Developing Country Studies
ISSN 2224-607X (Paper) ISSN 2225-0565 (Online)
Vol.7, No.10, 2017

A Conceptual Model of Delay Factors Affecting Government Funded Hydropower Projects

Abdul Anwar[1] Dr. Sohail Ahmad Malik[2]
1. M.S Student, Construction Engineering & Management, National University of Sciences & Technology, H-12 Sector, Islamabad, Pakistan
2. Professor, School of Civil & Environmental Engineering, National University of Sciences & Technology, H-12 Sector, Islamabad, Pakistan

Abstract
Over the past decades, delay in Hydropower projects particularly Government owned has been a noteworthy issue in the Pakistan. The current study is carried out to study the issues that are contributing or resulting in delay of Hydropower projects. The main purpose is to identify and determine a conceptual model of delay factors which subsequently will be used to examine the impact that delay factors has on government funded hydropower projects. From literature review, thirty one (31) delay factors were identified. Survey was conducted by distributing questionnaires across stakeholders that included consultants, contractors and owners from hydropower projects. Factors of delay under study were categorized under six main groups namely owner, consultant, contractor, project, contract and external and then their impacts on delay were assessed using regression analysis. The three most notable factors of construction delays were identified as: (1) Slow decision making process by owner; (2) Difficulties in financing project by owner; (3) Inadequate contractor's human resources. The study concluded that owner related delay factors had the highest impact on project completion followed by contractor related while project related exhibited the least impact. This study can benefit stakeholders dealing with the hydropower projects to mitigate and establish suitable solutions for overcoming the delay.
Keywords: Government owned, Hydropower projects, Delay factors, Pakistan

1. Introduction:

In Pakistan, construction industry is facing immense pressure regarding construction of dams and hydropower projects; the current level of electricity generation indicates that hydel power potential has not been fully exploited over the years. The relative share of hydroelectricity to total power generation has declined from 64.9% during 1960 to 29% during 2016. The imbalance between hydel and thermal generation has increased the demand for imported fuel and severely affected the balance of payment situation. Adding to this, delay in completion of hydropower projects in Pakistan like Neelum Jhelum, Gomal Zam, Satpara and Tarbela 4th Ext. etc.; have incurred cost mounting to billions of rupees. Due to delays in timely completion of these projects, gap between demand and supply of electricity has been considerably widened in recent years and 10–12 hours load shedding become a norm across country affecting daily lives of people immensely.

Keeping in view the above, objectives of the study were:

- To identify and validate the factors causing delays in Hydropower Projects
- To statistically quantify the impact of delay factors on project completion with a view to develop conceptual model.
- To suggest measures to overcome identified factors.

2. Literature Review

For decades, various studies have been conducted regarding delays in construction projects with the aim of discovering different factors and their respective groups that cause delays.

In developing countries like Pakistan, completing a construction project let alone Hydropower within the planned time and cost is considered to be a sign of great achievement. However, construction is subjected to many unpredictable and changing factors such as stakeholders performance, availability of resources, environmental conditions, third parties involvement and contractual relations which cause time and cost overruns, thus completion of the project within the estimated time is rare (Assaf and Al-Hejji, 2006).

Assaf and Al-Hejji (2006) recognized 73 causes of delay further categorized into 9 major groups and data collected were ranked on the basis of frequency, severity and importance. The only common cause among all the parties was found to be "owner's directed change orders during construction". Results of Spearman rank correlation showed that extent of agreement in between owners and consultants was highest with the percentage of 72.4 while the lowest was found between owners and contractors with the percentage of 56.8.

Lo et al. (2006) determined groups and causes of delays in construction projects of Hong Kong. The delay factors identified were 30 and these were grouped into 7 categories. The categories were named as client delays, engineer delays, contractor delays, human behavior delays, project delays, external delays and resource delays.

