

# Delay Management A Fast Track Mitigation Strategy Using ERP

Sudeesh Thembalath<sup>1</sup>, Jeena Mathew<sup>2</sup>P.G Student, Department of Civil Engineering, SNGCE, Kadayiruppu, Kerala, India<sup>1</sup>Associate Professor, Department of Civil Engineering, SNGCE, Kadayiruppu, Kerala, India<sup>2</sup>

**ABSTRACT:** This study investigates the causes of delay in building construction projects in Ernakulam, Kerala and determine the most significant factors affecting construction project. Possible causes of delay identified from the literature survey and by face to face interviews with experts in the industry. Questionnaire survey was conducted for the identification of the most important factors causing delay. The range of survey includes contractors, clients, consultants, project managers, site engineers etc. Analysis of questionnaire survey was done using SPSS software. The relative importance of the individual causes and the groups are calculated and ranked by their relative importance index. The most significant delay causing factors found in the research are client, consultant, labour, managerial and contractor issues. Case studies has been conducted in the locality as a validation for the results obtained in the survey and the factors from case study showed maximum resemblance with the survey result. Root cause study was done on the significant factors by interviewing the experts in the field and it was understood that an ERP system can control significant delay causing factors. Implementation of a six dimensional ERP system is suggested as the best possible remedy to control delay, the statement is supported with case study on a normal project and ERP implemented project.

**KEYWORDS:** Causes of delay, 6D ERP, SPSS, Questionnaire, Survey, Managerial issues

## I. INTRODUCTION

Construction is the second largest industry in India and therefore having a proper control on the complexities of construction project is the area of interest for all in construction sector. The industry plays a vital role in developing the country's infrastructure, a pre-requisite for high level of economic growth. During the construction planning process as well as during the subsequent construction phase a large number of technical planners, engineers, architects, companies, craftsmen, consultants, public authorities and supporting public bodies are involved. As the complexity is high, the chances for delay are inevitable. Construction projects are often delayed by unforeseen conditions and managerial issues [10]. This problem can be sorted out only by highly experienced people in the field and the efficiency depends on the talent of the person handling the project. Handling multiple and complex issues manually is time consuming and is of high risk. A successful project is the one which completes the targets as per planned schedule and minimum cost. A variety of software packages have become available to support the application project control methods, for example Microsoft Project, Asta Power Project, Primavera, etc [11]. The project delivery system is a key factor in enabling successful implementation of a building project [12]. A standardized approach to explore the possibilities and advancement in project management can be done through Enterprise resource planning.

An Enterprise Resource Planning (ERP) system is a fully integrated business management system covering functional areas of an enterprise like Logistics, Production, Finance, Accounting and Human Resources. The implementation of this system is a difficult and high cost proposition that places tremendous demands on corporate time and resources. Most of the ERP implementations have been classified as failures because they did not achieve predetermined corporate goals. Over 40% of Indian construction projects are facing time overrun ranging from 1 to 252 months; the reasons for which are being studied by researchers to suggest possible remedial measures[1]. The main goal of this research is to identify the significant factors causing delay and to prove efficiency of an ERP system to control delay in Kerala.

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## II. RESEARCH OBJECTIVE

The main objectives of this study are:

1. To identify the significant factors causing delay in construction.
2. To evaluate delays factors, its significance and related issues.
3. To measure the impacts of significant factors causing delays on completion and cost of the project.
4. To do root cause study on top five delay causing factors.
5. To prove the efficiency of an ERP system to control delay.

## III. LITERATURE REVIEW

A construction project delay is defined as the time during which part of the construction project has been extended beyond what was originally planned due to unanticipated circumstances or the time overrun beyond project delivery date. The factors causing delay varies to location, the is the reason for delay in India can be different from that of United States. Phaniraj K and K S Sreekumar(2014) says “a construction project is successful only if the target(s) is/are achieved as per schedule”[2]. As per Owolabi James, AmusanLekan et al (2014)“project management problem, mistake and discrepancies in contract document, equipment availability and failure, mistakes during construction, bad weather, fluctuation in prices of building materials, inappropriate overall organizational structure linking to the project and labour are the significant factors causing delay”[3]. As per K. L.Ravisankar, S. AnandaKumar et al(2014) “Shortage of unskilled & skilled labour, Design changes by owner or his agent during construction, Fluctuation of prices, High waiting time for availability of work teams and Rework due to errors are the top five delay factors which affect construction project”[4].

