INNOVATIVE CONTRACTS TO ADDRESS METRO RAIL CONSTRUCTION DELAY

[1]Ms. Jayalakshmi Bangaru, [2]Mr. Kiran K M
[1]Departement of Civil Engineering.SJC Institute of Technology
(Visvesvaraya Technological University)Karnataka,India
[2]Assistant Professor,Department Of Civil Engineering,Sjcit Chickballapur
Email Id: jgourav_2@rediffmail.com

Abstract

Purpose - Metro rail projects involve construction activities having long term work zones, which lead to increase in road user cost, a major unaccounted monetary loss. In order to curb the heavy cost arising from the lane closure/congestion, the non-excusable (contactor origin) delay factors had to be studied, their delays quantified and contract modifications proposed to minimize the impact. The clauses which incorporated road user cost as penalty were called Innovative Contractual Clauses.

Design/methodology/approach - Literature review commenced with the study of general project delay factors and research methods adopted in their analysis. The existing studies on Indian Metro rail construction delays were reviewed, followed by the analysis of prior studies on Road user cost. Subsequently, the contractual remedies to prevent and mitigate delays caused by contractors and Conventional contractual clauses and difficulties in their implementation were studied. Innovative Contractual clauses along with their benefits in foreign country projects were studied. Mixed Method Research was chosen for the study due to presence of both qualitative data (semi-structured interviews) and quantitative data (road user cost and project schedule delay) in the data collection process.

Findings - Upon analysing the delay factors through case studies, appropriate Innovative contractual method(s) / clause(s) could be applied to the metro projects, thereby reducing project delay and eventually, the road user cost.

Research limitations/implications –The study aims to quantify the delay caused by contractor and proposes contract modifications to minimize the impact on road user cost caused by work zone closure.

Practical implications – This could pave way for more efficient structural and work zone designs for faster completion of projects.

Keywords – Construction Delays, Road user cost, Vehicle operating cost, Work zone

Introduction

In order to cater to the stark urban population, rise in Metro rail projects involve construction activities having long term work zones with lanes taken over by the contractor for extended durations metros have been conceptualized. In spite of the criticality of the projects, they are marred with schedule and cost overruns resulting from various stakeholder / external factors. As a result of project delay, the smooth commute of common man is affected, an issue which has not received due attention. Public convenience must be the prime factor driving the core need of achieving timely metro rail completion. Metro rail projects involve construction activities having long term work zones with lanes taken over by the contractor for extended durations. According to ***Bhutani, Ram, & Ravinder, 2016***, the long-term work zones lead to issues such as reduction in capacity, increase in travel time delays, queue length, fuel consumption, number of forced merges and roadway accidents, which in combination are termed as road user cost, a major unaccounted monetary loss. ***Mittal & Paul (2018)***, through a questionnaire survey, have identified and ranked various factors (Client, consultant, contractor, labour, material, equipment and external contributed factors) causing metro rail construction delays in India In order to curb the heavy cost, the factors

causing project delay at the work zones, primarily of non-excusable nature, have to be studied from a case study point of view, and appropriate contractual clauses have to be customized and levied. From the Indian metro rail construction context, neither have there been any dedicated studies on non-excusable delay factors (contractor origin), nor any studies on application of innovative contractual clauses. This study aims to fill the aforementioned lacuna by undertaking a case study approach.Mixed Method Research was chosen for the study due to presence of both qualitative data (semi-structured interviews) and quantitative data (road user cost and project schedule delay) in the data collection process.

Literature review

Delay Definition

Mensah & Knight (2017) defined delay as "the inability to meet the scheduled time". ***Colin &Retik (1997)*** have written that delays are of two kinds, namely, excusable & non-excusable wherein "excusable delays" are ones comprehensible by the stakeholders and "non-excusable" are of conflicting nature. ***Trauner (2009)*** says that excusable delays are of two kinds, namely compensable and non-compensable. "Compensable delays" originate from the owner and allow the contractor to reimburse time and cost whereas delays of "non-compensable" nature are the exact inverse. ***Trauner (2009)*** adds on that construction project delays can originate from any of the stakeholders on projects. ***Sweis, Hammad &Shboul (2008)***, believe that construction assignments worldwide experience delays despite the availability of advanced technology and project management methods to the stakeholders.

