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Segmental Box Girder (SBG) Monitoring and Control System in Light Rail Transit Line 3 (LRT3) Construction Project using Microsoft Project

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Abstract: Malaysia is a developing country with numerous new construction and buildings scattered across the country. However, not all construction projects are successful and, in some cases, a project may be problematic and fail. Failure to complete the project on schedule will be caused delays in the future. A study was conducted at AlKauthar Kinematics Sdn Bhd company which is involved in the construction of the LRT3 project and focuses on the casting and installation of Segmental Box Girder (SBG). In order to improve the delivery of successful projects, the aim of this study is to determine the factors of construction project delay, analyze the affected cost and time in construction project using Microsoft Project and propose ways to minimize the construction project delay. Method used in this study is analyzing the data obtained from industry using Microsoft Project. From the findings, it can be concluded that the factors of the delay in LRT3 construction project at GS10 package are MCO period cause by covid-19, conditions on construction site, delivery of material and defects on some segments. This will help all government and private construction organizations in overcoming project failure.

Keywords: Factor of Construction Project Delay, Microsoft Project, Covid-19, LRT3, Segmental Box Girder

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1. Introduction

Malaysia is known for its development, and one of the most well-known sectors that contributes to that development is the construction industry. Even though there have been few studies in recent years, the focus of this study is mostly on construction delays in railway construction projects in Malaysia [1]. According to a study by M. Z. Ramli, here are numerous varieties of railways in rail transportation, demonstrating that this mode of transportation is in high demand. According to the government, the majority of capital formation comes from construction projects, and regular Malaysia Plan (published every 5 years) have been developed to ensure a planned development of the country [1].

There are two ongoing project involving railway construction in Malaysia which is LRT3 construction project and MRT2 construction project. Based on the industry, AlKauthar Kinematics Sdn Bhd, the ongoing project for this company is Construction and Completion of LRT3 from Bandar Utama to Johan Setia that focuses on the installation of Segmental Box Girder (SBG). There are two types of bridges used which is U-Through Girder and Segmental Box Girder (SBG) in LRT3 construction project.

The project owner is from Prasarana Malaysia Berhad and main contractor is from MRCB George Kent Sdn Bhd (MRCBGK) following their nominations as the Project Delivery Partner (PDP) of LRT3 on September 4, 2015. The other companies that involved in this project is MMSB Consult Sdn Bhd as lead consultant and S.N.AKMIDA Holdings Sdn Bhd as subcontractor, and our company, AlKauthar Kinematics Sdn Bhd as deck specialist subcontractor which skillful in Segmental Box Girder (SBG) construction.

In this study, the focus in mainly on the industry ongoing project which is Construction and Completion of LRT3 from Bandar Utama to Johan Setia at GS10 Package. The problem that occurred from this construction project is the delay of construction that caused the cost and time overrun. A study by Shah, the most common causes of delays in the construction industry in both developed and developing countries are time and cost overruns. In a study of 258 companies from 20 nations and five countries throughout the world, it was discovered that nine out of ten projects had cost overruns by [2].

Cost overrun includes design changes, poor planning, unpredictable weather condition and the fluctuation, and prices of building materials. Time overrun because of delay and the expected completion of the project is not achieved. This study aims to determine the factors of construction project delay, to analyze the affected cost and time in construction project using Microsoft Project and to propose ways to minimize the construction project delay. Therefore, it will be carried out using project monitoring and control method that use Microsoft Project. This method focuses on process which collect and record information regarding the project. The results of the research conducted will be produced in the graph s-curve which can display a performance between the actual performance and the planned performance.

2. Klang Valley Light Rail Transit Line 3 (KVLRT3)

Rail technology has developed over time, such as from hand power, wooden rails to metal rails, and steam engines to electric-powered engines. As a result, it has become the most efficient public transit system and the most important method of transportation in each country. Malaysia's rail transportation system is now divided into three categories: urban, suburban and rural. The urban rail transportation network was intended to relieve city congestion by improving mobility among urban residents [3].

