattern, making it an enhanced version of the classic Bull's Trench Kiln. The fire technique guarantees improved heat dispersion, and bricks are piled in a zigzag manner. Better than the FCBTK in terms of brick quality and fuel usage. It uses 20–30% less gasoline. Due to their lower emissions of smoke and particulate matter, zigzag kilns are thought to be more ecologically friendly than FCBTKs.

Figure 2.11: Zigzag Kiln

3. Hybrid Hoffman Kiln (HHK)

It combines a fixed chimney with the continuous fire process of the tunnel kiln. It is made out of a big room with a fixed chimney that produces heat by burning coal. Coal combustion is used to fire bricks, and the kiln runs constantly. Extremely high in contrast to conventional kilns. less fuel-intensive and energy-efficient. Compared to earlier kiln types, it produces a lot fewer emissions and contaminants.

4. Tunnel Kiln

Bricks are continually loaded at one end of this long, horizontal construction, heated in the center, and cooled at the other end. The bricks are pushed on carts or moved along a conveyor belt as they pass through the kiln. Extremely efficient since it requires less fuel and guarantees even heating. Regarded as eco-friendly and with low emissions.

5. down-Draft Kiln

The heat in this kiln travels through the kiln chamber from the top. In order to provide more even heat dispersion for brick fire, heat is pulled lower. Moderately effective. Despite being less frequently utilized in large-scale production, it has a moderate environmental impact.

6. Clamp Kiln

One of the oldest and most conventional techniques involves firing bricks in an open kiln without a chimney while they are piled in layers.

The construction is lit from the bottom when the fuel is positioned in between the bricks. Low effectiveness and heavy fuel usage. Open fire produces a lot of smoke and other pollutants, making it extremely harmful.

7. Vertical Shaft Brick Kiln (VSBK)

A vertical kiln construction with several shafts where green bricks are loaded from the top, and burnt bricks are discharged at the bottom. The kiln operates constantly, with the heat rising higher, providing improved fuel economy. Highly energy-efficient compared to older techniques. VSBK is more ecologically friendly with decreased fuel usage and less emissions.

8. Beehive Kiln

A beehive-shaped kiln in the shape of a dome. Coal is burned in a central furnace to provide heat that is dispersed uniformly throughout the building. Moderate but diminishing in frequency. Emits considerable amounts of emissions, although not as much as earlier kilns such as the clamp kiln.

2.5 Traditional Kilns and Energy Inefficiency

Coal, wood, and other fossil fuels have historically been used to power brick kilns. The most popular kiln types, such the Down-Draught Kiln, Clamp Kiln, and Bull's Trench Kiln (BTK), waste a lot of fuel and are extremely energy inefficient. Less than 30% of the fuel energy input is actually converted into product heating by typical kiln methods, according to UNDP (2020) studies, with the remaining energy being lost to the environment as waste heat.

1. Inefficiency in BTKs:

Particularly well-known for its energy inefficiency is the Bull's Trench Kiln, which is still in use in South Asia. In order to reach the necessary firing temperatures, more fuel must be used because of the open-top construction, which lets a lot of heat escape into the sky (UNDP, 2020).

2. Improved kiln technologies:

More energy-efficient substitutes are now available because to modern kiln technologies like the Tunnel Kiln and Vertical Shaft Brick Kiln (VSBK). Better insulation, less heat loss, and improved control over combustion conditions are all features of these kilns. According to a Singh et al. (2019) study, these technologies can drastically lessen the environmental effect of brick manufacture by reducing fuel usage by up to 50%.

2.6 Waste Generation in Brick Manufacturing

Ash waste from fuel combustion and solid trash (broken or unusable bricks) are the two primary categories into which waste output in Dhaka's brick industry may be divided. There are serious environmental problems when this garbage is not managed properly.

2.6.1 Solid Waste from Broken Bricks

A significant quantity of solid waste is produced throughout the brick-making process in the form of broken or useless bricks. These are usually thrown away in brick factories or in the surrounding communities, which pollutes the soil. These leftover bricks are frequently allowed to build up and might eventually deteriorate the soil's quality.

- **Improper disposal**: Broken bricks and other solid waste items are frequently dumped in uncontrolled landfills or left in agricultural fields, where they provide a risk to the environment, according to studies by Sarkar et al. (2021). Brick debris buildup can change the soil's physical characteristics, making it less appropriate for building or cultivation.

- **Recycling potential**: While there is potential for recycling waste bricks as aggregate in construction materials, this practice is not widely implemented in Dhaka. Encouraging the recycling of brick waste could help mitigate the environmental impact of waste generation and reduce the need for new raw materials.

Figure 2.12: Solid Waste from Broken Bricks

2.6.2 Ash and Residual Waste from Fuel Combustion

Ash is produced in large quantities by the burning of fuel in brick kilns. If not adequately handled, this ash can pollute soil and water supplies since it frequently includes dangerous contaminants including heavy metals.

- **Ash disposal:** Typically, the ash generated in brick kilns is either filled in low-lying regions or dumped close to the kilns. Guttikunda et al. (2018) claim that this method may pollute the environment since precipitation may carry the ash into adjacent bodies of water. Additionally, the ash may penetrate into the soil, harming agricultural output and soil health. (Ahmed et al., 2008).

Figure 2.13: Coal Dust

Figure 2.14: Rubbish mixed with coal dust

2.7 Waste Management Practices in Brick Industry

With no governmental monitoring or enforcement, waste management in Dhaka's brick manufacturing sector is primarily done in an informal manner. The industry's negative effects on the environment are made worse by inadequate recycling and waste disposal facilities.

2.7.1 Current Practices

- **Unregulated dumping**: As previously mentioned, brick kiln ash and solid debris are frequently disposed of in untreated adjacent locations. This practice contributes to environmental degradation by polluting the land and water. Although brick makers are required by law to adhere to certain waste disposal criteria, these restrictions are frequently disregarded since they are not strictly enforced.

Figure 2.15: Unregulated dumping of Brick Field waste

- **Absence of facilities for recycling:** The infrastructure for recycling brick refuse is not very strong. Waste bricks are frequently crushed and utilized as aggregate in building materials like concrete and road sub-base in various areas of the world. However, a lack of recycling incentives and knowledge has prevented this practice from becoming widely accepted in Dhaka. (Ahmed et al., 2008).

2.7.2 Potential Improvements in Waste Management

- **Reusing and recycling:** The environmental effect of Dhaka's brick industry might be lessened by putting in place a structured mechanism for recycling damaged bricks. Waste bricks may be utilized in place of natural aggregates in building materials, according to research by Sarker et al. (2021). This would lessen the environmental impact of brick manufacture in addition to lowering the requirement for new raw materials. (Patel, N. 2019).

- **Ash utilization**: The ash produced by brick kilns may find use in agriculture, as a soil conditioner, or in the manufacturing of cement and other products. Ash from biomass-based kilns may be utilized as fertilizer since it includes nutrients including phosphorus and potassium, according to research by Islam et al. (2020). However, before being used in agriculture, ash from coal-based kilns would need to be carefully inspected and treated since it can contain harmful heavy metals.

- **Improved regulations and enforcement**: Addressing the environmental effects of the brick kiln sector requires stepping up the enforcement of environmental laws pertaining to waste management at these facilities. This entails offering incentives for the use of cleaner and more effective technology as well as tougher sanctions for kilns that disregard appropriate waste disposal procedures.