In Pakistan, Haseeb et al. (2006) studied and identified 27 delays causes affecting construction industry and subsequently categorized them into 7 groups named as client, consultant, contractor, contract, labor, project conditions and labor related. Survey results indicated majority factors were related to client.

Nasir et al. (2011) identified the 28 cost overrun factors and 30 delay factors in highway projects of Pakistan. Based on relative importance index, top ten delay factors for cost and time overrun were determined. Most of the identified factors come under the responsibility of client.

In Malaysian construction industry, Sambasivan and Soon (2007) studied causes and effects of delays. Based on the relative importance index, ranking of 28 identified delay factors from the perspective of owners, consultants and contractors was carried out. The top most important cause of delay according to the owner, consultant and contractor was "Contractor's inappropriate planning", "Contractor's inappropriate planning" and "poor site management by contractor" respectively.

In Egypt, Abd El-Razek et al. (2008) identified 32 delay causes that affect the building projects. Using importance index, ranking of the identified delay causes was carried out and top five causes based on results were i) contractor's finance during construction; ii) delayed payment by owner to the contractor; iii) changes in design directed by owner or engineer during construction; iv) incomplete payments during construction; and v) ineffective management of construction and contract. Further, results of Pearson and Spearman correlations showed that degree of agreement between consultant and contractor was highest while the same between owner and contractor was lowest.

In view of the aforementioned literature review, it is suggested that most studies prioritizes identification of delay causes and ranked them using mean scores or relative importance index. However, quantification of impact of delay factors has not been discussed in detail. For example, mitigation measures undertaken to overcome a critical factor may result in a situation where other non-critical factors become critical thus causing more delay than initially foreseen. Hence, it is imperative to determine the correlation and develop a predicted model equation between various factors of delay. A couple of studies related to identifying the relationship and quantifying impact of various factors of delay are discussed below:

Hemanta Doloi et al. (2012) identified the 45 delay attributes in Indian construction projects under six groups namely project related, authority delays, site delays, process delays, human caused delays and technical concerned delays. Using regressions analysis, a predictive model was derived on the basis of best fit attributes for anticipating time overrun in the project.

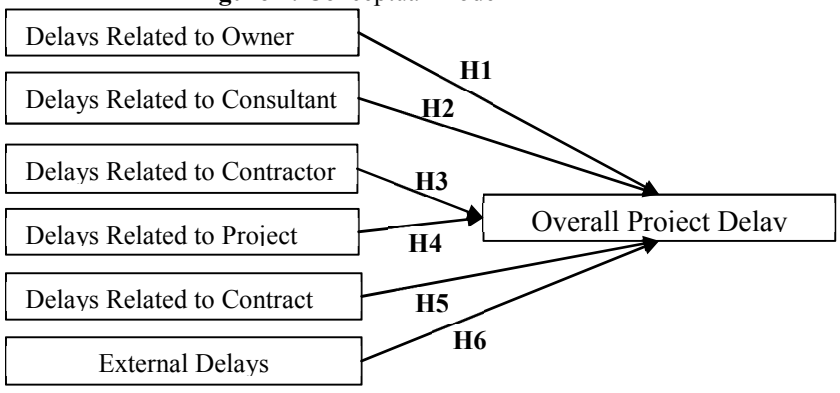
Van et al. (2015) identified 28 delay factors into six delay groups in government construction projects of Vietnam. Factor analysis was used to develop conceptual model and by using regression analysis, it was found that contractor and owners related delay factors have the significant effect on project's timely completion.

Majority of the aforementioned studies have their scope comprised of general construction projects as opposed to the detailed analysis of different categories of construction projects in different sectors such as private, government or individual projects etc. Since most of the hydropower constructions work in Pakistan is controlled by their governments as a main client therefore, current study is mainly focused on government funded hydropower projects. Nevertheless, finding from this study should be relevant to all the developing countries because most of them counter similar issues in terms of delay. Literature review on causes of delay has been summarized in Table 1.