Causes of Delays

Bagaya & Song (2016) carried out a questionnaire survey of 140 stakeholders and used a "quantitative statistical method" to analyze their "frequency, severity and importance indices". They ascertained "Financial capability of the contractor, Financial difficulties of the owner, Equipment availability of the contractor, Slow payments for completed work, and Poor sub- contractor performance by the contractor" as top 5 reasons for project delay in the context of *Burkina Faso*.***Oyegoke& Al Kiyumi (2017)*** conducted a questionnaire survey from 53 stakeholders in Oman and analyzed the results using "Relative Importance Index (RII) method". They concluded the top reasons of delay in Oman projects to be "Selection of the lowest bid instead of best bid for the client, Financial condition of the main contractor, Delay in decision-making by the client, and Poor construction planning by the main contractor".***Amoatey& Ankrah (2017)*** conducted empirical analysis on 48 Ghanaian road projects in order to ascertain their time consumption. They discovered that 70% of the road projects experienced delays and the average time over-run was 17 months. They shortlisted the five most critical causes of delay as "Payment delay by the owner, Lack of contractor's experience, Scope change by the owner during execution, Delay in handing over site to contractor by owner, and Rigid funding allocation for the project". ***Gündüz, Nielsen & Özdemir (2013)*** discerned the construction delay factors by conducting thorough literature study and arranging interviews with industry specialists. They categorized the delay factors (83 different ones) into 9 major groups and visualised them using Ishikawa (Fishbone) diagram. "Relative Importance Index method" was adopted to identify the correlative factor significance. The top three factor groups contributing to delay were contractor, owner and consultant related. Contractor group were constituted by factors like recurrent change of contractors, inadequate experience of contractor, unsuitable construction methods, inefficient project planning and scheduling among many others.

Existing Studies on Indian Metro Rail Project Delays

Mittal & Paul (2018) carried out a questionnaire survey to determine the major sources of metro rail project delay in India. Based on the opinions of clients, consultants and contractors, they shortlisted 49 delay factors spread across 7 categories, namely "Client, consultant, contractor, material, equipment, labour and external factors". The study ranked the top 10 delay factors based on calculation of "Relative Importance Index (RII)", of which the 3 top critical delay factors were "(1) Delay in land acquisition and handing over of site to contractor, (2) Utility shifting and contingency works and (3) Work scope

change." The three factors seen above cause delays during Pre-Construction and not delays during Construction. According to ***Karthik (2018)***, the main issues arising during the construction phase of metro are due to time crunch, handling of traffic and space constraints of working within city limits. Linking the execution stage delay purely to lack of space is broad reasoning. Detailed analysis is needed to discover the finer reasons underlying the causes for delay, which calls for an interview-based interaction with the project stakeholders. The purpose of this thesis is to find out reasons of delay occurring at critical junctions during execution stage.

- **Impact of Metro Rail Construction Delay – Work zone**

Bhutani et al. (2016) studied the repercussions of metro rail construction work on traffic conditions by quantifying the economic losses arising from the effects of work zone queue length. Structured scheduling of the work zone and smoother management of traffic were the suggested measures to combat impacts arising from the metro rail project work zone. The quantified economic loss, also known as "Road User Cost", has been systematically defined below.

- **Road User Cost**

Daniels, Ellis & Stockton (1999), defined Road User Cost as "The additional cost often incurred due to the reduction of work zone capacity, decrease of travel speed, increase in travel time, potential increase of accident rates, and negative impact on the natural environment". It is represented by the below formula:

"RUC = VOT + VOC + AC" Where, "VOT = Value of time; VOC = Vehicle operating cost; and AC = Accident cost".

Daniels, Ellis & Stockton (1999) formulated a RUC calculation procedure for the "Florida Department of Transportation (FDOT)" using major inputs from previous research on "User benefit analyses and work zones, traffic analysis methods published in the Highway Capacity Manual and empirical data specific to Florida". The new procedure was validated after comparison with two existing models using "Correlation analysis, comparison of major calculation assumptions and input data analysis". The above procedures were found to be suitable for American conditions. For Indian conditions, guidelines from IRC: SP 30 (2009) were to be referred.