2.8 Environmental Impact Caused by Brick Manufacturing process

1. Air Pollution and Health Impacts:

One of the main causes of air pollution in the area is undoubtedly Dhaka City's brick kilns. Since low-quality coal is used as the fuel source in the majority of these kilns, particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), and nitrogen oxides (NOx) are released. These pollutants impair the quality of the air, causing smog to build and harming both the environment and public health.

Research suggests that elevated levels of particulate matter and harmful gasses have contributed to a rise in respiratory ailments such lung infections, bronchitis, and asthma among the surrounding populace. Particularly at risk are young people, the elderly, and people with health issues already present. Additionally, the pollution from these kilns promotes to the development of acid rain, which can harm the soil, water bodies, and ecosystems in the area

2. Greenhouse Gas Emissions and Climate Change:

Additionally, the production of bricks contributes significantly to the emissions of greenhouse gases (GHGs), mainly carbon dioxide (CO_2). Large volumes of CO2 are discharged into the environment as a result of the extremely inefficient way that coal is burned in conventional kilns. The city of Dhaka's brick kilns contribute significantly to the city's total carbon footprint, which exacerbates global warming.

Brick kilns release not just CO2 but also black carbon, a powerful yet transient climatic pollutant that hastens glacier melting and increases global warming. Unchecked emissions from this business pose a threat to Dhaka's susceptibility to climate-induced hazards such rising temperatures, unpredictable weather patterns, and an increase in the frequency of natural catastrophes. These emissions are also at variance with international efforts to mitigate climate change.

3. Soil erosion and land degradation:

The basic raw material for building bricks, topsoil, is extracted from agricultural land and is a major factor in Dhaka's brick production. Large areas of productive land have been degraded as a result of this practice, which has decreased agricultural production and jeopardized the region's food security. Removing topsoil also raises the possibility of soil erosion, which increases the vulnerability of the area to landslides and floods, particularly during the monsoon season.

Farmlands that were formerly fruitful are frequently abandoned due to over-extraction of soil for brick kilns, which has long-term negative effects on the environment and the economy. This not only jeopardizes the local farmers' means of subsistence but also fuels rural-urban migration, further taxing Dhaka City's resources and infrastructure.

4. Pollution and Depletion of Water Resources:

Water is used extensively in the brick-making process, particularly during the clay preparation and brick-cooling stages. The high water use of brick kilns puts further strain on local water sources in areas where water is already scarce. When groundwater is over extracted to satisfy brick production needs, water tables are lowered, endangering home and agricultural water supplies.

Furthermore, neighboring rivers, lakes, and groundwater reserves may become contaminated by the inappropriate disposal of effluent from brick kilns. Brick kiln water pollution includes chemicals, suspended solids, and other dangerous substances that deteriorate water quality and damage aquatic habitats.

5. Loss of biodiversity and deforestation:

Particularly in smaller, unofficial operations, wood is still occasionally utilized as the main or auxiliary fuel source in brick kilns. Deforestation from this method affects biodiversity, soil stability, and regional climatic patterns in a domino effect. The ability of ecosystems to sequester carbon is further diminished by the loss of forests, intensifying the consequences of climate change.

In addition to destroying wildlife habitats, deforestation upends the local inhabitants whose livelihoods depend on forest resources. Degradation of forests results in the loss of important ecosystem services including carbon storage, flood control, and water filtering. Forests are essential to the maintenance of ecological equilibrium.

6. Social Issues and Occupational Hazards:

There are dangerous working conditions for brick kiln workers, many of them are untrained and underprivileged laborers. They frequently encounter high dust concentrations, harmful vapors, and extreme heat, which can lead to long-term respiratory difficulties as well as other health concerns. Furthermore, a lot of brick kilns run in an unofficial or unregulated way, which puts workers and their families at risk of exploitation, low pay, and subpar living circumstances.

Due to the fact that many families that work in the kilns depend on their children's labor to reach production targets, the industry also contributes to child labor. This keeps people in poverty and keeps kids from getting an education or escaping the socioeconomic limitations that their surroundings place on them.

2.9 The possible solution how to minimize the environmental impact

1. Using Greener Technologies:

The use of cleaner, more efficient technology is one of the best strategies to lessen the environmental impact of the brick-making business. It has been demonstrated that, in comparison to conventional fixed chimney kilns, Hybrid Hoffman Kilns (HHKs) and Vertical Shaft Brick Kilns (VSBKs) considerably lower fuel usage and pollutant emissions.

With the use of these technologies, less coal is used, less particulate matter and greenhouse gas emissions are released, and the quality of the bricks produced is enhanced. To promote the switch to these more environmentally friendly technologies, brick kiln operators should receive government subsidies and incentives.

2. Efficiency in Energy and Fuel Switching:

By switching from coal to more environmentally friendly fuels like natural gas or biomass, brick kiln air pollution might be significantly decreased. In instance, natural gas is a greener alternative to coal since it generates less carbon dioxide and emits fewer pollutants. Brick kilns may be able to use biomass fuels, which are made from agricultural waste, as a renewable energy source.

Moreover, initiatives to increase brick kiln energy efficiency should be undertaken. Without needing a sizable capital expenditure, straightforward actions like enhancing kiln insulation, lowering heat losses, and streamlining combustion operations can assist lower fuel usage and emissions.

As demonstrated by kilns BK12, BK13, BK14, and BK15, using less coal helps cut emissions. Air pollution can be decreased by enticing other kilns to switch to alternate energy sources like electricity or natural gas. Cleaner technology may be used by the kilns (BK12 and BK15) that have switched to electricity. Promoting the adoption of energy-efficient electric machinery in every kiln might reduce emissions even further.

3. More stringent laws and regulations:

Brick kilns should be subject to rigorously regulated emission criteria set by the government, with ongoing oversight to verify adherence. Kilns that do not comply with regulations ought to be subject to fines, but those that do so can be granted recognition or financial incentives to promote ethical behavior.

In addition, zoning regulations must to be put in place to limit brick kiln locations to those that are remote from residential areas, therefore lessening the health effects on the populations that surround them. To reduce environmental deterioration, kilns that are close to forests or other environmentally delicate places should be moved.

4. Promotion of Sustainable Alternatives:

Promoting the use of substitute construction materials like fly ash bricks, compressed stabilized earth blocks (CSEB), or autoclaved aerated concrete (AAC) might decrease the market for conventional clay bricks and mitigate the environmental effects of brick production.
Because they employ industrial byproducts like fly ash, which would otherwise contribute to environmental pollution, and because they need less energy to generate, these materials are frequently more environmentally friendly. Market shifts towards more sustainable practices can be facilitated by government legislation, subsidies, or public awareness campaigns that encourage the adoption of these alternatives.

5. Measures for Conserving Water and Soil:

It is necessary to solve brick kilns' high water usage and topsoil extraction. Brick manufacture may be less dependent on fertile soil by using alternative raw materials like recycled materials or industrial waste (fly ash or building debris).

To cut down on water use and stop pollution, water conservation measures including rainwater collection, wastewater recycling, and installing water-efficient equipment should be put into place. For instance, BK15's water consumption may be minimized by implementing water recycling devices. Additionally, effluent from brick kilns needs to be treated before being released into the environment.