MoutazHaddara (2014) says “Enterprise resource planning (ERP) systems are large and comprehensive packaged information systems (IS) aimed at integrating business processes and functions”[5].SadraAhmadi (2015) says the readiness of any organisation for accepting an ERP system is an important issue in the pre-implementation stage[9].According to HongyiSun(2015) a significant way to overcome ERP delay is the administration of critical success factors[8]. As per E. W. T. Ngai, C. C. H Law et al (2008) “ Top management support, training and education are the most important critical success factors of an ERP system” [6].As per M. Moazzami, R. Dehghan et al (2011) ”Fast tracking is generally defined as the compression of the design and/or construction schedule through overlapping of activities or reduction in activity durations”[7].

## IV. RESEARCH METHODOLOGY

In the first phase, a literature search and a detailed study on the working strategy of a construction organisation was conducted. The literature review was conducted through books, internet and international project management journals that resulting in identifying 52 causes factor of delay grouped into 12 major groups which are further categorised as internal factors causing delay and external factors causing delay.The internal factors causing delay are Contractor related, Client related and Consultant related issues and external factors causing delay are Climate related, Geotechnical, Material related, Political related, Equipment related, Area condition, Labour related, Managerial issues, and other aspects. The first part of questionnaire compose of collection of general information concerning respondents and the second part include the list of identified causes of delay in construction projects. The respondents were requested to give their response to each factor based on their experience. Each 52 factors were to be answered for both probability of occurrence of delay and severity of impact of delay factor on cost in five point Likert scale. The Likert scale values were as follows: (0: no probability to happen, 1: unlikely, 2: Likely, 3: Almost certain, 4: Certain). One hundred questionnaires were distributed in Ernakulam and its premises, Kerala. Sixty five of them responded correctly. The collected data was checked for reliability of research using Cronbatch Alpha value in SPSS. The collected data are then ranked using Relative Importance Index (RII).

In the second phase a case study was conducted in Ernakulam on three different delayed construction projects. The factors lead to delay was studied on all the three projects. A root cause study was done on top five delay causing factors to find the possible ways to control delay.Inthe third phase of the research the working of Addspro ERP was studied and a case study was conductedon two projects one on which ERP is implemented and other without ERP implementation.Conclusion is made on the basis of study.

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## V. DATA ANALYSIS

### 5.1 Reliability Test

Cronbach's alpha reliability test is used for ensuring reliability of the questionnaire responses. When using Likert-type scales it is imperative to calculate and report Cronbach's alpha coefficient for internal consistency reliability for any scales or subscales may be using. The alpha value is inflated by a larger number of variables; so there is no set interpretation as to what is an alpha value. A rule of thumb that applies to the most situations is '≥ .9:Excellent', '≥ .8:Good', '≥ .7:Acceptable', '≥ .6:Questionable', '≥ .5:Poor' and '< .5: Unacceptable'. To make sure that the responses will be comparable if the questionnaire is used twice, a reliability test was performed. The value of reliability was obtained by using SPSS software. Cronbach's alpha is designed as a measure of internal consistency.

### 5.2 Relative Importance Index (RII)

The questionnaire survey asked the respondents to rate the probability of occurrence and severity of its impact on cost. The Likert scales provided ranged from 0 to 4. The quantitative measures of the probability of occurrence and the severity were obtained using the same scale that was assigned to them. But for some factors severity range is not equal to frequency range, as some factors which cause very often cause extreme severity. In such cases severity range is reversed so that the analysis will be more accurate when severity of impact on cost is considered.

The RII was calculated by using the formula as below:

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

Where, w = weight of scale; A = highest weight ('4' in this case); N = total number of respondent. The Relative Importance Index was important in identifying the major causes of delay and severity of its impact on cost. RII helped to rank the factors which are the main causes for time and cost overrun. Higher the value of RII, higher the importance for factor causing delay.

## VI. RESULTS

The Cronbach's Alpha value is calculated as 0.965 for probability of occurrence of delay factor and 0.955 for severity of its impact on cost. As the Cronbach's value is greater than 0.9, the results of questionnaire survey is excellent and can be used as genuine data for the research. The top delay causing factors that has maximum probability of occurrence and has maximum severity of impact on cost are ranked in table 1.

