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A SURVEY METHOD APPROACH TO IDENTIFY THE PROJECT MANAGEMENT CONTROLLABLE DELAY FACTORS: CASE OF MRTS PROJECTS

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ABSTRACT
Many new Metro rail transit system (MRTS) projects have been announced recently in India. In more than 20 cities new metro projects or extensions are in progress. Construction projects in India are suffering from delays as reported in various research articles. This paper identifies the factors of construction delays from the existing literature. A list of 31 delay factors predominant in mega constructions and large construction projects is identified upon expert opinion. A questionnaire survey has been conducted with 50 from the client side, 55 from consultants, and 46 from the contractor side working on MRTS projects. The listed 31 factors are analysed based on the manageable duration. The responses from industry professionals are analysed using Cronbach's alpha for reliability. One-way ANOVA is applied to test the variances in the perception of the client, contractor and consultant. The factors are also identified as manageable, partially manageable and unmanageable within the scope of construction management. Financial factors such as poor financial model, restructuring of finances and delay in legal compliances are identified as non-manageable factors within the scope of construction management.

Keywords: Construction Delays, MRTS, Relative Importance Index, Manageable factors.

1. INTRODUCTION
Construction projects are necessary for economic growth and to meet the population's requirements. The Urban population of India is expected to rise by 60% by the end of 2050. The rapidly growing need for the rising population has increased the demand for construction projects in India. A lot of investment has been made in the construction sector in India. New MRTS projects in more than 20 cities have been announced. The cities with existing MRTS are already undergoing extensions of new phases. These projects help in the betterment of the lives of people. Hence, delays can impact the lives of people directly and indirectly. There is a rapid need for the development of modes of public transport. A time-bound approach to meet the needs of the people is far more important The performance of the construction sector is important for the development of a nation. (Prasad et al., 2018). Construction performance is generally measured in terms of time, cost, and quality. Construction delays are a proven challenge for the industry and adversely impact the performance parameters of the projects. As per the Ministry of Statistics and Programme Implementation (MoSPI), Government of India annual report, 32 % of the projects are suffering from delays ranging from 1 to 341 months (MOSPI, 2022). A comprehensive literature is available on construction delays. Many researchers have identified the delay factors in different types of projects (Doloi et al., 2012; Kaming et al., 1997; Mittal & Paul, 2018; Mittal et al., 2020). The delay factors are classified based on the source of origin, stage of construction, and controllable and uncontrollable delays. Factors arising from external sources classified as uncontrollable include weather conditions, civil unrest, land acquisitions, natural calamities and government regulations. This study has excluded the factors from external sources and aims to identify and analyse the factors of delay pertaining to the MRTS projects within the scope of construction management.

2. LITERATURE REVIEW
A large volume of international research evidence exists relating to delays within the construction sector. Many researchers have investigated the reasons for delays and their classification including their sources.

Assaf & Al-Hejji, 2006 conducted a study to determine the causes of delay in construction projects in Saudi Arabia. The survey collected responses of 23 contractors, 19 consultants and 15 owners for 73 causes of delay.

The study identified delay in progress payments by owner, change orders by owner during construction, shortage of labor, ineffective planning & scheduling of the project by contractor and poor site management & supervision by contractor as the top causes influencing delays. The parameters chosen for the study are frequency and severity. The ranking was provided on the basis of severity and frequency separately. The spearman rank suggests the positive correlation among the responses of client, consultant and contractor.

Doloi et al., 2012 conducted a study on causes affecting delays in Indian construction projects. 45 attributes were selected for the study. The Relative Importance Index (RII) was calculated from the responses to rank the causes of delay. Further factor analysis of these 45 attributes was carried out and lack of commitment, inefficient site management, poor site coordination, improper planning, lack of clarity in project scope, lack of communication and substandard contract were found to be the most critical causes of delay. However, the sector of the study has not been specified.

Mehta et al. 2017 also identified cash flow, labour, improper planning, problems with equipments and material as the major delay factors in Indian construction industry. Cash flow related issues proved to be dominant in Indian conditions. The authors have conducted correlation analysis of the responses from the industry professionals and checked the variances in the responses from the client consultant and contractor. The study is restricted to the residential projects in India.

Prasad et al., 2018 identify the delay factor in different project type. The identified construction delay factors are financial related causes such as delay in settlement, contractor's financial difficulties, delay in payment were found to be the most critical causes of delay in all the type of projects. Land acquisitions and conflict with utilities are identified as major construction delay factor in transportation projects. The survey method is used to collect data on frequency and severity of delay factors. The projects are identified are based on the experience of the respondent.

Senouci et al., 2016 analysed the 30 megaprojects in India and concluded that transport projects are suffering from maximum number of delays. The factors may share some common characteristics but cannot be generalized. They have also identified the cost overrun correlation with delay. In most cases they have a positive correlation. They have concluded that projects with longer duration are more susceptible to variations and change which may leads to delay. The conclusions cannot be made specific due to low sample size.