The Klang Valley, which included cities and towns in Kuala Lumpur, Selangor and Putrajaya, has a population of 7.8 million people and is rising. Every year, over 500, 000 new car registrations are added, contributing to massive traffic congestion in the Klang Valley. In the Klang Valley, public transit such as rail, buses and taxis play a key role in reducing traffic congestion. By increasing connectivity

and lowering traffic congestion, the project is estimated to benefit 74, 000 passengers and 500, 000 people along the alignment [4].

Figure 1: Segmental Box Girder (SBG) at LRT3 Construction Site

In LRT3 construction project, AlKauthar Kinematics Sdn Bhd focuses on precast of segmental box girder (SBG) and the installation (launching). There are 79 segments that precast and 2 segments is cast-in-situ. Figure 1 shows one of Segmental Box Girder (SBG) segment at LRT3 construction site. The main reason behind the installation of SBG at GS10 package is that it is located at a highway area which is KESAS highway. GS10 package focusing on the installation of SBG because it used long span crossing. The distance of SBG installation at GS10 package is 250 meters.

2.1 Segmental Box Girder (SBG) Casting in LRT3

In today's Malaysia, the precast Segmental Box Girder (SBG) is a fairly common bridge construction technology. Construction of precast SBG is faster and less destructive to the surrounding environment [5]. Precast construction refers to the prefabrication of bridge segments or parts at a location other than the site, transportation to the site, and installed there. In comparison to cast-in-situ segmental bridges, precast segments provide a number of advantages. Table 1 shows the differences between precast segment and cast-in-situ segment of SBG.

Table 1: Precast versus Cast-in-Situ Segment

Precast Segment	Cast-in-Situ Segment
Better segment quality uniformity	Only one substructure can be started at a time

Manufacturing can begin concurrently with early field construction activities, allowing for a more efficient timeline	Due to shipping or transportation, does not have to regard weight and size constraints
The transportation and setup procedure between the casting yard and construction sites are quite important	It is not necessary to examine the site's restrictions (after all equipment have been delivered)

2.2 Segmental Box Girder (SBG) Installation in LRT3

When working on segmental bridges, it's crucial to figure out what kind of construction methods and materials to use. The construction method has a significant impact on the design, such as tendon arrangements. Construction loads have an important role in the design. Balanced Cantilever Method, Incremental Launching, and Span-by-Span Construction are three significant construction methods for segmental box girders [6].

In this LRT3 construction project, the launching method used is balanced cantilever method which the segment is lifted by crane. The crane used to lift the segments is usually weight around 500 tons to 800 tons. Bridge with limited spans ranging from 50 meters to 250 meters are built using the balanced cantilever method. This method is employed because it is highly recommended when scaffolding is difficult or impossible to build over large rivers or costly base requirements for scaffolds.

2.3 Factors of Construction Project Delay

Delays occur in practically every construction project and their length vary greatly from one to the next, ranging from a few days to many years. Construction delay is widely recognized as the most important factor affecting the scheduled, cost-effective and high-quality completion of construction project [7]. Despite the fact that the railway construction sector has invested a significant amount of money in improving management and technology, most projects in this industry failed to meet their schedules and budgets. Due to financial limits and project schedules, construction project presents a challenge to the client, consultant and contractor [8].

According to study by Raja Khan Mohammed Gopang, these are the top ten list of factors that can cause the construction projects to be delayed. The lists are such as conditions on the construction site, level of labor expertise, labor availability, labor productivity, payment has been delayed, poor site management, rework or defective work, consultant's testing and acceptance criteria, client or consultant changes the design, and defects in planning and scheduling [8].

Delays in construction business is one of the most significant issues that construction companies must overcome, and it is a typical occurrence in all civil engineering projects. Clients, consultants and contractors are the parties most affected by construction delays [1]. It is practically difficult to complete within the period stated since various criteria must be considered, such as the performance of the parties, the availability of resources, the involvement of additional parties, unpredictable factors, and the environment.

