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Prioritizing Delay Mitigation Strategies for Road Projects in Nigeria

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ABSTRACT: *This research focus on the study of delay mitigation methods of road construction projects awarded by the Niger Delta Development Commission in the Niger Delta Region of Nigeria from the perspective of the Client. The Cronbach Alpha Collection (CAC) was employed to test the questionnaires used for data collection and they were found to be statistically significant. The reliability analysis employed the use of interclass correlation of coefficients, multivariate analysis of variants (MANOVA) and the box test (Covariance Matrix). Delay mitigation strategies studied include Predictive, Preventive, Corrective and Organisational. Explorative Factor Analysis prioritised all selected nineteen (19) delay mitigation methods considered in this study. It was observed that "use of competent consultant to supervise and monitor road project" is the most significant mitigation strategy of road construction delay. Both "enforcing liquidated damage clauses" and "Use up-to-date technology utilization (best practice) in project management" are the most strongly and positively correlated with a correlation factor of 0.980. The least but positively correlated mitigation method is "Frequent/proper coordination of project team members" with a correlation factor of 0.745.*

Keywords: *Client, Construction Delay, Mitigation Strategies, Road Project, Statistical Package for Social Science (SPSS) software, Niger Delta Development Commission.*

I INTRODUCTION

The Niger Delta Development Commission (NDDC) was established by an act of parliament in the year 2000 as an interventionist agency to bridge the prevalent infrastructural and human capacity gap with a mission "to facilitate the rapid, even, sustainable development of the Niger Delta Region of Nigeria into a region that is socially stable, economically prosperous, ecologically regenerative and politically peaceful'' [1]. However, there have been knocks, jabs, negative comments, as well as unfavourable assessments and evaluation of the Commission's project delivery portfolio by critical stakeholders. Complaints range from poor quality of executed road projects to high cost and long-time overrun ([2], [3]). Though numerous project management templates, tools and techniques are deplored along with available software in the management of construction projects, road projects delays are still inevitable due to the many variables and uncertainties involved in its construction activities. This increases the likelihood of construction delay occurrence, making effective project management imperative to prevent undue extension of the planned construction work schedule. In this study, client's rating of delay mitigation methods of road construction projects awarded by NDDC is in focus wherein, project managers and directors managing road projects in the Commission represent the client. This study will be useful to all parties involved in road construction projects, especially in Nigeria. Additionally, the result of this study would enhance optimized investment decisions in the road

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construction industry in the Country in deploying resources to achieving effective road construction delay mitigation interventions.

II LITERATURE REVIEW

A construction project can either be a new project; a part of an ongoing project, program or portfolio; an upgrade of an existing project; a service to achieve a result; and, construction research activities [4]. For a project to be successful, delay must be minimized or reduced and construction delays mitigation efforts are important to minimise losses [5]. This is achieved by predicting and identifying the potential delay problems in the early stages of the project, and thereby diagnosing the delay causes to locate and execute the most appropriate economical resolutions [6].

A previous study which analysed and discussed typical construction delay mitigation templates with a view to providing a better understanding to the construction industry stakeholders, identified two methods of minimizing construction delays to include acceleration of site activities and provision of contingencies allowances [7]. Odeh and Baittaneh recommended the reinforcement of liquidated damages clauses; offering incentives for early completion; developing effective human resource management; and adopting a new contract award approach as delay mitigation strategies [8]. Also, in a study of the construction industry in Kuwait, it was observed that ensuring an adequate source of finance; performance of pre–construction planning; allocation of sufficient time and money during the design phase; hiring of independent supervising engineer to monitor progress of work; ensuring timely delivery of materials and selection of competent and reliable consultants to carry out the work were high impact construction delay mitigation measures [9]. Some construction delay mitigation initiatives profiled by different researchers were compiled by Chai et al and an adapted variant is presented in Table 1 ([5], [10], [11], [12]. [13], [14]).

