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Factors Influencing the Choice of Building Materials and their Relationships to Human Health

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Abstract

The significance of materials choice and their relationships to structural elements, the functionality of structure, aesthetic value, economic performance, and human health cannot be overemphasized in building development. This study carried out a critical review of the literature on several factors, including structural integrity, cost-effectiveness, aesthetic appeal, health considerations, and functional requirements, in the choice of materials for buildings and other structural developments. This study identified some building materials used to achieve structural stability and discourse sustainable and smart building materials. This study used primary data from physical observations and secondary data from relevant literature. This study observed that a well-designed and functional building enhances productivity, satisfaction, and overall user experience. The study also found that smart materials, such as programmable glass, self-healing concrete, and energy-generating facades, enhance functionality by incorporating features such as energy efficiency, improved thermal comfort, and interactive user experiences. The choice of construction materials is closely intertwined with the functionality of the structure, esthetic value, economic performance, and other factors. The study concludes that different materials possess specific properties that directly impact the performance, human health, and functionality of various building elements. The study recommends that in deciding on the choice of materials to be used for building development, hasty decisions should be avoided regarding buildings and the spaces that they occupy.

Keywords: Structural Elements, Functionality Features, Aesthetics Values, Economy Performance, Health and Well-Being

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INTRODUCTION

Selecting the appropriate building material is a crucial decision that affects various aspects of a construction project. The material choice must consider several factors, including structural integrity, cost-effectiveness, aesthetic appeal, health considerations, and functional requirements. Different materials have certain characteristics that can be used for different purposes. One may excel in one area but do the opposite in another. Hence, a proper evaluation is needed for building materials and how they excel at different building stages and for different purposes. Building materials refer to substances or elements used in construction to construct structures such as buildings, bridges, roads, and other infrastructures (Omer, and Noguchi, 2020). Building materials were classified in this study as natural building materials, which comprise wood, stone, and clay; synthetic building materials, which comprise concrete and steel; and composite materials, which comprise fiberglass, carbon fiber-reinforced polymers, and laminates. Sustainable building materials consisting of recycled, low-VOC, and renewable materials, among others, were discussed. Each type of building material has distinct properties and characteristics that determine its suitability for various construction applications. Materials can generally be categorized as either natural, artificial, or sustainable (Pinconsult Associates Limited, 2022).

Building materials for housing development cannot be overstated. The choice of the right building materials has a great impact on the quality of construction projects (Raouf, and AlGhamdi, 2020). Notwithstanding the presence of experts and their level of proficiency, when the materials are substandard and cheap, the structure will have many complications, will not stand the test of time, and might not last long. Usually, the choice of the right and accurate building materials is often ignored. Many contractors have a tendency to cut corners, breach the contract agreement, and negate the use of the best-quality materials. Repeatedly, the high cost of materials is the major reason for selecting alternative materials that are not as good as the original and superior choice. However, building professionals, including architects, engineers, and quantity surveyors, must consider original and superior choices to

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deliver the highest-quality buildings to their clients by using the most appropriate building materials. This guarantees the durability and safety of buildings (Kunitz, 2014). The choice of the right and suitable construction material adds and offers numerous benefits, for example, it will meet building specifications and standards, optimize construction cost, enhance the smooth execution of the project, and provide low maintenance cost, among others. It is expedient and necessary for an architect to certify the use of the right building materials both in terms of quantity and quality (Pinconsult Associates Limited, 2022). It is time to recognize the impact of the built environment on human health and well-being. However, hasty decisions to manage the situation should be avoided regarding the choice of building materials and the spaces that we occupy. Therefore, this study examined the challenges and issues in the choice of materials for structural elements, the functionality of structure, aesthetic value, economic performance, and human health to aid in housing development and housing performance. This study addressed research gaps in the selection of building materials and their consequent effects on human health with a view to inform policy on sustainable urban development

METHODS

Table 1. Classification of Building Materials

Material Type	Examples	Key Characteristics
Natural Materials	Wood, Stone, Clay	Readily available, biodegradable, durable
Synthetic Materials	Concrete, Steel, Plastic	High strength, industrially manufactured
Composite Materials	Fiberglass, Carbon Fiber, Laminates	Lightweight, enhanced mechanical properties
Recycled Materials	Reclaimed Wood, Recycled Concrete	Eco-friendly, reduces construction waste
Special Construction Materials	Polypropylene Fibers, PVC	Improved performance, specific applications
Finishing Materials	Paints, Plasterboards, POP	Aesthetic enhancement, surface protection
Sustainable Materials	Low-VOC Paints, Bamboo, Cork	Environmentally friendly, improves health

This study adopted a qualitative research approach, combining both primary and secondary data sources to ensure a comprehensive understanding of how building material selection influences human health and overall building performance. The research design emphasized literature analysis, expert consultation, and observational assessment of building materials in use.

