Second International Conference on Construction in the 21st Century (CITC-II)
"Sustainability and Innovation in Management and Technology"
10-12 December, 2003, Hong Kong

Determinants of Construction Durations for Building Projects: A Hong Kong Perspective

Albert P.C. Chan
Professor, Research Centre for Construction Management and Construction I.T.
Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong

Daniel W.M. Chan
Assistant Professor, Research Centre for Construction Management and Construction I.T.
Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong

Abstract
Construction projects are often launched in a fast changing and highly unpredictable environment. Construction Time Performance (CTP) has long provoked considerable concerns and interests of many construction researchers and project managers worldwide. This paper outlines the overall research process of the first phase of a funded research study which is being undertaken to identify significant factors influencing construction durations of building projects in Hong Kong, and to evaluate their relative importance.

Opinions of 93 project stakeholders were sought via a postal questionnaire survey and evaluated using factor analysis technique. Preliminary findings of the first phase investigation are highlighted and discussed. Such a determination of critical 'time' factors could subsequently generate a benchmark model for predicting project durations and effective strategies for mitigating project delays, which would be the main focus of the second phase of this study.

Keywords
Construction Durations, Time-influencing Factors, Building Projects, Hong Kong, Factor Analysis

1. Introduction

Construction projects are frequently undertaken in a rapidly changing and highly unforeseen environment. Project success is largely attributed to the effectiveness of construction planning efforts dedicated by the main contractor, subcontractors and suppliers (Chan, 1996). Construction time performance (CTP) is often regarded as one of the corner-stone measures of project success (Walker, 1995).

This paper was developed based on earlier research work by Chan and Kumaraswamy (1995a, 1995b, 1996, 1999). It expands on the current literature on the CTP subject by evaluating empirically the perceptions of project participants on what ingredients contribute to the actual project duration. A concise literature review of factors influencing project duration, the research methodology adopted, presentation of analysis results, and recommendations for further study are provided and explained.

The essence of key determinants of construction schedule performance demands immediate attention, and project managers should reward from its identification in project planning and schedule control. Such a determination of critical 'time' factors could well generate a construction time prediction model and useful insights into minimizing project delays, which would form the main theme of the second phase of this investigation.

2. Review of Previous Work

Studies in various countries appear to have contributed significantly to the body of knowledge relating to CTP in construction projects over the past three decades. In the context of this paper, the construction duration is defined as the construction period from the commencement of foundation works on-site to the practical completion of the building (Chan and Kumaraswamy, 1999).

Table 1: Summary of Some Statistical Models for Predicting Project Construction Durations [Source: Chan and Chan (2003a)]

Proposer(s)	Country	Main Parameters Included in Model			
		Project Scope	Project Complexity	Project Environment	Management Attributes
Bromilow *et al.* (1980)	Australia	★			
Ireland (1985)	Australia	★			★
Kaka and Price (1991)	UK	★			
Nkado (1992)	UK	★	★		
Yeong (1994)	Australia Malaysia	★ ★			
Blyth (1995)	UK	★	★		★
Chan and Kumaraswamy (1995a)	Hong Kong	★			
Walker (1995)	Australia	★	★		★
Chan (1996)	Hong Kong	★			
Khosrowshahi and Kaka (1996)	UK	★	★		
MacKenzie (1996)	UK	★	★	★	★
Chan and Kumaraswamy (1999)	Hong Kong	★	★	★	★
MacKenzie *et al.* (1999)	UK	★	★	★	★
Walker and Vines (2000)	Australia	★	★	★	★
Ng *et al.* (2001)	Australia	★			
Yousef and Baccarini (2001)	Western Australia	★			
Chan and Chan (2003b)	Hong Kong	★	★	★	★

A review of the literature suggests that there are numerous factors affecting the construction duration of a project to varying degrees. But a common thread running through all these time-influencing factors emerging from the literature can be grouped under four major factor categories (Chan and Chan, 2003a):

(a) Project-scope;
(b) Project complexity;
(c) Project environment; and
(d) Management-related attributes.