Resource-saving and recycling solutions should be implemented in kilns that use a lot of sand and it can lessen its need by substituting industrial waste for sand.

6. Safety and Well-Being of Workers:

Addressing the social effects of the sector requires improving the working conditions for people in brick kilns. Personal protection equipment (PPE), safe working conditions, and equitable pay and working hours for laborers are all requirements for employers.

To enhance workers' well-being, awareness campaigns about labor rights and occupational health and safety should be implemented. The fight to end child labor in the sector should also be stepped up, and workers' children should have access to healthcare and education.

7. Public Awareness and Multi-Stakeholder Engagement:

Increasing public knowledge of the negative social and environmental effects of brick production might influence customer choices for more environmentally friendly construction materials. A coordinated solution to the issues facing the brick-making business may be produced by involving a variety of stakeholders, including local communities, NGOs, government agencies, and trade groups.

Brick kiln operators may benefit greatly from public-private partnerships (PPPs) by receiving finance, training, and technical support to enable them to make the switch to more environmentally friendly operations. Furthermore, investments in cleaner technology and global collaboration can help ensure the industry's long-term viability.

Chapter III

METHODOLOGY

3.1 General

This study uses a combination of qualitative and quantitative research methodologies due to the complexity of the environmental issues related to brick kilns, including soil degradation, water contamination, and health implications. With the use of these techniques, an extensive evaluation of the environmental aspects of the brick manufacturing sector is intended.

The approach comprises many essential elements, such as the choice of research locations, techniques for gathering data, environmental sampling, life cycle evaluation, geographic information analysis, health effect evaluation. Understanding the many aspects of brick kiln operations and their implications on the environment and public health requires an understanding of each component.

Different types of brick manufacturing process in Dhaka city and their impact on environment are discussed here.

3.2 Literature review

We begin by reviewing the prior publications as we consider gathering this data and deciding which lines to choose. Since, in our opinion, the purpose of this type of literature review is usually to determine the extent of knowledge that exists on a particular topic. It may be used to identify research gaps, create research agendas, or just to have a conversation about a certain subject. Our team worked really hard to review sixty publications on the effects of brick manufacturing on the environment.

3.3 Flow diagram of Methodology

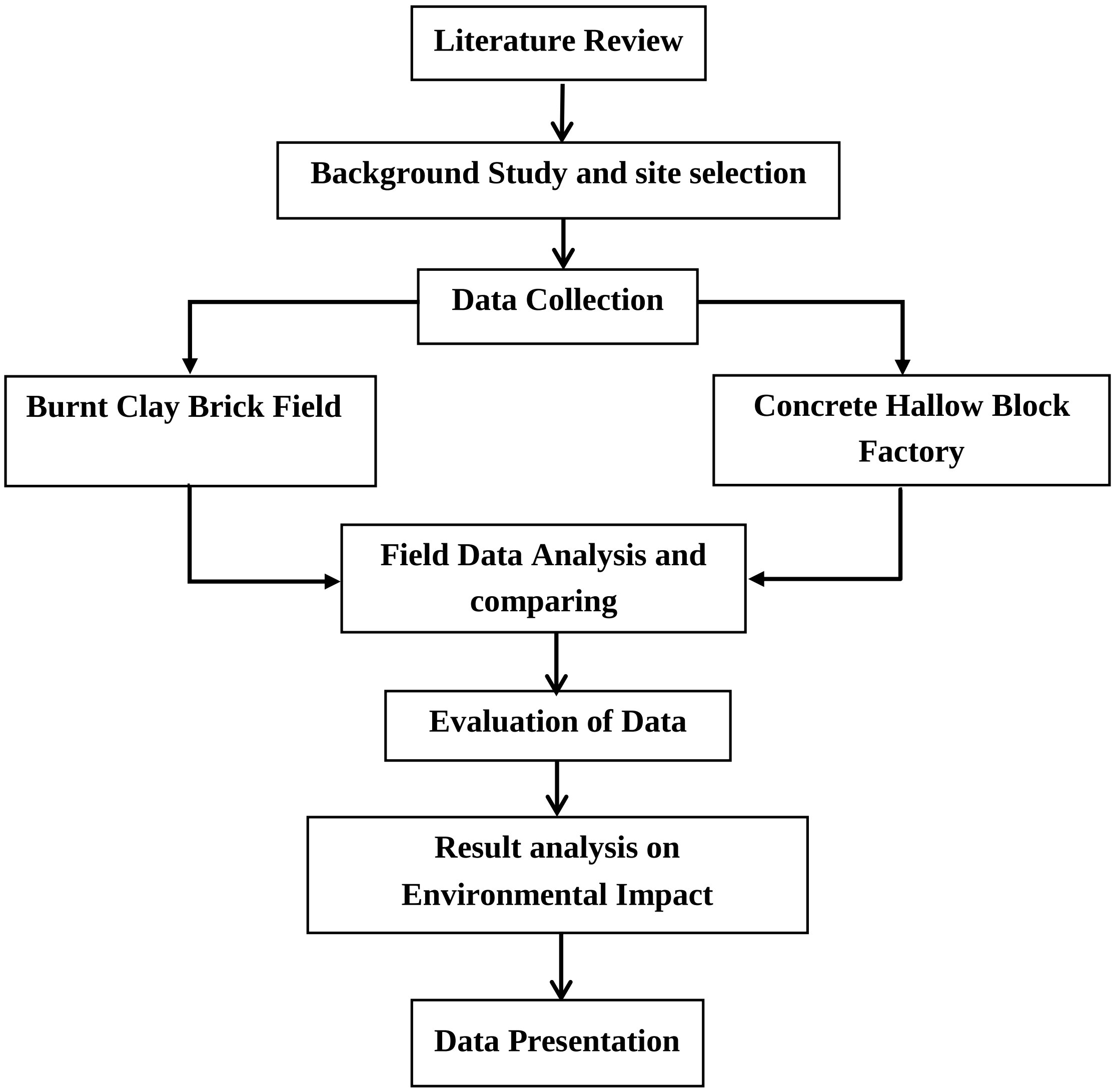

Figure 3.1: Flow Chart

3.4 Background study and site selection

Due to the strong demand for building materials, the research concentrates on Dhaka City and the adjacent areas, where a sizable number of brick kilns are in operation. These locations have been selected because they show the usual density of brick kilns associated with Bangladesh's urbanization. The study's chosen kilns reflect various technology setups.

The research area includes Dhaka's peri-urban and rural areas, where varying degrees of industrial activity and population density are predicted to have different effects on the environment. To determine the geographical distribution of kilns and their separation from residential areas, schools, hospitals, and agricultural land, Geographic Information System (GIS) mapping was employed. Visual depiction and geographical analysis of the distribution of kilns in the region are made possible by GIS, which facilitates an understanding of the effects of these facilities on the surrounding surroundings.

After the locations were examined, a few criteria were used to pick the sites.

a) **Closeness to Water Bodies:** In order to evaluate the risk of water pollution from the manufacture of brick runoff and waste water, brick kilns close to ponds, rivers, and groundwater sources were chosen.

b) **Effect on Agricultural Land:** To find out how clay extraction, or the removal of topsoil, affects soil fertility and agricultural production, kilns next to agricultural areas were selected.

c) **High Kiln Density:** To examine the combined environmental impacts on nearby populations, areas with a high density of brick kilns were chosen.

d) **Accessibility:** It was simple to do routine monitoring and environmental sampling (soil, and water) at the chosen locations. This made it possible to collect data in an efficient and uniform manner. (Ahmed et al., 2008).

