

**INVESTIGATION OF GREEN MATERIAL CLASSIFICATION FOR
GREEN BUILDING IN LIBYAN CONSTRUCTION INDUSTRY**

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DEDICATION

First, I would like to announce my appreciation to Allah Almighty for his grace, guidance and protection of me during Master study. I dedicate this dissertation with countless appreciation to my beloved parents, and to all my beloved family members, and especially to beloved husband who had supporting me throughout my study life.



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ABSTRACT

The global transition toward green building has encouraged nations to provide a proper fertile ground of legislation and standards that organize the transition to the green concept. A green materials classification is considered as one of the related issues of green building within the Libyan construction industry. That does not have a guide of classifying the green materials. This study aimed to identify the proper classifications of green building materials, as well as determining the main challenges of classifying the green materials in Libya. This study methodology relies on both approaches, quantitative and qualitative, primary data has been collected through a survey instrument, while the secondary data has been collected through an interview instrument. The survey instrument has used to collect the primary data, while the interview instrument has conducted with three experts in the field of green building construction. A total of 223 respondents have responded to examine the study hypotheses. The descriptive results have ranked the green materials classifications as follows; recycled base, reused base, and renewable base respectively. The correlation and regression results revealed high prediction from the recycled materials base to the green materials classification, following by the reuse base of classifications, while a significantly negative association has found between the renewable and green materials classifications. Besides that, according to the interview results, five challenges have identified in common for classifying the green materials in Libyan construction industry. Facilitating appropriate solutions to meet these challenges is the responsibility of the government and practitioners in practice. This study has ended with three recommendations, which contribute to overcome the current challenges in classifying the green materials in Libya.

Abstrak

Peralihan global ke arah bangunan hijau telah menggalakkan negara-negara untuk menyediakan tanah subur yang sepatutnya undang-undang dan standard yang menganjurkan peralihan kepada konsep hijau. Klasifikasi bahan hijau dianggap sebagai salah satu daripada isu-isu yang berkaitan bangunan hijau dalam industri pembinaan Libya. Yang tidak mempunyai panduan untuk mengelaskan bahan-bahan hijau. Kajian ini bertujuan untuk mengenal pasti klasifikasi yang betul untuk bahan bangunan hijau, serta menentukan cabaran utama untuk mengelaskan bahan hijau di Libya. Metodologi kajian bergantung kepada kedua-dua pendekatan, kuantitatif dan kualitatif, data primer telah dikumpulkan melalui instrumen kajian, manakala data sekunder telah dikumpulkan melalui instrumen temu bual. Instrumen kajian telah digunakan untuk mengumpul data utama, manakala instrumen temu bual telah dijalankan dengan tiga pakar dalam bidang pembinaan bangunan hijau. Seramai 223 responden telah memberi maklum balas menguji hipotesis kajian. Keputusan deskriptif telah kedudukan bahan hijau klasifikasi seperti berikut; asas kitar semula, asas semula, dan masing-masing asas yang boleh diperbaharui. Keputusan korelasi dan regresi mendedahkan ramalan tinggi daripada asas bahan-bahan kitar semula klasifikasi bahan hijau, berikut dengan asas digunakan semula klasifikasi, manakala persatuan ketara negatif telah mendapati antara klasifikasi boleh diperbaharui dan bahan hijau. Selain itu, menurut keputusan temuduga, lima cabaran telah dikenal pasti bersama-sama untuk mengklasifikasikan bahan hijau dalam industri pembinaan Libya. Memudahkan penyelesaian yang sesuai untuk memenuhi cabaran-cabaran ini adalah tanggungjawab kerajaan dan pengamal dalam amalan. Kajian ini telah berakhir dengan tiga cadangan, yang menyumbang untuk mengatasi cabaran semasa dalam mengklasifikasikan bahan-bahan hijau di Libya.