The above four factor categories were further explored in association with their constituent causal factors including both qualitative and quantitative contributors. This would suggest that project duration is determined by combining the influence of a number of factors. In essence, a set of statistical regression models previously developed for predicting project durations across different countries are summarized in Table 1.

3. Survey Methodology

The research study began with a review of relevant materials from textbooks, professional journals, conference papers, refereed publications, research reports and Internet information to capture background knowledge about the significant factors affecting the construction durations of projects. In addition, the research paper of Chan and Kumaraswamy (1996) on the evaluation of CTP in the Hong Kong building industry formed a solid basis for the empirical survey study. Finally, seventy-three (73) time-influencing factors identified from the literature were determined and constituted the empirical survey questionnaire.

Key staff of the client organizations, consulting practices and construction firms involved in such projects were identified by personal networking and approached via self-administered questionnaires in October 2002. Respondents were requested to rate the effect of each factor identified upon actual construction duration according to a five-point Likert scale [ranging from very low (1), moderate (3), to very high (5)], based on their actual hands-on experience in managing building projects.

A total of 93 valid responses were received for analysis and the overall response rate was about 30%. The 93 returned questionnaires consisted of respondents from client organizations, main contractors and consultants from various disciplines of construction. There were no responses from the groups of subcontractors and suppliers in this study.

4. Method of Data Analysis

The technique of factor analysis (FA) was used to analyze the responses received from the survey questionnaire. FA was applied to explore and detect underlying relationships/ dimensions among the construction time-influencing factors. FA was conducted using the SPSS-PC for Windows 11.0 software package and implemented through the *SPSS FACTOR program*.

FA is a statistical technique used to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables (Norusis, 1993). It was conducted in this study to reduce the 73 items (time-influencing factors) into a small number of ‘underlying’ grouped factors, factor scores being estimated for each case. An underlying factor can be regarded as a linear combination of the original variables (Chan and Chan, 2003a). The extraction and rotation of the factors were launched to generate a small number of factors and obtain a clearer picture of what these factors represent.

5. Factor Analysis of Time-influencing Factors

The main purpose of applying factor analysis was to identify the number of common factors (i.e. time dimensions) that would satisfactorily generate the correlations among the observed variables (Kim and Mueller, 1978). In this investigation, principal components analysis (PCA) was used to identify the underlying grouped factors because of its simplicity and distinctive characteristic of data-reduction capacity for factor extraction. PCA involves the generation of linear combination of variables in such way that they account for as much of the variance present in the data as possible (Kim and Mueller, 1978).

Study variables can be grouped by their correlations. The number of factors extracted was based on the criteria that the eigenvalue for each factor should be greater than 1 (Bryman and Cramer, 1999).

Apart from factor extraction, we need to launch the process of factor rotation which manipulates and adjusts the factor axes to achieve a simpler and pragmatically more meaningful factor solution (Kim and Mueller, 1978). To derive the simplest possible factor structure for seeking more interpretable factors/dimensions, promax oblique rotation with the power (Kappa) valued at 4 was used. Oblique rotation (as opposed to orthogonal rotation) was utilized as it allows the presence of correlations between factors/dimensions, and generates substantively meaningful factors (Norusis, 1993). Various methods of factor rotation including varimax, oblimin and promax were also tried out in this study, however promax gave the highest factor loadings for the same set of factors and more interpretable results in overall.

6. Results of Factor Analysis

To determine how many factors would be required to represent that set of data, the total percentage of variance explained by each factor was examined. Principal factors extraction with promax rotation with Kaiser normalization was carried out through the *SPSS FACTOR program* on 73 items of time influencing factors for a sample of 93 responses. Finally, 19 underlying grouped factors were generated and Table 2 exhibits their eigenvalue, percent of the variance and cumulative percent of variance explained.

