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COMPARATIVE LIFE CYCLE ASSESSMENT OF TRADITIONAL AND SUSTAINABLE BUILDING MATERIALS FOR RESIDENTIAL CONSTRUCTION

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A thesis submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Forest Resources Technology)

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DECLARATION

I hereby declare that the work embodied in this report is the result of the original research. The thesis has not been accepted for any degree and not submitted in candidature of any other degree.

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ABSTRACT

In this study, the life cycle assessment method was used to assess the impact of traditional and sustainable building materials on the environment. This life cycle assessment consists of 4 phases based on ISO14044 and ISO 14040. The phases are the goal and scope definition phase, the inventory analysis phase, the impact assessment phase and the interpretation phase. In the inventory analysis phase, traditional and sustainable building materials are selected for analysis. Subsequently, this selection underwent further scrutiny using the openLCA software, which facilitated the generation of conclusive results for this life cycle assessment. This software produces the final results for this life cycle assessment. Using rigorous methodology and advanced tools, this study aims to provide valuable insights into the environmental implications of adopting traditional versus conventional building materials, thereby aiding the practical decision-making process.

Keywords: Life cycle assessment, traditional and sustainable building materials, openLCA

ABSTRACT

Dalam kajian ini, kaedah penilaian kitaran hayat digunakan untuk menilai kesan bahan binaan tradisional dan lestari terhadap alam sekitar. Penilaian kitaran hayat ini terdiri daripada 4 fasa berdasarkan ISO14044 dan ISO 14040. Fasa tersebut ialah fasa definisi matlamat dan skop, fasa analisis inventori, fasa penilaian impak dan fasa tafsiran. Dalam fasa analisis inventori, bahan binaan tradisional dan mampan dipilih untuk analisis. Selepas itu, pemilihan ini menjalani penelitian lanjut menggunakan perisian openLCA, yang memudahkan penjanaan keputusan konklusif untuk penilaian kitaran hayat ini. Perisian ini menghasilkan keputusan akhir untuk penilaian kitaran hayat ini. Dengan menggunakan metodologi yang ketat dan alat lanjutan, kajian ini bertujuan untuk memberikan gambaran yang berharga tentang implikasi alam sekitar untuk menerima pakai bahan binaan tradisional berbanding dengan bahan binaan konvensional, dengan itu membantu proses membuat keputusan secara praktikal.

Kata kunci: Penilaian Kitar Hidup, Bahan Binaan Tradisional Dan Lestari, openLCA

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LIST OF SYMBOLS

%	Percentage
kg	Kilogram

LIST OF ABBREVIATIONS

LCA	Life cycle assessment
PE	Polyethylene
PVC	Polyvinyl chloride
HDPE	High-density polyethylene
PP	Polypropylene
RTP	Recycle thermoplastic polymer

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The term "life cycle assessment" (LCA) refers to a methodical examination of the possible environmental effects of a good or service over the course of its full life cycle. It is often employed to evaluate the possible environmental effect over the course of a product or service's complete life cycle (manufacturing, distribution, usage, and end-of-life phases). This also applies to upstream and downstream operations connected to the stages of renewable energy production, use, and disposal (Source: Dr. Matin Baitz, 2001). Implementing this "green" idea entails that specific mix design factors must be altered in order to produce concrete that is suitably pliable, robust, and long-lasting. The application and environment in which the concrete will be utilised must also be taken into account. All the variations between "green" and conventional concrete are taken into account for a more accurate environmental evaluation. The LCA technique must be used as a result. For preset system limits, this technique evaluates the environmental effects of functional units to the strength and durability/service life of conventional and "green" concrete throughout the course of their complete life cycles (manufacturing, usage, and end-of-life phase). The LCA framework is a dependable evaluation method that is frequently used. It is a multi-stage process that typically includes the following four steps: definition of the aim and scope, analysis of the inventory, analysis of the impact, and interpretation. This study article discusses the concrete properties that have a significant environmental influence. The life cycle inventory (LCI) data for concrete were compiled from the literature and compared. Additionally, it has been examined how these inventory data are assigned to the effect categories of different impact assessment approaches as well as how important input characteristics may influence the environmental score that is generated.

A building material is any substance that is utilised in construction, such as supplies for building a house. Clay, wood, cement, aggregates, metals, bricks, and cement are the most often used building materials in construction. These were chosen since they are inexpensive for construction tasks. Many naturally occurring materials have been used in building construction,

including clay, sand, wood and stones as well as twigs and leaves. In addition to the materials that are naturally occurring, several man-made objects, some more synthetic than others, are used.