Shah et al., 2019 studied delay factors in the slum projects in India. The financial reasons along with unclear project scope is identified as major delay factors in slum reconstruction in India. The data reliability is checked with the Cronbach alpha and factors are ranked on the basis of the Relative Importance Index (RII). The delay factors are identified on the basis of the stage of their occurrence. The study has concluded that the initial planning of the source of finances are important in projects to avoid delays. The extent of delays in various countries and identified factor are summarised in the Table I.

The construction industry is dynamic, complex in nature, and characterized by uncertainty. Construction projects comprise a large number of actors and differ in size, duration, objectives, and other dimensions (McCord, 2008). Each project is unique and no universal formula applies to all projects. Hence, the region, sector of the study, and finances are the important aspects of construction delay studies. Many researchers have identified the delay factors but very few have defined the sector of the study. The mitigation of these factors has always been a challenge for the construction managers. However, it is uncertain that which factors can be managed within the scope of construction management. This study aims to identify the factors which can be managed within the scope of project management.

Table I: Summary of literature review of construction delays in Developing economies

Country	Type of Project	Findings	Delay factors Identified	Sources
Saudi Arabia	Large Projects	70% of the large projects are 10% to 30% behind schedule	1. Lack of finance to complete the work by the client 2. Non-payment of contractor claim 3. Owners' interference 4. Replace key personnel 5. Negotiation by knowledgeable people 6. Delay in the settlement of contractor claims by the owner 7. Suspension of work by the owner 8. Delay in issuance of change orders by the owner	(Al-Kharashi & Skitmore, 2009)
Kuwait	Residential Buildings	Out of 450 buildings, 56% of projects experienced time overruns, 54% of the projects were delayed by four months or more,	1. Changes 2. Financial reasons 3. Weather 4. Lack of experience 5. Labour related issues 6. Material related issues 7. Equipment related issues	(Koushki et al., 2005)
Nigeria	Government projects	Nearly 70% of the projects in the Nigerian construction Industry suffer delays	1. Inadequate fund for the project 2. Inadequate planning of project before commencement 3. Inadequate tools and equipment Delay in delivery of materials 4. Design changes during project execution Subcontractor incompetency 5. Delay in response to decision taking 6. Incompleteness of technical documentation Variations 7. Labour dispute in form of strike or lock-out unexpected subsoil/ground condition Community issues	(Ameh & Osegbo, 2011)
Ghana	Government projects	49% of the projects studied were found behind schedule	1. Delay in honoring payment certificates Underestimation of cost of projects 2. Underestimation of complexity of projects Difficulty in accessing Bank credit Poor supervision 3. Underestimation of time for completion by contractors 4. Shortage of materials 5. Poor Professional Management Fluctuation of prices Poor Site management Construction methods 6. Delay in instructions from consultants' Late deliveries of materials	(Fugar & Agyakwah-Baah, 1970)

Qatar	Government Projects	54% cost overrun and a 72%-time delay observed in public projects. 50% delays in the maintenance projects	1. Delay in payment 2. Changes and variations 3. Government approvals 4. Delay in procurement 5. Labour related 6. Material related 7. Equipment related	(Senouci et al., 2016)

3. RESEARCH METHODOLOGY

A questionnaire survey is conducted to gather information from the client, owner, and consultants involved in the metro projects. A list of 49 factors of delay has been identified from the literature review. This questionnaire was sent to five experts for an initial review. Upon experts' review and recommendations, Similar factors and irrelevant factors related to metro projects have been removed and some of the questions were revised/reframed. The delay factors due to uncontrollable reasons and external sources were eliminated from the study.

The first sections briefly describe the purpose and scope of the study and collect the personal information of the respondents such as name experience designation, experience with labor and role as client consultant or contractor, and duration of the project. The next section aims to identify whether the delay factor is manageable within the scope of project management and how fast a delay factor can be managed. A scale is provided with six options, options 1 to 6 indicate the scale of manageable duration, where 1 is for extremely fast and 5 is for very slow whereas the 6th option is for unmanageable delay factors. The delay factors are classified into manageable, partially manageable and unmanageable delay factors within the scope of project management.

The collected qualitative data is checked for reliability using Cronbach alpha. One-way Anova is applied to check for the variances among the group of respondents. Content analysis of frequencies is conducted to classify the delay factors into manageable, partially manageable and unmanageable. The criterion for the classification of delay factors is listed in the Table II.

Table: II Criterion of classification of delay factors

Weights	Frequency	Classification
[1,2]	If response cases in [1,2] > 50%.	Manageable
[3,4]	If response cases in [1,2] < 50%, OR response cases in [5,6] < 50% OR If response cases in [3,4] > 50%.	Partially Manageable
[5,6]	If response cases in [5,6] > 50%.	Not manageable

4. DATA COLLECTION AND ANALYSIS

The survey aimed on obtaining data from the experts engaged in MRTS projects from client consultant and contractor side. More than 75% of the responses received have 5 or more years of experience. The survey yielded the 50 responses from the client side, 55 from consultants, and 46 from the contractor side working on MRTS projects. The designated project managers, section engineer, structural designers, site engineers' others involved in management were among the respondents. The stratification and summary of respondents are as shown in Table III.

