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Factors Influencing Time Contingency Assessment In Construction Projects

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ABSTRACT:- *Time schedule is a crucial task in construction project management. For instance, it can materially help to identify the expected financial requirements. It is also an important tool for the time control process. Construction project time schedule is greatly affected by many uncertain but predictable factors. Hence, a certain percentage of time contingency should be added to the scheduled time to arrive at more a reliable time schedule. This research list the main factors affecting time contingency and discusses their influence on schedule performance. In addition, a Analytic Hierarchy Process (AHP) model was developed in order to help the project planner to predict a more reliable time for an activity.*

Keywords:- *Time contingency, AHP Model Analysis*

I. INTRODUCTION

The main goals of any successful construction project management system are to complete the project on time, within the planned budget, and with the required quality limits. The three goals are inter-related where each of them is affecting, and being affected by, the others.

In order to meet the time deadline of a project, an accurate scheduling should be sought. Due to the unique nature of construction projects, time contingency and project uncertainty are essential for accurate scheduling, which should be flexible enough to accommodate changes without negatively affecting the overall duration of the project. It is essential to allocate a contingency value to both cost and time. Yet, there are situations where there could be delays in activities that result in a delay in the overall project duration.

These delays will consequently have a negative impact on the quality and budget of the project. Therefore, estimating time contingency is seen as a major factor for achieving a successful construction project. Therefore, the objective of the presented research in this paper is to identify the factors that affect schedule (time) contingency and develop a model that predicts the expected contingency of a construction project.

II. DATA COLLECTION

This research aims to identify the main factors which have effects on projects time contingency in the Indian construction market. Identifying these factors can help to accurately assessment the required time contingency which should be added to the project planned duration.

Eighty four factors were collected based on literature review as shown in Table 1. Such factors were identified based on the work provided by references Based on these factors, two forms of questionnaire were prepared in this research; first, aims to rank the previously identified factors according to their expected impact and probability of occurrence through direct interviews with the Indian construction market experts.

Then, the most important factors were identified. Second, data gathering sessions were conducted for 60 building construction projects.

Table 1- List of Factors Affecting Time Contingency, Based On Survey and References

Serial No.	Factor	Serial No.	Factor
1.Project Condition			
1	Project Location	2	Project Design complexity
3	Equipments shortage [Construction technology]	4	Material shortage [Market]
5	Project location [Near from governmental Buildings i.e. embassies, ministries, .etc]	6	Preparing the plan during project preliminary Stages[i.e. Initiation, Tender phase]
7	Limited time allowed for preparation of the schedule	8	Missing Project Scope Items [conflicts between project documents].
9	High Level of Quality requirements	10	Lack of Experience in similar projects.
11	Lack of Consultant Experience	12	Unexpected onerous requirements byclient's supervisors [Not a change order]
2.Management Conditions			
2.1 Contractual:			
13	Great Scope Changes [i.e. change scope from core & shell to complete finishing]	14	Deficiencies, errors, contradictions, ambiguities in contract documents
15	Change orders	16	Contract Risks [Force Majeure]
	Inadequacy of detailed drawings	18	Contract type: Lump sum
19	Contract type: Re-measured	20	Context of Contract
21	Inadequacy of dispute settlement procedures		
2.2 Time:			
22	Payments [Delays]	23	Risks related to Governmental Authority Constraints which limit the project completion date or any other stage
24	Imposed Holidays	25	High Percentage of critical activities in the baseline
26	Inaccurate planning by any party	27	Inaccurate control & follow up
28	Workload on the contractor resources	29	Client delays commencement date.
30	Client suspend works	31	Late project changes
32	Long time to make or take a decision	33	Delays in resolving litigation/ arbitration disputes
2.3 General:			
34	Unfavorable interference in work sequence	35	Amount of interference [lack of knowledge or experience in any party]
36	Inadequate supply, quality, timing of information and drawing by designer	37	Unexpected inadequacy of pre-construction site investigation data
38	Poor dispute resolution mechanism		
2.4 Environmental Conditions:			
39	Bad Weather conditions	40	Labor strike
43	Unknown geological conditions	44	Labor restrictions
2.5 Economical Conditions:			
45	Economical stability [Unexpected conditions such as Economic Crises]	46	Material Market rates [Escalation, Inflation or fluctuation]
47	Design changes due to Market Demand [i.e. town houses instead of large villas]		