Construction materials manufacture is a well-established industry in many countries, and the use of these items is frequently separated into specific trades like carpentry, plumbing, roofing, and insulation work (Source : Daniela Mačková, 2015).

Extension, refurbishment, or new building of a home or other structure meant to be used as a residence all fall under the category of residential construction. According to Ricardo Mateus (2011), residential development may be a difficult process with several phases and stakeholders. The widely used LCA method may be used to calculate a product's or process's environmental effect, such as its GHG emissions, which are the subject of this paper. A useful technique for determining the environmental effect of various building materials. (Source: Mateus, 2009).

A major improvement in the environmental life cycle and, consequently, the sustainability of construction, may arise from the use of more modern building materials and technologies. The environmental impact of a process or product may be assessed over the course of its full life cycle using a method called life cycle assessment (LCA). It is primarily quantitative and considers how matter and energy travel. It wasn't until the mid- to late-1990s that the technique was standardised, despite having been developed and used for many years. LCA is ideal for use with discrete products or materials, but it is also frequently used with full buildings and building supplies. Environmental performance is usually measured in terms of various potential impacts, such as global warming potential; stratospheric ozone depletion (Source: Ricardo Mateus 2011).

1.2 Problem Statement

The building sector significantly contributes to climate change, resource depletion, and environmental damage. Residential development, in particular, has a significant negative impact on the environment because of the quantity of resources and energy required. Given these circumstances, the significance of using sustainable building materials has become clear in the process of creating homes. Sustainable building materials seek to reduce the harmful environmental effects of building construction. Additionally, a thorough and uniform technique is needed to evaluate the environmental effect of construction materials. A well-known useful method for evaluating the environmental performance of materials throughout the course of their life cycle

is life cycle assessment (LCA). However, there is a need to emphasize the role of LCA in evaluating sustainable building materials specifically for residential construction. The environmental effect of materials and components used in residential building may be evaluated using a variety of techniques. Although suitable for some uses, it has some shortcomings. LCA is a mechanism for determining how much of an impact activities and products have on the environment over the course of their lifetimes. Global warming is one of the numerous repercussions of environmental development that is currently receiving the most attention and calls for change from the public, business, and government. Around the world, people are becoming more concerned about the local and global environmental condition. The accumulation of greenhouse gases (CO2, CH4, N2O, etc.) over time in the upper atmosphere is what causes global warming (Source: Song, X. 2017).

The building industry has a sizable influence on a number of environmental issues, including resource depletion, waste creation, and greenhouse gas emissions. As the need for residential construction keeps increasing, the impact of building materials on the environment is a crucial concern. Due to their energy-intensive production methods and extensive extraction of raw material resources, traditional construction materials including concrete, steel, and cement-based products are recognised to have a major environmental effect. Sustainable construction materials, such as bamboo, recycled materials, and timber from legally defensible sources, have come to light as prospective substitutes that promise to have less of an impact on the environment. However, the absence of complete and consistent data on the environmental performance of these materials prevents stakeholders in the building sector from making well-informed decisions. There is a need for comparative life cycle assessments that evaluate and contrast the environmental effect of conventional and sustainable building materials for residential construction in order to solve this problem and encourage sustainable practises. The research will identify areas for improvement, offer crucial insights into the sustainability of building materials, and direct stakeholders towards making ecologically responsible decisions throughout the construction process (Source: Dong, Y., & Ng, S. 2016).

1.3 Objectives

The objectives of this research are:

- To assesses the environmental impact of traditional and sustainable residential construction.
- To identify opportunities to reduce the environmental footprint of the entire housing project.

1.4 Scope of Study

With the increasing concern for environmental sustainability, the use of sustainable building materials in residential construction has gained significant attention. These instances will emphasise the environmental advantages provided by the use of sustainable materials as well as their beneficial effects on energy effectiveness, occupant health, and sustainability in general (Source: Neyestani, B. 2017). The scope of this comparative LCA would focus on residential construction materials and systems. The goal is to assess the environmental impacts of both traditional and sustainable building materials commonly used in residential construction.