3. Methodology

The method used in this study is analyzing the data obtained from industry using project monitoring and control method. The data was analyzed in a project management tools which is Microsoft Project. The expected result from this data analyzing is that it will develop an s-curve graph.

A project monitoring and control system identifies and reports the status of the project compares it to the plan, analyses the deviations, and implements the relevant corrective steps to minimize deviations

from the project plans [9]. Progress on the project must be supervised and monitored in order to identify and measure the variations between the plan and actual job performance [10].

Microsoft Project is a popular piece of software that performs a variety of tasks in a user-friendly manner, including scheduling, resource levelling, tracking, and reporting. It is intended to assist project managers in developing a project plan, assigning resources to task items, tracking progress, managing budgets, and analyzing workloads [11].

In order to achieve a successful objective, the method use for each objective are different. For the first objective, to determine the factors of construction project delay. The method used in this objective is by case study which the literature review related to the construction project will be analyzed to determine the factors. The second objective is to analyze the affected cost and time in a construction project using Microsoft Project. For this objective, Microsoft Project software are used to analyze the data as to develop an s-curve graph that show planning and actual performance. The last objective is to propose ways to minimize the construction project delay which the method used is by analyzing the data collected from industry.

4. Results and Discussion

AlKauthar Kinematics Sdn Bhd focuses on Segmental Box Girder (SBG) casting and launching (installation), the official data will focus on both methods. This study only covers the casting work of SBG. From Microsoft Project, a total of 79 segments of SBG were precast at the yard, Batang Kali, Selangor. It has 5 spans continuous box girder bridges at GS10 Packages which is P25-06, P25-07, P25-08, P25-10 and P25-12.

4.1 Factors of LRT3 Construction Project Delay

The factors of the factors of LRT3 construction project delay at GS10 package were determined from analysis of data in Microsoft Project. The estimated time of casting work is from the 24th of June 2020 till the 26th of December 2020. The actual date of casting is starting from the 11th of August 2020 till the 20th of April 2021. Based on data that has been analyzed using Microsoft Project, the factors of construction project delay are such as MCO period, conditions on construction site, delivery of material and defective work.

Coronavirus disease (Covid-19) appear at the end year of 2019, this is the main cause of the delay in theLRT3 project. During the MCO period that makes people work from home and are not allowed to work as a normal day. Thus, many people are affected not only in the field of construction, but also in various fields such as construction, tourism, learning, and business no matter whether small or large business. The MCO period is from 18th March 2020 until 12th May 2020, for about two months. The covid-19 virus not only spread in Malaysia, but it spread to almost the whole country.

For this LRT3 construction project in package GS10 that is related to SBG, the location is at a crossing above the KESAS highway which is considered live traffic. Therefore, it is a risky situation to install the segment of SBG in the daytime. Any long-span crossing segment erection located above the roadway is not allowed without carrying out temporary road closure. As night-time is the only way to install the segment, works related to it will be notified to the Traffic Management for Road Closure of KESAS Highway and JKR Road. After obtaining permission from KESAS Highway and JKR Road, the segment installation work can be carried out at a certain time.

Based on the environmental conditions, extreme weather conditions can cause serious safety hazards. For this LRT3 construction project, on a heavy rainy day, workers had to stop the segment installation works. This is because the installation work requires a material such as Sikadur adhesive. Sikadur cannot adhere well if exposed to water. So, it is important to ensure good weather to install the segment. The precast Segmental Box Girder (SBG) will be kept in storage at Batang Kali before being

delivered to the construction site at Klang. All material needs to be inspected when delivered to the site and immediately before use. It is to ensure the segment is not subjected to deterioration, damage or defect. Delivery of the SBG segment will take place when the installation work is to be done on a certain day and at a certain time.