Table 1: Construction Delays Mitigation methods from literatures

	Construction Delays mitigation methods	Abdul Rahamsan et al (2009)	Olawale and Sun (2010)	Kashimu andAbubakar (2012)	Smart Market Report (2011)	Ng et al (2010)	Abedi et al (2011)
1	Comprehensive Contract Documentation	■	■	■			
2	Hire an independent supervising Engineer to monitor project	■					
3	Multidisciplinary / competent project team	■	■		■		
4	Accurate initial time estimate	■				■	
5	Use up to date technology	■	■				
6	Accurate initial cost estimate	■	■	■	■		
7	Perform a preconstruction planning of project task and resource needs	■	■			■	■
8	Allocation of sufficient time and money at the design phase	■		■	■	■	■
9	Effective strategic planning	■	■	■			■
10	Clear information and communication channel	■	■				■
11	Developing professional and skilful human resources in the construction industry through proper training and	■	■			■	■

	classification of craftsman						
12	Systematic control mechanism	■	■		■		
13	Acceleration of site activities	■		■			
14	Ensuring timely delivery of materials	■					
15	Enforcing liquidated damage clauses	■		■			
16	Availability of resources	■				■	
17	Ensuring adequate and available sources of financing for the entire project	■					
18	Adopting a new approach to the contract award procedure by giving more weight to capabilities and past performance of contractors	■	■				
19	Selection of a competent consultant and a reliable contractor	■		■			
20	Commitment to Projects	■	■				
21	Competent Project Manager	■	■				
22	Frequent progress meetings	■	■				
23	Offering Incentives to early completion	■					
24	Absence of bureaucracy	■					
25	Adopting new procurement	■					
26	Awarding bid to the right experienced consultant and contractor	■	■		■		■
27	Proper emphasis on past experiences	■	■		■		■
28	Community involvement	■					
29	Contingency Allowance	■			■		■

Various types of construction delay mitigation strategies can be grouped as Predictive, Preventive, Corrective and Organisational ([5], [11], [15]). These groupings are defined accordingly:

Corrective Measures: Corrective is defined as to counteract, rectify, alter, or adjust to bring a situation back to its required condition [16]. Corrective measures are used to mitigate the effect of project controlling factors by acting as a remedy. They are used to handle delays after the occurrence to stop, track and reduce the effects of the delay. Corrective measures can be further classified as corrective predictive measures, which remedy the current situation and predict upcoming issues based on the current scenario, or corrective preventive measures, which are meant to correct the current issue and at the same time prevent the same problem from occurring in the future [5].

Predictive Measures: Predictive is defined as estimating whether something will happen in the future, making something known in advance by using tactical knowledge or declaring a situation in advance through basic observation and experience ([16], [17]). The predictive measures are defined as proposals, plans, steps, and suggestions taken into consideration proactively before the project starts. From the project management point of view, predictive measures minimise the disruption of project operation while allowing the budgeted scheduled time for reaction

Preventive Measures: According to The New Oxford Dictionary, preventive is defined as keeping something undesirable from occurring while The Webster's Dictionary defines it as "precautionary" ([16], [17]). These are active strategies implanted during the planning stage of a project. The initiative to provide better preventive measures can involve the active participation of staff through the contribution of the team, improvement at knowledge sharing, as well as management reviews and feedback.

Organisational Measures: An Organisation is defined as a group of people with a particular interest who normally have collective goals in achieving the same target [16]. Some authors have suggested that targeting the particular company organisational measures in delay mitigation play an important role to controlling the effect of project delay due to the company's beliefs, orientation, management style or philosophy, which

normally will not affect only one project but rather can affect all projects being undertaken by the company ([5], [16]).

III RESEARCH METHOTHOLOGY

The research was implemented according to the flow chart given in Figure 1 as adapted from an earlier work [18].