1.5 Significant of Study

Given the industry's huge environmental effect, the study's focus on sustainable building materials in residential construction is crucial. The study can aid in lowering greenhouse gas emissions and climate change by emphasising the value of sustainable materials and their role in reducing resource use, energy usage, and greenhouse gas emissions. The research acknowledges the value of environmentally friendly construction supplies in fostering healthier indoor settings. The health and wellbeing of occupants can be enhanced in residential construction by giving preference to materials with low VOC emissions, better ventilation, and less off-gassing. This component is important because it emphasises the link between environmentally friendly materials and human health, emphasising the development of healthier living environments (Source: Chang, J. 2019). A comprehensive LCA helps raise awareness of the environmental impacts associated with different building materials, making stakeholders more aware of their choices and therefore encouraging sustainable practices.

CHAPTER 2

2 LITERATURE REVIEW

2.1 LIFE CYCLE ASSESSMENT (LCA)

Life Cycle Assessment (LCA) is a very useful tool for identifying the environmental aspects and potential impacts associated with a product, process or service. This technique consists of an inventory of energy and appropriate material inputs that are released into the environment. The second is to identify potential environmental impacts associated with appropriate inputs. The third is to analyze the results to help make the right decisions about the human health and environmental impact of the product. LCA has been used to study a wide variety of products and processes including jet engines, diapers, dinner plates, laptops, waste disposal and recovery techniques (Source: B Corporation, 2008).

Life cycle assessment (LCA) is an environmental approach to environmental impact analysis that helps in making the right decisions for any product development. LCA is used to identify inputs or income such as resources and energy. Outputs or results such as waste gas, waste water and solid waste products across all stages of the life cycle (cradle to grave) (Source: Qiang et al., 2014). LCA provides quantitative and logical reasons for each of these exercises. As a rule, LCA feeds internal and external discussions and correspondence. Being dynamic in LCA implies having the capacity to communicate the natural effects of business items and forms.

According to (Source: Curran, 2013), the research was conducted according to the ISO 14044 standard. As a general conclusion, these LCA studies are sometimes very confusing because they generate different results for the same type of product. There are several dos and don'ts when conducting this life cycle assessment so that it can be properly understood. There are several important criteria for conducting LCA methodology:

1. Goals must be set and functional units must be identified.
2. The environmental impact must be allocated through the joint product from the beginning that is the process.
3. Acknowledgment must be given to avoid burden.

4. Resultant LCA.
5. Identify data uncertainty correctly.
6. Identify correctly between life cycle impact assessment and risk assessment.
7. Availability and transparency of inventory data.
8. Quality and quantity for information must be reported.
9. LCA is an iterative process.