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Chapter 1

INTRODUCTION

1.1 Introduction

Many construction materials contain large amounts of energy and produces toxic waste during the manufacturing process. Some are not healthy to use or live with it, and some are difficult to dispose of safely, as well as having a negative impact on the environment when incinerated (Alvira, Tomás-Pejó, Ballesteros, & Negro, 2010). Over the past decades or so, green thinking has increasingly recognized that the levels of sustainability depends on the basics and gradually increases the efficiency of resources in the advanced industrial countries (Jackson, 2011). All these issues need to be considered at the earliest opportunity when we design buildings. It is supposed choice of materials and components in order to improve the complex environmental specifications, and requires a balance between many issues (Calkins, 2008). It is essential to consider the natural effect of the material assembling, construction, operation, construction, support and destruction, and transfer. It is critical to consider the vitality utilized, assets expended, and the potential outcomes for reuse or reusing, and wellbeing impacts and discharges of contamination. It ought to consider the construction without bounds to convey the most reduced conceivable damage to clients and the earth (Nornes, 2005; Yiu, 2001).

1.2 Background of Study

The green material classification has been discussed and explained thoroughly in this study, as the classification includes the materials which are mainly recyclable. Nowadays, it is important to go green and protect the nature that is serving us in our daily lives. The world is facing the shortage of natural resources today, including Libya. By investigating the classifications and usage of green materials in construction industry in Libya, we can say that the carefulness and attention are not paid well for green materials. The objectives of this study is to explore the

construction sector of Libya in terms of using green materials and identifying the categories of green materials that generally exist, that have been used by construction industry in Libya.

Before a detailed discussion of green materials classify may define the green materials following term building materials typically considered to be 'green' include lumber from forests that have been certified to a third-party forest standard, rapidly renewable plant materials like bamboo and straw, dimension stone, recycled stone, recycled metal like copper sustainability and recyclability, and other products that are non-toxic, reusable, renewable, and/or recyclable (Balkcom. 2006). For concrete a high performance or Roman self-healing concrete is available. The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal combustion products, foundry sand, and demolition debris in construction projects. Energy efficient building materials and appliances are promoted in the United States through energy rebate programs.

Young (2000) recently summarized the hierarchy of materials efficiency that can be applied to construction materials:

- a. Voluntary simplicity. It includes a focus on selling services, rather than products. It also includes the redesign of products, buildings and settlements to dispense with superfluous materials. The great efficiencies resulting from ecological urban design and mixed-use development are in this category.
- b. Increased intensity of product use: All kinds of sharing are included here, and thus there is some overlap with category. Co-housing developments with shared facilities, for example, can substantially reduce the volume of materials use.
- c. Extended product life: Repair, reuse and remanufacturing are in this category, and in building there is vast potential for deconstruction (the disassembly of buildings) and the reuse of building materials. One step further is the design of buildings to be easily changed, repaired and disassembled.
- d. Finally, there is materials recovery, or recycling. This tends to require more energy, but some form of recycling will be ultimately necessary for every material at a point in its life cycle, no matter how durable, reused, or shared it has been.

- e. While this categorization is not sufficient in itself to deal with all the main dimensions of transforming materials used in construction, it provides a framework that can be built upon. We can add concerns of toxicity, human and ecosystem health, job creation and other aspects mentioned in product evaluation.

Key areas that are crucial to achieve this materials transformation are:

- Product Evaluation: “What is a green material”?
- Deconstruction and Reuse
- Alternative Materials: the intelligent use of local materials both natural materials (Rammed earth, cob construction, straw bale, etc.) and unorthodox resources provided by the waste stream: tires, cans, etc.
- Eco-industrial production: parks, networks and secondary materials industry.
- Regulation & the State: changing the rules of the game
- Consumption and consumerism

Understanding what a green material is relies on upon comprehension connection in nature, in the economy, in the middle of nature and the economy. It is an extremely complex matter and continually evolving. What is viewed as a green material is additionally always showing signs of change. It is positively critical to take a gander at each individual item and material; however it is frequently more proficient to take a gander at the building framework. This is especially clear when we see frameworks now being intended to permit structures to be effortlessly disassembled as opposed to destroyed. The connection in which a material is utilized is urgent. A routine petrochemical-based building material may be utilized as a part of structures and advancements that are entirely natural in general effect. Likewise, a "green" material may be conveyed or introduced in dangerous ways that totally discredit their positive attributes. By being rescued and reused, an exceptionally ordinary material may turn into a green material. It's an issue of connections that are multidimensional and always shifting.