Data Collection. The primary data was obtained through structured physical observations of building components and construction practices across various building types, including residential, institutional, and commercial structures. These observations focused on material types, application methods, and the presence of any material-related health risk indicators.

Secondary data were gathered from peer-reviewed scientific journals, technical reports, policy documents, and industry publications addressing building material classification, performance characteristics, sustainability considerations, and health-related impacts. Emphasis was placed on recent studies highlighting hazardous materials and emerging trends in eco-friendly and smart construction materials.

Data Analysis. The analysis was conducted using thematic synthesis to identify key patterns, challenges, and best practices related to material selection. A critical review of international standards, material safety data sheets (MSDS), and previous empirical studies provided insights into the

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correlation between material properties, structural functionality, economic factors, and human health implications.

Furthermore, specific attention was paid to identifying:

1) Commonly used materials that pose health risks (e.g., asbestos, lead-based paints, high-VOC products).
2) Recommended sustainable and health-conscious alternatives (e.g., low-VOC paints, natural insulation, recyclable materials).
3) The role of smart materials in enhancing both building performance and occupant well-being.

This holistic approach ensured a multidisciplinary perspective, integrating architectural, environmental, and public health considerations into the evaluation process.

RESULT AND DISCUSSION

The findings of this study reveal several critical insights into the factors influencing material choice and their subsequent impacts on both building performance and human health.

Factors Influencing Building Material Selection. The choice of architectural materials substantially impacts the level of comfort required by building users (Chen, et al. 2021). The right construction materials and services can be chosen to provide a comfortable and secure environment for occupants by considering elements like thermal comfort, lighting, sound, and ventilation (Huisman, et al, 2019). The health and safety of construction workers and future residents should be ensured by following rules on the usage, storage, and handling of building materials (Chen, et al. 2021). The building should be planned and constructed with the comfort and safety of people in mind by carefully choosing materials and conducting risk assessments (Stellman, 2020). There is a need to set the bar for offering a sustainable model that uses cutting-edge architectural materials, energy-efficient materials, and thorough risk evaluations (Huisman, et al, 2019). A building material that supports human healing, rehabilitation, and well-being for everyone who enters its doors will certainly be produced by balancing human comfort and safety while embracing developments in the construction sector (Tleuken et al, 2021). Furthermore, the comfort of users of a building can be improved by reducing noise levels through sound-absorbing materials, acoustic panels, and thoughtful layout planning (Kumari and Kumar, 2020). Building components and design tactics that efficiently deal with sound transmission can promote a calmer and more therapeutic atmosphere (Salonen, et al. 2022). Combining energy-saving artificial lighting with natural daylighting can increase the illumination level while consuming less electricity. Energy savings can be further increased by including intelligent lighting controls that adapt to the amount of natural light (Dirisu, et al. 2022). Factors that ought to be considered while selecting building materials in construction include the durability of the material, its strength, cost, load-bearing capacity, appearance, eco-friendly, and serviceability (Jamal, 2017). Table 2 outlines key factors guiding material selection and their health connections.

Table 2. Factors Influencing Building Material Selection and Health Implications

Factor	Description	Example Materials	Health Implication
Structural Integrity	Load-bearing capacity, durability	Steel, Reinforced Concrete	Indirect (safety, structural stability)
Functionality	Energy efficiency, thermal comfort, acoustics	Insulation, Acoustic Panels	Enhanced indoor environment
Aesthetic Value	Visual appeal, textures, finishes	Glass, Stone, Wood	Psychological well-being
Economic Consideration	Affordability, maintenance costs	Local Materials	Project feasibility, lifecycle efficiency

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Environmental Impact	Carbon footprint, recyclability, resource use	Recycled Aggregates, Bamboo	Eco-friendly construction
Health & Well-being	Air quality, toxin emissions, indoor safety	Low-VOC Paints, Natural Insulation	Direct improvement of occupant health

Durability of the Material. The material should be durable and resistant to the hostile nature of the environment, such as wind, high temperature, rain, flood, earthquake, and snow. The material should be sufficiently proficient to withstand high-intensity loads for a long period and to withstand environmental influences. The material should not reach the point of experience of disintegration and deterioration. Also, it should have crack resistance. Furthermore, it must not wear out effortlessly and must have adequate bonding strength (Tiger TMT. 2023).