Table 2: Factor Structure of Principal Factors Extraction and Promax Rotation on the 73 Construction Time-influencing Factor Items [Source: Chan and Chan (2003c)]

No.	Collective Label of Underlying Grouped Factor	Eigenvalue	Percent of Variance Explained	Cumulative Percent of Variance Explained
F01	Communication and site management	19.739	27.040	27.040
F02	Performance and management of site resources	4.300	5.890	32.930
F03	Professional competence of design and construction teams	3.617	4.954	37.884
F04	Waiting time for inspection and approval	2.980	4.082	41.996
F05	Financial strength of client	2.698	3.696	45.661
F06	Site conditions for construction	2.634	3.608	49.270
F07	External environments for construction	2.372	3.249	52.519
F08	Nature of client	2.113	2.894	55.413
F09	Selection of plant and construction technology	1.904	2.609	58.022
F10	Subcontractors' performance	1.854	2.540	60.562
F11	Project scope	1.708	2.340	62.901
F12	Client's priority on construction time	1.578	2.162	65.063
F13	Type of procurement system	1.488	2.038	67.102
F14	End use and work type	1.397	1.914	69.016
F15	Client-initiated variations	1.292	1.769	70.785
F16	Disputes and conflicts	1.237	1.695	72.480
F17	Type of foundations	1.223	1.675	74.155
F18	Quality of design and work required	1.149	1.574	75.729
F19	Adequacy of preconstruction planning	1.026	1.405	77.135

Various tests are required for the appropriateness of FA for the factor extraction, and the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Barlett's test of sphericity for the extraction factors were used in this study. The KMO value should be greater than about 0.5 for a satisfactory FA to proceed according to Norusis (1993). The value of the KMO statistic is 0.609 which is considered satisfactory for factor analysis to proceed. Barlett's test for sphericity tests the hypothesis that the correlation matrix is an identity matrix. In this case, the value of the test statistic for sphericity is very large (chi-square value = 5486.031) and the associated significance level is small (p-value = 0.000), indicating that the population correlation matrix is not an identity matrix.

Nineteen factors were extracted and altogether accounted for 77% of the variance in responses. SPSS drops factors 20 to 73 because their eigenvalues are less than 1.0, implying that they are less influential than the 19 observed grouped factors. The original 73 time-influencing factors were all included in one of these nineteen underlying factors. The criteria for group classification was that a variable which has the highest loading with value larger than 0.50 in one component belongs to that component (Awakul and Ogunlana, 2002). The first three factors accounted for 27.04%, 5.89% and 4.95% of the variance, respectively.

The grouped time-influencing factors were analyzed in descending order of significance to determine underlying features that linked them. A new underlying factor was felicitously labelled in accordance with the set of individual factors it contained. In order to facilitate the explanation on the results of factor analysis, it is necessary to assign an identifiable, collective label to the groups of factors of high correlation coefficients. The reason is that each of the underlying grouped factors is an aggregation of individual factors. However, emphasis has to be placed on that the suggested factor label is entirely subjective and other researchers might come up with a different label.

7. Conclusions and Recommendations

The research reported upon in this paper initiated a preliminary investigation of schedule performance of building projects in the Hong Kong construction industry. The primary objective of the first phase of this research study was to identify and investigate the relative importance of the factors influencing construction durations of building projects, according to the experience-based judgment and perceptions of clients, consultants and contractors in Hong Kong. Using factor analysis based on 93 valid responses demonstrated that the 73 'time' variables could be grouped into 19 underlying factors with the most significant one being 'Communication and site management'.

The next step for investigation is to test for any agreements or disagreements on the relative importance of the 19 underlying grouped factors among industry practitioners, i.e. clients, consultants and contractors. It is also envisaged that all the outcomes emerging from the first phase of this funded research would be incorporated into the development of a construction time prediction model for local private housing building industry in the future via a series of in-depth case study projects, as has been planned in the second phase of this research programme (Chan and Chan, 2003a).

8. Acknowledgments

The authors gratefully acknowledge The Hong Kong Polytechnic University for providing financial support to this research study (Central Research Grant No. G-YW63). Special gratitude is also extended to those industrial practitioners who have responded and contributed their valuable input in completing the survey questionnaires used in the first phase of this study in Hong Kong during October 2002.

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