Table 3.1: Location of The Data Collection points

S.N.	Brick Field Name	Brick Field code	Bricks Field Type	Brick field Location		Brick Field Location
				Latitude	Longitude	
01	MRB	BK1	Traditional Brick Fields	23.79324	90.31053	Amin bazar
02	FOUR STAR	BK2		23.88795	90.33752	Ashulia
03	MRM	BK3		23.79792	90.3132	Amin bazar
04	MBB	BK4		23.7982	90.30897	Amin bazar
05	ARB	BK5		23.79837	90.30749	Amin bazar
06	HBC	BK6		23.79978	90.31086	Amin bazar
07	AIM	BK7		23.79401	90.30911	Amin bazar
08	CITY	BK8		23.79253	90.31222	Amin bazar
09	MEGNA	BK9		23.88453	90.34141	Ashulia
10	TBC	BK10		23.89221	90.33839	Ashulia
11	MCB	BK11		23.89227	90.34707	Ashulia
12	4Star	BK12	Concrete Hollow Block Factory	24.379904	89.931704	Palima
13	TCBL	BK13		23.90235	90.29447	Ashulia
14	SBB	BK14		23.85704	90.3252	Akran
15	BEOB	BK15		23.715404	90.412079	Sadarghat

3.5 Data Collection

Interviews and surveys were undertaken with important people in the brick manufacturing Field. Both qualitative and quantitative data, such as operational specifics, environmental awareness, and health problems, were intended to be gathered via the survey questions.

Data was collected from three types of break manufacturing factory/Kiln.

1. Concrete Hallow block Factory.
2. Burnt Clay Brick Field
3. Auto Clay Brick Field

Bk1 to BK 11 are Burnt Clay Brick Field and Bk12 to Bk15 are Concrete Hallow Block Field

Both primary and secondary data sources are used in the extensive data collecting phase. Direct fieldwork is used to collect primary data at the chosen brick production locations. This includes field surveys, which document important operational information such the utilization of raw materials, production methods, energy sources, and labor practices. The physical procedures involved in brick manufacture, such as brick firing, energy use, and waste management procedures, are observed firsthand. Additional qualitative information on the daily activities, difficulties, and environmental management procedures at each site may be obtained through interviews with brick field operators, factory managers, workers, and technical specialists. On-site environmental measurements are made.

Government publications, environmental impact analyses, and ongoing scholarly research that offer historical background and additional information on emissions, energy use, and production patterns are the main sources of secondary data.

3.6 Brick Field Data Analysis and Comparing

After the collection of data from the different brick production procedures, the environmental effects of each approach are analyzed and compared. A statistical assessment of the energy usage related to each industrial technique is part of quantitative analysis. Excel is one of the software tools used in this investigation to do calculations and produce patterns from the data. Pollutant levels, energy consumption per unit of production, and the carbon footprint per brick are among the metrics that are compared between traditional, semi-automated, and contemporary brick manufacturing methods.

Likewise qualitative analysis is carried out, with an emphasis on the knowledge acquired via in-person observations at the brick fields and interviews. The social and economic aspects of each brick-making technique are better understood thanks to these qualitative results, which also serve to contextualize the quantitative data. For example, the study emphasizes disparities in production capacity and the viability of switching to more sustainable methods from an economic standpoint. The research provides a comprehensive understanding of the effects that various brick production methods have on the environment, economy, and society by integrating the two forms of analysis.

3.7 Evaluation of Data

The assessment step evaluates each brick manufacturing process's total environmental effect by synthesizing the results of the data analysis. Significant trends are identified by the study, including how much energy and emissions are reduced by contemporary technologies (such as auto clay brick fields and concrete hollow blocks) in comparison to conventional burning clay kilns. Taking into account variables including possible energy savings, reduced emissions, and the long-term financial advantages of cleaner manufacturing, the study assesses the cost-effectiveness of implementing more environmentally friendly brick-making techniques.

3.8 Result Analysis on Environmental Impact

The environmental effect results are the special focus of the outcome analysis. It offers a thorough analysis of the effects of various brick production techniques on important environmental metrics, including energy use, carbon emissions, and particulate matter. Potential enhancements to each method's environmental performance are also examined in the investigation. To further lessen the environmental effect, for example, more efficient kilns or alternative energy sources (such solar or wind power) can be implemented.

3.9 Data Presentation

The methodology's last phase entails clearly and understandably presenting the study's findings. Data is presented using visual aids.

Chapter IV

Result and Discussion

4.1 General

The result and discussion, which discuss the outcome of the entire effort, are the most crucial sections of a paper. What has been worked on, the types of results obtained from the data, the solutions, the reasons behind the incident, etc., are all mentioned. This section covers a wide range of often asked questions. Thus caution should be taken when working on this issue to ensure that no inaccurate information is released.

The use of coal, power, soil, sand, water, and brick manufacture are all important environmental aspects that must be taken into account in order to identify which brick field is the most ecologically friendly and which is the most harmful. Examining how these resources are consumed may help determine the environmental effect, since increased consumption often results in more damage to the environment.

Key Environmental Metrics:

1. Coal Consumption (measured in cubic feet): a significant contributor to greenhouse gas emissions and air pollution.

2. Consumption of electricity (in kilowatt-hours annually): The energy source (renewable or non-renewable) determines its effect on the environment.

3. Soil Consumption (in cubic feet): Excessive consumption causes soil erosion and land deterioration.

4. Sand Consumption (in cubic feet): Over-extraction of sand causes erosion of riverbanks and habitat degradation

5. Water Consumption (in liters): Excessive water use can exhaust nearby water supplies.

6. **Cement Consumption** (in cubic feet): The manufacture of cement uses a lot of energy and emits a lot of CO_2.

7. Brick Production (in lakhs of bricks): increased production translates into increased pollution and raw material usage.

Table 4.1: Data from Brick Fields

Kiln Name	Coal Consumption in ton	Electricity Consumption per kwh	Soil Consumption in kg	Cement Consumption in kg	Sand Consumption in kg	Water Consumption in Liter	Brick Production (lakh)
BK1	**110.0**	**0.0**	**2090000.0**	**0.0**	**385000.0**	**137500**	5.5
BK2	**162.0**	**0.0**	**2220000.0**	**0.0**	**390000.0**	**162000**	6
BK3	**108.0**	**0.0**	**2400000.0**	**0.0**	**420000.0**	**156000**	6
BK4	**126.0**	**0.0**	**2340000.0**	**0.0**	**480000.0**	**150000**	6
BK5	**154.0**	**0.0**	**2800000.0**	**0.0**	**525000.0**	**182000**	7
BK6	**160.0**	**0.0**	**3680000.0**	**0.0**	**656000.0**	**216000**	8
BK7	**216.0**	**0.0**	**3600000.0**	**0.0**	**640000.0**	**224000**	8
BK8	**225.0**	**0.0**	**4140000.0**	**0.0**	**765000.0**	**252000**	9
BK9	**280.0**	**0.0**	**4750000.0**	**0.0**	**900000.0**	**320000**	10
BK10	**360.0**	**0.0**	**5640000.0**	**0.0**	**1080000.0**	**384000**	12
BK11	**455.0**	**0.0**	**6240000.0**	**0.0**	**1235000.0**	**455000**	13
BK12	**0.0**	**36500.0**	**0.0**	**430700.0**	**474500.0**	**160600**	7.3
BK13	**0.0**	**37500.0**	**0.0**	**454882.5**	**525000.0**	**165000**	7.5
BK14	**0.0**	**36000.0**	**0.0**	**654579.0**	**540000.0**	**225000**	9
BK15	**0.0**	**63000.0**	**0.0**	**889875.0**	**682500.0**	**315000**	10.5

4.1.1 Coal Consumption

In conventional brick kilns, the use of coal serves as the main energy source. However, it also results in significant emissions of sulfur dioxide (SO_2), carbon dioxide (CO_2), and particulate matter, which worsen air pollution and accelerate climate change. The data's kilns show a broad range of coal usage.

