

Development of a Prediction Model for Time Overtruns in Construction Project

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ABSTRACT

Construction projects often suffer from high level of uncertainty in many fronts: time, cost, quality, safety, etc. Most of the conducted research focuses on estimating cost contingency. The factors that affect scheduling contingency and to develop a simple model that can be used in estimating the expected time contingency of a construction project. Results show that the predicted time contingency matches with 87% the estimated contingency for real projects. The developed time contingency model showed robust results. Estimating scheduling (time) contingency is a major factor in achieving a successful schedule for construction projects. It can be achieved by using mathematical techniques such as Typical pair-wise comparison. 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 acceptable. In this paper efforts are made to establish complete analysis of 20 papers published literature related to time contingency in construction projects. This paper discusses different research papers, articles, case studies that have been published in this field. There is great scope for time contingency in the construction field in future.

KEYWORDS: Construction projects, Time contingency, Typical pair-wise comparison

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I. INTRODUCTION

The main goals of any successful construction project management systems 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. 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. 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. 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. FACTORS AFFECTING TIME CONTINGENCY

Based on literature and practitioners, several factors that are thought to have a direct effect on time contingency were determined.

These factors were divided into three major categories:

- Project conditions
- Management conditions
- Environmental conditions

III. DEVELOPMENT OF TIME CONTINGENCY MODEL

Analytic hierarchy process (AHP) has been widely used and applied in different fields of theory and practices. It has been applied in multi-criteria decision making, planning and resource allocation, conflict resolution, and prediction problems.

IV. TYPICAL PAIR-WISE COMPARISON

- ❖ The diagonal elements are all equal to one because they represent the comparison of a criterion against itself.
- ❖ The lower triangle values are the reciprocal of the upper triangular values (i.e. $a_{ij} = 1/a_{ji}$).
- ❖ All numbers in the matrix are positive.
- ❖ After determining the weights of each factor in the hierarchy, the time contingency.
- ❖ Determine the relative weight of each major category; i.e. project conditions, management conditions and environmental conditions.
- ❖ Determine the weights (W_i) of the sub factors relative to the weight of its category.
- ❖ Calculate the factors score (S_i) for each of the thirteen factors (using a 1 – 9 scale) in which one represents the most ineffective and nine represents the most effective to the contingency value.
- ❖ Calculate the Probability of occurrence average (P_i) for each of the thirteen factors.
- ❖ Multiply the three values $W_i * S_i * P_i$.
- ❖ Sum all the values of multiplication, which constitute the time contingency value CD.

V. OBJECTIVES

- The purpose of a contingency plan is to allow an organization to return to its daily operations as quickly as possible.
- The contingency plan protects resources
- Minimizes customer inconvenience
- Reduce the risk, human error and building or equipment failures.

VI. LITERATURE REVIEW

A literature review is a detailed report of information obtained from the literature that are related to our topic of study. The review describe, summarize, evaluate and clarify this literature. It gives a base for the research and helps indetermining the nature of the study. This section represents the review of literature collected from various journals and articles that are most relevant to the study.

1. Douglas D. Gransberg, Jennifer S. Shane, and JunyongAhn (2011), “A Framework for Guaranteed Maximum Price and Contingency Development for Integrated Delivery of Transportation Projects”

This paper describes the components of a guaranteed maximum price (GMP) and proposes a framework for the development of GMPs as contract payment provisions for construction manager-at-risk (CMR) and design-build (DB) contracts for transportation projects. The research also discusses the development of three common types of contingencies that are often utilized in projects with GMPs. This will add an element of consistency to the procurement process that will make it easier for industry to understand and evaluate a given transportation project’s contract payment provisions.

2. Ali Touran, Jucun Liu (2015), “A Method for Estimating Contingency Based on Project Complexity”

This paper describes the large transportation projects have been afflicted by poor cost estimates and large cost overruns. This paper uses transit projects in the United States as an example to develop a probabilistic methodology for establishing sufficient contingency. Contingency is a reserve budget for coping with risks and uncertainties and to help keep the projects on budget. In order to establish the contingency budget, first, a rating system is used to determine the complexity of the project. It is assumed that the more complex projects are harder to estimate accurately, and the likelihood of cost overrun is higher for these projects. A validation is performed

using a set of actual project costs. A probabilistic method is presented to help in establishing capital budgets by considering the inherent underestimation of cost in traditional estimating approach and also the project complexity. A desired confidence level can be selected by the project owner and a budget calculated.