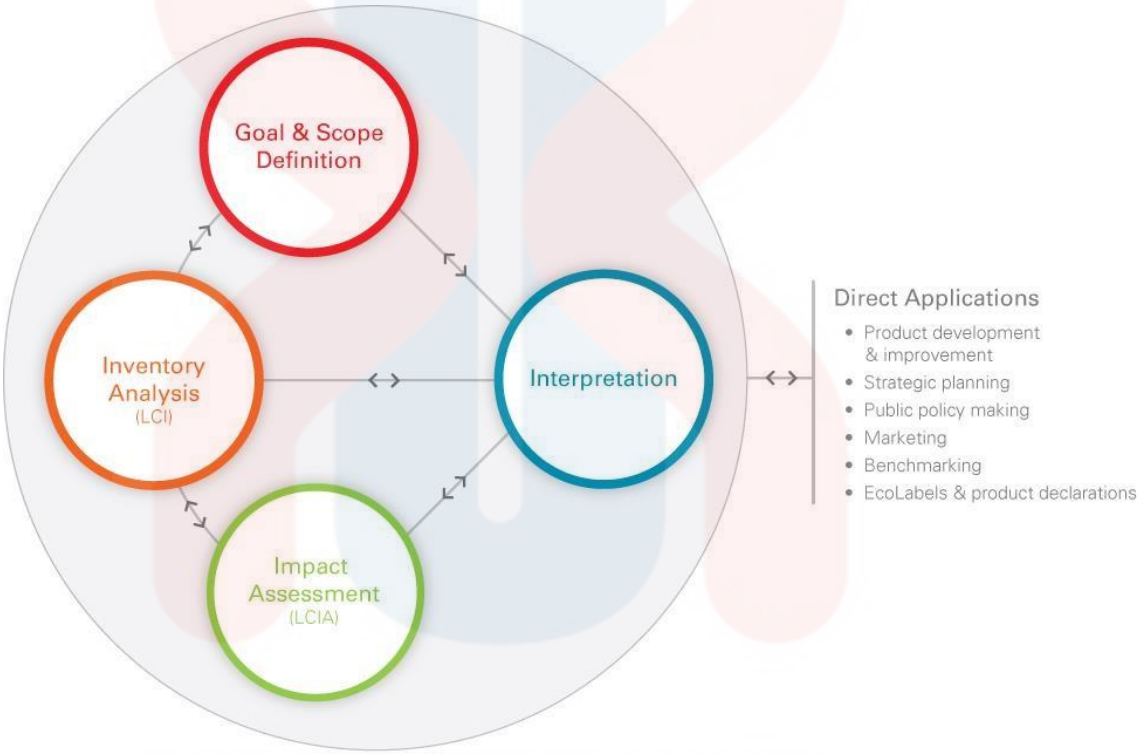

Figure 2.1: The LCA Applications.

Source: (LCANZ, 2015)

For a better results in conducting the life cycle assessment of a certain products or process, many important factors should be analyse and all the dependent processes of the LCA must be considered properly. The boundary conditions must be defineds so that it can reduce the complexity of the study itself and consider the immediate associated for the processes (Source: Marathe et al., 2019).

2.1.1 Goal and Scope Definition Phase

The scope of the investigation should be described in detail, demonstrating that the objectives may be achieved within realistic constraints. The number of life cycle phases and effect categories that must be evaluated determines the LCA's scope. A very targeted and concentrated review may only include one stage of the life cycle and one impact. Another may cover the complete life cycle across several impact areas and be far more detailed in scope. There are countless options between these two poles. When defining the study's scope, the following components should be considered and explained: System functions, functional units, and reference flows for products, limits of the system, Allocation techniques, Methodology for environmental impact assessments, types of environmental impact assessments, and the requisite interpretation, Data requirements, assumptions and limitations, data quality requirements, and issues about critical review (Source: Ellen Riise 2011). The functionalities that the product system offers are expressed in functional units. This is a crucial element of LCA and has to be explained in detail in the study. The functions that the product system offers are expressed using functional units. This is a crucial component of LCA, and the research needs to clarify it in detail. A functional unit is a numerical representation of how well the system under study works. It offers references for the product system's inputs and outputs (Ann-Christine Pålsson 2011). The next element of the reference flow consists of the physical flow of energy or material required to complete a functional unit. System boundaries provide the required inputs and outputs as well as the unit actions that comprise the product system (Source: Ann-Christine Pålsson, 2011).

2.1.2 Inventory Analysis Phase

After drawing the LCA boundaries, the LCA analyst is ready to start gathering data. During the LCI phase, the inputs and outputs of the industrial system are tracked and recorded (by functional unit). Towards the end of this stage, a comprehensive list of all the input/output data for the system under investigation is created. In the real world, inventory analysis involves collecting and interpreting data. Tracking relevant inputs and outputs throughout the life cycle of a product or process is a need of data collection. The term "inventory" describes the assortment of various environmental inputs and outputs that are a component of the life cycle. the gathering of data on production, consumption, transportation, building, and end-of-life (Source: Dr Subramanian Senthil kannan Muthu, 2022). The process of compiling an exhaustive Life Cycle Inventory (LCI)

for conventional and environmentally friendly building materials entails gathering information on the environmental inputs and outputs related to each material over the course of its life cycle phases. The extraction of raw materials, manufacture, transportation, usage, and end-of-life disposal or recycling are the usual life cycle stages. It is important to remember that getting accurate and representative data for LCI can be challenging since it might vary depending on the geographical location, production process, and other factors. As a result, average values or information that is pertinent to a particular place is usually included in LCA investigations. In order to understand each material's environmental impact and make comparisons between conventional and sustainable house construction options, LCI data is also used for the impact assessment step.

2.1.3 Impact Assessment Phase

In order to create a complete Life Cycle Inventory (LCI) for conventional and environmentally friendly building materials, data must be gathered on the environmental inputs and outputs associated with each material throughout each phase of its life cycle. The typical life cycle stages include raw material extraction, production, transportation, use, and recycling or disposal at the end of the product's useful life. It's crucial to keep in mind that obtaining accurate and representative statistics for LCI might be difficult because it may vary based on the region, manufacturing method, and other elements. Therefore, in LCA investigations, average values or information that is relevant to a certain location is typically provided (Source: Franzoni 2011). The material life cycle, which is closely related to the pre-use stage of a building, includes the extraction of raw materials, the manufacturing process, delivery to the construction site, installation on site, as well as additional materials required during the operation stage for maintenance, refurbishment, and renovation. The process has a variety of direct effects on the environment. It harms the local natural ecosystem, including the ground and surface water, flora, fauna, and landscape's character (Halliday, 2008).