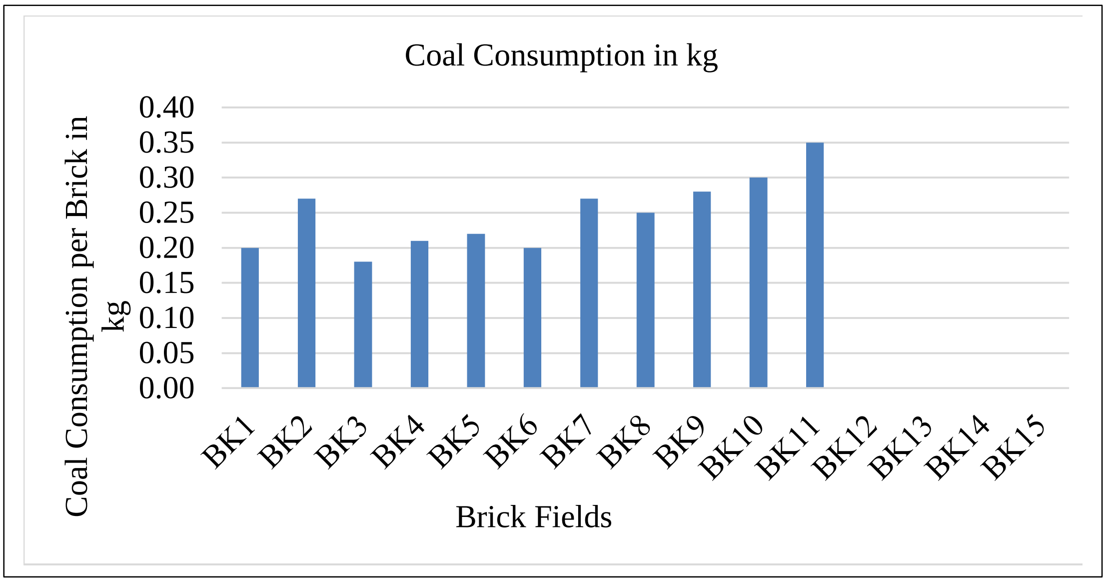

Figure 4.1: Coal Consumption

Highest: Because of their combined 0.65 kg of coal use per brick, BK10 and BK11 have a major influence on air pollution from greenhouse gas emissions.

Lowest: The combined coal consumption of BK1 and BK2 is comparatively modest at 0.45 kg per brick.

No Coal Consumption: The fact that BK12, BK13, BK14, and BK15 show 0% coal use suggests a move to potentially more ecologically friendly alternate fuels or technologies.

Traditional brick kilns in Bangladesh consume approximately 0.18–0.25 kg of coal per brick. **(Department of Environment (DoE), Bangladesh. (2017). Environmental Guidelines for Brick Kilns in Bangladesh.)**

4.1.2. Electricity Consumption

The amount of power used, particularly if it comes from non-renewable resources like gas or coal, is another important measure of the environmental effect of brick kilns. On the other hand, compared to coal-fired kilns, electricity-based processes often use cleaner energy.

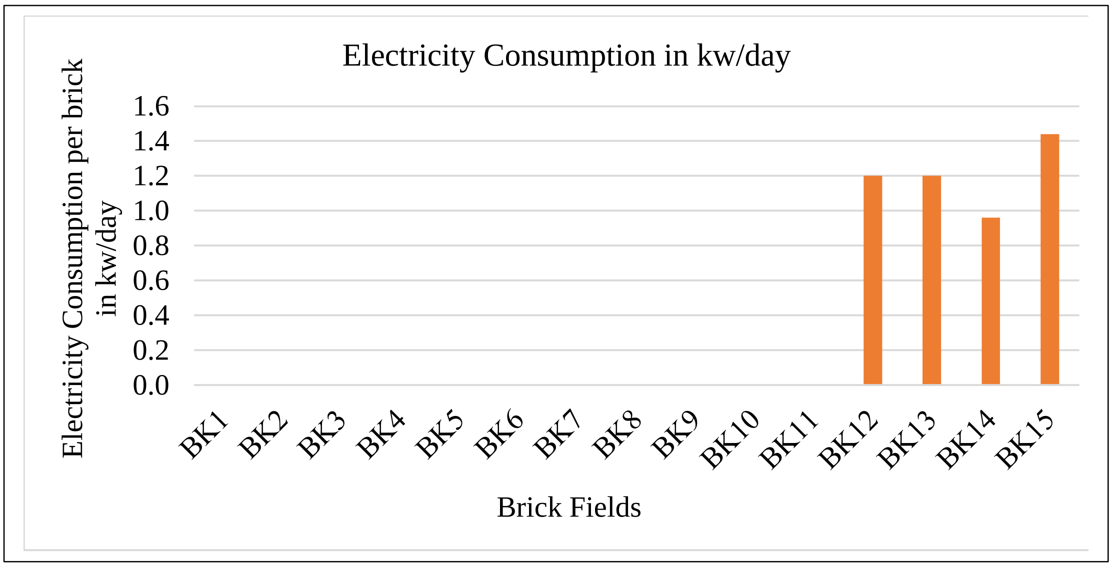

Figure 4.2: Electricity Consumption

Highest: The power usage of BK12, BK14, and BK15 is significant; it ranges from 0.87 kw/day (BK14) to 1.46 kw/day (BK12 and BK15) per brick. This suggests that the brick-making process makes use of electric-powered machinery or more sophisticated technology.

Zero Consumption: The power usage of the remaining kilns (BK1 to BK11) is 0 kw/year, indicating that they only use coal or other non-electric energy sources.

Traditional brick kilns in Bangladesh consume approximately 0.48–1.2 kw/day per brick for mechanized production processes. (**Energy-efficient practices in brick kilns, UNDP and World Bank reports on energy usage in brick kilns**)

4.1.3 Soil Consumption

Because it causes erosion, topsoil depletion, and degradation of land, soil consumption is a major environmental problem. These effects can have long-term effects on local ecosystems and agricultural production.

