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Life Cycle Assessment of Construction Phase of MRT Jakarta Track Structure

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Abstract

The Jakarta MRT was built to meet the mobilization needs of Indonesian citizens, especially the citizens of Jakarta to be more comfortable and safer, which was built with two double lanes. In this study, it raised research on the environmental impact of the cradle to grave for the main Jakarta MRT line. This study has taken into account the environmental impact of the construction of the Jakarta MRT train line using LCA because in this phase of construction, LCA has not done it. The calculations are modeled using SimaPro7 software. The LCA results show that the track bed casting stage has a greater impact than rail production and other major components. The maintenance and operation phase are outside the scope of this report, so further studies need to be carried out in the entirety of the Jakarta MRT train system, and the need to compare the use of other materials which may have a smaller environmental impact. The values raised in this LCA report can be used for stakeholders involved in railway transportation planning.

Keywords: Environmental impact, cradle to grave, life cycle assessment, Jakarta MRT

INTRODUCTION

At present in European countries, America and Asia are currently researching products, processes and systems that discuss the life cycle of a product, process and system that already exists what will be produced and applied. The Journey About Life Cycle began in the 1960s, which discussed life cycles (Life Cycle Assessment). Therefore, the author here wants to try doing research for the life cycle in railway transportation modes that is being discussed in Indonesian society, especially the citizens of DKI Jakarta, namely the Jakarta MRT railroad system. The author will conduct research on Life Cycle Assessment of Construction Phase of MRT Jakarta Track Structure.

Until now in the world, rail transport modes generally which are more often discussed only in relation to the calculation of environmental impacts during the operation phase, are rarely discussed during the construction or maintenance of the railway system. Understanding the system as a whole will contribute to the efforts made in today's effort towards sustainability. Nevertheless, research has shown that the main source of environmental impacts from railroad systems comes from the construction of railroad infrastructure or commonly called infrastructure. Construction of railroad infrastructure will certainly contribute to pollution emissions to the surrounding environment, among other environmental impacts. Therefore, the stage of construction of Railway infrastructure was chosen as the focal point in this study. This report is the result of a study in which life cycle assessments were carried out specifically on the main line of the Jakarta MRT, which carried out calculations of only 1 kilometer, representing 32 kilometers for double lanes.

GOAL AND SCOPE

The purpose of this report is to assess the environmental impact of the Jakarta MRT train line by using LCA to identify the most significant impact of the life cycle of the phase I Jakarta MRT railroad system.

The author here will give a limitation on the Life Cycle Assessment study that will be examined only on the railroad structure, which uses a railroad structure fix with prestressed concrete pads and only calculated along the 1-kilometer main line of the LCA cradle to grave process (raw material to construction phase).

Further assumptions from this study are Components of several MRT train lines are produced in Japan or other Asian countries, because there are values available for this at SimaPro. This Jakarta MRT line has its main structure, namely bridges and tunnels. However, in this study only the railroad and the main foundation to support the railroad components will be considered in the system. All LCA studies do not include the care and operation phase.

LITERATURE

Life Cycle Assessment (LCA) is a method for calculating and evaluating inputs and outputs that are relevant to the environment and has the potential for environmental impacts from the life cycle of a product, material or service (SABS ISO, 1998).

The phase in an LCA generally consists of four stages, definition of goal and scope, Inventory analysis, Impact Assessment and Interpretation of results (Figure 1).

There are 4 main choices for determining system boundaries used based on ISO 14044 standards in an LCA study, cradle to grave, cradle to gate, gate to grave and gate to gate (Figure 2).

