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Ranking of Delay factors in Road Construction Project due to Improper Construction Equipment Management

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Abstract: ***Construction time overrun is considered one of the most appearing problems in construction industry. In Road construction, Equipment plays a major role, Hence there is a need for control of delay in road construction projects. This paper aims to identify the equipment delay causes in road construction projects and ranks the critical factors. The equipment delay causes were identified through pilot study and literature papers. The pilot study was done by interviewing 20 experts and the questionnaire were designed. Totally 19 causes were identified and categorized into four main groups namely 1.Maintenance related causes, 2.Equipment related causes, 3.Financial related causes and 4.Personnel related causes. The questionnaire survey received 180 responses on the opinion of Contractor, Equipment dealer, Equipment operator, Site engineer, Project manager and others. The results were analysed using Relative Important Index (RII), Ranking the equipment delay causes identifies the most risky equipment delay factors in road construction project. The most five risky factors are Lack of spare parts, Over usage of equipment leads to crashing, Inadequate equipment, Non allocation of fuel purchase staff and Inexpert or unpractised equipment operator.***

Keywords: ***Delay factors, Equipment delay causes, Relative Important Index (RII), Road construction.***

I. INTRODUCTION

The construction industry is the one main sector, which provides an important component for development of economy. One of the major problems facing in construction industry is project delay[1]. Almost every construction project has to face delays in its execution for many reasons and causes, with consequences different from one project to another project depending on the management, technical knowledge, and skills in anticipating and managing delays[2].

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Time is money and time is an integral part of every construction plan and can affect the whole construction project. The time allowed for construction performance is an important consideration for both the project owner and project manager[3].

Project delay, which means non-completion of project within the specified duration, agreed under a contract[4]. Construction project schedule plays a major role in managing a project due to its impact on project outcome. Delay in construction project causes loss to the project organization[5]. Construction project delay has been a research topic for decades and several studies have investigated causes of delay in many countries based upon the requirement of region[6]. Delay of project affect the economical in construction industry, hence it must be identified and the causes should be addressed to overcome the time overrun.

Equipment usage and innovative methods in equipment makes the entire impossible task as possible hence, construction industry requires the mechanization of work. Equipment factor is one of the major time overrun cause in road construction projects. Delay through equipment, which is due to equipment's fault, maintenance, over usage of equipment etc., equipment associated delays can be corrected through repairing or arranging of alternative equipment's, so this will extend the time of projects. The equipment-associated delay can be controlled by identifying the causes and by taking preventive measures.

The advancement of road construction equipment is increased in construction industry for past decades; hence the management of equipment is important for any road construction project. In concentrating road construction project development in India to support its economic improvement, there is need to figure out the management of road construction project to enable better and more efficient performance , so that the project can be completed within the time limit and organization finance structure can be maintained.

II. LITERATURE SURVEY

Remon et al [4] this paper have listed out 293 delay causes through personal interview and questionnaire survey was conducted to consultants, contractors, site/design engineers and owner in road projects. Analysis is carried out with Relative Important Index (RII).

From analysis, the causes and groups of delays are discussed. Suggestion and recommendations are provided in order to overcome the delay causes in road construction projects.

Aziz [5] He have identified 99 factors on 9 major categories, the survey were conducted with experts and from public, private and local general construction firms. Ranking the factors representing the important factor by Relative Important Index (RII) and he discussed the most contributing factors, recommendation were provided to control delay in construction industry.

Senouci et al [7] this paper investigates on delay and cost overrun in Qatari public construction projects. They have collected the data from road, building and drainage projects, analysis carried out with ANOVA and regression methods. They have discussed the data collection on cost overrun and delay in construction projects and developing the regression models.

Djoen et al [2] this paper have analyzed the causes of delay and effects on project time, cost and quality in road construction projects in Cambodia. Questionnaire survey is conducted to engineers from contractor and consultant in assessing the frequency and severity of delay, so they can compute the important index. He had made a domination between the contractor and project and recommendations are presented to manage delay. The domination of factors provide a significant relationship between the factors and projects.

Tsegay et al [8] this paper investigates the causes and effects of delay in Ethiopian construction projects, they have identified 52 causes and 5 effects of delay from 77 respondents. Analysis through Relative Important Index and correlation coefficient, the analysis is done with relation in construction process and those factors were discussed.