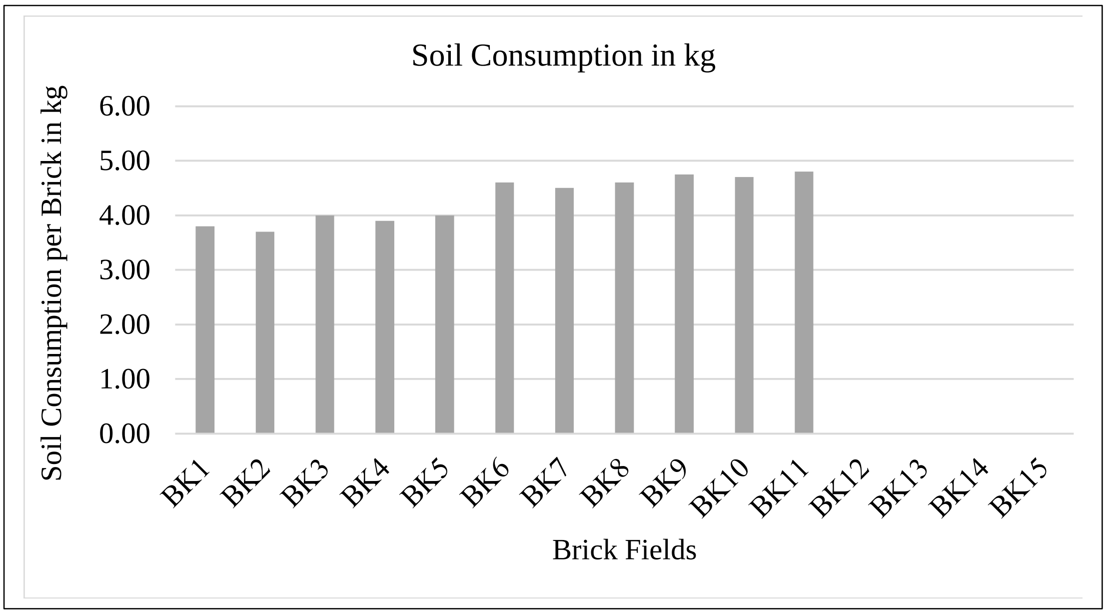

Figure 4.3: Soil Consumption in cft

Highest: In the vicinity of the kiln, BK9 uses 4.75 kg of soil per brick, which contributes to erosion and land degradation.

Lowest: BK1 has one of the lowest rates of soil consumption at 3.8 kg per brick.

Traditional brick kilns in Bangladesh consume approximately 3.5–4.5 kg of soil per brick for traditional bricks. **(Industry standards and best practices for traditional brick production in South Asia)**

4.1.4 Sand Consumption

Sand is a vital resource for making bricks, but getting it out of riverbeds and other places may seriously damage the environment by destroying habitats and causing river erosion.

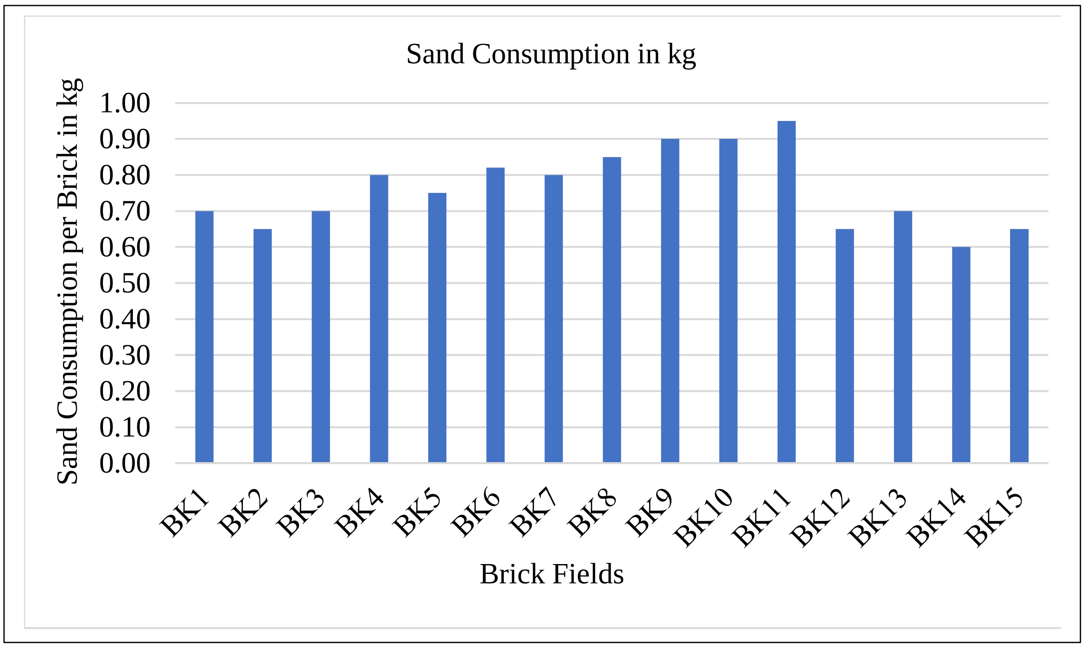

Figure 4.4: Sand Consumption in cft

Highest: With a sand consumption of 0.95 kg per brick, BK15 is the most materially intensive, which raises the possibility of riverbed damage and other environmental issues.

Lowest: BK1 and BK2 have much lower sand consumption at **0.70 kg** and **0.65 kg** per brick, respectively.

Traditional brick kilns in Bangladesh consume approximately 0.4–0.8 kg of sand per brick. **General guidelines for construction material usage, Bangladesh National Building Code (BNBC)**

4.1.5 Water Consumption

Understanding water usage is essential to assessing the burden on local water resources, particularly in places where access to clean water is scarce.

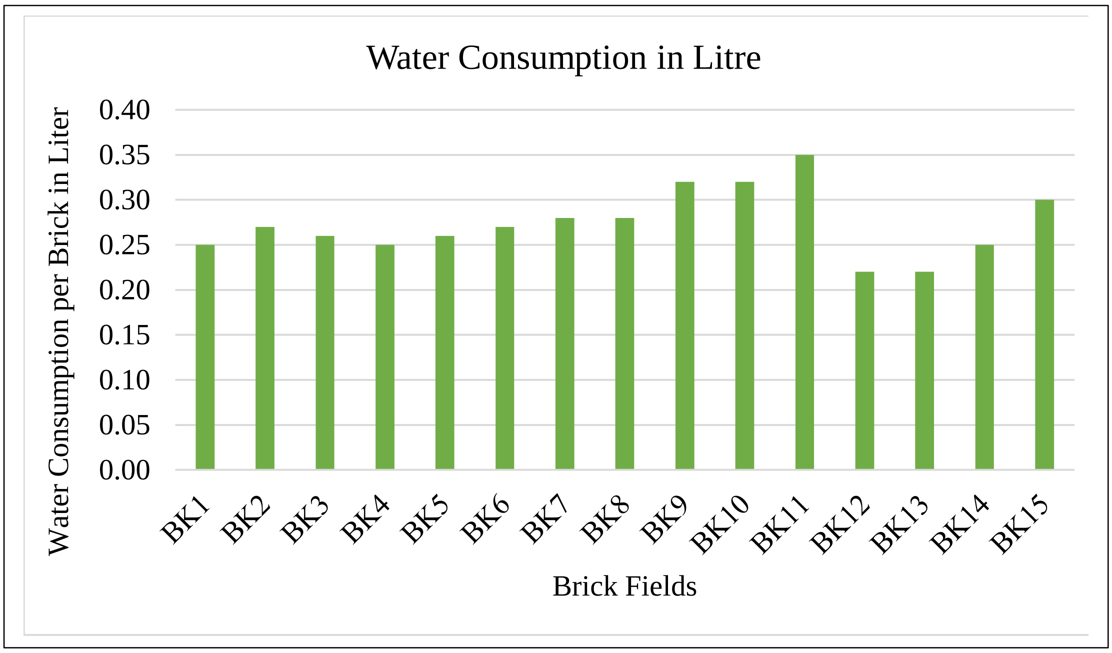

Figure 4.5: Water Consumption

Highest: BK11 uses 0.35 liters of water per brick, putting strain on the region's water supplies and accelerating their decline.