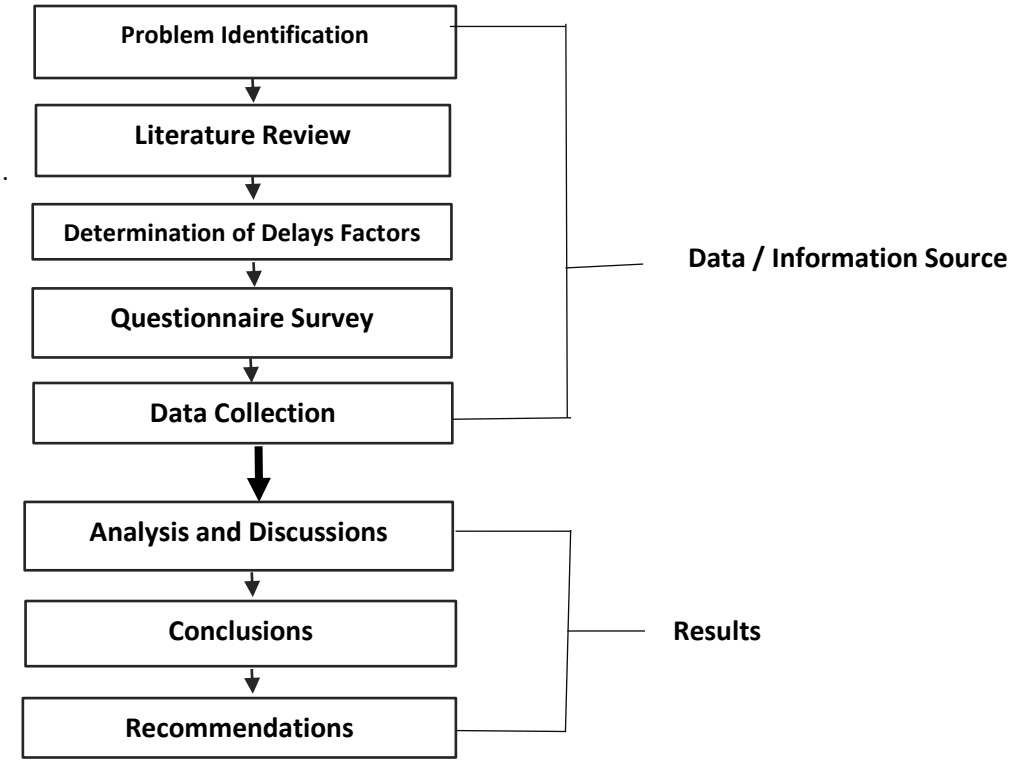

Figure 1: Main Research Activities and Methodology (adapted from Aziz 2013)

Quantitative systematic literature methodology as proposed by Pickering and Jason was employed [19]. This involved identifying keywords related to the study and systematically running electronic searches using the keywords. Filtering of the results were carried out to ensure their relevance to the subject [20]. The coverage of the questionnaire includes selected latent and indication factors of mitigation strategies of road construction delay, and the questionnaires were distributed to project managers and project directors in the Commission as client representatives. All respondents had a substantial knowledge and experience in road management and construction projects of the Commission since they have been involved with supervision and monitoring of road projects at either operational and strategic levels in the organisation, hence had a fair knowledge of issues bedevilling road projects awarded by the Commission. The questions on a Likert rating scale involved recording the contribution of each delay indicator variable to delay on a scale of 1 (not significant) to 5 (extremely significant) used by respondents in rating the impact of the road construction delay indicators. The questionnaires were collected from the participants within a period of 1-6 months after distribution. This approach removed any undue pressure from the respondents and gave them the freedom to fill-in the questionnaires as truthfully as possible. The valid data were analysed by the Statistical Package for Social Science (SPSS) software. This involved data processing and analysis, and exploratory factor analysis (EFA). A total of 200 questionnaires were distributed to the client's representatives out of which 162 were returned. Table 2 shows the latent constructs of mitigation strategies of construction delay while Figure 2 shows the measurement models for mitigation strategies of construction delay.

Table 2: Latent Constructs for road construction delay mitigation measures

Latent Constructs	Indicators	Codes
CORRECTIVE	Adequate contingency allowance (COR-1)	X1
	Enforcing liquidated damage clauses (COR-2)	X2
PREVENTIVE	Frequent progress site meeting (PRV-1)	X3
	Proper and timely material procurement (PRV-2)	X4
	Clear information and communication channels (PRV-3)	X5
	Frequent/proper coordination of project team members (PRV-4)	X6
	Proper project planning and scheduling (PRV-5)	X7
	Complete and proper design at the right time (PRV-6)	X8
	Comprehensive contract documentation (PRV-7)	X9
	Ensure adequate and available financial resources for projects (PRV-8)	X10
PREDICTIVE	Use appropriate construction methods (PRD-1)	X11
	Use up-to-date technology utilization (best practice) in project management (PRD-2)	X12
	Accurate initial cost estimates (PRD-3)	X13
	Accurate initial project duration estimate (PRD-4)	X14
ORGANISATIONAL	Prompt payment for certified works (ORG-1)	X15
	Community buy-in /involvement (ORG-2)	X16
	Use of competent consultant to supervise and monitor project (ORG-3)	X17
		X18
	Selection of competent contractor (ORG-4)	X19
	Offering incentives for early completion (ORG-5)	