Ibrahim et al [9] this paper conducted an investigation the time performance of road construction projects in the West Bank in Palestine to identify the causes of delay and their severity according to contractors and consultants through a questionnaire survey. He have 52 causes of delay from 34 contactors and 30 consultants. The top 5 severe delay causes are identified and discussed.

Pablo et al [10] this paper have examined on qualitative and quantitative dimensions of delay issues. They have two indicators as a time performance, describes the impact of delay on critical and non-critical activities, and have discussed the projects on time performance.

Murat et al [11] this paper have identified 83 delay factors and categorized into nine groups and ranking the factors through Relative Important Index (RII).the causes of delay were discussed and some recommendations are provided to minimize the delays.

Abd El-Razek et al [12] the causes are identified from the view of contractors, consultants, and owners. They have identified some list of causes for quantitative confirmation and identification of important causes of delay. Their analysis suggest to reduce the delay and causes were discussed on basis of type and size of project.

Murali et al [13] this paper involves an integrated approach and analyzes the impact of causes on effects. The questionnaire survey was conducted from clients, consultants and contractors, totally 150 respondents, identified 10 causes of delay from 28 different causes and six different effects of delay, and cause were discussed. They have provided relationship between the causes and effect of delay.

Sadi et al [14] this paper have identified the causes of delay on different types of construction projects in Saudi Arabia. 73 causes were identified from owner, consultant and contractor. From the contractor and consultant they have indicated the average time overrun s between 10% and 30%.

Hemnata et al [15] they have identified the factors impacting delay and establishing a relationship between the critical attributes for assessing the factors on delay. The significance of delay factors are examined with factor analysis and regression method. This finding provides a control on time overrun in Indian construction industry.

Mohamed et al [16] this paper have listed out the causes from literature, questionnaire survey is conducted from experts i.e. owners, consultants and contractors. The top ten causes were determine from Frequency Index, Severity Index, and Importance Index. Analysis is carried out by ANOVA method to test delay causes. The test provides a correlation between groups.

Abdalla et al [17] this paper have identified the most important causes of delay in construction projects with traditional contracts from contractors and consultants. The results from survey were discussed and gives a guide to improve performance of construction industry.

Yue choong kog [18] He have identified the top delay factors from the construction projects in Portugal, UK and US. 33 factors are identified, from that top 10 delay causes were discussed. He have presented the preventive measures for major causes in delay to improve schedule performance in construction projects in Portugal, UK and US.

Identification and categorization of equipment delay causes in road construction project are combined of existing literature are as follows, **1. Maintenance related causes** were identified as first group of equipment delay causes in road construction projects. Various studies have identified Maintenance related factor that causes delay [3],[4],[11],[14],[16]. Based on the studies, the researchers identified 5 causes of Maintenance related causes; **2. Equipment related causes**, were identified as second group of equipment delay causes in road construction projects. Various studies have identified Equipment related factor that causes delay[4],[5],[8],[13],[15],[19]. Based on the studies, the researchers identified 6 causes of Equipment related causes; **3. Financial related causes** were identified as third group of equipment delay causes in road construction projects. Various studies have identified Financial related factor that causes delay[3],[4],[17]. Based on the studies, the researchers identified 3 causes of Financial related causes; **4. Personnel related causes** were identified as fourth group of equipment delay causes in road construction projects. Various studies have identified Personnel related factor that causes delay. Based on the studies, the researchers identified 4 causes of Personnel related causes[15],[16][12].

The summary of literature review synthesizes the causes and effects of delay in construction project to reduce the time and cost overrun in construction project. In literatures, the causes of delay are identified through interviews or by background study and questionnaire is designed. After data collection, comparison of factors of delay in construction project is prepared through questionnaire survey and analysis is carried out by many statistical tools such as Relative Important Index(RII), Anova, Spearman's correlation coefficient, Regression modelling, importance index, frequency index, severity index, etc. Suggestion and recommendations are given for each and every causes of delay to minimize the construction delay. The results are based on comparative study or ranking position or showing the significant difference between the factors.