Moderate: The annual water consumption of BK1 to BK10 varies, ranging from 0.2 to 0.3 liters per brick.

Lowest: At 0.22 liters per brick, BK12 and BK13 uses the least quantity of water.

Traditional brick kilns in Bangladesh Approximately 0.15–0.25 liters of water per brick. **(Best practices in brick production and water management, UN-Habitat reports.)**

4.1. Cement Consumption

Cement manufacture is very highly energy-intensive, and its utilization in brick kilns may be a sign of more contemporary construction processes but also a contribution to carbon emissions.

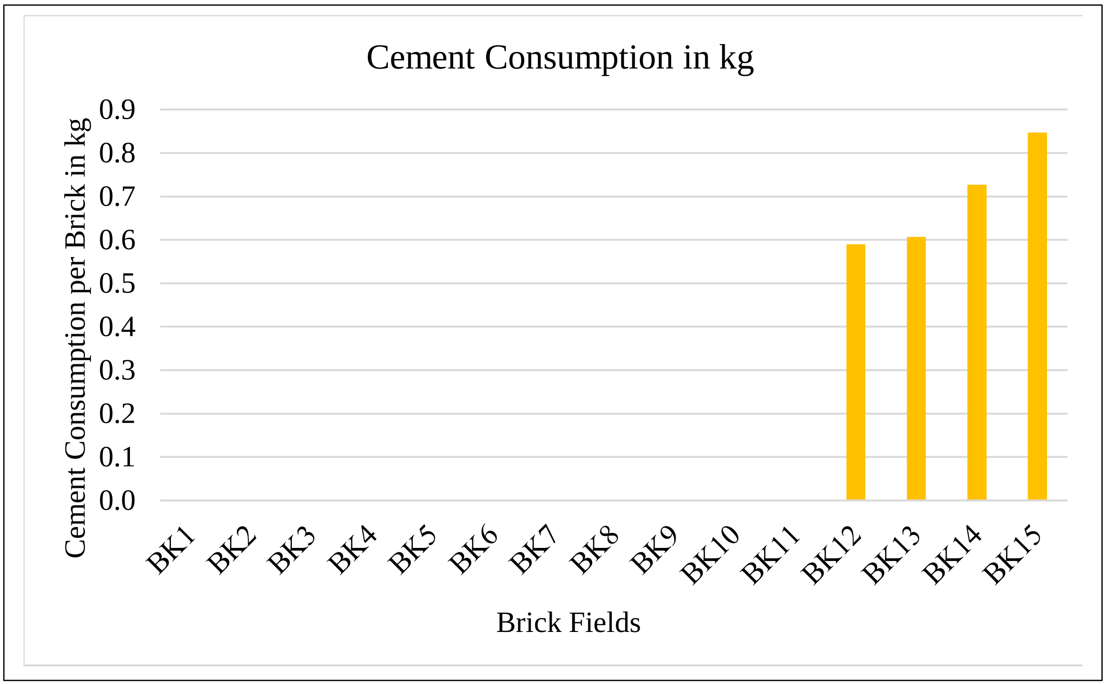

Figure 4.6: Cement Consumption

Notably High: Cement consumption is 0.7 kg/brick for BK14 and 0.8 kg/brick for BK15. The energy-intensive process of making cement has the potential to increase emissions of carbon dioxide.

No Consumption: Cement usage is not reported by BK1 through BK11.

Traditional brick kilns in Bangladesh consume For concrete bricks, approximately 0.5–1.0 kg of cement per brick. **(General industry standards for concrete brick production (Engineering and Construction Manuals)**

4.1.7 Brick Production

An important consideration when evaluating a kiln's overall effectiveness and environmental impact is its amount of brick output.

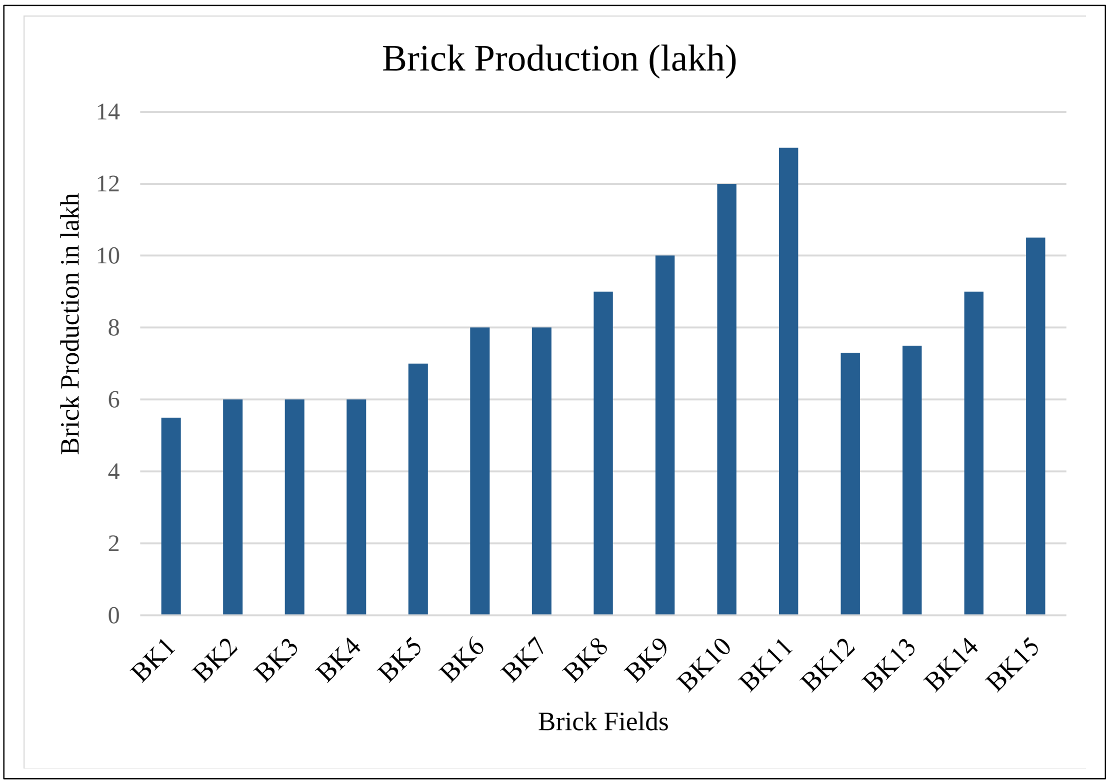

Figure 4.7: Brick Production

Highest: Although BK15 makes the most bricks—10.5 lakh—it also uses a lot of cement and sand.

Lowest: BK1 uses less coal and sand to create 5.5 lakh bricks, but more soil is used in the process.