Contractual Implications of Delay :*Kraiem& Diekmann (1987)*state that delays originating from the contractor's end are called non-excusable delays. Generally, for such delays, clauses known as Liquidated Damages are framed, stating the contractor's liability to pay damages to the client.Excusable delays occur due to reasons beyond the control of client and contractor. Example – Force majeure clause addresses this kind of delay. Whereas compensable delays occur as a result of an unexpected decisions taken by the client due to which the contractor is owed a compensation. Example of this are delays due to change in project scope or variation of site conditions from ones initially communicated by the client.This study focuses only on the contractor attributed delays and the methods to curb them..***Majid&McCaffer (1998)***mahighlight that although a sizeable quantity of research has been done exploring the non-excusable delay factors, they do not provide a total picture of time- linked complications. ***Arditi &Pattanakitchamroon (2006)***say that assigning the cause of delay to a particular stakeholder becomes arduous in many situations**.** ***Rubin (1983)*** feels that this makes it tough to decide which party to impose the compensation claim on. This conflict is particularly evident during occurrence of concurrent delays, a case wherein two or more delays are coexistent. If either of the delays occur stand alone, they would cause the whole project to overshoot the deadline. In the Indian Metro Rail context, the first step to reduce the occurrence of non-excusable delays is to conduct extensive research to identify the key causes. Secondly, alternative contracting methods should be tried. The first step is effective when done via case studies. The second step could be achieved by introducing techniques like innovative contracting.***Herbsman, Chen & Epstein (1995)*** state that, among the numerous innovative contracting procedures that exist, the four most popular ones are:1)A+B Bidding (Cost +Time),2)Incentive/disincentive (I/D),3)A+B Bidding combined with incentive/disincentive (I/D),4)Lane Rent A+B Bidding

As a part of the analysis by ***Herbsman (1995)***, results of 101 projects awarded on the A+B bidding method were compared to time and cost of conventionally bid projects. It was observed that, by using A+B method there was a considerable amount of saving in construction time achieved at nearly no extra cost. The result was ascribed to the planning and management efficiency of driven contractors who used time component in the bidding process.

Incentive / Disincentive Contracting: ***Herbsman et al., (1995)*** state that in I/D contracting method, the contractor would be entitled to an incentive fee (bonus) in the event of project completion ahead of schedule. If the same contractor overshoots the deadline, a disincentive fee (penalty) is levied by the owner. In USA, the value of daily incentive/disincentive fee is calculated using the Daily Road User Cost.

A+B Plus I/D Provision*:* ***Herbsman et al., (1995)*** state that "A+B plus I/D Provision" is a composite technique, wherein the lowest bidder emerges from the outcome of the conventional A+B bidding process. After bidder selection, the project duration offered by the contractor is taken as the contractual project period. Payment or collection of the Incentive/disincentive fees are then done in line with the contract duration. The value of incentive/disincentive fee is calculated using the everyday road user cost.

Lane Rental: ***Herbsman et al., (1995)*** described a method called Lane Rental, where, two different costs are included in the process of bidding by the contractor. First being the conventional construction cost & second is cost inflicted on general public due to traffic lane closure. Setup of contract time and determination of the lane closing cost under various working circumstances are done by the transportation agency responsible for running the project.

Summary: ***Herbsman et al., (1995)*** added that value of time is a major consideration by each of the four innovative contracting methods. It is mandatory for the project stakeholders to get accustomed to the principles and procedures binding the contracting methods. They summarized the innovative contracting methods as follows:

- Projects using innovative contracting methods were found to have 20-50% time reduction in comparison to conventional contract projects.
- A+B(Cost+Time) Bidding was found to be the most cost-effective of the four since it achieved time reduction through competition instead of remitting money to contractor.
- The I/D(Incentive/Decentive) method was observed being expensive & inefficient in comparison to A+B Bidding method, thereby justifying its decline in USA over the recent times.
- Lane rental and A+B plus I/D were found to be encouraging, but demanded extra information from additional case studies for further analysis.

Literature review commenced with the study of general project delay factors and research methods adopted in their analysis. The existing studies on Indian Metro rail construction delays were reviewed, followed by the analysis of prior studies on Road user cost. Subsequently, the contractual remedies to prevent and mitigate delays caused by contractors were studied. Conventional contractual clauses and difficulties in their implementation were studied. Innovative Contractual clauses along with their benefits in foreign country projects were studied. Finally, it was found that non-excusable delay factors attributed to contractors in Indian Metro rail construction had not been studied in detail. It was concluded that, upon analyzing the delay factors through case studies, appropriate Innovative contractual method(s) / clause(s) could be applied to the metro projects, thereby reducing project delay and eventually, the road user cost.

Research Methodology

Mixed Methods Research was chosen for the study due to presence of both qualitative data (semi-structured interviews) and quantitative data (road user cost and project schedule delay) in the data collection process.

Data Collection

A total of three case studies were conducted in Bengaluru Metro Phase 1, executed by different contractors. Critical work zones of each stretch were chosen for research (consisting of stations

and viaducts respectively). The three data elements collected from each work zone.