Table 1: Ranking of delay factors

Sl No.	Probability- occurrence of delay			Severity of impact of delay on cost		
	Delay Factors	RII	Rank	Impact of delay on cost	RII	Rank
1	Client	0.818	1	Client	0.842	1
2	Consultant	0.728	2	Consultant	0.769	2
3	Labour	0.71	3	Labor	0.742	3
4	Managerial issues	0.632	4	Contractor	0.658	4
5	Contractor	0.627	5	Managerial issues	0.645	5
6	Material	0.612	6	Material	0.634	6
7	Other aspects	0.512	7	Other aspects	0.544	7
8	Climate	0.473	8	Climate	0.519	8
9	Area condition	0.471	9	Area condition	0.487	9
10	Equipment	0.442	10	Equipment	0.486	10
11	Political	0.405	11	Geotechnical	0.435	11
12	Geotechnical	0.356	12	Political	0.419	12

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## VI. CASE STUDY

Taking just one method to collect data may not help the research study to be conducted well and that using other methods will assist in collecting enough and accurate information. Even though there are strength and weakness in using those strategies above for data collection, they provided better solutions to the research study in question than other methods that I have come across. In this project case study was conducted to correlate with the collected data. Survey results can consider as almost reliable data, even though, to have more idea about the present situation in construction industry, case studies were been conducted.

### 7.1 Case study on Residential Apartment, Trippunittura

AB Tower is an ongoing Apartment project in Trippunittura, Ernakulum with basement and ground floor for parking and first to thirteenth floor for residential purposes. The structure is a little complicated one as all the exterior columns are floating on Basement floor beams, the work was started in June 2015. It was identified that the estimated cost of the project was about 15 Cr and planned completion time was June 2017. But the project was delayed by about 6 months at the primary stage itself and the loss so far is calculated around one crore, i.e. till May 2016. So to collect the details about the building, a detailed enquiry had been done with the project engineers and identified some of the major causes which leads to time as well as cost overrun in that residential building. Change in decision by the Client:

All the works were assigned to appropriate consultants, contractors etc. But at the time of first floor casting the drawing provided by the structural consultant was found risky to take complete load acting on it and as the client was not ready to take any risk the Structural consultant was changed at the stage when the basement floor was almost completed.

#### Change in design by the consultant:

As per the new structural drawing in order to maintain the structural stability, eight additional piles are to be casted and all the existing columns were to be retrofitted by jacketing. Major portion of the slab which was already casted for basement was removed for the requirement of eight additional piles. Micro concreting was done as concreting is difficult in retrofitting process which is around three times expensive. Dynamic load test was done again on the basis of new drawing.

#### Contractor related issues in delay:

As the structural drawing got changed, the rate for additional works like demolition etc was quoted again by the contractor. Contractor was paid around twenty lakhs as compensation. The project was completely stopped for two months and it took another four months to reach back into the same level where inconsistency was felt once.

#### Managerial issues:

Managerial issues were severe as it was a takeover project. Electrical and ACP contractor left the work without completion. Old drawing and new drawings with different consultants and contractors created confusion. Cash flow management was affected in the fast completion of the work. Management failed to attach the unit rate quoted in 2012 for the building with the parking facilities near to it, which made the client to pay on 2016 local market rate basis to the contractor which is around 30 percent more than that of 2012, table 2 shows the comparison of contract rate.

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Table 2: Comparison of contract rate

SL.NO	DESCRIPTION	AMOUNT(2012)	AMOUNT(2016)
1	Earthwork Excavation	Rs 300/m <sup>3</sup>	Rs 450/m <sup>3</sup>
2	P.C.C 1:4:8 using 40mm nominal size broken stone for plinth beams, pile caps, lift pits, etc. including cost, conveyance, stacking and unloading of all materials, all labour, watering, curing, etc. complete	Rs 4400/m <sup>3</sup>	Rs 6500/m <sup>3</sup>
3	RCC M30 mix using 20mm size broken stones machine mixed for BEAMS as per structural and architectural drawings including the cost of material.	Rs 14000/m <sup>3</sup>	Rs 20000/m <sup>3</sup>
4	RCC M30 mix using 20mm size broken stones for Roof Slab as per structural and architectural drawings including cost of material and labour.	Rs 12000/m <sup>3</sup>	Rs 17000/m <sup>3</sup>
5	Cement concrete solid block masonry in cement mortar 1:6 using solid block of size 30x15x20cm, including cost, conveyance and unloading of all materials, all labour, scaffolding, watering, curing etc. complete	Rs 3500/m <sup>3</sup>	Rs 5100/m <sup>3</sup>
6	Plastering with cement mortar 1:4, 12mm thick one coat floated hard and trowelled smooth to the internal walls including the material cost	Rs 160/m <sup>2</sup>	Rs 250/m <sup>2</sup>