III. METHODOLOGY

The equipment causes of delay in road construction project were identified through pilot study and background study. Pilot study was done by conducting interviews from 20 construction experts. The Questionnaire was designed with reference to the identified factors. Questionnaire survey was conducted from 180 employees on the perceptive view of contractor, equipment dealer, equipment operator, site engineer, project manager and other. Analysis of causes of equipment delay using Relative important index (RII). The most risky equipment delay causes were identified to minimize the construction equipment delay in road construction projects.

IV. DATA COLLECTION

Questionnaire design is framed with reference of journals and pilot study. The questionnaire design is categorised into 4 main groups namely Maintenance related causes, Equipment related causes, Financial related causes and Personnel related causes and under each main groups, there are some causes i.e.[19]

1. Maintenance related causes

- Enhancement of maintenance system
- Non execution of systematic methods for maintenance work
- Inadequate everyday maintenance by operator
- Arrangement of personnel for maintenance management
- Precautionary maintenance

2. Equipment related causes

- Overhauling the equipment fault
- Low capacity of equipment
- Over usage of equipment leads to crashing
- Due to unfavourable climatic condition
- Outdated equipment
- Inadequate equipment
- Continuous performance of equipment causing jamming

3. Financial related causes

- Payments for inspection
- Idleness of equipment caused by purchasing of spare parts from other countries
- Lack of spare parts

4. Personnel related causes

- Lethargic scheduling of greasing and cleaning
- Non allocation of fuel purchase staff
- Inexpert or unpractised equipment operator
- Requirement of expert controller for a particular equipment

The questionnaire survey was carried out using google forms. Questionnaires were mailed to the respondents (Contractor, Equipment dealer, Equipment operator, Site engineer, Project manager and Others) and requested to give their own perceptive on the equipment delay causes. The completed questionnaire are mailed back to the researchers. The data were collected from 180 respondents.

V. RESULT AND DISCUSSION

The result is divided into 6 ranking lists namely Overall Relative Important Index (ORII), ranking through Category of Organization, Time overrun percentage, Experience in years and Categories of respondents.

Relative Important index (RII) is used to determine the relative important of the various causes of delay[20]. This method is adopted in this study to rank the causes of delay. The five point Likert scale is adopted and transferred as RII. RII for each factor is

$$RII = \frac{\sum W}{A \times N}$$

Where, W is the weightage given to each factor by respondents (i.e. 4 to 0), A is the highest weight (i.e. 4 in the case), N is the total number of respondents. The highest value of relative important index shows the most risky causes of delay in that construction project.

A. Overall Relative Important Index (ORII)

Table I shows the Overall Relative Important Index with main causes and the sub causes of delay. The RII is calculated for every causes to identify the significant cause. This ranking is made for overall respondents, the total number of respondents is 180 samples, i.e. N is 180 in Overall Relative Important Index.

Table I Overall Relative Important Index

Overall RII			
Factors		***ORII***	***Rank***
1.	**Maintenance related causes**		
(i)	Enhancement of maintenance system	0.343	13
(ii)	Non execution of systematic methods for maintenance work	0.339	14
(iii)	Inadequate everyday maintenance by operator	0.397	4
(iv)	Arrangement of personnel for maintenance management	0.293	18
(v)	Precautionary maintenance	0.392	5
2.	**Equipment related causes**		
(i)	Overhauling the equipment fault	0.371	8
(ii)	Low capacity of equipment	0.360	10
(iii)	Over usage of equipment leads to crashing	0.371	8
(vii)	Due to unfavourable climatic condition	0.331	16
(iv)	Outdated equipment	0.263	19
(v)	Inadequate equipment	0.403	2
(vi)	Continuous performance of equipment causing jamming	0.375	6
3.	**Financial related causes**		
(i)	Payments for inspection	0.353	12
(ii)	Idleness of equipment caused by purchasing of spare parts from other countries	0.331	16
(iii)	Lack of spare parts	0.400	3
4.	**Personnel related causes**		
(i)	Lethargic scheduling of greasing and cleaning	0.354	11
(ii)	Non allocation of fuel purchase staff	0.435	1
(iii)	Inexpert or unpractised equipment operator	0.372	7
(iv)	Requirement of expert controller for a particular equipment	0.338	15

The highest value of ORII is 0.435 (i.e. Non allocation of fuel purchase staff which comes under Personnel related causes). The least value of ORII is 0.263 (i.e. Outdated equipment which comes under Equipment related causes). Among the 19 causes of delay, the most five risky causes are Non allocation of fuel purchase staff (0.435), Inadequate equipment (0.403), Lack of spare parts (0.400), Inadequate everyday maintenance by operator (0.397), Precautionary maintenance (0.392).