3. Matteo Brunelli (2018), "A Survey of Inconsistency Indices for Pairwise Comparisons"

This paper describes the manuscript has two goals. Firstly, it surveys the most relevant inconsistency indices by means of a self-contained exposition. Secondly, by analyzing recent trends and milestones it presents some conclusions and a discussion on possible directions of future research. The most popular research topic is the inconsistency issue". The scope of this survey is precisely that of offering an overview on inconsistency indices and their connections with related topics. It has also shifted the discussion on the general idea of inconsistency index and on what we really mean with this definition. Although there is not (and there might never be) a complete agreement on what basic properties ought to be satisfied by an inconsistency index, it is safe to say that analyzing formal properties of inconsistency indices is a necessary step in order to make them intelligible and communicable.

4. Payam Bakhshi, Ali Touran (2014), "An Overview of Budget Contingency Calculation Method in Construction Industry"

This paper describes the reserve amount, known as contingency, is to absorb the monetary impact of the risk/uncertainties and to prevent cost overrun. Over the past two decades, many contingency calculation methods for construction projects have been introduced by practitioners and researchers. The contingency calculations methods and divides them into three main categories of 1) deterministic methods, 2) probabilistic methods and 3) modern mathematical methods. According to the present contingency definitions, there is consensus that cost contingency is a reserve budget for coping with monetary impacts of risks and uncertainties associated with a project. It should be noted that contingency budget is not intended to absorb the impacts escalation, major scope changes, and extraordinary.

5. A.J.ULASI, J.P.I. ILOH, O.K. OBI (2010), "Application of Linear Sensitivity Factors for Real Time Power System Post Contingency Flow"

This paper describes the linear sensitivity factors are methods in sensitivity analysis, used in determining the effect of power system component

variations on the remaining part of the system. This study presents the application of linear sensitivity factors for real time power system post contingency flow determination. The use of linear sensitivity factors in the form of power transfer distribution factor (PTDF) and line outage distribution factor (LODF), greatly reduce the computational work of power system analysis. This study has shown that linear sensitivity factor technique unlike the conventional methods of power system analysis, could be used to predict the post contingency line flow in a linear non-iterative manner, and still gives the same results as the conventional power flow analysis techniques which requires more calculations.

6. Moinul Hossain, Yasunori Muromachi (2014), "A Real-time Crash Prediction Model for the Ramp Vicinities of Urban Expressways"

This paper describes the Ramp vicinities are arguably the known black-spots on urban expressways. The newly proposed models could predict 50%, 42%, 43% and 55% of the future crashes with around 10% false alarm for the downstream of entrance, downstream of exit, upstream of entrance and upstream of exit ramps respectively. The proposed models have been specifically made for the ramp vicinities and may not be directly used for the long basic freeway segments of expressway. The model also did not consider variables related to weather. It is expected that the outcome of the study will reduce the gap between theory and practice for predicting crash in real-time and existing as well as future studies focusing on designing appropriate countermeasures, will be able to utilize the proposed models to evaluate their efficacy.

7. Tarek Zayed, Dalia Mohamed, Florida Srour, Wael Tabra (2013), "Assessing Time Contingency of Construction Projects Using Simulation-Based Analytic Hierarchy Process"

This paper describes the unexpected delays in construction projects are caused by owner, contractor, acts of god, or a third party in which several types of delays may occur concurrently. The effect of delays does not only influence the construction industry but the overall economy as well. Based upon the collected data for a sample of case study projects, time contingency is estimated to be 33.70% of project duration. This result is almost 95.20% close to the estimated time contingency for these real case study projects. The developed models are deemed essential to academics and planners of construction projects. 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) and integrated simulation-based AHP analysis method (ISAM). Results show that time contingency index (C) can be defined as normal probability distribution with a mean value of 33.70% based upon the collected sample. The developed models are verified using seven case study projects, which show robust results in assessing time contingency index with average AVP value of 95.70%. This value demonstrates that the obtained results are fairly good and acceptable.

8. Zenonas Turuskis, Marcin Gajzler & Agnieszka Dziadosz (2012), "Reliability, Risk Management, and Contingency of Construction Processes and Projects" This paper presents the evolution of concepts, an overview of research and applications pertaining to reliability in construction production, the use of reserves, robust itineraries, and contingency of time and cost. It describes areas of management advisory systems in relation to the cycle of risk analysis. This overview shows that the risk can be analyzed depending on a context. Risk should be treated as a state, in which there is a possibility of a loss. Efforts to create standards in planning and implementation of construction project activities allowed for elimination of such phenomena as instability of processes, unreliability, decrease in quality, unpredictability of events etc.