Green building materials are made out of renewable, instead of nonrenewable assets. Green materials are ecologically mindful in light of the fact that effects are considered over the life of the item (Vanegas, 2003). Contingent on task particular

objectives, an appraisal of green materials might include an assessment of one or a greater amount of the criteria recorded beneath (Hwang & Ng, 2013).

1.3 Problem Statement

The government of Libya recommends and encourages the construction industries to use green materials and go green, as the government is providing to all the construction companies an opportunity to use green materials. The study identifies the main problems and classifies them as crucial priorities to be performed. The problems are polluting the environment and air by using materials that generate a plenty of waste (Chi, Streicher-Porte, Wang, & Reuter, 2011). As we know that all constructions generate a lot of waste during building, but if they start using green materials or recycled materials, the waste could be reduced to a significant amount. By using recycled materials, the construction companies in Libya could avoid a plenty of waste, polluting air and environment. Today the concept and idea of Go Green is developing at a rapid path and becoming an important way of life without harming nature and people (Sarkar, 2013).

There are a wide variety of green building materials available and grown quantity and quality of these sustainable alternatives to meet growing demand in the domestic and overseas market (Belcher & Schreckenber, 2007). This includes green building materials supply to samples of actual products to various green building materials, accompanied by a description of a composite summary of the features and uses of each product (Spiegel & Meadows, 2010). Green materials can contribute to other sources of value that contributes to the formation of economic incentives. Many people tend to buy only for energy materials and indoor air pollution and ignore the protecting the ozone layer, and create local employment opportunities, and promoting social cohesion. There are many types of green materials can be used in construction (Omer, 2014). Challenges in the Libyan market are the classification types of buildings and materials, and the local environment and climate must be suitable for building. Therefore, Libyan construction needs to know what is the classification of green materials that can be used in the construction stages for sustainable construction (Aburounia, 2010).

1.4 Research Questions

- i. What are the green material classifications in Libyan construction industry?
- ii. What is the relationship between recycle, reuse, renewable with construction material?
- iii. What are the challenges of classifying green materials in Libyan construction industry?

1.5 Research Objective

The objectives of this study are mainly:

- i. To identify the green material classification in Libyan construction industry.
- ii. To investigate the relationship between recycle, reuse, renewable with construction material.
- iii. To investigate challenges of classifying green materials in Libyan construction industry.

1.6 The scope of study

The focus of this study is limited to explore the classification of green materials in Libya as a case study as the extent of the use of recycled materials, renewable materials, and local materials and re-used in the construction. It will focus on the challenge to the project team to implement green materials in various construction projects.

The scope of study concentrates on classification of green materials in Libya and their applications in the sector, in order to find better outcomes and applicable for the research hypothesis. The sample for this study includes 250 construction managers and engineers in Libyan construction industry. The study will consider longer time to the estimated time due to the current situation in Libya, which is unstable, a war zone country. This paper aims to find out the key success in classifying and using green materials in construction industry in Libya.

This study seeks to measure whether Go Green practice can be a good potential solution for Libyan construction industry. The topic is important as Investigation of Green Material Classification for Green Building in Libyan

Construction Industry has not been well researched. The potential effect of this study may go beyond Libya as the world is in need of a firm solution on Go Green practice.

1.7 Significant of Study

In order to hold stable economic growth, it is vital for Libyan construction to depend on green construction. Therefore, by studying how Libyan is utilizing of Green Materials to achieve the main goals for sustainability so should be known the using of green materials and classification of those materials that be in green building construction. This research is significant in order to help Libya and other similar countries to construct green building and helps the project teams, government, and stakeholders to awareness on the implementation of green materials and the challenges that might be in Libyan construction.

1.8 Organization of Report

The framework of the report is divided into five main chapters can be described as follow:

Chapter 1: This chapter introduces the research, the necessity of this research, problem statement of this research, aims and objectives of the study, scope of the research and significant of the research.