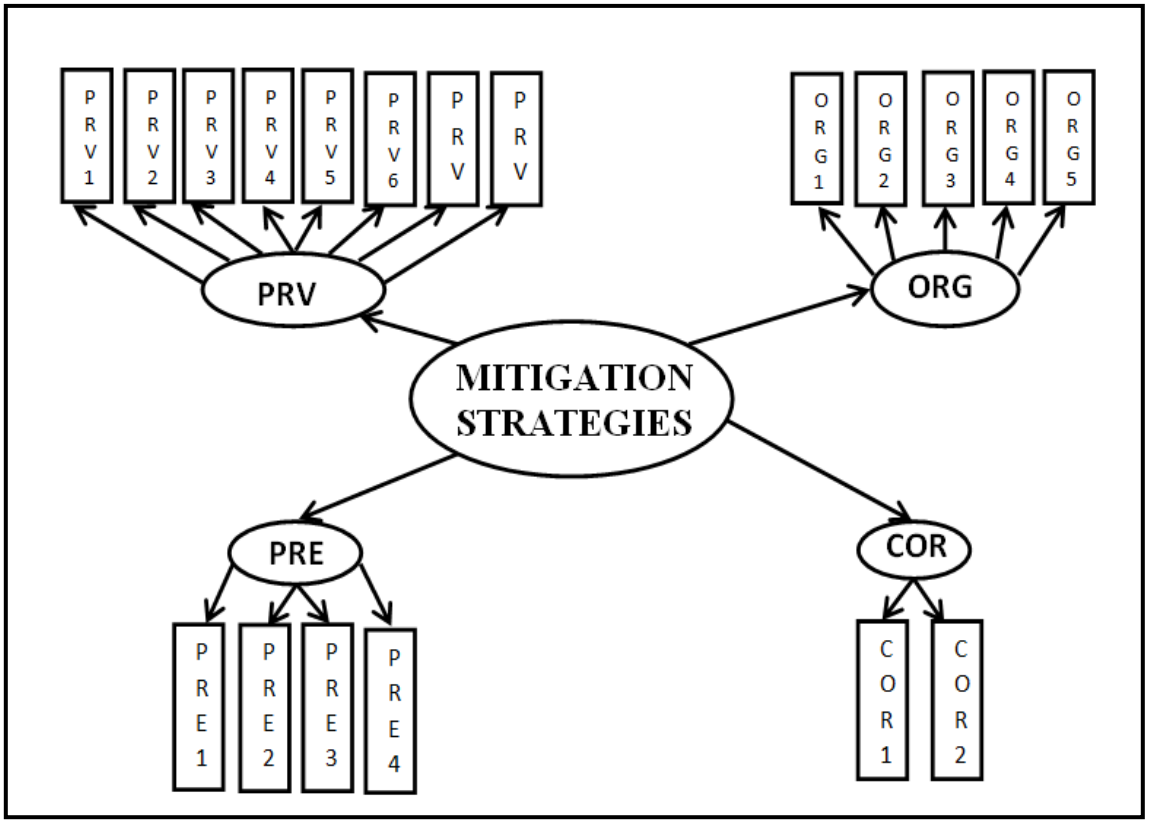

Figure 2: Initial measurement model for delay mitigation strategies

In Figures 2, the path arrows show the hypothetical relationship among the dependent variables and the independent variables (measured indicators). The rectangular shapes indicate the observed variables that are the individual items on the questionnaire survey.