2.1.4 Interpretation Phase

Analyse and interpret LCA data, take into account identified impacts, and contrast conventional and sustainable construction materials. Compare how different conventional building materials affect the environment. Determine the impact categories in which particular materials have more adverse or favourable impacts. This comparison may highlight potential growth opportunities and serve as a decision-making tool. Find the steps or phases of each substance's life cycle that have the greatest environmental impact. This identification enables targeted measures to mitigate consequences there. Analysing each material's environmental effect over the course of its full life cycle is necessary to interpret Life Cycle Assessment (LCA) results for conventional and sustainable building materials used in residential construction. The aim is to understand the differences in environmental performance between traditional and sustainable materials and to identify potential areas for improvement. The remainder of the four stages in LCA is understanding. The ISO 14044 standard depicts various checks to test whether ends are sufficiently strong by the information and by the systems utilized. The interpretation of the outcomes acquired over the effect classes considered is performed dependent on which affectability and vulnerability investigation is done. The LCA philosophy is characterized in the ISO 14040: 2006 and 14044: 2006 ordinarily to direct the different LCA contemplates completed on the environment. This method is urgent so as to give a shared conviction to all the investigation completed in this world.

2.2 TRADITIONAL BUILDING MATERIALS

Traditional construction techniques and materials are frequently faced with challenging circumstances; they might be creatively employed to satisfy contemporary building codes and living standards, or they can be in danger of disappearing due to the pressures of modernization. Because they employ locally available resources to solve local circumstances in an economical way, traditional construction materials and styles have gained fresh attention in the green building movement. The development of new technologies has improved the application and manufacture of many conventional construction materials. Some conventional construction materials are now more ecologically benign, commercially feasible, and technically sound as a result of these advances. The study identified the main benefits of using traditional construction materials as the promotion of cultural heritage, accessibility and affordability of the materials, energy efficiency,

reuseability, and biodegradability, among others. Some parts of the world are seeing a renaissance in the use of traditional building materials like earth, stone, wood, or straw as opposed to modern industrially produced materials like reinforced concrete, ceramic bricks, plastic, glass, or steel because the latter's production requires a lot of energy, leaves a big carbon footprint, and is expensive to produce and ship (Source: Jose Maria, 2022).

Brick, the bricks are fired instead of being dried like mud bricks. Brick is one of the most common building materials and is very commonly used as a building material for walls, fences, and other house elements in addition to using wood (Source: Kania Dekoruma, 2021). Maybe some of us only know that this stone is only made of soil. Example of brick, Ordinary Brick This type of brick is made from a mixture of clay or cement-sand. Bricks made from a mixture of clay are made through a machine cutting process. Both facing bricks are made from a mixture of clay or quality cement and sand and additives. Used as finishing work Third Fire bricks are made from a mixture of quality clay and other additives. Used for the construction of heat-resistant works. Fourth Bata engineering (engineering brick) is made of clay and quality additives. Used for heavy construction work that requires large, compact and non-absorbing loads (Source: Kania Dekoruma, 2021). Stone, stone has been used as a building material for thousands of years. It is durable, fire-resistant, and easy to work with, making it a popular choice for building foundations, walls, and other structures.

Modern architecture today uses innovative techniques, materials and technologies to create aesthetically pleasing and environmentally conscious structures. Some of these materials include Steel Modern skyscrapers and office buildings use steel for construction and design. Steel is now used as a structural body. Steel frames, handrails and door handles are used in many contemporary structures because of their strength, durability and lightness (Source: Liliana Alvarez 2010). Concrete, concrete is an ideal basic material for many types of construction and is therefore the most widely used material in many countries. The concrete mix, which is mainly composed of cement, can be easily formed by using suitable scaffolding. Most structures, whether old or modern, have concrete columns, beams, or structural foundations (Source: Liliana Alvarez, 2010).