Strength of the Material. The strength or asset of the construction material is the maximum load-bearing capability of the material to carry the load without failure. The machine should have adequate strength to carry bending, compressive, and tensile loads. For instance, steel should have high tensile strength, and concrete should have high compressive strength.

Cost of Material. This is one of the most significant factors affecting material selection. The construction material should be economical enough to be used in a larger quantity without disturbing or affecting the total cost of the building project. Before selecting the construction material, there is a need to analyze the different types of building materials and conduct a market survey on their cost. Select the obtainable material in sufficient quantity in the area, so that it can be easily transported at reasonable cost. The types of materials used in buildings also have a sensitive impact on the design of structures. Material selection should be as early as possible (Jamal, 2017).

Load-Bearing Capacity. The material must have a high load-bearing capability to withstand and sustain the higher loads imposed on the structure without structural failure. 5.1.5 Appearance of the Material: Aesthetics or appearance is also a significant criterion that must be considered when selecting construction materials. The material should have a good color and a smooth finish that make the constructions aesthetically good-looking (Jamal, 2017).

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Appearance of the Material. Aesthetics or appearance is also a significant criterion that must be considered when selecting construction materials. The material should have a good color and a smooth finish that make the constructions aesthetically good-looking (Jamal, 2017).

Choice of Materials and Their Relation to Structural Stability. Structural stability in buildings refers to the ability of a structure to withstand and safely support the loads and forces acting on it throughout its intended lifespan. It is essential for ensuring the safety and integrity of buildings and the protection of its occupants. The structural stability of a building is achieved through a combination of design, materials, and construction techniques that collectively ensure the structure's ability to resist external forces, such as gravity, wind, earthquakes, and other loads (Jain, et. al. 2022). The types of building materials used significantly affect the structural stability of buildings. Different materials possess varying properties and characteristics that can affect the strength, durability, and overall stability of structures (Jamal, 2017). Building materials play a vital role in structural stability. The durability and strength of a building are influenced by the quality and type of building material used. Construction materials must have the capacity to sustain and withstand high stresses and imposed loads. Currently, numerous unconventional construction materials are available in markets that are generally used for different construction purposes (Deloney, 2022). In ancient civilization, the Egyptians and the Greeks used stones to build massive structures, including pyramids and temples, using the strength and durability of stones such as granite and limestone. Wood was also used for structural purposes in columns, beams, and trusses (Sahoo, et al. 2021). In the middle ages and Renaissance, masonry was used, which is made up of stones or brick bound together by mortar and timber framing techniques using timber beams and posts connected with joinery techniques. With the advent of the industrial revolution, cast iron became a popular structural material (Cabeza, et al. 2021). It allowed for the construction of large-scale industrial buildings, bridges, and railway stations because of its strength and versatility. The introduction of structural steel, which has superior strength and flexibility, has led to the construction of skyscrapers and large-span structures. In modern times, the invention of reinforced concrete in the late 19th century marked a significant advancement in building materials. The high tensile strength enabled constructing tall buildings. Composite materials such as fiberglass, carbon fiber, and laminates have emerged as alternatives for structural applications (Kanitz, 2014).

The Choice of Materials and Their Relationship to Functionality. Functionality in a building refers to the ability of a space and its components to fulfill its intended purpose effectively and efficiently. The term refers to the effective utilization of space, thoughtful design, appropriate systems, and user-friendly features to support the activities, comfort, and safety of the occupants. To achieve building functionality, some key factors, such as space planning, ergonomics, construction, design, and materials, must be considered (Tiger TMT. 2023). A well-designed and functional building enhances productivity, satisfaction, and user experience. The history of building materials used to achieve functionality in construction has evolved alongside human needs and technological advancements.