B. Category of organization

Table II represents the Category of Organization; it is classified into three organization such as Individual, Private and Government. The main causes and sub causes are same for Individual, Private and Government, the number of respondents will be differing from each organization. In Individual organization the total number of respondents is (N = 103), Private organization is (N = 76), Government organization is (N = 1).

Table II Category of organization

Category of organization							
Factors		***Individual***		***Private***		***Government***	
		RII	***Rank***	***RII***	***Rank***	***RII***	***Rank***
1.	**Maintenance related causes**						
(i)	Enhancement of maintenance system	0.313	14	0.382	10	0.5	7
(ii)	Non execution of systematic methods for maintenance work	0.313	14	0.378	13	0	18
(iii)	Inadequate everyday maintenance by operator	0.352	7	0.454	3	0.75	5
(iv)	Arrangement of personnel for maintenance management	0.313	14	0.266	17	0.25	16
(v)	Precautionary maintenance	0.345	8	0.457	2	0.25	16
2.	**Equipment related causes**						
(i)	Overhauling the equipment fault	0.362	6	0.382	10	0.5	7

(ii)	Low capacity of equipment	0.325	12	0.405	8	0.5	7
(iii)	Over usage of equipment leads to crashing	0.333	11	0.414	5	1	1
(vii)	Due to unfavourable climatic condition	0.396	2	0.240	18	0.5	7
(iv)	Outdated equipment	0.274	19	0.237	19	1	1
(v)	Inadequate equipment	0.388	3	0.414	5	1	1
(vi)	Continuous performance of equipment causing jamming	0.379	4	0.368	15	0.5	7
3.	**Financial related causes**						
(i)	Payments for inspection	0.325	12	0.388	9	0.5	7
(ii)	Idleness of equipment caused by purchasing of spare parts from other countries	0.291	18	0.382	10	0.5	7
(iii)	Lack of spare parts	0.340	9	0.480	1	0.5	7
4.	**Personnel related causes**						
(i)	Lethargic scheduling of greasing and cleaning	0.313	14	0.408	7	0.5	7
(ii)	Non allocation of fuel purchase staff	0.430	1	0.447	4	0	18
(iii)	Inexpert or unpractised equipment operator	0.367	5	0.372	14	1	1
(iv)	Requirement of expert controller for a particular equipment	0.335	10	0.336	16	0.75	5

The highest value of RII in Individual is 0.430 (i.e. Non allocation of fuel purchase staff which comes under Personnel related causes), Private is 0.480 (i.e. Lack of spare parts which comes under Financial related causes) and Government is 1 (i.e. Inexpert or unpractised equipment operator which comes under Personnel related causes, Outdated equipment, Inadequate equipment and Over usage of equipment leads to crashing which comes under equipment related causes).

The least value of RII in Individual is 0.274 (i.e. Outdated equipment which comes under Equipment related causes), Private is 0.237(i.e. Outdated equipment which comes under Equipment related causes) and Government is 0 (i.e. Non execution of systematic methods for maintenance work which comes under Maintenance related cause and Non allocation of fuel purchase staff which comes under Personnel related causes).

Among the three organisation with respect to 19 causes, Government has the highest RII value in Inexpert or unpractised equipment operator which comes, Outdated equipment, Inadequate equipment and Over usage of equipment leads to crashing (under Personnel related causes and equipment related causes). In addition, Individual and private are in 5 and 14 position in Inexpert or unpractised equipment operator, because operators not provided with some training program in operating an equipment

C. Time over run %

Table III shows the Time over run %, the Time over run percentage is split into (0-5)%, (6-10)%, (11-15)%, (16-20)%, and above 20%. The number of respondents on (0-5) % is 73, (6-10)% is 38, (11-15)% is 30, (16-20)% is 20 and above 20% is 19

