Progress in Engineering Application and Technology Vol. 4 No. 2 (2023) 1140-1147

PEAT

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/peat
e-ISSN : 2773-5303

Improvements in Minimising Delays in Terrestrial Viaducts Construction for The RTS Link Project

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DOI: https://doi.org/10.30880/peat.2023.04.02.117
Received 02 July 2023; Accepted 13 July 2023; Available online 13 July 2023

Abstract: The rapid growth of critical infrastructure projects, such as railways, supports economic development by providing efficient transportation, reducing congestion, and enhancing accessibility. Delays in constructing terrestrial viaducts can disrupt project timelines, leading to increased costs and social challenges. To address this issue, it is crucial to identify the causes and effects of delays in viaduct construction and propose effective methods for minimizing or overcoming these delays, particularly for the RTS Link project. A questionnaire was developed to collect data from clients, consultants, and contractors, and the Relative Importance Index (RII) method was used to analyze the data. The study revealed that change orders and additional works were the primary causes of delays, cost and time overrun were common effects, and efficient communication and collaboration were identified as the most effective methods for minimizing construction delays.

Keywords: Relative Importance Index (RII), Rapid Transit System (RTS)

1. Introduction

Construction delays can be defined as exceeding the agreed-upon completion time mentioned in the contract or the mutually agreed date for project delivery. Delays are a common issue in construction projects, leading to increased operational expenses for contractors due to extended work time, higher labor costs, and inflated material prices. For project owners, delays result in lost profits due to unproductive facilities, unused rental space, or a reliance on existing services [1]. Construction projects vary in their size, complexity, objectives, duration, uncertainty, pace, and other dimensions [2].

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Terrestrial viaduct construction for railway projects stands out as a highly complex, large-scale, and lengthy undertaking.

As stated by R.F. Aziz [5], time holds significant importance throughout the entire project management life cycle and is considered a critical parameter for project success. Time delays are a prevalent global occurrence observed in almost all construction projects worldwide. Extensive delays have been identified in construction projects across India, as evaluated by Doloi et al. [6]. Consequently, it is imperative to conduct a systematic analysis of the causes of delays and enhance the understanding among industry professionals. Iyer and Jha [7] have reported that a significant proportion, over 40%, of construction projects in the country suffer from poor performance.

Several academic researchers have carried out studies over the years to investigate the causes of construction projects delays. A survey conducted by Al-Momani [16] in Jordan to investigate the causes of delays in public construction projects. The findings revealed that the major causes of delay were attributed to designers, user changes, weather conditions, site conditions, late deliveries, economic conditions, and increases in quantity. Odeh and Battaineh [17] identified the main causes of delays in construction projects from the viewpoints of construction, contractors, and consultants. They concluded that the top ten factors agreed upon by contractors and consultants included owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision-making, improper planning, and subcontractors.

Construction delays can have significant and wide-ranging consequences on construction projects, affecting various aspects of project performance and overall success. A study conducted by Chan and Kumaraswamy [21] in the Hong Kong construction industry highlighted that failure to meet project deadlines, budgeted costs, and specified quality standards can lead to various unexpected negative impacts on projects. When projects experience delays, they often require extensions or acceleration, resulting in additional costs. Fong et al. [22] emphasized that construction delays are commonly encountered in the building industry, often leading to numerous claims, some of which may escalate to litigation.

The purpose of this study is to identify the causes and factors contributing to the delay of the terrestrial viaduct construction projects, to analyse the effect of delays in the terrestrial viaducts construction and to propose the methods that can be used to minimize or overcome the delay of the terrestrial viaduct construction especially for RTS Link project.

2. Methodology

2.1 Research Methodology

To collect data for this study, a questionnaire was developed to assess the causes and effects of delays. Following the guidelines of Monette et al. [32], a questionnaire was considered an appropriate method for survey research. The questionnaire items were primarily adapted and modified from previous studies. To ensure heterogeneity in the survey responses and better understand the impact of various attributes on construction delays, three distinct groups of respondents were targeted: clients, consultants, and contractors. The information was gathered from a review of the literature. All the work flow of the research methodology are and will be based on the flowchart from Figure 1.