2.1 Conceptual Model of Research and Hypotheses

In light of the literature review, 31 delay factors were extracted. Based on the nature of extracted delay factors, these were categorized into six (6) major groups namely delays related to owner, contractor, consultant, project, contract and external. A preliminary theoretical framework of delay factors comprised of 6 groups is proposed in Figure 1.

Figure 1: Conceptual Model



The hypotheses that constitutes conceptual model are described as follow;
Hypothesis 1: Project Delay has a significant relationship with Owner related delay factors
Hypothesis 2: Project Delay has a significant relationship with Contractor related delay factors
Hypothesis 3: Project Delay has a significant relationship with Consultant related delay factors
Hypothesis 4: Project Delay has a significant relationship with Project related delay factors
Hypothesis 5: Project Delay has a significant relationship with Contract related delay factors
Hypothesis 6: Project Delay has a significant relationship with External related delay factors

3. Research Methodology

Survey approach based on the questionnaire distribution has been used for this research to identify the impacts of several delay factors on hydropower projects of Pakistan. A survey of stakeholders such as Owners, Consultants and Contractors involved in the Construction of following hydropower projects were conducted:

- Ghazi Barotha Hydropower Project
- Gomal Zam Dam
- Pehur Hydropower Project
- Malakand-3 Hydropower Project
- Satpara Dam
- Allai Khwar
- Keyal Khwar
- Khan Khwar
- Tarbela 4th Ext. Hydropower Project
- Neelum Jhelum Hydropower Project

Heterogeneity of respondents is imperative to determine the pragmatic impact of various aspects on construction delay (Sambasivan and Soon, 2007). Heterogeneity for the current study was maintained by choosing the selected group of respondents that were involved in above listed multiple hydropower projects. Selected projects as listed above that constituted the study population were Government Owned and either completed or near completion. Keeping in view the size of population, 169 questionnaires were sent through mails as well as hand delivered to target participants. Out of one hundred and sixty nine (169), one hundred and fifty (150) valid responses were collected. The analysis of data was then carried out on Statistical Package for Social Sciences (SPSS) software.

3.1 Questionnaire Development

Delay factors identification and development of questionnaire is an important step upon which the success of research is based. As evident from the literature review, considerable amount of work has already been carried out by various researchers in determining the causes of delay. For this study, 31 main delay factors relevant to hydropower projects were extracted from literature review under the six categories namely owner, contractor, consultant, project, contract and external related delay factors after discussions with the field professionals. The finalized questionnaire incorporated these 31 delay factors as listed in Table 1. Impact of delay factor was measured on five point Likert scale which denotes ("1" Very Low, "2" Low, "3" Medium, "4" High, "5" Very High). Questionnaire was the main instrument for collection of data from target respondents. The questionnaire was organized into three sections for achievement of aforementioned research objectives. Section-1 starts with the respondent's general information. The questions included: project name, project duration, project cost, percent complete, respondents name, designation, qualification, cell number and e-mail address. Section-2 was designed to get the respondent's opinion against each delay factor related to categories of Owner, Consultant, Contractor, Project, Contract and External etc. Section-3 was designed to get the opinions of respondents regarding duration of construction delays they experienced during the course of executing hydropower projects.