2.3 SUSTAINABLE BUILDING MATERIALS

The World Conference on Development and Environment, created by the WCED in 1987, endorsed the first definition of sustainability offered there. It takes advantage of a range of natural resources without compromising their renewable value for future generations and depleting them, and it safeguards stocks of usable natural resources like energy, water, and life. It also meets the needs of society today without having negative effects on meeting the needs of future generations. certified sustainable sources for wood Bamboo, Materials that have been recycled or reclaimed (such as recycled steel and recovered wood), natural insulating materials (such as cork and cellulose), and green roofing materials (such as vegetated roofs) are important (Source: Zainab Hamid Mohson 2021). These are environmentally friendly materials from renewable sources, such as bamboo, reclaimed wood and hemp crete. They also often require less energy to produce than traditional building materials such as concrete or steel. The idea of "sustainable and green architecture" began to gain greater traction among professionals in the construction industry sector in industrialized countries in the 1990s (Source: Zainab Hamid Mohson 2021). However, this movement's beginnings may be traced back over a number of years. Utilising resources that are already at hand, such the local building stock and land availability, is often successful. It elevates the structure's environmental friendliness towards its surroundings to a significant accomplishment. Taking into account local social, economic, and climatic factors, this architecture is always sustainable. (Source: Zeyad Ali Ismael 2021).

The selection of building materials is one of the finest methods to implement sustainability. Building processes may be made more sustainable by implementing new, stronger, lighter, and innovative materials that can assist address several issues facing the sector. Reducing the carbon footprint of buildings that employ these materials is an additional advantage of using them, which helps protect the environment. Together with being more visually beautiful and effective, they support a cleaner Earth and a sustainable future. Bamboo is one of the most ecological building materials because of its renewable and adaptable qualities. Bamboo has the same strength as wood yet is nevertheless flexible, despite being a species of grass. Construction projects can use bamboo in various applications such as supporting concrete, scaffolding, roofing and building other structures. The benefits of bamboo as a fast-growing, cost-effective and environmentally friendly renewable material to grow and harvest and absorb more CO2 than trees.

2.4 RESIDENTIAL CONSTRUCTION

Construction of single-family homes, duplexes, apartments, condos, and other residential structures not to exceed four storeys in height, including basements, when used exclusively as permanent residences is referred to as residential construction. It excludes building utilities (water and sewage lines), paving streets and working on other structures (such as those used for commercial and recreational purposes). The building of housing (apartments, flats and homes) is known as residential construction. A plot of land needs to be bought, cleared, and graded for any residential building project. Following the addition of drainage and other facilities, building development begins. After the house is completed, someone moves in, and the contractor goes on to the next job.

2.5 COMPARE TRADITIONAL AND SUSTAINABLE BUILDING MATERIALS

A common comparison is between traditional building materials such as concrete and steel versus sustainable alternatives such as wood. LCA studies have found that wood has lower energy and greenhouse gas emissions than concrete and steel (Source: B., Wilson, 2010). Wood also has the advantage of being a renewable resource, contributing to carbon sequestration during its growth. Another difference is between conventional insulation materials such as fiberglass and environmentally friendly alternatives such as cellulose insulation. Because it is renewable and recyclable, cellulose insulation has a reduced environmental impact, according to LCA studies. Compared to fiberglass insulation, it uses less energy and emits fewer pollutants during manufacture and disposal. Traditional building materials often use non-renewable natural resources, such as wood, bricks, and clay. Meanwhile, sustainable building materials are more likely to use renewable resources, such as bamboo, recycled wood, and other environmentally friendly materials.

Another comparison is between traditional insulation materials such as fiberglass and sustainable alternatives such as cellulose insulation. LCA studies have shown that cellulose insulation has a lower environmental impact due to its renewable and recyclable nature (Source:

Kiziltas, E, 2018). It requires less energy and produces fewer emissions during production and disposal than fiberglass insulation. Furthermore, studies have examined the effects of using recycled materials in construction, such as recycled concrete aggregates. LCA evaluations have shown that using recycled materials can significantly reduce energy consumption, emissions and waste generation compared to using virgin materials.

In order to evaluate the environmental effects of conventional construction materials and investigate more environmentally sound alternatives, comparative studies of these materials have proven crucial. The life cycle assessment (LCA) approach is widely used in these studies to examine a material's whole life cycle, from raw material extraction through manufacturing, construction, usage, and disposal. As there are natural materials like rocks and iron or industrial materials like concrete and steel, the usage of the right material in the right structure and the economic consideration play a part in picking materials (Source: Saba Salih Shalal 2021).