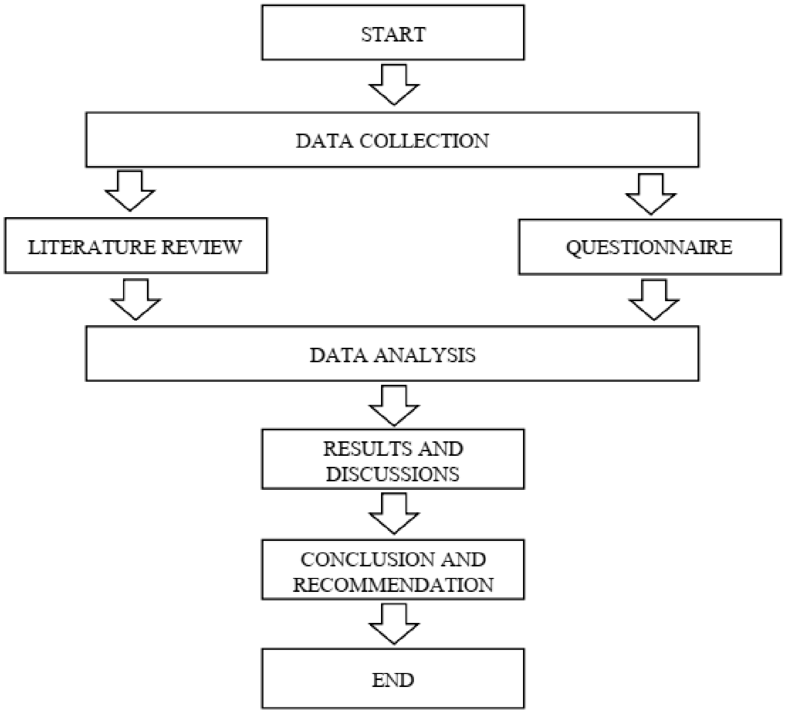

Figure 1: Flowchart Methodology of Study

2.2 Data Collection

Data for this study was collected from both secondary and primary sources. The primary data was obtained through the distribution of questionnaires, while the identification of factors causing delays relied on secondary sources such as literature, reports, publications, and internet research. Through this extensive research, a total of 10 causes and 7 effects of construction delays, as well as 3 methods to minimize or overcome such delays, were identified for inclusion in the survey.

A quantitative approach was employed to analyze the raw data collected. The literature review played a crucial role in identifying the initial factors, which were then supplemented by additional factors recommended by local experts. To gather the necessary data, a set of 30 questionnaires was distributed among three groups of respondents, namely clients, consultants, and contractors involved in the project.

2.3 Questionnaire Design

To gain insights and opinions from experienced individuals regarding construction delays in terrestrial viaducts, a questionnaire survey was developed. The questionnaire consisted of four sections: Section A focused on respondent background information, Section B addressed causes of construction delay, Section C examined the effects of construction delay, and Section D explored methods to minimize or overcome construction delay of terrestrial viaducts.

For the questionnaire, a 5-point Likert scale of ordinal measurement was utilized, allowing respondents to indicate their level of agreement on a scale from 1 to 5. The scale ranged from strongly disagree (1), disagree (2), moderately (3), agree (4) to strongly agree (5), providing a means to assess the degree of agreement for each item.

2.4 Data Analysis

The collected questionnaire data was processed using the RII (Relative Importance Index) method. This analysis aimed to determine the relative importance of the identified causes and effects of delay in the research. The RII method assigns values within the 1 to 5 range, aligning with the Likert scale mentioned earlier, to indicate the relative importance of each question.

$$RII = \frac{\sum W}{A * N} \quad Eq. 1$$

Where W = Weighting given to each factor by the respondents (ranging from 1 to 5).

A = Highest weight (i.e., 5 in this case)

N = Total number of respondents.

The RII (Relative Importance Index) value, ranging from 0 to 1, is used to assess the significance of causes and effects of delays. A higher RII value indicates greater importance of a particular cause or effect. By calculating and comparing the RII values, we can determine the relative importance of these factors as perceived by the three selected groups of respondents: clients, consultants, and contractors. This ranking enables us to identify the primary factors contributing to delays and define the major effects of delays in terrestrial viaducts construction as well to identify the methods to minimize or overcome the delay problem.

2.5 Data Representation

To present the data and findings effectively, various visual representations were utilized in the final stage. Tables, pie charts, and bar charts were employed as detailed in the subsequent chapter. The ranked characteristics were presented using tables and bar charts based on the average index analysis. Demographic results were displayed using pie charts, while bar charts were used to present the outcomes related to the objectives of the study. Additionally, based on the RII results, the ranking will be presented in tabular form.