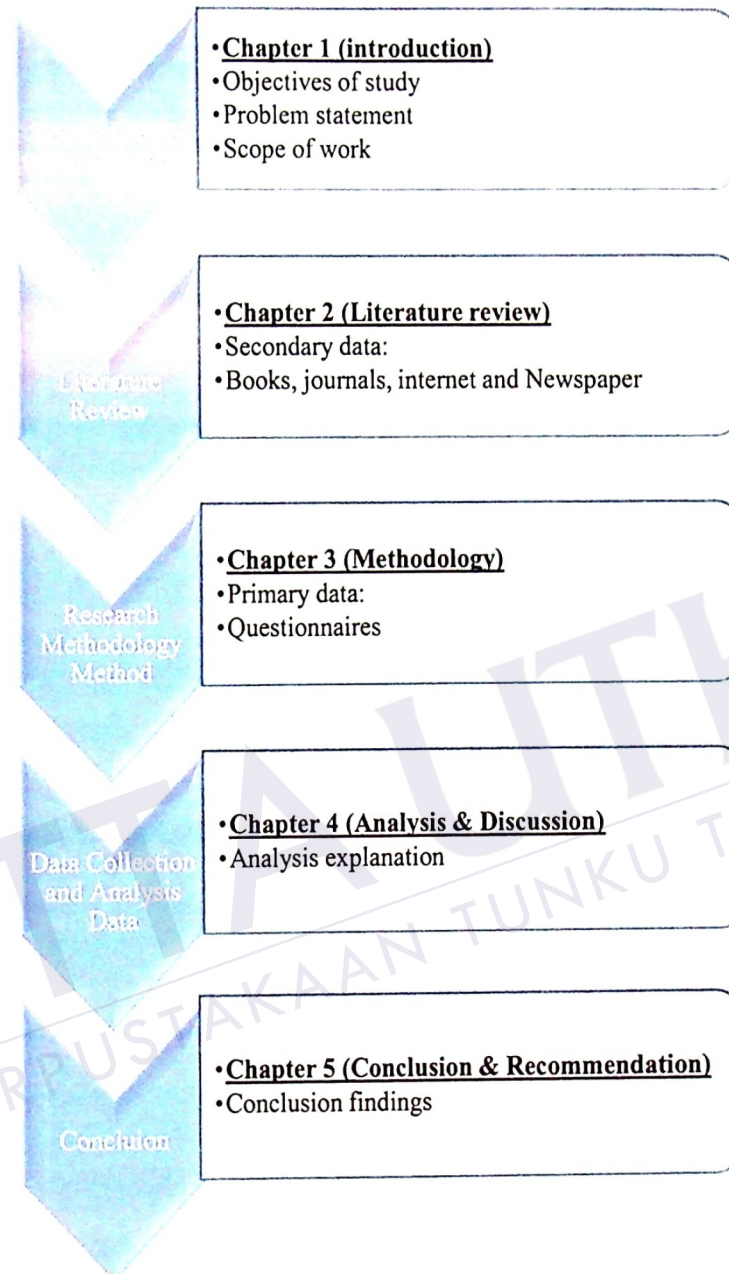
Chapter 2: The second chapter reviews the past literature on what has been done on Green building, sustainable materials and resources, also Green Materials product selection and classification.

Chapter 3: this chapter presents the research design and methodology. It provides the discussion on the approach selected to develop the research activities including on how this study will be conducted and how the data is gathered and analyzed in order to achieve the research objectives.

Chapter 4: presents the Results and Discussion of study which concentrate on the analysis of several methods.

Chapter 5: Conclusion and Recommendation for Future Research to summarizes and concludes the overall findings of Chapter 1 to Chapter 4 and also

recommendation for future research based on the results.



Chapter 2

LITERATURE REVIEW

2.1 Literature review

This chapter reviews the literature in relation to the primary research objectives. An analysis of the rationales inside the green building materials will be used, besides a close look at the current Green Materials of available functionalities to support sustainability.

2.2 Introduction

Green materials include those that are renewable and/or cause the least impact on the environment. In design, it is the creative initial layout (both of the spaces and the structure) and building design that takes full advantage of green building. With this, Green materials can be considered waste products, which hold no harmful effects, are considered at the end of their useful life, and can be used in conjunction with other construction materials for a building's construction (Krygiel & Nies, 2008).

Building and construction activities worldwide consume 3 billion tons of raw materials each year or 40 percent of total global use (Tudora, 2011). Utilizing green building materials and items advances preservation of waning nonrenewable assets globally. Likewise, coordinating green building materials into building tasks can decrease the natural effects connected with the extraction, transport, handling, creation, establishment, reuse, reusing, and transfer of these building industry source materials (Adamtey, 2012).