### 6.3 Case study on Commercial cum Residential building, Kakkanad

RKS is an ongoing commercial cum residential project in Kakkanad, Ernakulam with basement to sixth floor for parking and shopping purpose and from seventh to thirteenth floor for residential purposes. It was a takeover project which was left incomplete at the primary stage. The work was started in July 2013. It was identified that the estimated cost of the project was about 16.5 Cr and planned completion time was March 2016. But the project was delayed by about 6 months and as per the corrected schedule, the expected date for completion is September 2016 and the expected cost at the time of completion is 18cr. So to collect the details about the building, a detailed enquiry had been done with the project engineers and identified some of the major causes of delay.

#### Cash flow from client:

There was a delay in payment by the client as two new projects were launched by the client in the meantime. The loan amount which was promised by the bank and the stage wise payment by the customer was not made in time as there was a delay from the builder to complete the level as per the contract with the bank and the customers.

#### Design Changes:

Initially the building was designed as first eight floor for parking and shopping, remaining for residential purpose. The building was left abandon by the former builder and then was taken over by Blue Berry. Small changes were made of the architectural and structural drawings. As per the new first six floors were allotted for shopping and parking, remaining for residence. Plumbing consultant prepared drawing as per the old drawing on which the tender was quoted which was different from the actual. Around four months were delayed in order to recognize the mistake and make new drawings.

#### Labour Issues:

North Indian labors completely vanished from the site at the time of election, as the election was held in five stages the company had a tough time to find labour. The output gained from local labour's is 6.5 hours a day where as we can get

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complete 8 hours output from North Indian labour's. When the salary is compared, for eg. Mason, the labor charge for North Indian mason is Rs 600 per day whereas Rs 900 is the daily labour charge of a local mason. Union labours created problems on their payment and the tile and electrical works were delayed from scheduled date.

## Contractor related:

Work was stopped about one week due to complaints on quality of work and there was a delay in progress of work when the quality control from client side got strict. Ex. The shuttering sheets which were used four cycles were not allowed to use in fifth cycle etc. The rate quoted was in the year 2012 and the present rate is too high on which the contractor was not possible to go ahead with the contract and there created an issue at the completion time of the contract period, that is on march 2016 and the client was forced to increase contract rate. The drawings for outside car parking, sump tank, septic tank etc were prepared after the quote by contractor, but when considered from client side, unit rate is quoted and so will be the same for additional drawings too which was prepared immediately after quote.

## Managerial issues:

Managerial issues were severe as it was a takeover project. Electrical and ACP contractor left the work without completion. Old drawing and new drawings with different consultants and contractors created confusion. Cash flow management was affected in the fast completion of the work. Management failed to attach the unit rate quoted in 2012 for the building with the parking facilities near to it, which made the client to pay on 2016 local market rate basis to the contractor which is around 30 percent more than that of 2012. Delays were occurred when the consultant staff is late to the site for site inspection and mistakes marked on the day of concrete.

## VII. VALIDATION

The case study can be considered as a validation of questionnaire survey. The results obtained from both studies are comparable. Case study mainly pointed out the client issues, consultant issues, labour issues, managerial issues and contractor issues as the top most factors lead to delay and the impact on delay on cost was clearly explained in AB Tower, Trippunittura. While reviewing it's identified that the identified factors in case study are included in the identified top ranked factors in questionnaire survey. So it's able to say that the questionnaire survey done was reliable and the identified top five ranked factors of delay as well as impact of delay on cost can be consider as the major causes for delay and loss in building construction.

## VIII. ROOT CAUSE STUDY

After finding the top five delay causing factors, root cause study was conducted in the form of a semi-structured interview with experts (Client, Consultant, Contractor) having a minimum of 25 years' experience in the industry. The key points from root cause study are: Client related- Decision change, lack of clear cut image of complete project. Consultant related- Design changes, Systematic management of digital data is either missing or discontinuing. Labour related- Lack of labour productivity measuring techniques, Labour satisfaction measures to control absenteeism. Managerial issues- Planning, Inadequate techniques to make sudden changes of scheduled work for facing unexpected scenarios. Contractor issues- Contractors overbooked on other projects, usage of old construction techniques.

From root cause study it is clear that simultaneous solutions are required for multiple issues to have a proper control on delay which can be obtained by a well-structured ERP system.