Table 1: Identified Delay Factors & Sources

Category	Factors Causing Delay	Source
Owner Related Delays	**O1.**Slow Decision Making Process by Owner **O2**.Long waiting time due to owner's authority decentralization in approving project **O3**. Incompetent owner **O4**.Difficulty in financing project by owner **O5**.Long waiting time due to owner's authority decentralization in approving bidding results **O6**.Delay by owner in acceptance of completed works **O7**.Delay in payment to the Contractor of completed works **O8**.Bureaucracy of owner **O9**.Delay of owner in solving the arising during the project implementation **O10**.Long waiting time due to owner's authority decentralization in approving payment **O11**.Long waiting time due to owner's authority decentralization in approving design and cost estimate **O12**.Unrealistic project duration imposed on Contractor **O13**.Lack of continuous updating of the project implementation process by owner **O14**.Long waiting time due to Owner's authority decentralization in approving adjustments	(Ahsan & Gunawan, 2010), (Van, Sang, & Viet, 2015), (Abd El-Razek et al.,2008) (Faridi and El-Sayegh, 2006)
Contractor Related Delays	**CT1**.Difficulties in financing project by Contractor **CT2**.Inadequate contractor's human resources **CT3.**Shortage of material & equipment of contractor	(Akogbe et al., 2013), (Hwang et al.,2013), (Assaf & Al-Hejji, 2006)
Consultant Related Delays	**CS1**.Inadequate supervision of Consultant **CS2**.Incompetent design Consultant **CS3**.Incompetent project management Consultant	(Gunduz Nielsen & Ozdemir,2013), (Hamzah et al., 2011)
Project Related Delays	**P1.** Lack of coordination & information between the parties **P2**. Poor Project Planning & Scheduling **P3**.Complexity of project **P4**.Remote location of site	(Doloi et al., 2012), (Pourrostam & Ismail, 2012), (Fugar & Agyakwah-Baah, 2010), (Assaf & Al-Hejji, 2006)
Contract Related Delays	**CO1**.Poor Contract Management **CO2**.Change Orders **CO3**.Ineffective Delay Penalties	(Khosgoftar et al., 2010), (Yang et al., 2013), (Assaf & Al-Hejji, 2013)
External Related Delays	**E1**.Changes in government regulation and laws **E2**.Price fluctuations of construction materials **E3**. Act of God (War, Terrorism, earthquake, flood, etc.) **E4**.Complex geological conditions	(Haseeb et al., 2011), (Hamzah et al., 2011), (Assaf & Al-Hejji, 2006), (Wong & Vimonsatit, 2012)

4. Data Analysis & Results

4.1 General Characteristics of Respondents

Respondents opted for the study comprised of professionals involved in Pakistani Construction Sector (contractors, owners and engineers) with considerable experience in hydropower projects of Pakistan. The study sample comprised of project directors, designers, site engineers, project and construction managers, contract administrators and structural engineers. Respondents' profile with regards to profession and relevant experience has been depicted in Table 2 below.

Table 2: Respondent's Profile

Stakeholder	Experience(Years)				Total	% by Professional Role
	Less than 5	5-10	10-15	More than 15		
Owner	5	7	14	12	38	25.33
Contractor	8	13	16	15	52	34.66
Consultant	7	7	33	13	60	40
Percentage by Experience	13.33	18	42	26.66		

In order to get the most reasonable response, preliminary discussions were made with each respondent for the purpose of explaining and clarifying the research objectives. 169 questionnaires were sent through mails as

well as hand delivered to target participants for their feedback, in response to which 150 valid responses were received thus resulting in a response rate of 89%. The highest proportion (40%) amongst the respondents was from the consultants involved in hydropower construction followed by the contractors (35%) whereas replies from the owner were 25%. Most of the respondents had an average experience of about 10-15 years.

4.2 Ranking of the Delay Factors

Descriptive analysis was processed by using the data that were collected as a result of questionnaire survey as it is an imperative estimate to rank the delay factors based on their criticality as comprehended by the respondents. For this study, descriptive statistics namely mean score has been used for ranking the delay factors as discerned by the respondents. This analysis was done using SPSS in which ratings allocated to each of the delay factors by the respondents were inserted and as a result, the responses from all the questionnaires were subjected to statistical analysis for further understanding and conclusion. Ranking of each of the delay factors is shown in Table 3 below.