Table III Time over run %

Time over run %											
Factors		***(0-5)%***		***(6-10)%***		***(11-15)%***		***(16-20)%***		***(above 20)%***	
		RII	***Rank***	***RII***	***Rank***	***RII***	***Rank***	***RII***	***Rank***	***RII***	***Rank***
1.	**Maintenance related causes**										
(i)	Enhancement of maintenance system	0.363	15	0.329	8	0.217	18	0.413	4	0.421	8
(ii)	Non execution of systematic methods for maintenance work	0.356	16	0.349	5	0.258	13	0.363	10	0.355	12
(iii)	Inadequate everyday maintenance by operator	0.462	1	0.289	11	0.292	11	0.400	7	0.526	1
(iv)	Arrangement of personnel for maintenance management	0.394	10	0.237	18	0.242	16	0.238	19	0.158	18
(v)	Precautionary maintenance	0.435	4	0.276	15	0.433	2	0.300	16	0.487	4
2.	**Equipment related causes**										
(i)	Overhauling the equipment fault	0.438	3	0.283	12	0.250	15	0.400	7	0.447	6
(ii)	Low capacity of equipment	0.373	12	0.263	16	0.342	9	0.450	2	0.434	7

(iii)	Over usage of equipment leads to crashing	0.432	5	0.434	1	0.258	13	0.375	9	0.184	17
(vii)	Due to unfavourable climatic condition	0.418	7	0.224	19	0.392	6	0.250	18	0.197	16
(iv)	Outdated equipment	0.322	19	0.257	17	0.167	19	0.313	15	0.145	19
(v)	Inadequate equipment	0.397	9	0.336	6	0.417	3	0.425	3	0.513	3
(vi)	Continuous performance of equipment causing jamming	0.394	10	0.336	6	0.417	3	0.363	10	0.329	13
3.	**Financial related causes**										
(i)	Payments for inspection	0.418	7	0.283	12	0.275	12	0.338	13	0.382	10
(ii)	Idleness of equipment caused by purchasing of spare parts from other countries	0.329	18	0.283	12	0.350	8	0.363	10	0.368	11
(iii)	Lack of spare parts	0.370	14	0.375	3	0.417	3	0.413	4	0.526	1
4.	**Personnel related causes**										
(i)	Lethargic scheduling of greasing and cleaning	0.353	17	0.329	8	0.233	17	0.475	1	0.474	5
(ii)	Non allocation of fuel purchase staff	0.455	2	0.414	2	0.450	1	0.413	4	0.395	9
(iii)	Inexpert or unpractised equipment operator	0.425	6	0.355	4	0.375	7	0.300	16	0.276	14
(iv)	Requirement of expert controller for a particular equipment	0.373	12	0.316	10	0.325	10	0.338	13	0.263	15

The highest value of RII in (0-5)% is 0.462 (i.e. Inadequate everyday maintenance by operator which comes under Maintenance related causes), (6-10)% is 0.434 (i.e. Over usage of equipment leads to crashing which comes under Equipment related causes),(11-15)% is 0.450 (i.e. Non allocation of fuel purchase staff which comes under Financial related causes), (16-20)% is 0.475 (i.e. Lethargic scheduling of greasing and cleaning which comes under Personnel related causes) and above 20% is 0.526 (i.e. Inadequate everyday maintenance by operator which comes under Maintenance related causes and Lack of spare parts which comes under Financial related causes)

The least value of RII in (0-5)% is 0.322 (i.e. Outdated equipment which comes under Equipment related causes), (6-10)% is 0.224 (i.e. Due to unfavourable climatic condition which comes under Equipment related causes),(11-15)% is 0.167 (i.e. Outdated equipment which comes under Equipment related causes), (16-20)% is 0.238 (i.e. Arrangement of personnel for maintenance management which comes under Maintenance related causes) and above 20 % is 0.145 (i.e. Outdated equipment which comes under Equipment related causes).

Among those Time over run percentages with respect to 19 causes, Above 20% has the highest RII value in Inadequate everyday maintenance by operator and Lack of spare parts (under Maintenance related causes and Financial related causes). In addition, (0-5)%, (6-10)%, (11-15)%, (16-20)% are in 1st, 11th, 11th, 7th position in Inadequate everyday maintenance by operator and 14th, 3rd, 3rd, 4th position in Lack of spare parts, because importing of spare parts from other countries consumes more time in a project and lack of everyday maintenance, causes equipment's breakdown or equipment repair which takes more % of delay in a road construction projects.

