Analysis of Factors Affecting Time Contingency in Construction Projects

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Abstract- *The delays are occurred in construction projects due to different time contingencies. Even though construction project scheduling has received extensive attention of researchers, time contingency was not treated well in the literature. In order to meet the deadline of a project and due to the complex nature of construction projects, scheduling should be flexible enough to accommodate changes without negatively affecting the overall project duration. As such, the objectives of the presented research in this paper are to identify, study, and assess the effect of the factors that affect time contingency and to develop a model that predicts such contingency. Time contingency models are developed using deterministic approaches. With the help of AHP questionnaire survey, ratings are taken for different factors and time contingency percentage is calculated according.*

Keywords- Time contingency, AHP, Deterministic, delay.

I. INTRODUCTION

Planning and time schedule is one of the most important tools for construction project management. For instance, it is the base for the project time control. One of the major functions of time schedule is the prediction of the expected project completion time. The reliability of such prediction is greatly affected by many uncertain but predictable factors. So a certain time contingency should be added to the scheduled completion time to arrive at a more reliable prediction for that time.

The time contingency is the amount of time added to the base estimated amount to achieve a specific confidence level or allow for changes where experience shows obligation. An accurate estimating of time contingency is seen as a major factor for achieving a successful construction projects.

Although several industrial sectors developed and used software for estimating time and cost contingencies in order to minimize delays and over budget, yet limited efforts are reported in the literature in the area of predicting time contingency in the construction sector. An accurate scheduling should be sought in order to meet the time deadline of a project. Time contingency is used to guarantee the completion time of either an activity or a project. Due to the unique nature of construction projects, time contingency and project uncertainty are essential for true scheduling, which should be flexible enough to accommodate changes without negatively affecting the overall duration of a project. It is also essential to allocate a contingency value to both cost and time. Yet, there are situations where there could be delays in activities, whether they are within the critical path or not, which result in a delay in the overall project duration. These delays will consequently have a negative impact on the quality, budget, and might be safety of a project. Therefore, estimating time contingency is seen as a prime factor in achieving a successful construction project.

II. OBJECTIVES

Objective of the paper are as follows.

- To identify & study the factors that affect time contingency.
- To determine the effectiveness of each factor.
- Develop the model for determination of time contingency.
- To determine time contingency index.
- To identify the most effective factor that affect time contingency.

III. LITERATURE REVIEW

Based on literature and the opinion of practitioners, several imperative factors that affect time contingency are identified and studied. They are divided into three major criteria: project, management, and environmental condition related factors. Project conditions include location, size, material, and equipment availability. Management conditions include amount of interference, number of change orders, payments delay, time taken to make informative decisions, and productivity of labor and equipment. On the other hand, environmental conditions cover weather and soil conditions as well as labor strikes and shortages of human resources. It is quite clear that the identified criteria and factors effectively contribute to the uncertainty in construction project scheduling, which in turns, impact the assessment of time contingency. In the present research, these factors are considered in predicting project time contingency.

Criteria	Factor	Description
Project Conditions	Project Location	Location may influence the amount of risk and level of contingency.
	Project size (Design complexity)	It affects planned schedules negatively. In large projects, there are many activities that require different resources and involve many parties. All of these variables are interfering together, which may cause delay in 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 site conditions and storage areas. Transported material from suppliers to site is time consuming, which require prior arrangements.
Management Conditions	Amount of interference	A project might stop work because of owner/representative or engineer interference. This occurs due to lack of knowledge and experience from all participants. If the amount of interference increases, schedule delay increases.
	Equipment Conditions	The condition of equipment greatly affects productivity that in terns affects delays.
	Number of change orders	Change orders or extra work order usually requires long process of redesigning or modifying specification. It may force the contractor to accelerate work, which leads to loss of labor productivity and causes delay.
	Payment delays	Any delay of payment may cause delay of supplying resource to the project, which affects the planned schedule.
	Time to make a decision	Decision process and time in the owner side greatly affect project schedule particularly in case of a claim.
	Productivity uncertainty of labor and equipment	Losing labor productivity due to acceleration or extra work affects project schedule. Any damage of equipment causes serious delay on the current activity, which consequently causes delay in project schedule.
Environmental Conditions	Weather condition	Weather in some countries has the highest impact on schedule delays.
	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, such as work accident, sickness, social, psychological and other unpredicted events, may cause labor pain or absenteeism. Hence, this factor will cause delay in the activity and schedule.

Table no. 1: Factors affecting time contingency

IV. RESEARCH METHODOLOGY

The methodology of the research paper was as follows.

1) Factors that affect time contingency are identified and discussed using literature review and experts opinion.

2) A questionnaire survey is conducted to collect the impact of each factor on time contingency.

3) 3) The research methodology is performed using model deterministic analysis method, based on Analytic Hierarchy Process (AHP) analysis.