2.6 OpenLCA

GreenDelta has been developing open-source software for Life Cycle Assessment (LCA) and Sustainability Assessment since 2006. One such programme is OpenLCA. It's free software that doesn't require a licence because it's opensource. Multiple application domains can benefit from the use of OpenLCA, such as environmental life cycle assessment (LCA), economic life cycle costing (LCC), social life cycle assessment (social LCA), carbon and water footprint, design for environment (DfE), environmental product declaration (EPD), and product environmental footprint (PEF). (Source: Gmbh, 2017).

Making LCA thinks about as indicated by global principles, it very well may be utilized for maintainability detailing and showcasing of items or item plan. openLCA can likewise turn out to be increasingly more an innate piece of the organizations. openLCA additionally permits quicker

count for the outcomes with the biggest arrangement of information accessible for LCA. openLCA is anything but difficult to introduce, offers a cutting edge and natural UI and can be utilized for working in a group. The report high light of openLCA where a total html report is made is especially fascinating for distributing and sharing outcomes.

OpenLCA as of now gives highlights and conceivable outcomes that are not accessible in other LCA programming, for example, the likelihood to incorporate GIS information. This makes it especially fascinating for application in research covering imaginative inquiries in the LCA region. This openLCA is an open source so it very well may be stretched out to meet and incorporate or to test new methodologies. openLCA is a breakthrough and easy to understand programming and the source code can be seen by everybody.

3 CHAPTER 3

3.1 MATERIALS AND METHOD

The selection of building materials chosen by UMK JELI is a representative set of traditional and sustainable building materials. The traditional building materials chosen are Concrete, Steel, and Brick. The sustainable building materials chosen are Bamboo, Reclaimed Wood, Crete Hemp.

The research was conducted according to the ISO 14044 standard. There are four phases in the Life Cycle Assessment study. This selection is made for comparison of building materials for residential construction. The phases of LCA are:

1. Goal and scope definition phase;
2. Inventory analysis phase;
3. Impact assessment phase;
4. Interpretation phase;

Life Cycle Assessment software, openLCA, was used to perform the impact assessment (Sule, 2012). Gole and scope, the aim of the study is to assess the environmental impact of residential construction. This study only focuses on environmental impacts due to time constraints. Begin by determining the purpose of this study's analysis. The aim of this study is to compare the environmental impact of several types of traditional and sustainable building materials. Or the party concerned wants to evaluate the environmental impact of a type of building material against certain criteria, such as carbon emissions or energy consumption.

Inventory analysis phase, this study only focused on residential building materials. Inventory data for the selection of materials to be used. In this phase the selection of traditional and sustainable materials to be used in residential construction. This research is only focused on residential building materials. Inventory data for the selection of materials to be used in the form of input and output. In this phase the selection of traditional and sustainable materials to be used in residential construction. Define traditional and sustainable building materials for the desired data analysis. Examples of traditional building materials include brick, steel and concrete.

Sustainable building materials may include recycled materials, such as recycled glass or environmentally friendly materials such as bamboo. Collect data on the life cycle of materials, including stages of production, use and disposal. This includes data on emissions, energy consumption and the use of other resources during the material's life cycle.

Impact assessment phase, Life Cycle Assessment software, openLCA, is used to analyze the environmental impact of residential construction. The openLCA software has produced the final results for this life cycle assessment. Environmental impact analysis, use OpenLCA to calculate the environmental impact of the life cycle of building materials. These can include greenhouse gas emissions, energy consumption, water pollution and land degradation. Compare the environmental impact of traditional and sustainable building materials that have been analyzed. Note which areas have a greater environmental impact and identify opportunities to reduce their impact.

Interpretation phase, In this phase, the results are analyzed and linked to the aims and scope of the study, conclusions are drawn, limitations are identified and recommendations are given based on the findings during the LCA phase. According to (Woolridge et al., 2006) most of these environmental parameters such as fresh water aquatic ecotox, global warming, human toxicity, marine aquatic ecotoxicity, ozone layer depletion (ODP) are considered for evaluation.

CHAPTER 4

4 RESULTS AND DISCUSSION

4.1 OpenLCA Analysis

Indicator	Unit
Fresh water aquatic ecotox.	kg 1,4-DB eq
Global warming (GWP100a)	kg CO2 eq
Human toxicity	kg 1,4-DB eq
Marine aquatic ecotoxicity	kg 1,4-DB eq
Ozone layer depletion (ODP)	kg CFC-11 eq

Figure 4.1: The LCIA categories of the selected LCIA method of the project.