IV ANALYSIS OF RESULTS

EXPLORATORY FACTOR ANALYSIS

Exploratory factor analysis is a statistical technique used to reduce data to a smaller set of summary variables and to explore the underlining theoretical structure of the phenomena. It is used to identify the structure of the relationship between the variables and the respondents. In this case, exploratory factor analysis was employed to explain the opinions of the client with regards to mitigation measures of construction delay of road projects awarded by NDDC in the Niger Delta Region of Nigeria

INFERENTIAL STATISTICS FOR MITIGATION STRATEGIES FOR CONSTRUCTION DELAY

This was used to test the co-linearity of the selected delay mitigation factors. The selected mitigation measures of construction delay were used as the independent variable while the respondent views were used as the dependent variable. The null and alternate hypothesis of inferential statistics were formulated as: **H0:** No significant difference in the selected mitigation measures of construction delay according to client's opinion, and **H1:** Significant difference exists in the selected causes of construction delay according to client's opinion. The analysis was performed at 95% confidence interval Thus, for $p < 0.05$, the null hypothesis is accepted and it is concluded that no significant difference exists among the selected causes of construction delay. But for $p > 0.05$, the null hypothesis is rejected and it is concluded that significant difference exists among the selected mitigation strategies of construction delay. Descriptive statistics of the selected mitigation measures of construction delay based on inferential statistics is presented in Table 3 respectively

Table 3: Descriptive statistics of mitigation strategies of construction delay of client's view

Descriptives

Client's View

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
X1	5	12.80	12.598	5.634	-2.84	28.44	0	27
X2	5	13.20	12.112	5.417	-1.84	28.24	0	27
X3	5	12.60	13.446	6.013	-4.10	29.30	0	32
X4	5	11.40	11.950	5.344	-3.44	26.24	0	30
X5	5	12.60	11.261	5.036	-1.38	26.58	0	28
X6	5	10.80	9.654	4.317	-1.19	22.79	0	26
X7	5	12.00	15.652	7.000	-7.44	31.44	0	39
X8	5	11.40	12.095	5.409	-3.62	26.42	1	29
X9	5	12.60	13.428	6.005	-4.07	29.27	0	33
X10	5	12.60	10.854	4.854	-.88	26.08	0	27
X11	5	12.80	10.450	4.673	-.18	25.78	0	26
X12	5	13.20	14.856	6.644	-5.25	31.65	3	38
X13	5	12.00	13.546	6.058	-4.82	28.82	0	30
X14	5	12.60	11.127	4.976	-1.22	26.42	0	30
X15	5	12.00	12.510	5.595	-3.53	27.53	0	30
X16	5	12.60	14.775	6.608	-5.75	30.95	0	32
X17	5	13.40	13.145	5.879	-2.92	29.72	0	29
X18	5	12.60	14.775	6.608	-5.75	30.95	0	36
X19	5	12.60	9.099	4.069	1.30	23.90	0	24
Total	95	12.41	11.363	1.166	10.10	14.73	0	39

The difference in the computed mean and standard deviation as observed in Table 3 revealed the different strength of the selected mitigation measures of construction delay from the view of the client. The levene test as presented in Table 4 was employed to test for equal variance or homogeneity of variance.

Table 4: Levene test statistics on mitigation strategy of construction delay from client's view

Test of Homogeneity of Variances

Client's View

Levene Statistic	df1	df2	Sig.
.368	18	76	.990

With a p-value of 0.990 ($p > 0.05$), the null hypothesis was rejected and it was concluded that significant difference exists among the selected mitigation measures of construction delay according to the client view. On whether to finally accept or reject the null hypothesis, analysis of variance (ANOVA) table was generated and presented in Table 5.

Table 5: Analysis of variance parameters of client's view for mitigation strategies of construction delay

ANOVA

Client's View

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	39.789	18	2.211	.014	1.000
Within Groups	12097.200	76	159.174		
Total	12136.989	94			

From the result of the analysis of variance, it was observed that the p-value is > 0.05 ($p = 1.000$). For $p > 0.05$, the null hypothesis was rejected and the alternate hypothesis was finally accepted and it was concluded that significant difference exists among the selected mitigation measures of construction delay according to the client view.

RANKING OF DELAY MITIGATION STRATEGIES

To rank mitigation methods of road construction delay according to the view point of the client, the mean plot of performance was generated and presented in Figure 3. From Figure 3, predictive, preventive, corrective, and organisational mitigation measures were the major strategies that mostly mitigate delay in construction of road projects awarded by NDDC. It is observed that "use of competent consultant to supervise and monitor project" is the most significant mitigation strategy of road construction delay. To identify the other mitigation strategies of construction delay that are strongly and positively correlated with "use of competent consultant to supervise and monitor project", post-hoc test using the least significant difference (LSD) was done and presented in Table 6