4) weights are obtained using AHP using pair wise comparison matrices.

5) In order to determine the value of the score (Si) and probability of occurrence (Pi) of a factor, simple average method is implemented to the collected data from practitioners.

6) Time contingency index is calculated by using formula

$$C = \sum_{i=1}^{n} Wi \times Si \times Pi$$

Where,

C = time contingency index for the project
n = the pair-wise comparison matrix dimension
Wi = weight of factor i
Si = score of factor i
Pi = probability of occurrence of factor i.

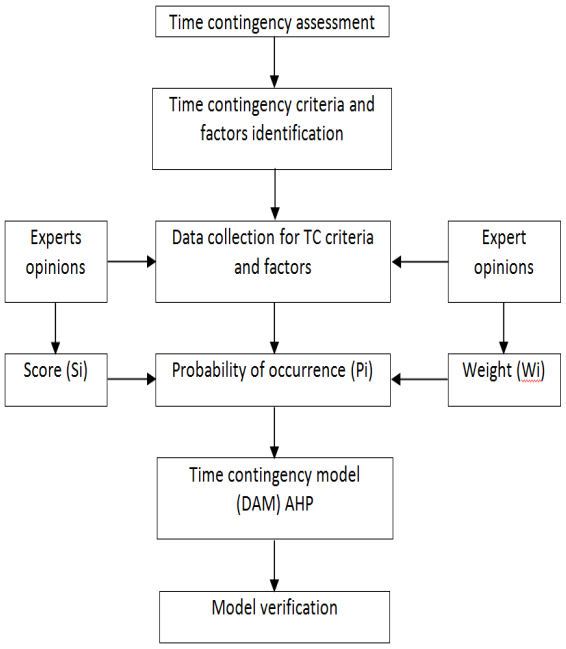

Fig no. 1: Methodology flow chart

V. RESULT

It is quite clear from this table that management condition criterion has the highest impact on time contingency with a weight of 36.65%. However, productivity uncertainty is the least effective factor to time contingency with an average relative weight of (Wi = 4.47%). In order to determine the value of the score (Si) and probability of occurrence (Pi) of a factor, simple average method is implemented to the collected data from practitioners. Table 2 shows the average values of Si and Pi for each factor. It is noticed that number of change orders has the highest probability of occurrence (0.613); however, the amount of owner's interference has the highest score (0.785).

The calculated average values of weights (Wi), scores (Si), and probability of occurrence (Pi) for all factors is obtained. The summation of this multiplication leads to the value of time contingency index (C = 0.3304) as shown in Table 2. This result can be interpreted as, on average, there is a tendency to time delays of almost 33.04% of project duration due to the occurrence of several qualitative factors as discussed in Table 1. It also provides the contractor with a tool to estimate project duration considering the above-mentioned factors. Because not all factors could occur in a specific project, the contractor is liberated to select the factors that are significant to the project in hand and calculate the C value based only upon the selected factors. The value of C might be less than the calculated average in Table 2.

Table no. 2 : Time contingency calculation using deterministic analysis method (DAM)

Criteria	Weights	Factors	Local weights	Relative Weights	Score	Probability	Time contingency
Project Conditions	0.3665	Size	0.2121	0.0777	0.622	0.511	0.0247
		Location	0.2031	0.0744	0.599	0.532	0.0237
		Equipment availability	0.2924	0.1072	0.785	0.562	0.0473
		Materials availability	0.2924	0.1072	0.741	0.544	0.0432
Management conditions	0.3402	Amount of interference	0.1941	0.0660	0.771	0.593	0.0302
		Number of change orders	0.1651	0.0562	0.713	0.613	0.0245
		Time required for decisions	0.1746	0.0594	0.612	0.525	0.0191
		Payments delays	0.182	0.0619	0.742	0.492	0.0226
		Equipment condition	0.1528	0.0520	0.501	0.336	0.0088
		Productivity uncertainty	0.1314	0.0447	0.699	0.323	0.0101
Environmental Conditions	0.2933	Soil condition	0.2439	0.0715	0.612	0.455	0.0199
		Weather conditions	0.2246	0.0659	0.711	0.236	0.0111
		Strike	0.2412	0.0707	0.721	0.333	0.0170
		Site shortage of resources	0.2903	0.0851	0.684	0.485	0.0282
			Time contingency = ∑(Wi x Si x Pi)				0.3304

VI. CONCLUSION

Estimating scheduling (time) contingency is a major factor in achieving a successful and realistic schedule for construction projects. In the present research, a survey is sent to many construction companies to identify, study, and assess the factors that affect time contingency. The obtained data from surveys are then processed to assess factors' weights, using the Analytic Hierarchy Processes (AHP), then, several models are developed to predict time contingency index (C) using deterministic analysis method (DAM). Results show that time contingency index (C) is obtained as 33.04%. This value demonstrates that the obtained results are fairly good and acceptable.

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