A green building, also known as a sustainable building, is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner (Roodman, Lenssen, & Peterson, 1995). Green buildings are

designed to meet certain objectives such as protecting occupant health; improving employee productivity; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment (Shapiro, 2009).

2.3 Libya background

This study will concentrate on Green Materials in Libyan development. Libya, which is situated in North Africa, stretches out more than 1,759,540 square kilometers and positions as the seventeenth biggest country on the planet (90% of the nation is desert). Green Building or Go Green is begun to be actualized in Tripoli in 2013. It has the longest Mediterranean coastline 1770 kilometers (1100 miles), and its atmosphere is for the most part dry and abandon like aside from in the north (Mediterranean atmosphere). In 1922, the most elevated ever recorded temperature, 57.8 centigrade, was enrolled in El-Azzizia close Tripoli, Libya's populace as indicated by the 2006 registration achieved 5,673,000 with an along the coast in Tripoli and Benghazi.



Figure 2.1: Location of Libya

Source: World Atlas

Libya's population is growing by 3.5% annually. With half of the population under the age of 20 and more than 85% living in cities, there is an urgent need for new homes, schools, hospitals, and infrastructure facilities. It is estimated that 500,000 homes will be needed in the next decade.

The development business in Libya faces genuine difficulties and challenges because of quick improvements and reliance on remote specialists. The present limit of the Libyan development industry can't meet national lodging supply needs. As of late, the nation is seeing another development blast that will sidestep all other development exercises of the previous decades. New homes, air terminals, ports, railroads, and streets should be assembled and overhauled. Lodgings, office structures and resorts are required to address the issues of a growing tourism industry. Be that as it may, development approaches over the previous decades, and an absence of administrative, money related and specialized abilities have made the current dangerous circumstances of the business. The new requests for fast social, monetary, political and mechanical changes will encourage strain the delicate business. To meet present and future needs and difficulties, new strategies, changes and rebuilding of the building business are required.

2.4 Libyan construction industry in classification of green material

The construction industry in Libya has witnessed several changes over the last fifty years. In the early 1950s, when funds were limited and the country was emerging from the Italian occupation, construction was of limited scale and value. In these early years, construction was considered a social activity. In addition, construction skills were transferred from one generation to another, and construction products reflected people's values and cultures (Allan, 2014).

After the insurgency of 1969 and amid the oil blast that followed in the 1970s, the development business assumed a key part in social and monetary advancement forms. Accordingly, the nation encountered an enormous increment in the scale and volume of development exercises. For example, toward the end of the 1970s Libya was the world's driving per capita purchaser of concrete on the planet. This pattern proceeded until mid 1980s, when the development business endured a few mishaps, including the end of neighborhood private development organizations and their fuse into general society division. The development business stopped in the mid-1980s because of the colossal drop in oil incomes. Furthermore, the political issues confronting Libya amid the most recent two decades added to financial challenges that influenced the business enormously. The above contemplations mirror the dangerous circumstances of the Libyan development industry, which can

be ascribed, when all is said in done, to a few components, including the outcomes of fast social, monetary, political and mechanical changes, and an absence of neighborhood administrative, budgetary and specialized capacities (Allan, 2014).

As of now, ecological mindfulness among the development specialists is developing. Henceforth, Industry and business professionals have begun assessing how their exercises influence the earth. Further, society has worried about the issues of common asset exhaustion and ecological corruption brought on by the development business. For this, numerous associations have begun investigating methods for moving past consistence utilizing contamination counteractive action methodologies and natural administration frameworks to enhance their ecological execution. One of the methodologies utilized for such ecological execution green materials (Allan, 2014).

The construction industry is one of the essential financial behaviors that contribute towards the monetary advancement of a country (Omran, 2012). The construction business has assumed a noteworthy part in monetary improvement, as one would expect in a nation generally without foundation amid the mid-1960s. In Libya, the construction business blossomed as an aftereffect of outside oil organization venture amid the 1960s.