3. Results and Discussion

3.1 Causes of Construction Delay Based on Respondent's Survey

Table 1: Causes of Construction Delay Based on Respondent's Survey

Causes of Construction Delay	RII	Rank
Change orders/ Additional works during construction works	0.88	1
Shortage of labors supply	0.0.84	2
Rework due to change of design	0.83	3
Slow decision making by clients/ contractors/ consultants etc.	0.83	3
Rework due to errors during construction	0.78	5
Delay in approving shop drawing, sample material, and revising & approving documents by client/ contractors/ consultants etc.	0.77	6
Changes in material types & specifications during construction	0.73	7
Poor site management and supervision by contractor	0.73	7
Complexity of the project	0.71	9
Original contract duration is too short or unrealistic	0.67	10

Based on Table 1 shown above, the highest to the lowest ranked for the causes of delay in a construction of terrestrial viaducts based on all the groups of respondents' survey are: Change orders/ additional works by clients during construction (RII=0.88), Shortage of labors supply (RII=0.84), Rework due to change of design (RII=0.83), Slow decision making by clients/ contractors/ consultants etc. (RII=0.83), Rework due to errors during construction (RII=0.78), Delay in approving shop drawing, sample material, and revising & approving documents by client/ contractors/ consultants etc. (RII=0.77), Changes in material types & specifications during construction (RII=0.73), Poor site management and supervision by contractor (RII=0.73), Complexity of the project (RII=0.71), and original contract duration is too short or unrealistic (RII=0.67). Change orders/ additional works by clients during the construction of terrestrial viaducts can be the highest ranked cause of delays because the changes often require modifications to the original design, leading to additional design work, approvals, and adjustments to the construction plans.

3.2 Effects of Construction Delay Based on Respondent's Survey

Table 2: Effects of Construction Delay Based on Respondent's Survey

Effects of Construction Delay	RII	Rank
Cost overrun	0.91	1
Time overrun	0.91	1
Excessive working time	0.81	3
Bad image to country	0.79	4
Arbitration and litigation	0.75	5
Dispute	0.74	6
Total abandonment	0.62	7

Based on Table 2 above, the highest to the lowest ranked for the effects of delay in a construction of terrestrial viaducts based on all the groups of respondents' survey are: Cost overrun (RII=0.91), Time overrun (RII=0.91), Excessive working time (RII=0.81), Bad image to country (RII=0.79), Arbitration and litigation (RII=0.75), Dispute (RII=0.74) and Total abandonment (RII=0.62). Time overrun and cost overrun are often considered the highest ranked effects of delay in the construction of terrestrial viaducts. When delays occur, they can extend the overall project duration, leading to time overrun. This can have various consequences, including increased labor costs, extended equipment rentals, and prolonged project management and supervision expenses.

3.3 Methods to Minimize or Overcome Construction Delay Based on Respondent's Survey

Table 3: Methods to Minimize or Overcome Construction Delay Based on Respondent's Survey

Methods to Minimize Construction Delay	RII	Rank
Efficient communication and collaboration with all parties	0.93	1
Comprehensive planning and scheduling	0.91	2
Early risk identification and mitigation	0.82	3

Based on Table 3 shown above, the highest to the lowest ranked for the methods to minimize construction delays based on all group of respondents' survey are: Efficient communication and collaboration with all parties (RII=0.93), Comprehensive planning and scheduling (RII=0.91) and Early risk identification and mitigation (RII=0.82). Efficient communication and collaboration with all parties involved are considered the highest ranked methods to minimize construction delays in the construction of terrestrial viaducts. Effective communication ensures that everyone is on the same page regarding project requirements, timelines, and any potential changes or issues that may arise. It allows for prompt and clear dissemination of information, reducing misunderstandings and minimizing delays caused by miscommunication.

4. Conclusion

This research has successfully achieved its objectives throughout the completion of the study. The first objective, identifying the causes and factors contributing to delays in terrestrial viaduct construction, has been accomplished. Identifying these causes enables decision-makers to proactively address them and minimize or avoid delays. The second objective, analyzing the effects of delays in terrestrial viaduct construction, has also been achieved. Understanding these effects helps decision-makers take proactive actions to minimize or mitigate the risks associated with delays. Lastly, the objective of proposing methods to minimize or overcome delays in terrestrial viaduct construction, particularly for the RTS Link project, has been accomplished. Among these methods, efficient communication and collaboration were found to be the most effective method in minimizing construction delays.

There are a few recommendations to further enhance the significance of this research in the future. The recommendation might be mixed-methods approaches, increase the number of respondents, data collection from projects in other countries and multiple case studies.

Acknowledgement

The authors would like to express their gratitude to Malaysia Rapid Transit System Sdn. Bhd. for cooperating on this research. This study was conducted as part of a project sponsored by the Universiti Tun Hussein Onn Malaysia.

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