CHAPTER I
INTRODUCTION

This chapter contains the background of the problem, problem formulation. research objectives, problem limitations, and systematics writing.

1.1 Background

As a developing country, Indonesia is placing a strong emphasis on infrastructure development to support its economic growth and improve the quality of life for its citizens. This focus on infrastructure is expected to not only boost the country's economic potential but also create jobs and reduce regional disparities, ultimately contributing to Indonesia's long-term prosperity and stability. To align with this priority, the government has significantly increased the infrastructure budget in recent years. This investment reflects the government's commitment to enhancing connectivity, reducing logistical costs, and fostering economic growth.

The value of the infrastructure budget in 2023 is IDR 392 trillion in the 2023 Rancangan Anggaran Pembangunan dan Belanja Negara (RAPBN). This budget is an increase of 7.8% from the 2022 budget of IDR 363.8 trillion. These funds are planned to build various basic services including 3,511 flats and construction, rehabilitation or renovation of facilities and infrastructure for 670 primary and secondary schools. These infrastructure development activities have significantly increased the demand for raw materials.

One of the important materials in infrastructure development is cement. Cement is made from limestone and other additives through a fairly long process from the stages of raw material mining, raw material preparation, reaction in the kiln at high temperatures, size adjustments, and product finalization and product packaging (Lestianingrum & Ariyanto, 2022). Cement is also an important adhesive material for the construction industry (Nugraha et al., 2018). The role in providing strength and durability to these structures makes it indispensable in ensuring their long-term stability and safety. Additionally, cement is used in a wide range of applications, from small-scale residential projects to large infrastructure developments, making it a fundamental material in modern construction.

Indonesia is one of the countries with the largest cement consumption and producer in ASEAN (Devia et al., 2017). Cement consumption will continue to increase until it reaches 100 million tons in 2026, based on consumption trends and increasing infrastructure budgets (Devia et al., 2017). According to data released from the Ministry of Industry of the Republic of Indonesia, cement production data in the first semester of 2023 was 29.3 million tons, with national cement demand reaching 28 million tons (Kemenperin, 2023). This significant production capacity not only meets domestic needs but also positions Indonesia as a major supplier of cement to neighboring countries, reinforcing its strategic importance within the ASEAN region.

The cement industry is fully equipped to meet all cement needs, efficiently supplying the essential materials required for various construction projects. This robust sector plays a crucial role in addressing the demands of residential, commercial, and infrastructure developments. By consistently investing in advanced technology and expanding production capacities, the Indonesian cement industry not only fulfills domestic requirements but also strengthens its position in regional markets. This commitment to innovation and growth drives progress and significantly contributes to the nation's overall development and economic advancement.

The cement industry sector's contribution to the national economy. By employing thousands of workers in manufacturing, logistics, and distribution, the industry provides essential job opportunities that support livelihoods and stimulate local economies. Additionally, the sector generates substantial tax revenue, which contributes to public finances and supports government initiatives. Moreover, the cement industry plays a vital role in boosting downstream industries, such as construction and building material manufacturing, by providing the key materials needed for development projects. This interconnected growth enhances overall economic stability and fosters broader industrial advancement.

The cement industry is one of the industries that is classified as an energy-intensive industry, because in the production process it consumes quite a lot of energy, equivalent to 25 to 35% of the total production costs (Prayudi, 2009). The amount of cement production in Indonesia is certainly in line with the high energy demand in the production process. In general, the energy intensity for producing cement was around 3.4 GJ/ton in 2018 and for producing clinker it was 3.57 GJ/ton (EBTKE, 2020). The energy source in the cement industry still predominantly uses fossil energy which is coal reaches 90%. (Worrell & Galitsky, 2008).

High of energy used in the cement production process will lead to negative impacts. This activity will disturb Indonesia's energy sustainability and security. In addition, Indonesia's commitment to reduce greenhouse gas emissions stated in the First Nationally Determined Contribution is 29% or 314 million tons of CO_2e (unconditional) and 41% or 398 million tons of CO_2e (conditional) by 2030 could also be difficult to achieve. High energy use in cement production will result in an increase in greenhouse gas emissions, most of which come from fossil sources that contribute to carbon emissions. the increase in CO_2 caused by the cement production process will be in line with the increase in greenhouse gas emissions.

Emissions from coal amounted to 298.9 million tons of CO_2. This amount is equivalent to 89.3% of total GHG emissions in 2030. The greenhouse gas emissions from burning coal, it really dominates. This shows that the cement production process greatly contributes to greenhouse gas emissions because many companies still use fossil fuels in the form of coal in the combustion process (EBTKE, 2020).