Table III. Respondent Profile

Role		
	Frequency	**Percentage**
Client	50	33.1
Consultant	55	36.4

Contractor	46	30.1
Experience		
Under 5	35	23.2
5 -10 years	42	27.8
10- 15 years	42	27.8
More than 15 Years	32	21.2

The reliability of the data collected using the reliability analysis. The reliability test uses the Cronbach's alpha value. On the off chance, if the acquired value of the Cronbach's alpha, for the data is under 0.3, the information isn't appropriate for further investigation, the information is considered for further examination, just if the value of Cronbach's alpha is more than 0.7 which infers that the data are having a high level of reliability. The obtained Cronbach alpha value is .947 which shows the data is reliable and suitable for further examination.

Table IV: Cronbach alpha reliability

	No. of samples	**Value of alpha**
Manageable Duration	151	0.947

The One-way Anova is performed to check the variance in responses among the groups of respondents. In some cases, there is a level of disagreement in client, consultants and contractors which can be clearly observed in the Table V. The Anova significance value below .05 represents the significant differences in means of the responses.

Table V: Classification of delay factors with Anova Significance (95% confidence level)

	Manageable	**Partially Manageable**	**Not Manageable**	**Mean**	**Anova Significance**
Shortage of labour	√			2.94	0.002
Unavailability of skilled Labour for high precision works		√		3.75	0.011
Shortage of basic amenities for labour	√			3.05	0.021
Change in staff		√		3.07	0.016
Work halt due to accidents		√		3.46	0.009
Equipment breakdown	√			2.93	0.000
Unavailability of Specialized equipment		√		3.84	0.023
Shortage of equipments/consumables	√			3.13	0.000
Maintenance of the specialized equipment	√			3.25	0.000
Lack of space for Installation of specialized machinery/equipments		√		3.22	0.102
Transport issues in congestion hours	√			2.82	0.005
Lack of adequate space for storing materials on site	√			2.85	0.002
Inaccurate estimation of materials		√		3.19	0.012
Shortage of construction material	√			3.04	0.002
Delay in material supply	√			3.10	0.000
Ambiguity in specifications in drawings	√			2.99	0.012
Delayed coordination among the teams of the project	√			2.85	0.014

Delay in getting approvals		√		3.30	0.437
Clash within building elements		√		3.30	0.119
Rework due to mistakes		√		3.26	0.036
Design errors		√		3.32	0.892
Change in scope of work by client		√		3.50	0.193
Delay in clash resolution due to change		√		3.46	0.448
Delay in payments		√		3.67	0.774
Financial restructuring for the work related to scope change			√	3.79	0.025
Under estimation of the cost of work		√		3.60	0.225
Poor financial model specific to project			√	4.64	0.229
Delay due to poor project control		√		3.36	0.370
Delay due to improper planning of resources during execution		√		3.44	0.188
Improper construction method		√		3.42	0.052
Delay in legal compliances			√	4.70	0.301

5. RESULTS AND DISCUSSIONS

The results indicate that financial related delay factors are major concerns in MRTS projects. Financial restructuring during project and poor finances are not manageable within the scope of project management. However, Delay in payments can be partially managed by the project managers. In MRTS projects, Governments as well as private owners implementing large projects are delaying payments and in the challenge of managing stressed cash flow, due to delay in payments from the government end, contractors are forced to delay payments to vendors which can even further cause delay in material supply or shortage of construction material at site. This may even sometimes lead to clashes among parties which is also a delay factor. Underestimation of cost of work can also disturb the finances of contractor which can be partially managed within project management scope

Labour related factors are also identified as the delay factors. MRTS projects require skilled labour for high precision works with expertise in various disciplines to ensure the successful completion of the work. The unavailability of skilled labor is another major delay factors in MRTS projects. There are several activities like handling of specialized equipments, maintenance of equipments, and various construction activities which can be done by skilled labour only. The resources planning is always important for a project perspective and hence identified as important factor in construction delay which is partially manageable. Delay due to accidents can be avoided by maintaining safety protocols at site. In MRTS projects, section engineers have the responsibility to ensure safety measures and is categorised as partially manageable.

Heavy equipments and machinery are necessary component of MRTS projects. The section engineers have to pre-book the specialized equipment for construction activity. Most of the times only single equipment is available for a 3 kms stretch and similar activity is going on multiple places. In these situations, Shortage and unavailability of equipments can halt the work progress. Better resource scheduling can prevent such delays and can be partially managed.

Inadequate project control can result in delays in critical activities, such as procurement, approvals, design reviews, and construction progress. This can disrupt the overall Project duration, causing delays in the completion of the MRTS projects. Successful completion of a building project requires close coordination and cooperation between the client consultant and contractor. Lack of clarity may lead to reworks and change in scope which are predominantly delay cause in MRTS projects. This may lead to clashes which can halt the work.

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