9. Richard A. Jimoh, Shaaba M. Adama (2014), "Assessment of Contingency Sum in Relation to the Total Cost of Renovation Work in Public Schools in Abuja, Nigeria"

This paper describes in construction projects, plans and cost estimates are usually drawn to ensure that the work is carried out to the desired quality, within time and budget. It was discovered that location of the project, the level of dilapidation, type of project, volume of work and duration of the project determine the percentage addition of preliminary sum to the total cost of renovation work. Based on this, actual contingency sum should always be considered bearing in mind these factors in renovated work. It is concluded that the location of the project determines the percentage addition of contingency sum to the estimated cost, that the volume of work determines the percentage addition of contingency sum to the estimated cost, that the level of dilapidation determines the percentage addition of contingency sum to the estimated cost, that the type of client does not

determine the percentage addition of contingency sum to the estimated cost, that the duration of the project determines the percentage addition of contingency sum to the estimated cost and that the type of project determines the percentage addition of contingency sum to the estimated cost.

10. Payal Singla, Er. Mohit Kakkar (2015), "Construction Cost Overturn Prediction Using Artificial Neural Network on Text and Numerical Data"

This paper describes now-a-days, with the increase in technology every information is available on internet but sometimes it becomes difficult to find accurate information in short. Earlier model shows an average accuracy of 43.72% also creates a problem of redundancy and the work has been done by ensemble classifiers. After having this problem we have created a neural network that discusses how text can be processed, combined with numeric values then give the cost overturn with the accuracy of approx. 87% with improved performance and remove redundancy. The results were compiled and we found out that due to a high correlation in the data extracted from text-file, the Artificial Neural Network when trained is able to classify the construction cost overturn by 90% accuracy. Although, the results can be approximated to 87% accuracy when tested on a very large test set. The result shown above concludes that the system we have implemented will produce a high performance with great accuracy that also helps to improve the speed and remove redundancy that makes it easy to interpret and process fast.

11. Emad Harash, Suhail Nassir Al-Timimi, Fatima Jasem Alsaad, Abdulkhalik Y. Zaier Al-Badran, Essia Ries Ahmed (2014), "Contingency Factors and Performance of Research and Development (R&D): The Moderating Effects of Government Policy"

This paper describes while this relationship is critical to organizations using Strategy, Organizational structure, Financial aspect, the critics suggest that other factors will effect on the relationship between Strategy, Organizational structure, Financial aspect and Performance of Research and Development (R&D). This study was found the Relationship between relationship between Contingency factors and the Performance of Research and Development (R&D). This is significant for at least three parties, i.e. customers, companies and the relevant authorities' bodies, to strategize on containing the existence of the effect

in Universities by accordingly controlling the selected factors.

12. José Ignacio Ortiz-González, Eugenio Pellicer, Gregory Howell (2014), "Contingency Management in Construction Projects: A Survey of Spanish Contractors"

This paper describes the delivery of any construction project faces risk and uncertainty. Contingencies cover residual risks and absorb both variability and uncertainty. The management of contingencies plays a key role in improving risk management and project performance. This research aims to shape contingencies as a driver of process improvement in construction. Conclusions will help practitioners to deal with risk and uncertainty in construction projects. This research initiative aims to overcome this gap, exploring the actual practices of construction companies during the construction phase of a project. Improving the knowledge on this topic is essential if contingency management is to drive process improvement.

13. Addo, J. N. T (2015), "Determination of Contingency Sum for Building Projects in Ghana"

This paper describes the building industry is always surrounded by many risks and uncertainties and their degree in a project results from a combination of factors which differ from one project to another. One of the attempts to handle risks is by allocating project contingency sum. Traditionally, construction professionals determine cost contingency simply by adding; say 10% contingency onto the estimated cost of a project. Unexpected ground conditions (substructure works), design consideration, project duration and project specification have also emerged as the most influencing factors. The study has established that contingency sum is mainly used to cater for Unexpected or unforeseen conditions and project cost overrun representing 73% and 63.6% of selected professionals respectively in the building industry.

14. Mr.P.Vittalkumar, Dr.K.Divakar(2016), "Factors Influencing Time Contingency Assessment in Construction Projects"

This paper describes the 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. 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.

15. Osama Moselhi, Ahmad Salah(2013), "Fuzzy set-based Contingency Estimating and Management"

This paper describes the contingency estimating and management are critical management functions necessary for successful delivery of construction projects. Considering its importance, academics and industry professionals proposed a wide range of methods for risk quantification and accordingly for contingency estimating¹. Considerably less work was directed to contingency management including risk mitigate during a project. Generally, there are two types of risks; (i) known risks which can be identified, evaluated, planned and budgeted for and (ii) unknown risks which may occur. In this paper, contingency estimation using fuzzy set theory was presented as an effective and accurate in comparison to commonly used methods. The limitation of this method is the assumption that all risks associated with project are well identified, reliably evaluated, and effectively responded to by risk management plan.