The main environmental impact of the cement industry due to high energy use is air emissions, especially CO_2 emissions (Nugraha et al., 2018). Large cement production in cement industry is also causes more than 7% of annual anthropogenic greenhouse gas (GHG) emissions resulting from energy use and chemical reactions (Miller et al., 2021). GHGs are a combination of several gases that form a layer that traps solar heat from entering the earth (Yurinda et al., 2022). Industrial processes and product use are one of the contributors to greenhouse gas emissions in Indonesia, reaching 60,175 gigagrams of CO_2 or the equivalent of 60 million tons of CO_2 in 2019. The largest number of emissions came from cement at 52.42%. The cement industry in 2008 was 0.869 tons of CO_2/ton of cement with national emissions of 33.446 million tons of CO_2 per year (Winanti et al., 2009). A lot of negative impact of cement production is a major obstacle to achieving net zero emissions by 2050.

The cement industry also has a significant negative impact on public health. This impact can be divided into several main aspects, namely dust exposure, air pollution, and environmental disturbances. Exposure to cement dust is one of the most significant impacts on health. Cement dust can fly in the air and cause lung diseases, such as bronchitis and asthma. Air pollution is also another impact of the cement industry. The cement production process involves mining, crushing, and grinding raw materials, which produce dust and smoke (Muhusari, 2019). Dust and smoke emitted from the cement production process can cause air pollution that negatively impacts public health. The existence of the cement industry has a positive impact on increasing regional revenue, but also causes a decrease in air quality so that people experience health problems (Raffetti et al., 2019). The other impact of cement production process also causes damage to the ecosystem.

The cement production process significantly impacts surrounding ecosystems through several mechanisms. Quarrying for raw materials disrupts local habitats, leading to the loss of biodiversity and changes in land use. The high energy consumption involved in cement manufacturing, primarily from fossil fuels, contributes to air and water pollution, which can harm plant and animal life. These environmental disruptions collectively compromise ecosystem stability and biodiversity in the areas around cement plants.

The cement production process give impact on the surrounding ecosystem, especially when viewed from a Potentially Disappeared Fraction or PDF perspective. PDF is a measure used to assess the environmental impact of various human activities, including the cement industry, on biodiversity. The cement production process involves mining raw materials such as limestone and clay, which is often carried out in ways that destroy natural habitats and cause land degradation. Excavation and exploitation of land for cement raw materials results in loss of vegetation, which in turn affects the fauna that depends on the ecosystem. Pollutants produced by the cement production process, such as dust, can spread into the surrounding environment and cause damage to flora and fauna. Plants can experience impaired photosynthesis due to layers of dust covering the leaves, while gas pollutants can damage plant tissue and reduce their productivity (Sulasmi et al., 2022).

Assessing possible environmental impacts arising from the cement production process of various types of products is very important to reduce the impacts (Ige & Olanrewaju, 2023). One of the efforts by the Indonesian government is aimed at reducing emissions that impact the environment, thereby lowering greenhouse gas levels. Indonesia issued the UU Harmonisasi Peraturan Perpajakan (UU HPP) to increase the fiscal policy used to control climate change in Indonesia on 7 October 2021. The carbon tax is contained in the HPP Law chapter VI article 13 which consists of 16 paragraphs. Another form of Indonesian concern is the Program Penilaian Kinerja Perusahaan (PROPER) by Ministry of Environment and Forestry (KLHK) to encourage companies to comply with laws and regulations and carry out environmental management activities. Presidential Decree (PP) Number 61 of 2011 contains institutions responsible for the national GHG emission reduction target, policy directions for each sector, and mitigation actions that may be implemented to achieve the national GHG emission reduction target (ASI, 2014).

Sustainability issue reducing environmental impacts is currently a big concern for industrial players and governments around the world. As a form of participation in reducing greenhouse gas emissions in the world, Indonesia ratified the Kyoto Protocol for the UN framework on climate change through Law of the Republic of Indonesia Number 17 of 2004 concerning Ratification Kyoto Protocol to the United Nations Framework Convention on Climate Change (PUPR, 2021). Sustainable cement production includes the potential for improvements in the efficiency of energy used, reducing pollutants produced, reusing heat that has been released in the combustion process and using raw materials or alternative fuels (Devia et al., 2017).

One of cement industry in Indonesia is PT Semen Padang. PT Semen Padang also faces significant challenges related to emissions in its cement production process. The primary issue is the release of carbon dioxide (CO_2), a major greenhouse gas, which is an inherent byproduct of cement manufacturing. Despite efforts to implement cleaner technologies and improve energy efficiency, the company still grapples with the need to balance production demands with environmental sustainability. The reliance on traditional fuels and raw materials further complicates the issue, as these contribute to high levels of CO_2 and other pollutants. Additionally, regulatory pressures and global climate goals necessitate continuous innovation and investment in emission-reduction strategies.