Efficient Kilns: Producing 7.3 lakh and 7.5 lakh bricks, respectively, BK12 and BK14, with no coal use but modest power consumption, may be more efficient and have less of an impact on the environment since they use less coal.

4.2 Discussion

General Observations:

1. High Coal Users (BK10, BK11& BK13) have significant effects on the environment as a result of high CO2 emissions and air pollution. Their manufacturing methods are less efficient in terms of output compared to resource consumption, making them less sustainable.

2. Electricity-Dependent Fields (BK12, BK14 & BK15) have the potential to have less of an impact on the environment, if their power comes from sustainable sources. In terms of production efficiency per resource unit, these fields likewise record the highest brick output.

3. Soil and Sand Extraction continues to be a major issue in all brick sectors. Fields like BK15 and BK14, which utilize more sand, are probably going to degrade the soil further. To reduce environmental damage, sustainable substitutes for raw resources should be taken into account.

4. Water Consumption BK1 and BK9 have the largest customer numbers, albeit this varies throughout brick fields. The use of water-saving technology will alleviate environmental strain, particularly in metropolitan areas like as Dhaka, where water supplies are scarce.

- **Best Brick Field (Environmentally Friendly): BK12**

Advantages: Cleaner energy use (assuming power is renewable), no soil or coal consumption, and comparatively less water use.

Disadvantages: excessive use of sand, which may cause serious soil degradation.

Overall: Although better sand utilization is required, BK12 is the greatest alternative since it has the least environmental impact because it doesn't need coal or soil.

- **Worst Brick Field (Environmentally Harmful): BK10**

Disadvantages: excessive use of coal and soil, which results in degraded land and enormous CO2 emissions.

Overall: Because of its heavy reliance on non-renewable resources, BK10 has the greatest environmental effect, greatly accelerating climate change, air pollution, and land degradation.

Chapter V

Conclusion and Recommendation

5.1 General

A vital component of the construction sector, the brick making industry in Dhaka City supplies the growing need for reasonably priced building materials. Nonetheless, this sector has a large environmental impact and presents serious risks to the public's health and the local ecosystem. Air pollution, land degradation, and climate change are just a few of the environmental problems that traditional brick kilns have exacerbated. These problems are mostly caused by the kilns' heavy reliance on inefficient manufacturing techniques and fossil fuels like coal.

5.2 Conclusion

According to table it shows how 15 brick fields differ in terms of efficiency and resource usage. BK10 and BK11 are coal-dependent fields with severe environmental consequences because of excessive coal consumption and emissions, whereas BK12 and BK15 are electricity-based fields that produce more bricks without using coal and are thus more sustainable. But certain areas, especially BK15 and BK9, use a lot of water and sand, which might be harmful to the environment. BK12 is the most eco-friendly and efficient overall, whereas BK10 and BK11 have the worst negative effects, highlighting the need for resource optimization and cleaner energy.

5.4 Limitation

1. Limited Technological Scope: The thesis will focus primarily on brick kilns and will not explore other building materials or alternative construction methods

2. Temporal Limitation: The data collected will cover a specific time period (2023-2024), limiting insights on long-term environmental changes or future trends.

3. Technical Constraints: Due to resource limitations, in-depth technical analysis of emission control technology or advanced laboratory testing on emissions may be outside the scope.

5.3 Recommendation

1. This article only examined one year of the brick manufacturing process; further years would have yielded more information.

2. In this article, only 15 brick field locations were examined; however, additional data will be accessible if more areas are analyzed.

3. Many software of calculating environmental impact could not be used because of their high valued paid versions, if this environmental impact study are calculated through this software in the future, more information and accurate results will be available.

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Serial no	Name	Address	profession	Contact Number	Kiln Name
1	Monir	Jashore	Worker	1306656676	MRB
2	Sagor	Jashore	Worker	1794349024	MRB
3	Robiual Islam	Dinajpur	Worker	1717184506	MRB
4	Md. Manik	Hatibandha	Worker	1749928168	MRB
5	Md. Fajlul korim	Gobindogonj	Worker	1737932452	MRB
6	Md. Chanmia	Gobindogonj	Worker	1792620774	MRB
7	Rayhan	Hatibandha	Worker	1328740559	MRB
8	Md. Rakib	Amin Bazar	Accountant	1313671503	FOUR STAR
9	Abu Hossain	Hatibandha	Worker	1834477523	FOUR STAR
10	Sahin	Islampur	Worker	1724910652	FOUR STAR
11	Sobuj	Khulna	Worker	1780592813	FOUR STAR
12	Rakib Hasan	Jashore	Burnt worker	1309654359	FOUR STAR
13	Jueal Mia	Sherpur	Worker		FOUR STAR
14	Md Khalek	Sherpur	Worker		MRM
15	Sagor	Rangpur	Worker	1317467192	MRM
16	Ruhul Amin	Gobindogonj	Worker	1760960755	MRM
17	Md. Oyasim	Jamalpur	Shopkeeper	1867209939	MRM
18	Mintu Shekh	Foridpur	Coal Worker	1991933386	MRM
19	Md. Habib Rohman	Rajbari	Worker	1938611200	MBB
20	Md. Mejbah Uddin	Parah Gah	Farmer	1926870739	MBB
21	Shown Sharker	Uttora	Manager	1878435373	MBB
22	Aslam Hossain	Savar	Mechanical worker	1922981789	MBB
23	Md. Masum	Gaibandha	Worker Leader	1913648635	MBB
24	Mejan	Jamalpur	Engine Worker		ARB
25	Md. Mamun	Gaibandha	Worker	1782046341	ARB
26	Md. Siblu Mirja	Amin Bazar	Shopkeeper	1863710575	ARB
27	Md. Abdur Rajjak	Ashulia	Manager		HBC
28	Md. Rahmot Ali	Ashulia	Worker	1300207095	HBC
29	Jueal	Ashulia	Ticket Master	1775978267	HBC
30	Md. Hazrat Ali	Ashulia	Manager	1823879074	HBC
31	Md Anamul Hossain	Savar	Worker	1743617865	HBC
32	Abdul Kalam	Khulna	Manager	1716803621	AIM
33	Md. Anarul Islam	Savar	Worker	1739775670	AIM
34	abdul Gaffer	Jashore	Worker	1648542856	AIM
35	Momotaj Ali	Savar	Worker	1946860059	AIM
36	Jahid Hossain	Shatkhira	Worker	1837514767	CITY
37	Imran	Ashulia	Manager	1913852954	CITY
38	Rakibul Hasan	Akrain	Manager	1707653884	CITY
39	Salim	Moymonsingh	Worker	1637637432	CITY
40	Musa Ali	Savar	Manager	1738740876	CITY
41	Habib	Moymonsingh	Worker	1313162823	MEGNA
42	Aminul	Moymonsingh	Worker	1642593055	MEGNA
43	Samsul	Moymonsingh	Worker	1986057936	MEGNA
44	Rofiq	Savar	Manager	1812345678	TBC
45	Abdul Ajij	Jashore	Worker	1865292241	TBC
46	Md. Nasir	Jashore	Worker	1406381974	TBC
47	Md. Ruhul Amin	Mohammadpur	Worker	1618577120	TBC
48	Samiul	Mohammadpur	Worker	1796873108	MCB
49	Antor	Sherpur	Worker	1933367978	MCB
50	Mojaffor	Bogura	Unloader	1746382667	MCB