16. Hugo Dias Amaro, Ilse Maria Beuren(2018), "Influence of Contingency Factors on the Academic Performance of Accountancy Students"

This paper describes to achieve this purpose, several factors that can influence the HEIs need to be considered. First, it is necessary to identify their current contingent situation, that is, how the HEI is structured to meet the possible diversities of its environment. Among the organizational theories that study the organizational management process, the Contingency Theory refers to this aspect. Nevertheless, no single organizational structure can be effective in all organizations, as their optimization depends on contingency factors. This study aimed to verify the influence of contingency factors on the academic performance of Accountancy students at a Federal Higher Education Institution. Among the variables related to external factors, the ones that influenced the academic performance of the students under analysis were: father's education level ($x_2 = 15.660$; $p = 0.016$); weekly hours of extraclass study ($x_2 = 26.725$; $p = 0.000$); and professional experience ($x_2 = 11.540$, $p = 0.0402$). The other external variables were not influential. Thus, H1 was partially accepted.

17. Ibrahim Adel Eldosouky, Ahmed Hussein Ibrahim, Hossam El-Deen Mohammed(2014),

“Management of Construction Cost Contingency Covering Upside and Downside Risks”

This paper describes the post-mitigation simulations show that value of CCR is 2.88% of project cost but there is a potential saving due to opportunities. The project is monitored after eight months from its assumed start date with one assumed emergent risk. A contractor can balance project upside risks and its downsides to increase his chance to win tender of the project. Concerning recommendations for further research there are some risks that cannot be identified in the project risk register because their impacts cannot be definitely determined, e.g., labor injuries, fire hazard, and site workers absence. Identification of such risks may be allowed if there is a facility to impact project duration or project cost; not individual activities' duration or costs.

18. B. Amade, E. O. P. Akpan, F.P.O. Ukwuoma, C.C. Alajemba(2014), “Project Cost Contingency in the Nigerian Construction Industry”

The study further found out that most of the professionals see contingency allowance as a means of providing for risk and uncertainty in their construction projects and finally, they also allot less than ten percent (10%) of the total cost of construction projects to cost contingency during their estimating activities. Professionals in the built industry in Imo State specifically can borrow a leap from this study as a way of creating the platform for the realization of their project cost contingency objectives in a bid to meeting up their estimation challenges. Other climes are keying into the use of probabilistic approaches to developing their cost estimates which is lacking in Sub Saharan Africa and Nigeria in particular, a lot needs to be done in this direction to set the records straight.

19. Haiqing Zhang, AichaSekhari, YacineOuzrout, AbdelazizBouras (2014), “Optimal inconsistency Repairing of Pairwise Comparison Matrices Using Integrated Linear Programming and Eigenvector Methods”

This paper describes the experiments for crisp elements show that the proposed approach can preserve more of the original information than previous works of the same consistent value. The convergence rate of our algorithm is significantly faster than previous works with respect to different parameters. The experiments for fuzzy elements show that our method could obtain suitable modified fuzzy PCMs. In the future work, we will apply this approach to different applications. Meanwhile, efforts should be made to explore the

perfect range of β and study the issue of selecting the situation where we can supply a consistency PCM to an inconsistency one based on real-life meaning.

20. Gang Kou, DajiErgu, ChangshengLin,Yang Chen(2014), “Pairwise Comparison Matrix in Multiple Criteria Decision Making”

This paper describes the measurement scales, consistency index, inconsistency issues, missing judgment estimation and priority derivation methods have been extensively studied in the pairwise comparison matrix (PCM). It is hoped that this paper will provide a comprehensive literature review on PCM, and act as informative summary of the main developments of the PCM for the researchers for their future research. First, it was found that various approaches were proposed to deal with the measurement scales, consistency index, inconsistency issues and priority derivation methods either in multiplicative, additive or interval (fuzzy) PCM. The most popular research topic is the inconsistency issue, the employed techniques mainly include linearization technique and nonlinear optimization approach. Second, it was noticed that the priority derivation approaches were paid more attention when the statistical analysis methods are employed. In addition, integrated approaches become popular than single method.

VII. 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 timecontingency value is estimated as 36.78%. The developed model is verified using seven cases studies, which shows robust results (87%). This value shows thatthe obtained results are fairly good and acceptable.

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