2.6 Country Conditions:			
48	Fraudulent and kickbacks in laws	49	Administration[Bureaucratic towards foreign investment..etc]
50	Laws and regulations [e.g. Import and export regulations]	51	Unavailability & Bad Quality of Resources
52	Changes in regulations and law	53	Fraudulent and kickbacks in laws
3.Factors related to Contractor:			
55	Shortage of experienced staff and labors	56	Contractor start delay [i.e. project starting or concrete pouring milestones…etc]
57	Contractor poor performance	58	Efficiency of planning by contractor
59	Bad Relationship between top management and site Staff	60	Bad Relationship between site management and Laborers
61	Bad relationship between Contractor's representatives and Client representatives	62	Inadequate control over subcontractors
63	Bad coordination between laborers	64	Poor productivity of equipments
65	Fire	66	Theft
67	Contractually defined "expected risks"	68	Unforeseen events [i.e. Great Accidents…etc]
69	Inadequate tender pricing	70	More than estimated waste of materials in site
71	Poor productivity of laborers	72	Disputes on site between laborers
73	Poor performance of claim engineer	74	Lack of coordination between Engineer and Contractors
75	Contractor financial difficulties		
4.Factors related to Subcontractor:			
76	Extra duration due to variability of subcontractors bid	77	Uncertainties related to subcontractor's technical Qualifications
78	Uncertainties related to subcontractor's financial stability	79	Uncertainties related to subcontractor's quality of material and equipment
5.Factors related to Planner:			
80	Planner's personality traits	81	Clerical errors
82	Planner's biases in technical issues	83	Wrong method of estimating
84	Planner's lack experience		

III. THE MOST IMPORTANT FACTORS

The questionnaire respondents were asked to provide numerical scoring expressing their opinions based on their experience in the construction field in India. The respondents have inserted two scores in front of each factor. First, the degree of impact of each factor on projects time contingency.

Second, is the probability of occurrence of each factor. The Time Contingency Effect [TCE] was concluded by multiplying the impact of each [total score of TCEs]; N = total number of respondents to each factor.

All factors have been considered as a ratio of the most important factor. Weights greater than 70% are considered highest important factors based on a survey with construction consultants in india using a questionnaire aims to find out the most important factors among all factors. Based on the previous analysis, the most important factors were shown in Table 2 which illustrates the most important 11 factors affect time contingency

Table 2 MOST IMPORTANT FACTORS

Criteria	**Factor**	**Description**
Project Conditions	Project Location	Location may influence the amount of risk and therefore the level of contingency.
	Project size (Design complexity)	It affects planned schedules negatively. In the large projects there are many various activities that required many different resources and involved many parties. All of these variables are interfering together which may cause delay in the project duration.
	Equipments availability (Construction technology)	Technology requirements comprising of method of construction "equipments" Issue of renting equipments, damages that may occur will increase contingency.
	Material availability (Market)	This factor is related to the site condition and storage area. Transport material from the supplier to the site is time consuming which required a prior arrangement.
Management condition	Amount of interference (Skills)	Any project could have stop work order because of the owner or engineer interference, this is happened due to lack of knowledge and experience from all the participants. If the amount of interference increased the delay of schedule will be increase until they make their decision.
	Number of change orders	Change of orders or extra work order usually requires long process of redesigning or modifying specification. In addition the extra work may force the contractor to accelerate work which could cause loss of the labor productivity and then caused the delay.
	Payments (Delays)	Any delay of payment may cause delay of supplying resource to the project which will affect the planned schedule.
	Time to make a decision	Owner is the main responsible in this case until he/she makes the decision of change or not. The contractor should record this delay against the owner in case of claim.
	Productivity of labor and equipments	Losing of labor productivity that caused by acceleration or extra work will affect the project schedule. Any damage of equipment will cause serious delay on the current activity consequently causes delay in project schedule.
Environmental	Weather condition	Weather in some countries has the highest impact on the schedule delay.
	Soil condition	Some unforeseen soil conditions in the site cause delay in the schedule.
	Labor strike	This stoppage will cause delay in project schedule.
	Shortage of human resources	Some unforeseen events like work accident, sickness, social, psychological and other unpredicted event may cause labor pain, or absenteeism. Hence, this factor will cause delay in the activity and schedule.

IV. DEVELOPMENT OF TIME CONTINGENCY MODEL

Analytic hierarchy process (AHP) has been widely used and applied in different fields of theory and practice (Al-Barqawi, 2006; Saaty, 1982 & 1991). It has been applied in multi-criteria decision making, planning and resource allocation, conflict resolution, and prediction problems (Saaty, 1982 & 1991). Therefore, the AHP is used in the presented research to assess the weights of various factors that affect time contingency through pair-wise comparison matrices. These matrices have several important characteristics.

Typical Pair-Wise Comparison Matrix for Different Factors

Factors	**a1**	**a2**	**a3**	**a4**
a1	1	a12	a13	a14
a2	a21	1	a23	a24
a3	a31	a32	1	a34
a4	a41	a42	a43	1

1. The diagonal elements are all equal to one because they represent the comparison of a criterion against itself.
2. The lower triangle values are the reciprocal of the upper triangular values.($a_{ij} = 1/a_{ij}$)
3. All numbers in the matrix are positive.
4. Square matrix (i.e. number of rows equal to number of columns) The weight of each factor is determined using Equation (1) as follows.

$$Wx = \sum_{j=1}^{j=n} \frac{a}{\sum_{i=1}^{Nn} aj} \text{-------------------------(1)}$$

Where a_{ij} represents the matrix elements for I row and I column; n represents the pair wise comparison matrix dimension; and Wx represents the weight of factor x.