PT Semen Padang is one of the largest cement industries in Indonesia with a capacity of 10.4 million tons of cement per year. The amount of energy used by PT Semen Padang in producing cement is around 783,950,176 kWh of electricity and 1.6 million tons of coal in years. The higher the level of production, the greater the potential for pollution, which can disrupt communities around the industrial area due to the extensive use of natural resources (Nugraha et al., 2018). The production capacity at PT Semen Padang shown in **Table 1.1**

Table 1. 1 Production Capacity at PT Semen Padang

Production Capacity of PT Semen Padang	
Pabrik Indarung I	Disable
Pabrik Indarung II	Disable
Pabrik Indarung III	Disable
Pabrik Indarung IV	1.920.000 tons/years
Pabrik Indarung V	3.000.000 tons/years
Pabrik Indarung VI	1.500.000 tons/years
CM Dumai	900.000 tons/years
Total	8.900.000 tons/years

PT Semen Padang is actively addressing the challenges of sustainable cement production by implementing strategies to minimize emissions associated with cement manufacturing. As part of its commitment to environmental responsibility, the company has adopted advanced technologies and practices aimed at reducing carbon dioxide (CO_2) emissions and other pollutants. These efforts include optimizing energy efficiency, utilizing alternative fuels, and also incorporating materials that lower the carbon footprint of cement production. The company's initiatives align with global trends and regulatory pressures to make the cement industry more sustainable while maintaining production efficiency.

The use of Alternative Fuels and Raw Materials (AFR) at PT Semen Padang demonstrates the company’s strong commitment to environmental preservation. The utilization of waste as raw materials or fuel not only promotes environmental sustainability but also offers financial advantages by lowering production costs through savings on raw materials and fuel. PT Semen Padang is also focused on utilizing renewable energy as part of its support for government programs. The use of AFR is expected to be an environmentally friendly solution that reduces dependence on non-renewable natural resources, lowers emissions, and creates economic opportunities for the surrounding community. Additionally, the use of AFR has the potential to reduce CO2 emissions, contributing to the mitigation of global warming effects.

One of the assessments used by the cement industry to comprehensively evaluate the environmental impacts is the Life Cycle Assessment (LCA). This study refers to the SNI ISO 14040:2016 and SNI ISO 14044:2017 standards regarding life cycle analysis (LCA), namely recording and evaluating input, output and possible environmental impacts of a product system during its life cycle. In the LCA process, an objective procedure for evaluating environmental impacts is carried out by quantifying all flows in/from the system to the environment (exchange flows) at each stage of the system life cycle. One of the reasons LCA was developed was to assess the environmental impacts caused by factories and production processes (Khalizah et al., 2019.).

Life cycle assessment beneficial for industry and the environment, such as obtaining maximum and efficient production results, to help find continuous improvements so that we can protect the environment for the future (Yekti & Mirwan, 2021). LCA in the cement industry will be a mechanism for assessing the environmental impact of related cement production (Setiawan et al., 2021). Thus, using LCA can be used to analysis and evaluate the ecological impact on the production process at PT Semen Padang. This research activity was carried out at PT Semen Padang which focused on the Indarung 6 Factory taking into account that this factory produces cement with the largest capacity. The expected results from this research are recommendations for improvements to the life cycle of the cement production process that occurs at PT Semen Padang.

1.2 Problem Formulation

Based on the description in the background section, the problem in this research can be formulated, namely:

1. What is the impact on the cement production process at PT Semen Padang with Life Cycle Assessment approach?
2. What recommendations can be given based on the impact on the cement production process at PT Semen Padang?

1.3 Research Objectives

The objectives of the research conducted are as follows:

1. Find out the impact on the cement production process at PT Semen Padang with this Life Cycle Assessment approach.
2. Know the appropriate recommendations based on the impact on the cement production process at PT Semen Padang.

1.4 Research Scope

The problem limitation of this research are follows:

1. The data processing using Life Cycle Assessment approach has gate-to-gate limitations which is the limitation from transportation from quarry until cement mill process
2. This research focus at Indarung VI Factory of PT Semen Padang.
3. The type of cement is Type I
4. The quarry process excluded implosion of the quarry

1.5 Systematics Writing

The outline of this report are follows.

CHAPTER I INTRODUCTION

Chapter I contains the background of the research, the formulation of the problem, the purpose of the research, the research scope, and the outline of this report.

CHAPTER II LITERATURE REVIEW

Chapter II contains supporting theories according to the research to be carried out and theories to solve problems as well as analysis of the results obtained.

CHAPTER III RESEARCH METHODOLOGY

Chapter III contains systematic research steps, starting with the field study and literature study stages then ending with the analysis stage of the results of research data processing.

CHAPTER IV DATA COLLECTING AND PROCESSING

Chapter IV contains data collected and data processing carried out using software.

CHAPTER V ANALYSIS

Chapter V contains the analysis after doing the calculation of research that have been carried out previously, which is adjusted to the research objective and giving the improvement recommendation.

CHAPTER VI CONCLUTIONS

Chapter VI contains the conclusions of this research based on the processing and analysing data, and also suggestion based on the result of research obtained and improvement for the next researcher.