Table 3: Ranking of Delay Factors

ID	Delay Factors	Mean Score	Rank
O1	Slow decision making process by owner	4.2000	1
O3	Difficulties in financing project by owner	4.0600	2
CT2	Inadequate Contractor's human resources	4.0467	3
CS1	Inadequate supervision consultant	4.0200	4
E5	Act of God (War, Terrorism, earthquake, flood etc.	4.0133	5
O2	Long waiting time due to owner's authority decentralization in approving the project	3.9200	6
P1	Lack of coordination and information between parties	3.8400	7
CO2	Change Orders	3.8133	8
O4	Unwillingness of government towards construction of hydropower projects	3.6267	9
CT1	Difficulties in financing project by the contractor	3.6067	10
O6	Long waiting time due to owner's authority decentralization in approving bidding results	3.4600	11
O5	Delay in payment to the contractor of completed works	3.4467	12
P2	Poor project planning & scheduling	3.4333	13
CS2	Incompetent design consultant	3.4200	14
O7	Bureaucracy of owner	3.3333	15
O8	Low bid contract award system	3.3200	16
CO1	Poor contract management	3.3000	17
CT3	Shortage of material & equipment of contractor	3.1867	18
E4	Complex geological conditions	3.1800	19
O10	Long waiting time due to owner's authority decentralization in approving design & cost estimates	3.1400	20
P3	The complexity of project	3.1267	21
O11	Unrealistic project duration imposed on client	3.1200	22
O12	Lack of updating of project implementation process by owner	3.1200	23
O9	Long waiting time due to owner's authority decentralization in approving payment	3.1200	24
P4	Remote location of site	3.0400	25
O13	Long waiting time due to owner's authority decentralization in approving payment	3.0067	26
CS3	Incompetent project management consultant	2.9533	27
E2	Land requisition & resettlement	2.9400	28
E1	Changes in government laws & regulations	2.9200	29
E3	Price fluctuations of construction materials	2.9133	30
CO3	Ineffective delay penalties	2.7800	31

Based on the rankings, three most critical factors are (1) Slow decision making process by owner; (2) Difficulties in financing project by owner; (3) Inadequate contractor's human resources. It can be easily understood that why slow decision making by owner is the most common and critical cause of delay in hydropower projects construction. Due to unpredictable nature of hydropower projects, various complex situations might arise from conception phase to completion phase whether these are externally imposed or naturally created. However, swift and timely action is required by the owner in such cases to avoid delay. Unfortunately, majority of the hydropower projects in Pakistan are delayed due to inability of owner to decide

and act on time as evident from the rankings.

Two factors having the lowest means as compared to others are price fluctuations of construction materials and ineffective delay penalties.

4.3 Reliability Analysis

Reliability was assessed using Cronbach's alpha coefficient which is commonly used to determine whether questionnaires with multiple Likert scale questions are reliable. The allowable lower ceiling for the Cronbach's alpha is generally considered to be 0.7, however, exploratory research even allow for values as small as 0.6 (Hair et al., 2010). For the present study, Cronbach's alpha of owner delays, contractor delays, consultant delays, contract delays, project delays and external delays turned out to be 0.869, 0.702, 0.703, 0.784, 0.701 and 0.694 respectively.

4.4 Multiple Linear Regressions

Since descriptive analysis does not determine any significant results in predicting the impact of various delay factors on project completion, further analysis using advanced statistical methods such as multiple linear regression is required.

Multiple regression analysis is widely used method in social sciences research to explore the correlation between one dependent (target) variable and more than two independent (predictors) variables. In this study, the overall project delay as a dependent variable is correlated with owner related delays, contractor related delays, consultant related delays, project related delays, contract related delays and external related delays as independent variables by using the technique of standard multiple regressions in SPSS. Results of the multiple regression analysis are depicted in Table 4.

Table 4: Regression Results

	β	**Std. Error**	**t-value**	**Sig.**	**R square**	**Adjusted R Square**	**F-value**
(Constant)	.552	.258	2.138	.034	.493	0.472	23.197 at sig. value 0.000
Owner Related Delays	.169	.056	3.026	.003			
Contractor Related Delays	.163	.049	3.341	.001			
Consultant Related Delays	.111	.053	2.087	.039			
Project Related Delays	.096	.045	2.150	.033			
Contract Related Delays	.120	.049	2.453	.015			
External Related Delays	.135	.066	2.036	.044			

The findings of the regression analysis showed that owner delay factors and contractor delay factors have major impact on timely completion of project with β coefficient as (0.169) and (0.163), respectively.