In 1975, the administration started to revamp the construction business and make it more proficient. Around then, there were around 2,000 contractual workers, which a hefty portion of them were little proprietorships. The priest of lodging has given the power to consolidation contracting firms into bigger firms that are skilled in performing vast construction ventures. Firms with capital in an overabundance of LD 30,000 were changed over into organizations, and the dominant part shares were sold to people in general or the administration. The administration had beforehand set up a few state-claimed construction organizations to fabricate processing plants and to perform structural designing tasks. Among the organizations were the National Industrial Contracting Company, the General Corporation for the Construction and Maintenance of Roads, and the General Corporation for Civil Works (Omran, 2012).

The Libyan government has paid attention to implement the green concept, starting from the public facilities; several initiatives have suggested providing a proper fertile ground of adopting the green building approach. Classifying the green materials and setting the integrated guide of green materials classifications was one

of the priorities. In this context, in September 2012 the Office of Sustainable Design (OSD) was authorized by the Libyan Civil Status Authority to overhaul its IT working in Janzour to enhance effectiveness. It was the principal venture of its kind in Tripoli. The current structure had been analyzed as a "debilitated building," implying that the working conditions were unfortunate and wasteful. Mold, buildup, tobacco smoke and poor ventilation prompted poisonous indoor air quality. Tinted window glass shut out 50 percent of the daylight, so counterfeit light was utilized amid the day. Around 70 percent of the building arrangement was wastefully utilized or squandered. The objective was to update the working with insignificant changes and misuse of material. Through straightforward modifications, the architects could expand sunlight in workplaces while decreasing aggregate warmth pick up from the sun by 15 percent, hence diminishing cooling use in summer. Lost space was re-dispensed to adaptable workstations, expanding the building inhabitation by 40 percent. Another open air zone for work breaks and impair availability was made to support staff confidence and empower group building.

2.5 Overview of Sustainable Building Materials

Ecological financial aspects and reasonable advancement have ended up focal worries to individuals from all controls and in all nations. Numerous natural discourses focus on the idea of biologically economical improvement (ESD) since the significant oil emergency of the 1970s. ESD, from a building improvement perspective, is the productive utilization of assets to meet the prerequisites and requirements of present and future eras whilst minimizing the unfriendly impacts on the regular habitat (Balderstone, 2004).

Structures directly affect the earth, running from the utilization of crude materials amid development, support and redesign to the emanation of destructive substances all through the building's life cycle (Balaras, 2005). The development business and nature are inseparably connected. It was unavoidable that the business has ended up at the focal point of concerns in regards to ecological effect. Natural issues connected with asset utilization have been stretched out from the nearby size of indoor air contamination to a worldwide size of commitment to environmental change and ozone exhaustion.

Development is not an earth well-disposed procedure and it impactsly affects the consumption of normal assets and on the discharges of nursery gas (GHG) as an aftereffect of fossil fuel burning. In the US, the development division is the third biggest industry part as far as commitments to GHG outflows (Li, 2010). All inclusive, it exhausts 40% of normal materials, devours 40% of the aggregate essential vitality, 15% of the world's new water assets, produces 25% of all squanders and transmits 40–50% of GHG (Ramesh, 2010).

To minimize the business' natural effects, the utilization of manageable building materials has turned into the fundamental center of innovative work in accomplishing the objective of practical development. This is one path in which the development business can make a dependable commitment towards securing the earth (Du Plessis, 2007). Accomplishing the objective of feasible development is not about limiting the aggregate sum of development, but rather to give careful consideration to how the outline and choice of reasonable building materials can supplement the earth to enhance living quality, client wellbeing and solace. The determination of maintainable building materials ought concentrate on the execution details as well as select materials that have the most reduced GHG discharges (Ip and Mill operator, 2012).

Biological building outline is described by the utilization of common materials instead of man-made materials that require vitality simultaneously, and has an accentuation on solid, non-dangerous detail to minimize contamination (Halliday, 2008). In a perfect world materials ought to likewise be executed into detached configuration and environment control, for example, warm mass. Berge (2009) states that a satisfactory objective of accomplishing a manageable future is the extreme diminishment and movement in the utilization of crude materials. This is especially imperative while considering rare and non-renewable assets. Similarly critical is the decrease of wastage and misfortunes amid the production of materials, the development procedure furthermore all through the administration life of the finished building. The reusing of materials amid annihilation of a building must likewise get to be managed. The reusing procedure ought to be painstakingly arranged and figured out how to guarantee that these materials can be dealt with, keeping up them to their unique quality as opposed to discarding them.

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