



# APPLICATION OF ANP TO RANK DELAY FACTORS IN INDIAN PUBLIC SECTOR PROJECTS

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**Abstract—** Time and cost are the major consideration throughout the project life cycle and can be considered as the most important parameters of a project and the driving force of project success. This research work attempts to identify, investigate, and rank factors perceived to affect delays in the Indian Public Sector Projects with respect to ANP so as to proffer possible ways of coping with the delays in the execution of project. Expert's interviews and literature reviews are considered to prepare the delay factor list. The common delay factors were segregated based on to the frequency of appearance into the literature. The major 10 delays factors were critically examined considering the Analytic Network Process (ANP) to get the better results. The most important delay factors were listed and it will be helpful to the Public Sector Industry for effective project management of the Upcoming Public Sector Projects in the India.

**Index Terms—**Analytic Network Process(ANP), Causes of delay, Public sector Project

## I. INTRODUCTION

The literature revealed that successful projects should be completed before project due dates and within allocated budget. The causes of time overrun and cost overrun are important to the Earned value analysis of the project. Many researchers, in the literature, revealed that

project delays affect the company's performance and overall economy of the country's growth. The delays into the projects are usually linked with the time, cost and the quality. Any project considered to be successful when it delivered the desired deliverable within cost, allotted budget and the up to the customer's satisfaction. Every organization are desired to maximize their profit, to achieve this it is important for the every organization to carefully identify the factors that affect the success of project and estimate their impacts before bidding stage.

Project Schedule plays a key role in the project management due to its influence onto the project success. Project Delay causes considerable losses to the parties involved into the projects. The results of the delays are as follows: (1) Time Overrun, (2) Cost Overrun, (3) Poor Quality, (4) Disruption of Work, (5) Low Productivity, (6) Third Party claims, (7) Disputes (8) Termination of contracts. Therefore, a delay causes dissatisfaction of all the parties involved into the projects.

Most respondents were agreed that the frequent design changes, delayed payment by clients, contractors poor site management and cash flows, Poor planning are the leading causes of the projects delays and the Stakeholder management, large number of the contractors and the Environmental concerns are the least important causes. Objective of this research is to identify and rank the delay factor using the decision making tool Analytic Network Process (ANP). The outcomes can be used by not only local, but also international industry practitioners, who may be further interested in

venturing into potential mega scale projects, but possess no prior practical knowledge of the construction industry specially construction firms in India. It will be helpful to the project manager for the effective project management of the upcoming and ongoing site. The literature has identified several factors causing delay in construction projects that the researcher has explored in this study. This research ranks the factors causing delay in construction projects in India.

## II. LITERATURE REVIEW

In this paper four field have been selected to study in the literature review.. The first field includes the oil and gas, Second field includes those projects which are executed in a long path, such as highways and railways. The last and largest field is public/ governmental project executed in the world.

In Indonesia Trigunaryah identified that the 47% of the project were completed in scheduled time, 15% ahead of schedule and 38% behind the schedule. In majority of the construction industries large numbers of parties are involved which leads to the delays.

In details study of Mega sand Project in Alberta, Canada Jergeas identified the causes of the Time and cost overrun. The researcher, based on the 3 Mega oil sand projects found that after Root cause analysis the main reason of the delays are associated in the phase of Feasibility study, Risk management, Primary cost estimated, time estimation and engineering.<sup>[1]</sup>

There are many factors which are contribute to the delay causes into the planning and design phases, Yang and Wei investigated the delay causes and reveals that the most important cause is the frequent design change or changes in the clients requirement.

There are many factors that contribute with delay causes in construction projects. Sambasivan and Soon identified the causes and effects of delays facing in the Malaysian construction industry. A questionnaire was designed and distributed among the three major groups of participants (Owners, Consultants, and Contractors). They identified main causes of delay and 10(ten) most important causes were as follows: (1) Contractor's improper planning (2)

Contractor's poor site management (3) Inadequate contractor experience (4) Inadequate owner's finance and payments for completed work (5) Problems with subcontractors (6) Shortage in material (7) Labor supply (8) Equipment availability and failure (9) Lack of communication between parties (10) Mistakes during the construction stage. They identified main effects of delay and they were as follows: (1) Time overrun (2) Cost overrun (3) Disputes (4) Arbitration (5) Litigation and (6) Total abandonment. As an important contribution, they also studied the empirical relationships between the causes and the effects of delays.<sup>[2]</sup>

Assaf and Al-khalil investigated the delay causes in the large building construction in Saudi Arabia. They indicated the 56 delays factors. Their study concluded that preparation and approval of shop drawings, delays in contractor's progress, payment by owners and design changes. The architects and engineers view were cash problems during construction, the relationship between subcontractors and the slow decision making process of the owner are the major causes of delay.