After processing of multiple regressions, following regression model has been resulted:

Overall Project Delay = .552+.169(Owner Related Delays) +.163(Contractor Related Delays) +.111 (Consultant Related Delays) +.096(Project Related Delays) +.120(Contract Related Delays) +.135(External Related Delays)

4.5 Testing Validity & Relevancy of the Regression Model

The relevancy of the research model equation can be determined by computing tests such as F-test, t-test and coefficient of determination.

4.5.1Coefficient of Determination

R square value tells determines the variance that is explained by the explanatory variables in the dependent variable. The regression results shown in Table 4 calculated value of R2 as 0.493, which indicates that 49.3% of variance in the dependent variable is justified by differences in independent variables, and 51.7% in unaccounted for. "Adjusted R square" is modified form of "R square" that incorporates the effect of number of independent variables in a model. The adjusted R2 value is 0.472. We can conclude from R squared value that the estimated model has reasonable predictive ability.

4.5.2F-test

F-test is used to determine whether any one of the predictor variable is related to explanatory variable in model equation. From the above Table 4, it is evident that F significance value is less than .05 thus; at least one independent variable is linearly related to dependent variably thereby proving the validity of model equation.

4.5.3T-Test

The 'T' test assesses whether each of the regression coefficient is significant. The above Table 4 justifies that all the significance values of regression coefficients are less than .05. Therefore, there is enough evidence to conclude that all the independent variables are related to dependent variable.

5. Conclusions

This research has developed a regression model equation including 31 delay factors that affect the performance of hydropower projects owned by Government. These delay factors are comprised of 6 groups and further categorized into owner, Contractor, Consultant, Project, Contract and External delay factors. Identified delay factors were validated by developing a questionnaire and following validation, multiple linear regression analysis was carried out using SPSS 23.0 to evaluate impact of each delay group on project delay. The results of regression showed that project delay is majorly controlled by factors relating to owner and contactor whereas project related factors has least impact of project delay.

6. RECOMMENDATIONS

In light of the research results and conclusions, following points are recommended to limit and mitigate the delays in hydropower projects:

6.1 For Owners:

- Decentralization in decision making should be narrowed down to the a single person or entity.
- Payment of interim and final payment certificates to the contractor should be done timely because it impedes the contractor's cash flow.
- Variation or change orders should be kept to minimum during construction to avoid delays. If variation order is issued then it should be approved on time.
- Award of contract should be done keeping in view the expertise of bidders in respective field. This will ensure the award of contract to best company and chances of project completion within estimated budget and time will be increased.

6.2 For Contractors:

- Considering nature of Hydropower Projects, Civil Contractor should be in close coordination with E&M (Electrical & Mechanical) Contractor in order to avoid interface delays.
- Rather than focusing on making irrelevant claims, Contractor should find ways to mitigate events causing claims.
- Adequate number of labors ought to be doled out and propelled to enhance productivity.
- The Contractor should practice Value Engineering in order to reduce cost and time.
- Shop drawings and method statements should be submitted on schedule so that Engineer has sufficient time for review.
- Planning and scheduling is one of the most important components of project from initiation till completion and it should be continuously monitored and updated to overcome cost and time overrun.
- Construction on site should be managed in such a way that all activities remain uninterrupted. Manpower, equipment & machinery should be allocated based on the criticality of activities in order to ensure smooth running of project.

6.3 For Consultants:

- Drawings and design documents should be issued and approved timely.
- Drawings and design documents should be free from any errors and discrepancies.
- While deciding merit of claim, its substantiation needs to be thoroughly analyzed and inspected because disagreements on claim often lead to arbitration and litigation which are costly and time consuming.
- While evaluating contractor's works, consultants should remain flexible and cooperative.

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