Functionality in the Context of Sustainable and Smart Materials. In recent years, the focus on functionality has expanded to include sustainability and smart technologies. Sustainable building materials, such as recycled materials, low-impact materials, and energy-efficient systems, promote functionality while minimizing environmental impact. Smart materials, such as programable glass, self-healing concrete, and energy-generating facades, enhance functionality by incorporating features such as energy efficiency, improved thermal comfort, and interactive user experiences. The materials used for construction are closely intertwined with the functionality of a structure. Different materials possess specific properties that directly impact the performance and functionality of various building elements ((Raouf, and Al-Ghamdi, 2020; Civil Engineering Notes for AE/JE & GATE 2023).

Choice of Materials and Relationship to Aesthetic. The history of building materials used to achieve aesthetic purposes in construction has been diverse and has evolved over centuries as architectural styles and cultural preferences have changed. Ancient civilizations used locally available natural materials to create aesthetically pleasing structures. Stone, wood, and clay were carved, shaped, and arranged in intricate patterns and decorative motifs (Lomas, 2019). During the middle ages,

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stonework played a significant role in architectural aesthetics. Intricate carvings, gargoyles, and ornamental details decorate structures such as cathedrals and castles, highlighting craftsmanship and artistic expression. Islamic architecture, known for its intricate geometric patterns and decorative tile, uses materials such as colorful ceramic tiles, glazed bricks, and intricate plasterwork to create visually stunning and ornate structures. The Renaissance and Baroque periods in Europe saw a resurgence in classical architecture. Marble, known for its elegance and timeless beauty, has been extensively used for sculptures, columns, and facades, creating visually striking buildings (Jamal, 2017).

The Industrial Revolution brought about advancements in iron production and fabrication techniques. Ornamental ironwork such as decorative railings, broils, and elaborate cast-iron facades has become a popular architectural element. In the 20th-century, the advent of modernism in architecture embraced materials such as glass and steel. Glass curtain walls and steel structures create a sleek, minimalist aesthetic, emphasizing transparency, light, and clean lines. Contemporary trends have brought sustainable building materials into the forefront, and in recent years, there has been a growing focus by building professionals on the use of sustainable and eco-friendly materials for aesthetic purposes. Reclaimed wood, recycled materials, and innovative sustainable products are being incorporated to create unique and environmentally conscious designs. Advanced design technologies and computer-aided design tools have opened up new avenues for architectural aesthetics. Parametric and digital design allows architects to generate complex and customized forms by exploring unconventional shapes and patterns.

How the Choice of Material. Affects Aesthetic Form and Shape: Different materials have inherent properties that can influence the form and shape of buildings. For example, materials such as steel and glass allow for sleek and contemporary designs with clean lines and expansive openings, whereas natural materials such as stone or wood can create a more organic look.

Texture and finish. Materials with varied textures and finishes contribute to the visual and tactile experiences of a building. Smooth surfaces, rough textures, polished finishes, and natural grains all play a role in creating a specific aesthetic for instance, exposed brickwork can add rustic or industrial charm, while polished marble finishes can convey elegance and luxury.

Color and tone. The color palette of building materials significantly impacts aesthetic appeal. Different materials offer a range of colors, from earth tones to vibrant hues. The material choice helps create a harmonious or contrasting color scheme while enhancing the desired aesthetic. For example, warm-toned wood can create a cozy and inviting atmosphere, while cool-toned glass and steel can create a modern and sleek aesthetic.

Visual patterns and details. Certain materials have inherent patterns or visual details that contribute to the overall aesthetic. For instance, decorative tiles, intricate carvings, and ornamental ironwork can add visual interest and create a unique aesthetic statement. The choice of materials that possess these characteristics can enhance the overall architectural style and cultural influences (Lomas, 2019).

The selection of materials should also consider the surrounding context and environment. Building materials can be chosen to harmonize with natural surroundings or create a distinctive contrast. The materials chosen can help establish a visual dialog with neighboring structures, blend into the landscape, or make a bold architectural statement. The use of locally available natural materials to create aesthetically pleasing structures such as stone, wood, and clay should be carved, shaped, and arranged in intricate patterns and decorative motifs. Stonework should play a significant role in architectural aesthetics, such as intricate carvings, gargoyles, and ornamental details that adorn structures that showcase craftsmanship and artistic expression. Architectural aesthetics are known for their intricate geometric patterns and decorative tile work, which use materials such as colorful ceramic tiles, glazed bricks, and intricate plasterwork to create visually stunning and ornate structures. Marble, known for its elegance and timeless beauty, is recommended for use extensively in sculptures, columns, and facades in building development, creating visually striking buildings.