Al-Kharashi and Skitmore (2009) studied the 10 previous researches done on public projects in Saudi Arabia as their research base. Their study concluded that total 112 delay causes exist in the public project in Saudi Arabia. 112 delay factors were recognized related to several parties and parameters of project including "client, consultant, contractor, material, contract, relationship, and labor". Final results present the most important cause of each group. Identifying delay causes can be studied from a different aspect. Delay is one of the root causes of conflicts in projects. Delay imposes much overhead cost on contractors and prevent owners from achieving benefits of project operation, so each party tries to blame the other side.<sup>[3]</sup>

According to Al-Momani (2000), the root cause of the owner and contractor disputes is "weak initial assessment of project duration". He investigated the causes of delay in 130 public projects in Jordan. The author tested the planed time versus actual time of projects and showed that there was a linear relationship between them. Finally, it was recommended that an adjustment should be done for initial assessment

of cost and time of projects.<sup>[4]</sup>

Elinwa and Joshua (2001) investigated delays are common in among construction projects; however, it seems that the governmental and public sector projects have the worst condition. They declared that while about 80 to 90% of all construction projects were faced with the delay, majority of the delayed projects (89%) belonged to the government/public sector. Furthermore, they asked four groups of professionals including architects, quantity surveyors, engineers, and builders to rank the 23-delay cause list<sup>[5]</sup>.

Gunduz et al. identified the delay factors in construction projects, since delays are considered to be a serious problem in the construction industry. Through detailed interview with experts from Turkish construction industry, a total of eighty-three (83) different delay factors were identified. The identified delay factors were categorized into nine (9) groups. The demonstration of these groups of delay factors was achieved by utilizing the Ishikawa (Fish Bone) diagram as it is capable of showing factors, interrelations between different groups of factors, and consequences affected from factors. They quantified relative importance of delay factors and demonstrated the ranking of the factors and groups according to their importance level on delay.

Mohammad Hossein Fallahnejad identified the 10 major delay factors in the Iran Gas Pipeline. The detailed interview with the experts and literature review he identified the 43 major delay factors into the Iran Gas pipeline. The delay factors were categorized into the 9 groups. With the help of the questionnaire survey, the ranking of the delay factor were done. Their research conclude that the major 10 delay factors were as below: (1) imported materials, (2) unrealistic project duration, (3) client-related materials, (4) land expropriation, (5) change orders, (6) contractor selection methods, (7) payment to contractor, (8) obtaining permits, (9) suppliers, and (10) contractor's cash flow.<sup>[6]</sup>

Marzouk et al. (2008) studied the engineering-related causes of delay. They found out 22 main causes related to engineering classified in three categories: "design development, work shop drawings preparation

and/or approval, and project parties' changes".<sup>[7]</sup>

Mansfield et al. (1994) presented some delay causes in Nigerian completed highway projects which are published by Nigerian Federal Ministry of Works and Housing. Mansfield et al. (1994) reviewed the causes of delays and cost overruns and found that there was a very good agreement between the respondents on those factors that could cause delays and cost overrun.<sup>[8]</sup>

Financial problems can be noticed as the root cause of many other delay causes. Some researchers focused on this topic due to its importance. Abdul-Rahman et al. (2009) investigated the financial problems which lead to delay in construction projects in Malaysia. They presented the root causes and mitigation actions and assessed the relationship between financial problems and delay.<sup>[6]</sup> Dlakwa and Culpin (1990) tried to explore causes of cost and time overruns. They found 17 causes for time overrun and 5 main causes for cost overrun. They presented that the item "payment delays to the contractor" had a very important role in project delay. By using a questionnaire survey, they ranked the main causes of delay in Nigerian public sector construction projects from each party's point of view. There was a consensus among all parties: agencies, consultants, and contractors the financial problems were the most important causes.<sup>[9]</sup>

In a study comparing the performance of international development projects in India, China, Bangladesh, and Thailand, Ahsan and Gunawan (2010) reported that construction projects in India showed the worst schedule performance (Ahsan and Gunawan, 2010). The study found that in India average schedule overrun is the highest (55% of actual schedule) compared to the other nations. Construction projects, especially infrastructure projects, in India have come under tremendous international scrutiny in the wake of the recent 2010 Commonwealth Games (Hindustan Times, August 2009). The current status report published by the Ministry of Statistics and Programme Implementation (MOSPI) highlighted that out of the 951 projects being monitored 309 projects have cost overruns and

474 projects are behind schedule. MOSPI has reported that “Of the total reported cost increase of USD 12.4 billion, USD 8.4 billion is on 466 delayed projects” (www.mospi.nic.in). Reasons for these problems range from land acquisition, improper planning and budgeting, to poor coordination and monitoring of the projects.