- **Project Schedule**: It was collected to understand the quantum of variation in planned vs. actual dates of construction. Viaduct activities included were piling, pile cap, pier, pier cap and segment launching. Station activities included were piling, pile cap, pier, concourse beam and platform beam works.
- **Stakeholder Interviews**: Semi structured interviews were conducted with the project stakeholders (Client, Contractors and PMC) in order to ascertain the factors for construction delay. The interview process was carried out with constant reference to the project schedule activities. The delay factors corresponding to the various activities were noted as shared by the stakeholders.
- **Road User Cost**: The traffic volume count was carried out at each case study work zone, to be later used for calculation of road user cost.

Data Analysis:

The steps followed in Data Analysis are as follows:

- Analysis of Project Schedules: The construction delays corresponding to each activity of the viaduct and station were tabulated. Four types of delays were studied, namely a) Pre-construction delay, and b) Construction delay, c) Overall activity delay and d) Pier intra activity delay.
- Analysis of Interview Data: Based on the responses of different stakeholders from the semi-structured interviews, the delay factors were tabulated corresponding to each activity in the schedule.
- Calculation of Road User Cost: This particular cost element was calculated for each work zone under study using the traffic volume count collected and IRC: SP 30 (2009) guidelines.
- Correlation: Using the interview inputs, delays arising from non-excusable factors were noted and correlated with the unit road user cost to get the accumulated road user cost at the zone.
- Stipulation of Innovative Contractual Clauses: Were coined after analysing the road user cost and delay factors. The quantum of damages associated with each clause were in direct correlation with the road user cost.

S.No.	Parameters	Case Study 1	Case Study 2	Case Study 3
1	Excusable delay factors	Utility diversion, work diversion due to priority changes, design changes.	None	Work diversion due to change in priority, design changes, absence of timely work clearance.
2	Non-excusable delay factors	Poor traffic management, insufficient logistics planning, delayed material delivery, lack of machinery, rework due to bad quality, labour shortage.	Lack of machinery, labour shortage, breakdown of launching gantry and failure of segment supply from casting yard.	Poor traffic management, insufficient logistics planning, untimely delivery of materials, rework due to bad quality, non- availability of machinery (crane), non-availability of formwork sets.
3	Innovative contractual clause Proposed	Lane Rental	A+B plus Incentives/Disincentives	Lane Rental

Table I - Outcomes of the three case studies.

Conclusion

The core idea of the thesis was to reduce the inconvenience faced by public arising from prolonged lane closure/congestion at metro rail construction work zones. The inconvenience was discovered to be a major monetary component called Road User Cost. Further reading helped form a four-point objective, namely:1)To identify the factors causing metro rail construction delay at work zones.2)To identify the non-excusable factors (contractor origin) responsible for the delay affecting traffic.3)To calculate the road user cost arising from the work zone closure by the contractor.4)To minimize the road user cost arising from the work zone closure through innovative contractual clauses that prevents delays.

In order to achieve these objectives, a case study approach was undertaken and three work zones were selected for study in Bengaluru Metro For each case study, three data elements were collected, firstly, the project schedules, to ascertain the quantum of time overrun. Secondly, semi structu1red interviews were conducted with the major stakeholders of the zone (client, consultant and various contractors) to identify major factors causing delay. Lastly, traffic volume count was done at the respective work zones to calculate the road user cost.The data analysis was a five step process, which started with analysis of project schedules. For each case study, different types of delays were analysed, like pre-construction delay, construction delay, intra-pier activity delay and overall activity delay. Next, the interview data was analysed. Based on the inputs given by the interviewees, it was observed that the no. of days delayed by non-excusable factors summarized. Excusable delay factors identified were utility diversion, scope change, drawing delay, approval delay and change of work priority. Non-excusable delay factors identified were poor traffic management planning, poor logistics management, shortage of machinery, material and labour. By identifying the quantum and factors of excusable and non-excusable delays, the first two objectives of the thesis were met. Next, value of time, vehicle operating cost and accident cost were calculated for all three work zones, together yielding the road user cost. After this, the quantum of non-excusable delays was correlated with the road user cost, yielding the monetary loss at each stretch. By calculating the road user cost at the respective work zones, the third objective of the thesis was met. In a quest to combat these high losses, special clauses were stipulated, which used the road user cost as a penalty component. These clauses are called Innovative contractual clauses. Lane Rental and Incentives/Disincentives Clauses were applied to the work zones. The former stipulated hour wise and area wise rentals at the work zones. The latter involved incentive and disincentive implications depending on fast completion or delayed completion of work. The main intention of these clauses was to push the contractor to plan better, work swiftly and vacate the zone early, thereby causing least inconvenience to the road user. By stipulating the above clauses, the final objective of the thesis was met.