Other factors would be the defect of the segments that have been cast. This defect will be the cause of SBG launching or installation delay. After the SBG is cast, an inspection will be made, which is a post-pour inspection to see if there is a defect or not. If there is a defect in any segment, it will be rectified which is called remedial works. If the defect of the segment is not rectified quickly, it will slow down the installation of the segment and cause a delay in each task.

4.2 Data Analysis in Microsoft Project

Two moulds will be used for casting long-span segment for package GS10 of the LRT3 construction project. One mould is for typical and one mould is for the variable segment. Mould preparation for precast Segmental Box Girder (SBG) in choosing design mould & fabrication take time from 16th October 2019 to 23rd June 2020. As Movement Control Order (MCO) period starts on 18th March 2020 till 12th May 2020, here is the starting point, the main point where the delay starts to begin. After the mould arrived, it would be unloaded and assembled at the casting yard. Then, the casting work will begin at the casting yard after the mould assembled has been completed. After all of the data collection has been done, an analysis of data was made in order to analyze the Gantt Chart and developed into an s-curve graph by using Microsoft Project.

4.2.1 Casting of Segmental Box Girder (SBG)

In order to determine the delay in this project, the date, time and schedule are very important to be taken note. By doing this, we can identify the delay from how many days, months, or years it could be for some of the projects. As in data obtained, there is the casting date of Segmental Box Girder (SBG) for the LRT3 construction project.

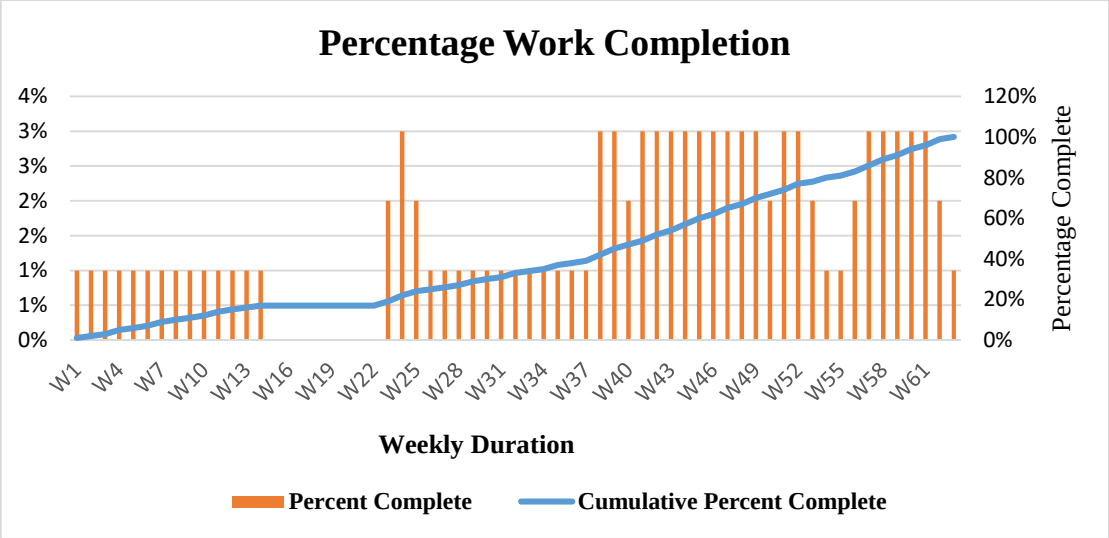

Figure 2: S-Curve Graph of Percentage Work Completion

Figure 2 above is a physical s-curve graph of the percentage of work completion which shows the percentage work completed by week. The blue colour in the graph indicates a cumulative of percent complete which increased dramatically. By looking at the axis of the graph, the x-axis is the weekly duration and the y-axis is the percentage work complete. From week 1 to week 14, the percentage of work that has been completed is only about twenty percent (20%). During week 15 to week 22, the work suddenly ceased to operate due to Covid-19. From week 23 until week 63, the casting work has

increased the work completion. This is due to the MCO period has ended, and life as usual returning to normal.