After determining the weights of the each factor n the hierarchy, the time contingency (C_D) is developed using the model shown in equation (2)

$$C_D = \sum_{i=1}^{n} Wi * Si * Pi \text{ ----------(2)}$$

Where, Wi- represents the general weight of factors I;
Si- represents the score of each factor in a specific project
Pi-represents the probability of occurrence of factor I Cd – Time contingency

V. TIME CONTINGENCY MODEL IMPLEMENTATION

The following are the steps that were used to develop time contingency model using the collected data.
1) Determine the relative weight of each major category; i.e. project conditions, management conditions and environmental conditions.
2) Determine the weights (Wi) of the sub factors relative to the weight of its category.
3)Calculate the factors score (Si) for each of the thirteen factors (using a 1 - 4 scale) in which one represents the most ineffective and nine represents the most effective to the contingency value.
4) Calculate the Probability of occurrence average (Pi) for each of the thirteen factors.
5) Multiply the three values Wi * Si * Pi.
6) Sum all the values of multiplication, which constitute the time contingency value CD.

Table-3: Time contingency calculation

Criteria	**Weights**	**Factors**	**Weights**	**Relative Weights (Wi)**	**Score (Si)**	**Probability(Pi)**	**Time contingency(CD)**
Project condition		Size	0.2348	0.0760	0.638	0.533	0.0258
		Location	0.2198	0.0712	0.613	0.542	0.0237
		Equipmet Availabiy	0.2749	0.0890	0.750	0.550	0.0367
		Materials availability	0.2704	0.0876	0.750	0.583	0.0383
[illegible]		Amount of		0.067	0.775	0.56	0.029

		interferences	0.1841			7	7
		Number of change orders	0.1601	0.0588	0.656	0.675	0.0260
		Time required for decisions	0.1642	0.0603	0.600	0.600	0.0217
		Payments (delays)	0.1773	0.0651	0.750	0.458	0.0224
		Equipments condition	0.1428	0.0525	0.520	0.400	0.0109
		Productivity uncertainty	0.1714	0.0630	0.700	0.617	0.0272
Environmental condition		Soil condition	0.2209	0.0682	0.613	0.592	0.0247
		Weather conditions	0.264	0.081	0.738	0.533	0.0321
		Strike	0.264	0.081	0.738	0.267	0.0161
		Site shortage of resources	0.250	0.077	0.700	0.600	0.0325
C.D							0.368

VI. MODEL VERIFICATION

In order to check the accuracy of estimated average time contingency (0.3678), data were collected from experts through direct interview regarding the actual delays in their previous projects, which include the starting and planned finish dates in addition to actual dates. Delays for the project, in months, were calculated by subtracting the planned from actual finish dates, then, divide this delay over the planned project duration to obtain time contingency. Table 4 includes the collected data and its analysis for seven projects. It is noticed that time contingency ranged from 0.167 to 0.778 out of project duration. Thus, the average time contingency of the seven projects is 35.4%, which is close to the value obtained from the developed model. Based on Zayed and Halpin (2005), two equations are used to verify the developed time contingency model as shown in Equations (3) and (4).

Where, AIP = Average Invalidity Percent
AVP = Average Validity Percent
E_i = Estimated/Predicted Value
C_i = Actual Value
Applying these equations to the collected cases shows that AIP = 0.127 and AVP =0.87.

The values of AIP and AVP show that the developed model is robust in predicting the values of time contingency.

Project	Start date	Scheduled end date	Actual end date	Planned project	Delays in months	Contingency
1	Aug 11	Feb-012	Mar-8	6	1	1/6=0.167
2	Sep-08	May-09	July-09	8	3	3/8=0.200
3	Aug-08	April-09	Sep-07	20	5	5/20=0.250
4	Feb-09	Feb-013	Aug-07	24	6	6/24=0.250
5	July-09	Oct-10	Mar-05	15	5	5/15=0.330
Average Contingency Value						0.354

VII. RESULT AND CONCLUSION

Estimating scheduling (time) contingency is a major factor in achieving a successful schedule for construction projects. In this research, a survey was conducted on many construction companies to assess the factors that affect time contingency. The data obtained from the survey was then processed using Analytic Hierarchy Process (AHP) in order to evaluate the weight of each factor and estimate the time contingency value. . The results show that the average time contingency value is estimated as 36.78%. The developed model is verified using seven cases studies, which shows robust results (87%). This value shows that the obtained results are fairly good and accept.

REFERENCES

Journal Papers:

[1] Zayad, T (2003).”Condition rating models models for underground infrastructures: Sustainable water mains,, *International Journal of Modeling and Simulation, 18(2)*, 1998, 112-116.

Books:

[1]. K.K.Chithkara,Construction Project Management(2014) .

[2]. Theses:

[3]. Park,M. and Kiziltas, S(2005), Prediction of organizational effectiveness in construction company, doctoral diss., J of construction Engineering and Management, ASCE, February,131(2), pp 252-26 .

[4]. Proceedings Papers:

[5]. Hoffman, G.J, (1994) Attributes of UK construction clients influencing project consultants erformance. Construction management and economics.