References

[1]Agyekum-Mensah, G., & Knight, A. D. (2017). The professionals' perspective on the causes of project delay in the construction industry. Engineering, Construction and Architectural Management, 24(5), 828–841. https://doi.org/10.1108/ECAM-03-2016-0085

[2]Amoatey, C. T., & Ankrah, A. N. O. (2017). Exploring critical road project delay factors in Ghana. Journal of Facilities Management, 15(2), 110–127. https://doi.org/10.1108/JFM-09-2016-0036

[3]Arditi, D., Khisty, J., and Yasamis, F. (1997). "Incentive/disincentive provisions in highway contracts." J. Constr. Eng. Manage., 123(3), 302–307.

[4]Arditi, D. and Pattanakitchamroon, T. (2006), "Selecting a delay analysis method in resolving construction claims", International Journal of Project Management, Vol. 24 No. 2, pp. 145-155.

[5]Bagaya, O., & Song, J. (2016). Empirical study of factors influencing schedule delays of public construction projects in

Burkina Faso. Journal of Management in Engineering, 32(5). https://doi.org/10.1061/(ASCE)ME.1943-5479.0000443

[6]Bhutani, R., Ram, S., & Ravinder, K. (2016). Impact of Metro Rail Construction Work Zone on Traffic Environment. Transportation Research Procedia, 17(December 2014), 586–595. https://doi.org/10.1016/j.trpro.2016.11.113

[7]Colin, J. and Retik, A. (1997), "The applicability of project management software and advanced IT techniques in construction delays mitigation", International Journal of Project Management, Vol. 15 No. 2, pp.107-120.

[8]Daniels, G., Ellis, D., and Stockton, W. (1999). *Technique for manually estimating road user costs associated with construction projects*, Texas Transportation Institute, Texas A&M Univ., College Station, Tex.

[9]Gündüz, M., Nielsen, Y.,& Özdemir, M. (2013). Quantification of delay factors using the relative importance index method for construction projects in Turkey. Journal of Management in Engineering, 9364(1995)121:3(273)

[10]Herbsman, Z. J. (1995). A +B Bidding method-hidden success story for highway construction. Journal of Construction Engineering and Management, 121(4), 430– 437. https://doi.org/10.1061/(ASCE)0733-9364(1995)121:4(430)

[11]Herbsman, Z. J., Chen, W. T., & Epstein, W. C. (1995). Time is money: Innovative contracting methods in highway construction. Journal of Construction Engineering and Management, 121(3), 273–281. https://doi.org/10.1061/(ASCE)0733-

[12]Karthik, R. N. (2018). Problems involved in various stages of construction of metro rail in India and the judicial view of the problems. International Journal of Civil Engineering and Technology, 9(4), 128–1289.

[13]Karthik, R. N. (2018). Problems involved in various stages of construction of metro rail in India and the judicial view of the problems. International Journal of Civil Engineering and Technology, 9(4), 128–1289.

[14]Knight, A. and Ruddock, L. (2008), Advance Research Method in Built Environment, Wiley- Blackwell, Oxford.

[15]Kraiem, Z.M. and Diekmann, J.E. (1987), "Concurrent delays in construction projects", Journal of Construction Engineering and Management, Vol. 113 No. 4, pp. 591- 602.

[16]Majid, M.A. and McCaffer, R. (1998), "Factors of non-excusable delays that influence contractors' performance", Journal of Management in Engineering, Vol. 14 No. 3, pp. 42- 49.

[17]Mittal, Y. K., & Paul, V. K. (2018). Identification of Critical Factors for Delay in Metro Rail Projects in India. International Journal of Students' Research in Technology & Management, 6(1), 30–39. https://doi.org/10.18510/ijsrtm.2018.615

[18]Oyegoke, A. S.,& Al Kiyumi, N. (2017). The causes, impacts and mitigations of delay in megaprojects in the Sultanate of Oman. Journal of Financial Management of Property and Construction, 22(3), 286–302. https://doi.org/10.1108/JFMPC-11-2016-0052

[19]Rubin, A.R. (1983), Construction Claims: Analysis, Presentation,

Defense, Van Nostrand Reinhold, New York, NY.

[20]Sweis, G., Sweis, R., Hammad, A.A. and Shboul, A. (2008), "Delays in construction projects: the case of Jordan", International Journal of Project Management, Vol. 26 No. 6, pp. 665-674.

[21]Trauner, T.J. (2009), Construction Delays, 2nd ed., Elsevier Butherworth-Heinemann, Burlington.