## IX. SOLUTION

### 10.1 Addspro ERP

Addspro ERP is a web based 6D (Length, breadth, height, cost, time, information exchange) enterprise resource planning system. Addspro intends to connect the engineering aspect with ERP system so that time delays due to overlap or redoing the same work which was one at one stage by consultant firms are not overlapped with the works

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done by management firms. Eg. Structural software like RCDC by Bentley gives complete reinforcement detailing and detailed estimate of the structure with high range of accuracy, but this output from structural firm is less often carried to the management firm and complete estimate is again done manually which is time consuming.

The advantages of using Aadspro ERP system are: Integrate the output from fast track software, Make a workflow structure by connecting a time factor, Create data for managing the works at site, Integrating all the works and inventory, Managing the stock of materials and labour, Managing Human Resource, The Gantt chart used in the ERP system can be exported to other programs like MSP etc for resource crushing and smoothening, The data from the site is directly entered into the system by the site engineer and therefor time lag can be controlled and quality can be improved.

## 10.2 Case Study on ERP Implemented Project

A case study was conducted of two similar projects one on which Addspro ERP was implemented which is located at Kaloor and another with normal construction method which is at Kadavanthra. Table 3 shows time schedule of each project and it is seen that the ERP implemented work is completed in 370 days and the work in Kadavanthra took 591 days for completion. Here approximately around 200 days are saved by the implementation of ERP system. For a project with Rs 2500 per square feet land cost and Rs 2500 per square feet construction cost the total investment comes Rs 5000 per square feet. If such a project is delayed by one year the losses to be faced are 10 percent interest amount as most of investments are on bank loan, 7 percent inflation cost and 3 to 5 percent rate of return together makes a loss of 20 percent which is Rs 1000 per square feet. In addition to this an ERP implemented project can make a profit of 10 percent on the material and labour expenses which comes around Rs250 per square feet. That is the loss on actual construction cost reaches Rs6500. This proves that an ERP implemented construction project can reduce the total cost of the project by 30 percent.

Table 4: Time comparison with and without ERP implementation

Project		Normal Project	ERP Implemented Project
	Contractor	APP Constructions	APP constructions
Project details	Location	Kadavantra	Kaloor
	Floors	B+G+4	B+G+4
	Floor Area	15610	14730
	Foundation	Pile+Raft	Pile+Raft
	Pile Depth(Approx.)	33	47
	No. of Piles	27	20
	Raft slab depth	30cm	30cm
	Floor Height	4m	4m
	Project Starting Time	10/4/2014	2/5/2015
	Project Finishing Time (Structural)	7/2/2016	1/6/2016
	ERP implementation	No	Yes
	Planning	Yes	Yes
	Scheduling	Yes	Yes
<b>Duration</b>		<b>Days</b>	<b>Days</b>
<b>Pre-Construction</b>			
Architectural Planning/ Working drawing/Approval/ BOQ		30	20
Structural Design			
	Layout Preparation	1	1
	Modelling in computer	3	3
	Analysis and Design	3	3

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	Detailing	12	3
	Estimation	15	2
	BBS Preparation	5	1
	Total	69	33
<b>Construction (Structural)</b>			
	Work Planning	21	3
	Piling	39	37
	Basement	45	23
	Ground Floor	42	21
	Second Floor	35	32
	Third Floor	37	24
	Fourth Floor	37	25
	Fifth Floor	45	24
	Terrace	41	28
	Total	342	217
<b>Finishing and furnishing</b>			
	Total	180	120
<b>GRAND TOTAL</b>		<b>591</b>	<b>370</b>

## X. CONCLUSION

A successful project is the one which completes the targets as per planned schedule and minimum cost. Construction schedule delays in a project can cause major problems for all the project participants. Occurrence of delay varies from project to project which emphasis the necessity of defining the reason behind delay. In my study 52 delay causing factors were found out and was grouped into 12 major factors. The factors causing delay were analysed using SPSS software and was ranked using relative importance index(RII). The top five delay causing factors which has maximum probability of occurrence using RII are Client related, Consultant related, Labour related, Managerial issues and contractor related. The case study conducted in three different delayed projects justify that major delay occurred due to this top five delay factors. From root cause study it was clear that a well-structured ERP system can have simultaneous control on multiple tasks been carried out for the project.

Implementation of a well-structured six dimensional ERP system is suggested as the best possible remedy for delay management and to minimize the impact of delay causing factors. It was proved from the study that a wastage of 30 percent of actual cost can be saved by the implementation of ERP system.

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