D. Experience in years

Table IV shows the Experience in years, the Experience in years is split into (0-5)%, (6-10)%, (11-15)%, (16-20)%, and above 20%. The number of respondents on (0-5) % is 69, (6-10)% is 50, (11-15)% is 27, (16-20)% is 20 and above 20% is 14.

Table IV Experience in years

Experience in years											
Factors		***(0-5)%***		***(6-10)%***		***(11-15)%***		***(16-20)%***		***(above 20)%***	
		RII	***Rank***	***RII***	***Rank***	***RII***	***Rank***	***RII***	***Rank***	***RII***	***Rank***
1.	**Maintenance related causes**										
(i)	Enhancement of maintenance system	0.312	17	0.350	10	0.324	13	0.450	6	0.357	9
(ii)	Non execution of systematic methods for maintenance work	0.355	11	0.385	4	0.278	16	0.238	18	0.357	9

(iii)	Inadequate everyday maintenance by operator	0.370	7	0.390	3	0.389	4	0.488	2	0.446	2
(iv)	Arrangement of personnel for maintenance management	0.308	18	0.300	18	0.259	18	0.288	16	0.268	16
(v)	Precautionary maintenance	0.362	9	0.325	13	0.380	6	0.438	7	0.732	1
2.	**Equipment related causes**										
(i)	Overhauling the equipment fault	0.341	15	0.365	8	0.352	10	0.475	3	0.429	3
(ii)	Low capacity of equipment	0.351	13	0.340	11	0.343	12	0.425	8	0.411	4
(iii)	Over usage of equipment leads to crashing	0.435	1	0.380	6	0.269	17	0.313	14	0.304	12
(vii)	Due to unfavourable climatic condition	0.370	7	0.310	16	0.324	13	0.275	17	0.304	12
(iv)	Outdated equipment	0.279	19	0.290	19	0.250	19	0.175	19	0.232	19
(v)	Inadequate equipment	0.399	4	0.385	4	0.444	1	0.475	3	0.304	12
(vi)	Continuous performance of equipment causing jamming	0.380	6	0.375	7	0.435	2	0.350	12	0.268	16
3.	**Financial related causes**										
(i)	Payments for inspection	0.355	11	0.305	17	0.389	4	0.400	9	0.375	6
(ii)	Idleness of equipment caused by purchasing of spare parts from other countries	0.351	13	0.320	14	0.306	15	0.375	11	0.250	18
(iii)	Lack of spare parts	0.395	5	0.400	2	0.361	7	0.475	3	0.393	5
4.	**Personnel related causes**										
(i)	Lethargic scheduling of greasing and cleaning	0.326	16	0.365	8	0.361	7	0.400	9	0.375	6
(ii)	Non allocation of fuel purchase staff	0.428	2	0.440	1	0.417	3	0.513	1	0.375	6
(iii)	Inexpert or unpractised equipment operator	0.424	3	0.340	11	0.361	7	0.338	13	0.304	12
(iv)	Requirement of expert controller for a particular equipment	0.359	10	0.320	14	0.352	10	0.300	15	0.321	11

The highest value of RII in (0-5)% is 0.435 (i.e. Over usage of equipment leads to crashing which comes under Equipment related causes), (6-10)% is 0.417 (i.e. Non allocation of fuel purchase staff which comes under Personnel related causes),(11-15)% is 0.444 (i.e. Inadequate equipment which comes under Equipment related causes), (16-20)% is 0.513 (i.e. Inexpert or unpractised equipment operator which comes under Personnel related causes) and above 20% is 0.732 (i.e. Precautionary maintenance which comes under Maintenance related causes).

The least value of RII in (0-5)% is 0.279 (i.e. Outdated equipment which comes under Equipment related causes), (6-10)% is 0.290 (i.e. Outdated equipment which comes under Equipment related causes),(11-15)% is 0.250 (i.e. Outdated equipment which comes under Equipment related causes), (16-20)% is 0.175 (i.e. Outdated equipment which comes under Equipment related causes) and above 20 % is 0.232 (i.e. Outdated equipment which comes under Equipment related causes).

Among those Experience in years with respect to 19 causes, Above 20% has the highest RII value in Precautionary maintenance (under Maintenance related causes). In addition, (0-5)%, (6-10)%, (11-15)%, (16-20)% are in 9th, 13th, 6th, 7th position in Precautionary maintenance, because Precautionary maintenance will avoid equipment failure, equipment repairing consumes more% of delay in road construction projects.