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Ornamental ironwork such as decorative railings, broils, and elaborate cast-iron facades should become a popular architectural element. Architecture should embrace materials such as glass and steel. Glass curtain walls and steel structures should be designed to create a sleek, minimalist aesthetic that emphasizes transparency, light, and clean lines. Current trends, such as the use of sustainable building materials, should be encouraged, focusing on the use of sustainable and eco-friendly materials for aesthetic purposes. Reclaimed wood, recycled materials and innovative sustainable products should be incorporated to create unique and environmentally conscious designs. Advanced design technologies and computer-aided design tools should be utilized to create new possibilities for architectural aesthetics. Digital and parametric design should allow architects to create complex and customized forms by exploring unconventional shapes and patterns

Choice of Materials and Their Correlation to Economy. Economic considerations play a crucial role in determining the affordability, costeffectiveness, and overall financial feasibility of the project. Here are some ways in which the choice of building materials is related to economic background.

Cost of Materials. The economic background of a project influences the construction budget. The cost of building materials varies significantly, and their affordability can impact the selection process. For example, high-end materials such as marble or exotic wood may be economically feasible for luxury projects but not for budget-conscious development (Sui Pheng and Shing Hou 2019).

Construction and Installation Costs. The materials chosen affect the construction and installation costs. Some materials require specialized labor or complex installation techniques, which can increase the overall project expenses. In economically constrained projects, materials that are easy to work with, require less skilled labor, or have lower installation costs are preferred to keep construction costs under control.

Lifecycle Costs. The economic background of the project stakeholders often involves considering long-term financial implications. While certain materials may have higher upfront costs, they might also offer cost savings during the lifecycle of the building. For example, investing in energy-efficient materials and systems can reduce operational costs, reducing energy consumption and maintenance.

Maintenance and Repair Costs. The choice of materials can affect the ongoing maintenance and repair costs of buildings. Some materials require regular maintenance and periodic replacements, which can increase long-term expenses. Materials with higher durability and lower maintenance requirements are often favored in economically sensitive projects to minimize ongoing costs (Sui Pheng and Shing Hou 2019).

Economic sustainability. Economic background can also drive the selection of materials from a broader economic sustainability perspective. In some cases, a preference may exist for locally sourced materials to support the local economy, create job opportunities, or reduce reliance on imported materials. Additionally, economic factors can influence decisions related to using recycled or environmentally friendly materials that align with sustainable practices, even though they may have a slightly higher upfront cost (Jamal, 2017).

Why Materials Selection and Human Health Consideration is Important. Several building materials may contain chemicals of concern and concerns that might lead to long-term and short-term health implications and impacts. Short-term impacts may include eye irritation, skin allergy, sneezing, and throat irritation, whereas long-term impacts may include cancer, asthma, and infertility. Some of these health issues and concerns can be transmitted to the next generation, such as obesity, endocrine disorders, and autism. Many of the ingredients in building materials can be persistent bioaccumulative toxins (PDTs) and persistent organic pollutants (POPs), which can severely damage the environment and have lasting impacts on human health (Hoisington, et al. 2019).

CONCLUSION

This study has shown that several building materials contain chemicals of concern and worries that might lead to long-term and short-term health implications and impacts. Short-term impacts may include eye irritation, skin allergy, sneezing, and throat irritation, whereas longterm impacts may

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include cancer, asthma, and infertility. Some of these health issues and concerns can be transmitted to the next generation, such as obesity, endocrine disorders, and autism. Many of the ingredients in building materials can be persistent bioaccumulative toxins (PDTs) and persistent organic pollutants (POPs), which can severely damage the environment and have lasting impacts on human health.

The choices we make for building materials affect every aspect of a building; therefore, when choosing materials, we have to consider the best material that will enhance the performance of the building in every aspect. The study observed that the structural stability of buildings can be achieved through a combination of design, materials, and construction techniques that collectively ensure the structure's ability to resist external forces. The type of building material used in construction significantly affects the structural stability of buildings. Different materials possess varying properties and characteristics that can affect the strength, durability, and overall stability of structures. The study concluded that economic considerations play a crucial role in determining the affordability, cost-effectiveness, and overall financial feasibility of a project. The study also resolved that when deciding on the selection of materials to be recommended for building development, hasty decisions should be avoided regarding buildings and the spaces that we occupy. A more educated approach toward building materials and their impact on human health and well-being will go a long way to improve not only human health but also the environment and aesthetics value.

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