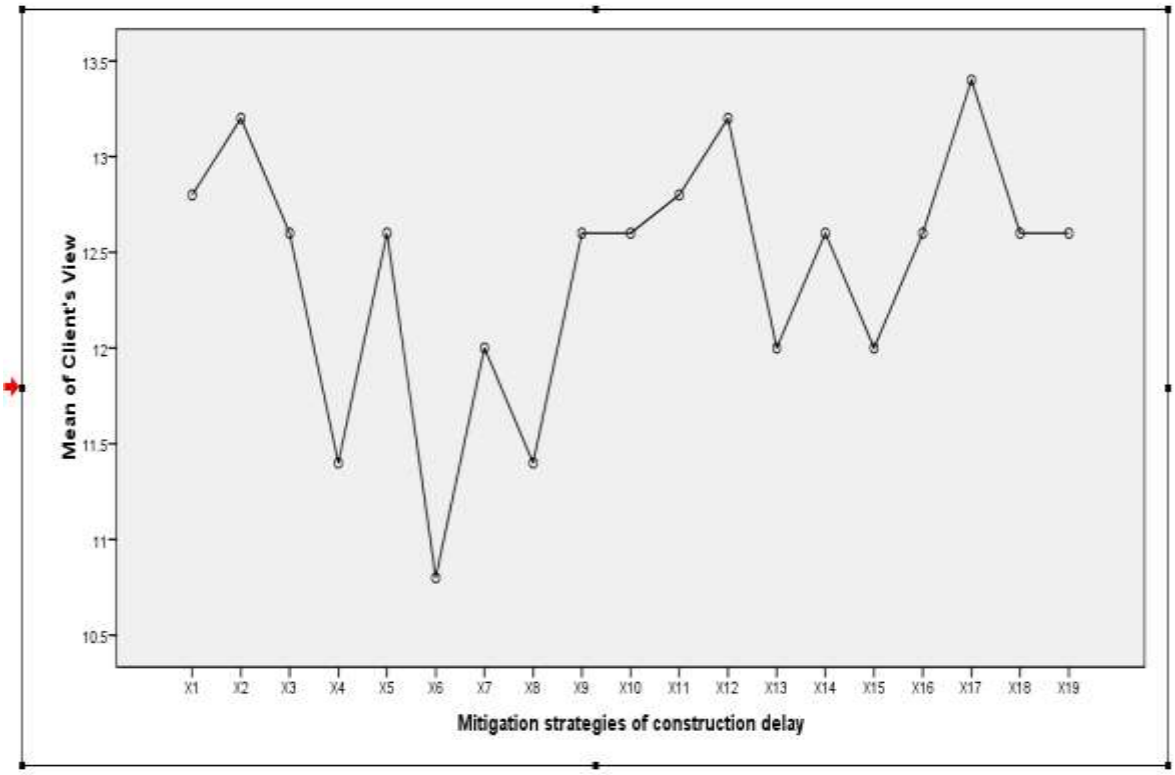

Figure 3: Mitigation strategies of construction delay according to Client

Table 6: Post-Hoc Analysis using LSD of client's view on mitigation strategy of construction delay

X17	X1	.600	7.979	.940	-15.29	16.49
	X2	.200	7.979	.980	-15.69	16.09
	X3	.800	7.979	.920	-15.09	16.69
	X4	2.000	7.979	.803	-13.89	17.89
	X5	.800	7.979	.920	-15.09	16.69
	X6	2.600	7.979	.745	-13.29	18.49
	X7	1.400	7.979	.861	-14.49	17.29
	X8	2.000	7.979	.803	-13.89	17.89
	X9	.800	7.979	.920	-15.09	16.69
	X10	.800	7.979	.920	-15.09	16.69
	X11	.600	7.979	.940	-15.29	16.49
	X12	.200	7.979	.980	-15.69	16.09
	X13	1.400	7.979	.861	-14.49	17.29
	X14	.800	7.979	.920	-15.09	16.69
	X15	1.400	7.979	.861	-14.49	17.29
	X16	.800	7.979	.920	-15.09	16.69
	X18	.800	7.979	.920	-15.09	16.69
	X19	.800	7.979	.920	-15.09	16.69

From the post-hoc analysis presented in Table 6, it was observed that all the selected mitigation strategies of road construction delay are strongly and positively correlated with "Use of competent consultant to supervise and monitor project" but "enforcing liquidated damage clauses" (0.980) and "Use up-to-date technology utilization (best practice) in project management" (0.980) are most strongly and positively correlated. The least positively correlated is Frequent/proper coordination of project team members (0.745). This is summarized in Table 7 and Table 8.