E. Categories of respondents

Table V shows the Categories of respondents, Categories of respondents such as Contractor, Equipment dealer, Equipment operator, Site engineer, Project manager and others. The number of respondents on Contractor is 21, Equipment dealer is 2, Equipment operator is 7, Site engineer is 82, Project manager is 32 and Others is 36.

Table V Categories of respondents

Categories of respondents													
Factors		*Contractor*		*Equipment dealer*		*Equipment operator*		*Site engineer*		*Project Manager*		*Others*	
		RII	*Rank*	*RII*	*Rank*	*RII*	*Rank*	*RII*	*Rank*	*RII*	*Rank*	*RII*	*Rank*
1.	**Maintenance related causes**												
(i)	Enhancement of maintenance system	0.571	2	0.375	6	0.214	10	0.313	17	0.258	19	0.368	12
(ii)	Non execution of systematic methods for maintenance work	0.298	15	0.250	12	0.179	11	0.363	7	0.305	14	0.396	7
(iii)	Inadequate everyday maintenance by operator	0.548	7	0.125	16	0.143	15	0.394	2	0.352	8	0.431	5
(iv)	Arrangement of personnel for maintenance management	0.238	18	0.250	12	0.036	18	0.294	18	0.320	11	0.361	15
(v)	Precautionary maintenance	0.560	4	0.125	16	0.107	17	0.363	7	0.359	7	0.479	2
2.	**Equipment related causes**												
(i)	Overhauling the equipment fault	0.536	8	0.250	12	0.179	11	0.319	15	0.398	2	0.389	8
(ii)	Low capacity of equipment	0.583	1	0.375	6	0.250	8	0.325	14	0.320	11	0.368	12
(iii)	Over usage of equipment leads to crashing	0.250	17	0.125	16	0.179	11	0.372	4	0.375	4	0.486	1
(vii)	Due to unfavourable climatic condition	0.298	15	0.500	3	0.571	1	0.319	15	0.305	14	0.347	16
(iv)	Outdated equipment	0.190	19	0.250	12	0.286	6	0.278	19	0.273	18	0.257	19
(v)	Inadequate equipment	0.560	4	0.500	3	0.571	1	0.369	5	0.352	8	0.389	8
(vi)	Continuous performance of equipment causing jamming	0.345	12	0.750	1	0.464	3	0.363	7	0.320	11	0.417	6
3.	**Financial related causes**												
(i)	Payments for inspection	0.476	11	0.375	6	0.179	11	0.331	12	0.367	6	0.347	16
(ii)	Idleness of equipment caused by purchasing of spare parts from other countries	0.488	10	0.375	6	0.250	8	0.328	13	0.297	17	0.306	18
(iii)	Lack of spare parts	0.560	4	0.375	6	0.321	5	0.378	3	0.422	1	0.368	12
4.	**Personnel related causes**												
(i)	Lethargic scheduling of greasing and cleaning	0.500	9	0.125	16	0.036	18	0.334	10	0.375	4	0.375	11
(ii)	Non allocation of fuel purchase staff	0.571	2	0.500	3	0.464	3	0.403	1	0.398	2	0.451	4
(iii)	Inexpert or unpractised equipment operator	0.321	14	0.625	2	0.286	6	0.366	6	0.305	14	0.458	3
(iv)	Requirement of expert controller for a particular equipment	0.345	12	0.375	6	0.143	15	0.334	10	0.328	10	0.382	10

The highest value of RII in Contractor is 0.583 (i.e. Low capacity of equipment which comes under Equipment related causes), Equipment dealer is 0.750 (i.e. Continuous performance of equipment causing jamming which comes under Equipment related causes), Equipment operator is 0.571 (i.e. Due to unfavourable climatic condition and Inadequate equipment which comes under Equipment related causes), Site engineer is 0.403 (i.e. Non allocation of fuel purchase staff which comes under Personnel related causes), Project manager is 0.422 (i.e. Lack of spare parts which comes under Financial related causes) and Others is 0.486 (i.e. Over usage of equipment leads to crashing which comes under Equipment related causes).