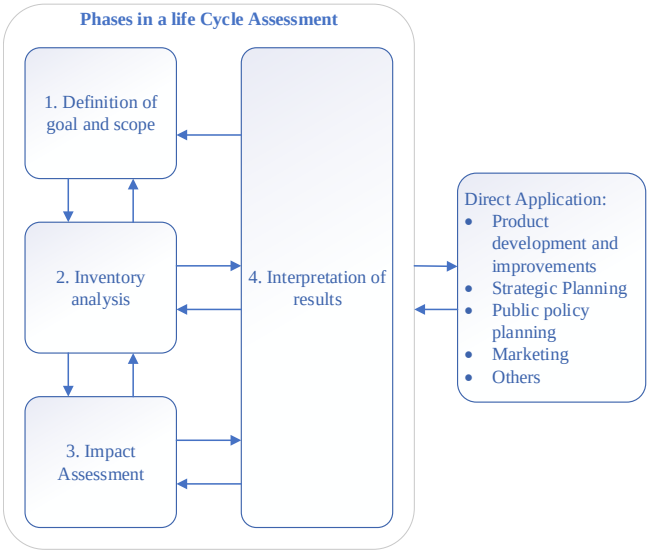

Figure 1 Framework for Life Cycle Assessment

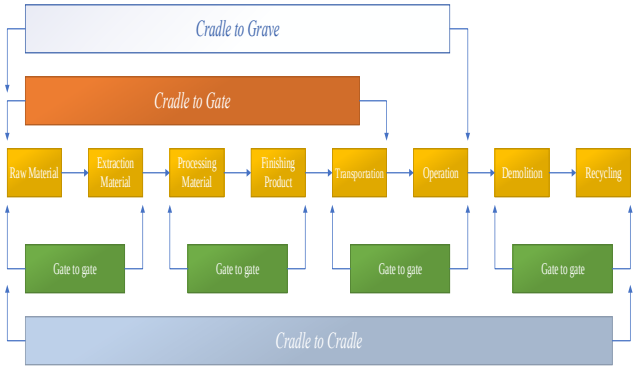

Figure 2 Scope of Life Cycle Assessment

There are several main components that will be calculated in one Life Cycle Assessment of Track Structure: Rail, PC Sleeper, Fastening System, Track bed.

METHODOLOGY

In this study, the author will measure emission factors that have an impact on the environment, from the production stage, to the construction phase of the Jakarta MRT railroad infrastructure until the disposal phase. The author measures the components of the MRT line, which was explained in the previous chapter regarding the structure of the Jakarta MRT train line.

For LCA modeling in this study using SimaPro 7.1.8 software. SimaPro. The system boundary is illustrated in Figure 3, this shows the different steps that will include estimating the life cycle impact of the cradle to grave, using calculation method with Eco-indicator 99 (H) Ver. 2.0.6.

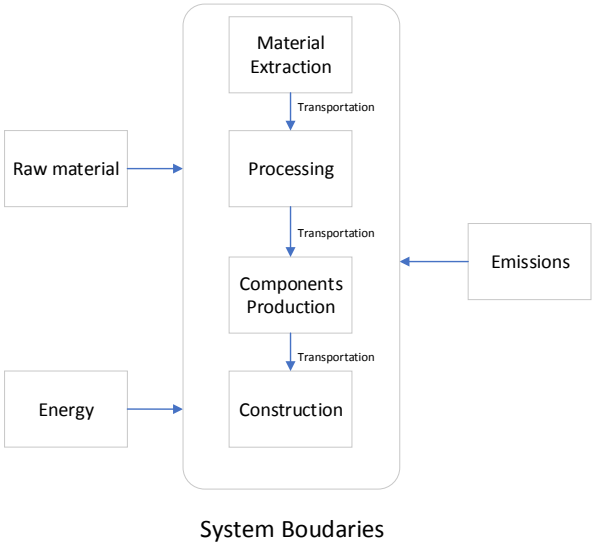

Figure 3 Simple Process Flow of the Jakarta MRT Line Construction System

Life Cycle Inventory Analysis

Figure 4 illustrates the detailed process flow diagram for the railway system under investigation. Extraction of raw materials, processing of materials, components of production and construction of railway lines.