Table 7: Priority Ranking of Delay Mitigation Strategies for NDDC Road Projects

Group	Delay Mitigation Measures	Correlation Index	Ranking
CORRECTIVE	Adequate contingency allowance	0.940	**3**
	Enforcing liquidated damage clauses	0.980	**2**
PREVENTIVE	Frequent progress site meeting	0.920	**4**
	Proper and timely material procurement	0.803	**6**
	Clear information and communication channels	0.920	**4**
	Frequent/proper coordination of project team members	0.745	**7**
	Proper project planning and scheduling	0.861	**5**
	Complete and proper design at the right time	0.803	**6**
	Comprehensive contract documentation	0.920	**4**
	Ensure adequate and available financial resources for projects	0.920	**4**
PREDICTIVE	Use appropriate construction methods	0.940	**3**
	Use up-to-date technology utilization (best practice) in project management	0.980	**2**
	Accurate initial cost estimates	0.861	**5**
	Accurate initial project duration estimate	0.920	**4**
ORGANISATIONAL	Prompt payment for certified works	0.861	**5**
	Community buy-in /involvement	0.920	**4**
	Use of competent consultant to supervise and monitor project	1.000	1
	Selection of competent contractor	0.920	**4**
	Offering incentives for early completion	0.920	**4**

Table 8: Group Ranking of Delay Mitigation Strategies for NDDC Road Projects

Ranking	S/No.	Delay Mitigation Measures	Correlation Index	Group
1	1	Use of competent consultant to supervise and monitor project	1.000	Organisational
2	2	Enforcing liquidated damage clauses	0.980	Corrective
	3	Use up-to-date technology utilization (best practice) in project management	0.980	Predictive
3	4	Adequate contingency allowance	0.940	Corrective
	5	Use appropriate construction methods	0.940	Predictive
4	6	Frequent progress site meeting	0.920	Preventive
	7	Clear information and communication channels	0.920	Preventive

	8	Comprehensive contract documentation	0.920	Preventive
	9	Ensure adequate and available financial resources for projects	0.920	Preventive
	10	Accurate initial project duration estimate	0.920	Predictive
	11	Community buy-in /involvement	0.920	Organisational
	12	Selection of competent contractor	0.920	Organisational
	13	Offering incentives for early completion	0.920	Organisational
5	14	Proper project planning and scheduling	0.861	Preventive
	15	Accurate initial cost estimates	0.861	Predictive
	16	Prompt payment for certified works	0.861	Organisational
6	17	Proper and timely material procurement	0.803	Preventive
	18	Complete and proper design at the right time	0.803	Preventive
7	19	Frequent/proper coordination of project team members	0.745	Preventive

V CONCLUSION

The study ranks all nineteen (19) mitigation strategies of construction delay of road projects awarded by NDDC. It was observed that "use of competent consultant to supervise and monitor road project", which is an Organisational strategy, is the most significant mitigation strategy of road construction delay. While all the other eighteen mitigation strategies of road construction delay are positively correlated with the "use of competent consultant to supervise and monitor road project", both "enforcing liquidated damage clauses" (corrective) and "Use up-to-date technology utilization (best practice) in project management" (predictive) are the most strongly and positively correlated with correlation factors of 0.980. The least but positively correlated mitigation method is "Frequent/proper coordination of project team members" (preventive) with a correlation factor of 0.745. Therefore, it is suggested that the recurring decimal of road construction delays in NDDC's project delivery portfolio shall be significantly mitigated by meaningfully adopting all the nineteen (19) delay reduction measures examined in this study. Other related Ministries, Departments and Governmental Agencies (MDGs) can also benefit from the findings of this research work.

Usually, MDGs inclusive of NDDC are challenged by insufficiency of fund to execute variants of proposed road projects. Thus, there is the need for a Confirmatory Factor Analysis to determine the critical mitigation measures from among the nineteen (19) examined in this study. This will enable an efficient deployment of available human and financial resources to reducing and/or mitigating road construction risks, issues and delays.

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