The least value of RII in Contractor is 0.190 (i.e. Outdated equipment which comes under Equipment related causes), Equipment dealer is 0.125 (i.e. Inadequate everyday maintenance by operator and Precautionary maintenance which comes under Maintenance related causes, Over usage of equipment leads to crashing which comes under Equipment related causes and Lethargic scheduling of greasing and cleaning which comes under Personnel related causes), Equipment operator is 0.036 (i.e. Arrangement of personnel for maintenance management which comes under Maintenance related causes and Lethargic scheduling of greasing and cleaning which comes under Personnel related causes), Site engineer is 0.278 (i.e. Outdated equipment which comes under Equipment related causes), Project manager is 0.258 (i.e. Enhancement of maintenance system which comes under Maintenance related causes) and Others is 0.257 (i.e. Outdated equipment which comes under Equipment related causes).

Among those Categories of respondents with respect to 19 causes, Equipment dealer has the highest RII value in Continuous performance of equipment causing jamming (under Equipment related causes). In addition, Contractor, Equipment operator, Site engineer, Project manager and others are in 12th, 3rd, 7th, 11th, 6th positions in Continuous performance of equipment causing jamming, because over usage of equipment reduces the efficiency of equipment and causes jamming, to avoid this an alternative equipment can be provided.

VI. CONCLUSION

This paper investigated the causes of equipment delay in road construction projects, the causes of delay were from the perceptive of Contractor, Equipment dealer, Equipment operator, Site engineer, Project manager and others. The 19 causes of delay are identified and ranked using Relative Important index (RII) in different types namely Overall relative important index (ORII), Category of organization, Time overrun %, Experience in years and Categories of respondents. Among the Overall relative important index (ORII), Category of organization, Time overrun %, Experience in years and Categories of respondents, the Government from category of organization has the highest RII value as 1 in Inexpert or unpractised equipment operator which comes under Personnel related causes; Outdated equipment, Inadequate equipment and Over usage of equipment leads to crashing which comes under equipment related causes. The most risky causes with respect to the 19 causes of delay are Non allocation of fuel purchase staff (under Personnel related causes); Lack of spare parts (under Financial related causes); Inexpert or unpractised equipment operator (under Personnel related causes); Outdated equipment, Inadequate equipment and Over usage of equipment leads to crashing (under equipment related causes); Inadequate everyday maintenance by operator (under Maintenance related causes); Lethargic scheduling of greasing and cleaning (under Personnel related causes); Precautionary maintenance (under Maintenance related causes); Low capacity of equipment (under Equipment related causes)and Due to unfavourable climatic condition (under Equipment related causes). These most risky causes shows the efficiency and management of equipment is necessary in a road construction projects. Identification of delay causes can minimize and control time overrun in construction projects, this also helps in completing the project with the specified duration and the cost of construction projects can be maintained.

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APPENDIX

QUESTIONAIRE SURVEY

COMPANY PROFILE
Category of organization:
Time overrun % in a project:
RESPONDENT PROFILE
Name of respondent:
Designation:
Experience:
5 Points liker scale
4-Strongly Agree 3-Agree 2-Neutral 1-Disgree 0-Strongly Disagree
Factors

1. Maintenance related causes

S.no	Causes	4	3	2	1	0
(i)	Enhancement of maintenance system					
(ii)	Non execution of systematic methods for maintenance work					
(iii)	Inadequate everyday maintenance by operator					
(iv)	Arrangement of personnel for maintenance management					
(v)	Precautionary maintenance					

2. Equipment related causes

S.no	Causes	`4	3	2	1	0
(i)	Overhauling the equipment fault					
(ii)	Low capacity of equipment					
(iii)	Over usage of equipment leads to crashing					
(vii)	Due to unfavourable climatic condition					
(iv)	Outdated equipment					
(v)	Inadequate equipment					
(vi)	Continuous performance of equipment causing jamming					

3. Financial related causes

S.no	Causes	4	3	2	1	0
(i)	Payments for inspection					
(ii)	Idleness of equipment caused by purchasing of spare parts from other countries					
(iii)	Lack of spare parts					

4. Personnel related causes

S.no	Causes	4	3	2	1	0
(i)	Lethargic scheduling of greasing and cleaning					
(ii)	Non allocation of fuel purchase staff					
(iii)	Inexpert or unpractised equipment operator					
(iv)	Requirement of expert controller for a particular equipment					