Lo et al. (2006) identified 30 causes of delay in Hong Kong construction projects fewer than 7 categories namely client related, engineer related, contractor related, human behavior related, project related, external factors and resource related. Using rank agreement factor (RAF), percentage agreement (PA) and percentage disagreement (PD) difference in perceptions of various construction practitioners on causes of delay.

In India, Iyer and Jha (2005) identified the project success and failure attributes and their latent property failure attributes being: conflict among project participants, ignorance and lack of knowledge, presence of poor project specific attributes and non-existence of cooperation, hostile socio economic and climatic condition, reluctance in timely decision, aggressive competition at tender stage, short bid preparation time.

Chan and Kumaraswamy (1997) compared the results of the research in Hong Kong with researches done in Saudi Arabia and Nigeria and found that the respondents’ interpretation of causes and their importance are different. On the other hand, they presented that each project party may have its own interpretation, so researchers must adopt extracted factors concerning their own conditions.

#### A. Analytic Network Process (ANP)

The analytic network process (ANP) is a methodology for multi-criteria decision making used to derive priorities of the compared elements in a network hierarchy, where the dependences and feedback within and between the elements can be considered. In the ANP, the network allows clusters of element influence each other, or has loops if the elements in the clusters have inner dependences. So the network spreads out in all directions and its clusters of elements are not arranged in a particular order (Saaty, 2004).

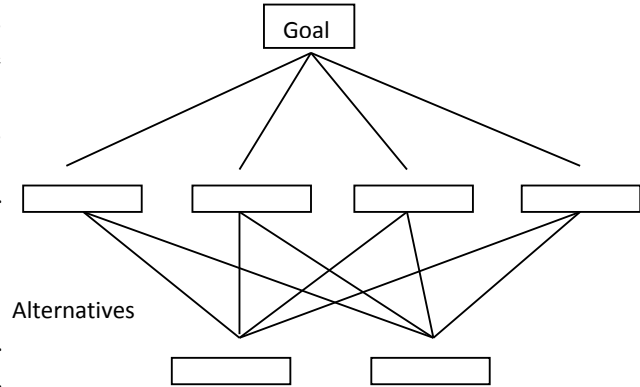


Figure 1. ANP Decision Tree

In the literature, ANP has been applied in many complicated decision making problems. The ANP has its own advantages and has produced ideal results in various fields. Chung et al. proposed ANP for the selection of product mix for efficient manufacturing in a semiconductor fabricator. Coulter et al. developed and tested a comprehensive model for media selection and budget allocation using the ANP technique. Gencer and Gurpinar proposed the decision making model based on ANP and implemented in a company of electronic firm. Wu et al. made an attempt to evaluate the favorable management strategies using ANP approach. Chen et al. incorporated the ANP approach to partner selection for strategic alliance. Yang et al. proposed an evaluation and measurement of manufacturing performance for wafer fabricating industry by implementing ANP technique. Banaret al. applied the multi criteria decision approach for choosing a recycling system using ANP and ELECTRE II. Nikolai Bobylev implemented ANP approach to select optimum underground sewer construction technologies. Pramod et al. applied ANP Analysis in Indian Telecommunication Service Supply Chain. Yazgan et al. presented an ANP method to determine the weights of selection criteria for civil pilots. Das et al. implemented ANP technique for selection of optimum non-traditional machining processes. Toosi et al. used ANP as an effective tool for ranking water transfer projects. Shahroudi et al. used a Multi-Criteria Decision Making approach of ANP-TOPSIS to evaluate suppliers in Iran’s auto industry. Chena et al. implemented an ANP technique to select green supply chain

management strategies in an electronic industry . Shiue et al. performed an evaluation of optimal recycling strategy for waste in solar energy industry based on BOCR model using ANP technique. Promentilla et al. has proposed an ANP technique to rank the potential CO<sub>2</sub> sources and sinks to identify sites for CO<sub>2</sub> capture and storage demonstration projects.

Table 1.ANP Scale

Scale	Meaning
1	Equally importance
3	Moderately importance
5	Strongly importance
7	Very strongly importance
9	Extremely importance
Other values between 1 to 9	Intermediate values used to represent compromise

### III. RESULTS AND DISCUSSION

The delay factors found into the literature has been critically analyzed using the Analytic network process (ANP). The SuperDecision Software has been used for the formulations of the problem model. The views of the industrial experts have been used for the pairwise comparison of the delay factors. The results obtained from the SuperDecision software are mentioned in the below table.

Table 2.Final Ranking of Factors from ANP Tool

Payment delay by client	0.215
Frequent design changes	0.179
Unrealistic schedule imposed by client	0.15
Contractor poor cash flow and site management	0.107
Lack of schedules and plans	0.1051
Delays in subcontractor work	0.069
Slow delivery of material	0.049
Non availability of technology	0.0381
Large number of contractor	0.0304
Delays in transportation of material	0.016
Stakeholder management	0.013

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