4.2.2 Costing for Each Segment of Segmental Box Girder (SBG)

Since this research is only focused on the production of Segmental Box Girder (SBG), the costing will also be focused on it and the cost for installation will not be included. In a larger construction project budget or cost, the cost is private and confidential. Similar to this railway construction project, the KVLRT3 construction project is one of the largest projects in Malaysia, so the cost-related data is only an assumption according to the actual cost which refers to the company's cost. These data related to cost will be analyze in Microsoft Project.

The cost for each segment will be determined according to the price of concrete, type of mould used, the weight of the segment, delivery of concrete and more else. Based on the data collected, the planning cost is around 2 million Ringgit Malaysia, which is RM2, 743, 962.00. Meanwhile, the actual cost is above 3 million Ringgit Malaysia which is RM3, 838, 296.00. The increase in cost is due to the cost of goods getting more expensive after MCO. This is because, during the MCO period, many people suffer from financial shortages.

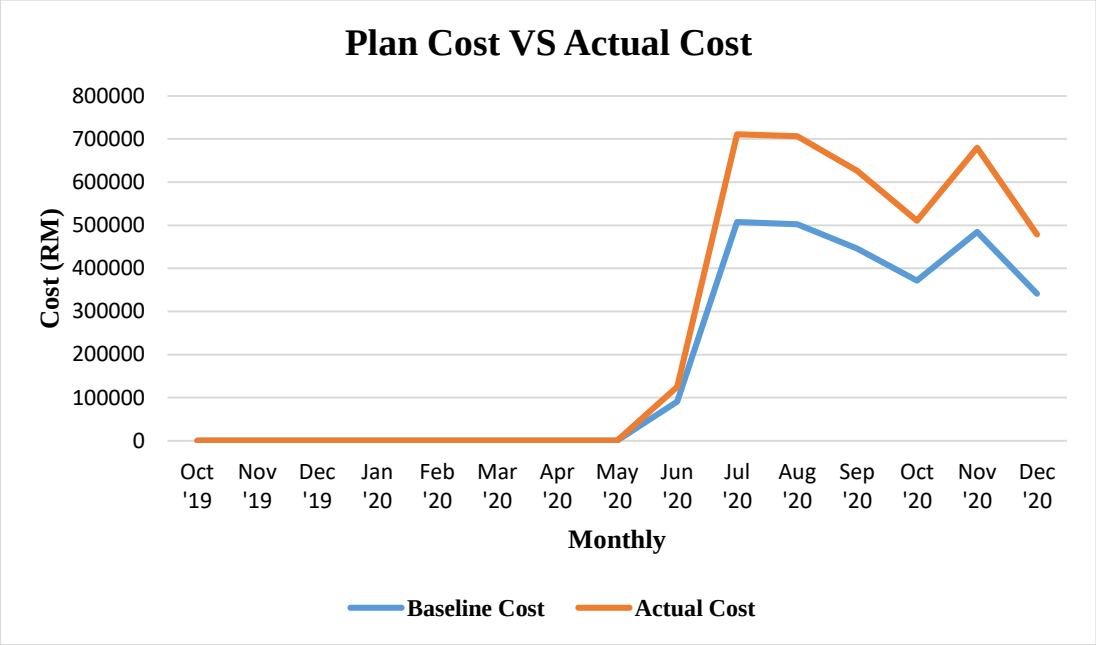

Figure 3: S-Curve Graph of Planned Cost versus Actual Cost

Figure 3 above shows a financial s-curve graph of planned cost versus actual cost for LRT3 construction at the GS10 package. The blue colour is the baseline cost or known as the planned cost that we have planned in a project. The orange colour is the actual cost that has been used in completing this construction project. The y-axis is the cost in Ringgit Malaysia (RM) and the x-axis is the time in monthly from the start of the project till the end of the project. By this graph, it is proven that the cost overruns are due to delays in the project. For the first few months from October 2019 to February 2020, the task is the process of mould design and fabrication. So, the cost is not applied until after the MCO period when the casting work begins to be carried out.