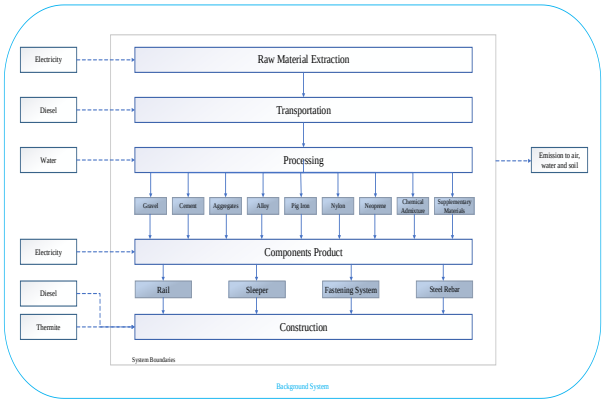

Figure 5 Detail Flowchart of the Jakarta MRT lane system

For a 1-kilometer long crossing the main MRT requires a number of main components as much as:

Table 1 Number of main components for 1-kilometer main crossing with a 0.1-meter long track panel gap in straight section.

No.	Component Name	Number of Components
1	Track panel	200
2	PC Sleeper	1400
3	Fastening System	2800
4	Rail	80

RESULT AND DISCUSSION

In evaluating the assembly of the 1-kilometer MRT train line, the results of normalization in Figure 6 show that the use of fossil fuels, resp. inorganic and climate change is the highest environmental burden during the construction of the Fc'30 MPa cast-in situ track panel, which requires mobilizing the concrete mixture from the plant to the work area.

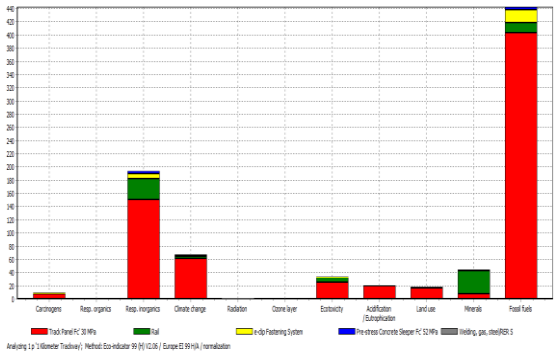

Figure 6 Normalization result of railway track

In figure 7 the damage value from the construction of the highest 1-kilometer track way is due to the cast-in situ casting process of the track bed, the ozone layer is damaged, followed by inorganic compounds and eutrophication or acidification. The reason why the track panel has the highest load on the ozone layer depletion, maybe because the transportation used is using mixer trucks that have to carry a concrete mix which in 1 mixer truck is only capable of carrying 12 m3 in one transport, so it requires 53 mixer trucks to do track way casting 1-kilometer long.

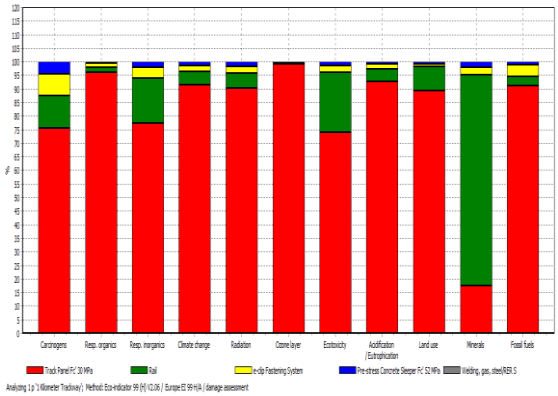

Figure 7 Damage Assessment of Railway Track

CONCLUSION

The purpose of this study was to identify the environmental impact of the construction of the Jakarta MRT train line and look for hotspots from the life cycle in the phase I construction phase Jakarta MRT track I. Based on the results of the study, the results obtained according to the authors' expectations were the greatest environmental impact or the hotspot of the MRT railway line construction is in the construction phase of the 1-kilometer MRT track panel, this is because the transportation used to transport the concrete mix track panel uses a mixer truck, which in 1 mixer truck can only carry 12 m3 in a single haul, so it requires 53 mixer trucks to do a 1-kilometer track way casting. But there are drawbacks in this study, namely the maintenance phase and its waste management are not taken into account, due to the lack of a database in this SimaPro 7.1.8 software, so the authors cannot include materials that might potentially be recycled as a whole after the component's lifespan, such as rails, steel reinforcement, and concrete which of course can be recycled and can be used for other purposes.

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