Indicator	Option1	Option2	Unit
Fresh water aquatic ecotox.	1.74926e+4	1.90759e+4	kg 1,4-DB eq
Global warming (GWP100a)	3.89770e+4	4.59548e+4	kg CO2 eq
Human toxicity	3.13016e+4	3.22720e+4	kg 1,4-DB eq
Marine aquatic ecotoxicity	3.95502e+7	4.40396e+7	kg 1,4-DB eq
Ozone layer depletion (ODP)	1.29999e-3	1.46611e-3	kg CFC-11 eq

Figure 4.2: The results from the openLCA software.

Figure 4.3: The graph that are generated by the openLCA software.

Based on the results obtained from the openLCA software, the parameters that have been used are fresh water aquatic ecotox, global warming, human toxicity, marine aquatic ecotoxicity and ozone depletion (ODP). Based on Figure 4.3, this table shows the results produced using the openLCA software. In the figure, option 1 and option 2 are shown. For option 1, the estimated results for sustainable materials have shown irregular readings. After that for further analysis, use option 2. For option 2, it is estimated that the traditional material gets a constant reading of 100. This figure shows that, after some increase in the value of the sustainable material, the figure still shows an irregular result. The result of option 1 shows that a number of 100 indicates a strong impact on the environment and option 2 shows that a number less than 100 shows only a slight impact on the environment. Comparison of option 1 and option 2 is option 2 traditional building materials often use non-renewable natural resources, such as wood, brick, and clay. Meanwhile, option 1 sustainable building materials are more likely to use renewable resources, such as bamboo, recycled wood, and other environmentally friendly materials.

Based on Figure 4.5, the OpenLCA Software has performed the calculations and converted all calculations to different units for emissions to percentage (%). Option 2 is a traditional building material that has a greater environmental impact due to the use of non-renewable natural resources and emissions produced during the production process. On the other hand, option 1 sustainable

building materials tend to have a lower environmental impact because they use more sustainable resources and a more environmentally friendly production process. Strength and durability of option 1 and option 2, option 2 traditional building materials such as brick and steel can have very high strength and good resistance to weather and damage. However, sustainable building materials of choice 1 can also offer competitive strength and durability, depending on their type.

In terms of building quality, option 2 traditional building materials such as brick and steel are often considered to have high strength and durability, which can guarantee the safety and stability of the house structure in the long term. Compared to option 1, sustainable building materials such as well-processed bamboo can also offer sufficient strength to be used in residential development. In terms of location, some traditional building materials may be easier to find and easy to build anywhere in the selected location, while sustainable building materials may be more difficult to find depending on geographic location and availability of local resources.

In the openLCA software, the inputs that can be entered into the software are: calcium carbonate. After that, the output that can be analyzed is the amount of petroleum that can be released from residential construction materials. Input and output data can only be entered based on the database available in the openLCA software. Product lifecycle emissions focus on emissions to air, water and land. Based on these results, building materials cause little harm to the environment. The main reason is that during construction, causing dust and material dust that is blown away by the wind causes disease to humans. With this, workers should wear a face mask to avoid dust.

CHAPTER 5

5 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

In conclusion, this life cycle assessment method is very good for analyzing any good or bad that will be released by any product. For traditional and sustainable building materials, this building material is better because it does not emit any harmful effects and saves costs. By incorporating a life cycle point of view in administration in general, bring items and processes forward in an increasingly sustainable way. The association can also collect the natural advantages, well-being and safety associated with words, dangers and quality administrations and in addition create and use cleaner item processes and alternatives.

Life cycle methodology will help demonstrate the use of an increasingly practical way by offering better data for purchasing, transportation frameworks and life resources to manage buyers. It offers a stage for multi-stakeholder discourse and open association with enterprises and governments. Moving from neighborhood motivations to national and universal procedures for economic progress.

5.2 RECOMMEBDATIONS

There are several weaknesses and limitations in this study. The main weakness of this study is that this life cycle assessment is incomplete because this life cycle assessment only assesses the environmental impact. For a complete life cycle assessment, the study should consist of social, financial, economic and environmental aspects. For further studies, perhaps in a master study, this research can analyze all important aspects to obtain a complete life cycle assessment. Next, due to time limitations, this study can only focus on the comparison between building materials. For the improvement of this research, this study can distinguish between two or three types of traditional and sustainable building materials. Subsequently, the database obtained from the free version of openLCA is not completely complete due to funding limitations. For a complete database, the database itself should be purchas.

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