4.3 Ways to Minimize LRT3 Construction Project Delay

As the factors of delay in the LRT3 construction project have been determined, ways to minimize the delay were also determined from data that has been analyzed in Microsoft Project. These are three important ways proposed, such as remedial works of precast SBG, proper planning and scheduling for

installation of SBG and hiring a competent person and experienced workers. Remedial work also known as rectification work. It is carried out if there are defects found on the segment. Major defect is required to be rectified as it will be a problem if not repaired. Client can issue NCR if there is a defect no matter whether the defect is major or minor because it involves the safety of people around. Remedial works are divided based on defects on segment of SBG.

Since this research is related to project planning and scheduling, it is important to make proper planning and scheduling for large projects. This LRT3 construction project has project monitoring and control but is not efficient. This problem is because it may have been overlooked by the person making it. Effective maintenance planning and scheduling revolve around prioritizing and organizing tasks so they can be completed as efficiently as possible. For example, the installation of SBG is only done at night and good weather should be emphasized. This is because rainy weather makes the installation of SBG less efficient and materials.

Another way to minimize the delays is by hiring people who are a more competent person and experienced workers. This delay results in an increase in terms of cost and time. Therefore, companies need to figure out ways to overcome such delays. For example, a company can select the competent person and experienced employees. With this, the work can be done quickly and completed well. In this LRT3 construction project, the workers are comprised of someone who is experienced in the construction field, especially in the field of SBG casting and installation. With this, it can reduce costs and speed up the completion time of the manufacture and installation of SBG.

5. Conclusion and Recommendation

Based on the previous chapter, data analysis and discussion, it is seen that the objectives of the research are achieved. During the course of this study, three (3) objectives were chosen. The first step is to determine the factors of construction project delay, the second is to analyze the affected cost and time in the construction project Microsoft Project, and the third and last is to propose ways to minimize the construction project delay.

The first objective of the study, to determine the factors of construction project delay in the LRT3 project at GS10 package in Malaysia has been successfully achieved. This research has highlighted four main factors to determine the factors of construction project delay in the LRT3 project at GS10 package in Malaysia which is MCO period, conditions on the construction site, delivery of material and defective work. The second objective of the study was to analyze cost and time in construction project using Microsoft Project was also successfully achieved. The affected cost and time regarding the LRT3 construction project at GS10 package involving SBG have been analyzed using Microsoft Project software. According to the findings, the two typical impacts of delay in this project were cost overrun and time overrun. As a result, it is critical for construction key players to identify the causes of delays in the LRT3 construction project so that delays can be avoided.

The last objective which was to propose the most suitable action that should be taken to minimize the construction project delay also has been successfully achieved. these are three important ways proposed by the industry, such as remedial works of precast SBG, proper planning and scheduling for installation of SBG and hiring a competent person and experienced workers. The remedial work of the precast segment is to ensure that the defect which is major and minor defects can be successfully rectified. Proper planning and scheduling for SBG installation are to avoid the accidents or incidents from occurring and also to monitor the schedule effectively. By hiring a competent person and experienced workers, the work can be done quickly and can overcome the time that has been delayed.

The main causes contributing to project delays in the construction industry have been discovered as a result of this research, and have a possible solution to this problem. There is recommendation for construction experts as well as future scholars interested in continuing this research such as if the researcher has the opportunity to meet with the supervisor personally while in the company, please do

so and provide a comprehensive description of the study, as this will assist them in properly understanding the study. As a result, the researcher will be exposed to more direct comments and suggestions not found in any reference literature.

As Malaysia moves closer to more comprehensive execution of railway construction projects, all construction role players must work together and commit fully, maturing quickly and effectively handling all problems in delivering a project on schedule in a more positive and productive manner.

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