An analysis of factors that impact a project budget during execution.

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Abstract:

Certain factors conspire to militate against the completion of a project at the budgeted cost. The aim of the study was to identify, rank and categorise the factors that impinge on a project budget during the implementation stage and to examine the relative importance of the identified factors. Based on an extensive literature review and discussions with industry practitioners, sixty-seven variables that impinge on a contractor's project budget during the implementation stage were identified. The sixty-seven variables were then used to design the questionnaire for the research. The data obtained from the survey was subjected to statistical analysis using the Statistical Package for Social Science (SPSS) software. The statistical t-test results showed that out of the sixty-seven risk factors, fifteen are significantly important. The testing of the research hypotheses has enabled those key potential risk factors that can wreak havoc on a construction project and thereby reduce a construction firm's profit margin to be isolated. In doing so, construction firms can now focus their prevention strategies on those fifteen variables identified by this research. Effectively addressing the factors that have been identified would enable them to improve upon their cost control practices with a view to remaining profitable. In addition, the statistically significant findings of this research provide insight into several areas for future investigations.

Keyword: construction, project, budget, risk factors.

Introduction

The construction industry is considered to be one of the most important industries in a nation's economy. It is well recognised that the construction sector significantly contributes to the Gross Domestic Product (GDP). The industry influences most, if not all, sectors of the economy (Chen, 1996; Lewis, 2004; Miler *et al*., 2004). The huge sums of capital invested by individuals, corporate bodies and governments at all levels in various construction projects attest to this fact.

Every construction project is special in a way. The construction process itself is influenced by a number of highly variable and sometimes unpredictable factors Chang, (2002). Consequently, it is absolutely imperative for those factors that could influence the project budget during the execution of a project to be constantly monitored (Clarke, 1999). Such monitoring will result in the development of scenarios aimed at highlighting the variables that are crucial for the effective control of costs during the implementation stage of a project. There is no denying the fact that identifying those factors will enable the firm to formulate policies that will guide their operations.

Cost is an important concern in any construction project (Chan and Park, 2005). To control costs within an acceptable level requires appropriate and accurate identification of various project-related determinants as well as an understanding of the magnitude of their effects (Yakubu and Ming, 2010; Anuja and Parag, 2015; Shanmuganathan and Baskar, 2016). It is commonplace to say that the construction business is dynamic, challenging and also full uncertainty and associated risks. Organisations are today operating in a more turbulent, fast changing and fluxing environment than ever before. Turbulent environments tend to be heterogeneous through time. They added that success in such circumstances requires flexibility, rapid response and innovation. Nguyen *et al*. (2004) observed that the intrinsic complexity, uncertainty and dynamics associated with most construction projects create difficulties for even the best project managers. According to Meyer *et al*. (2002), the challenge of how to handle a construction project successfully within a prescribed budget has attracted substantial research attention in the past couple of decades.

Many situations conspire against the completion of a project within the allocated budget. Furthermore, the peculiarity of construction is that no two projects are identical in terms of site conditions, design, use of construction materials, labour requirements, construction methods, technical complexity and level of management skill required (Ikegwuru, 2006).

Research Methodology

Based on an extensive literature review as well as discussions with some industry practitioners, a total of sixty-seven variables (potential risk factors RF's) that have an impact on a project budget during the construction phase were identified. These factors were classified under four major headings namely: Design Phase, Contract Award Phase, Planning Phase and Construction Phase. The sixty-seven factors identified were then used to design the questionnaire used to collect the data for this research. The aim of the questionnaire was to capture the opinions of experts on the degree of importance of each of the factors.

The questionnaire was divided into two broad sections. The first section requested the respondents to provide information regarding the general background of the organisations involved in the study. In addition, this section also required the respondents to provide their personal details, such as their job title, educational qualifications and experience.

The second section included a list of sixty-seven possible factors that impact on contractor's budget during the execution of a construction project. The respondents were asked to express their perception on the degree of importance of each of the factors. They were asked to indicate the extent to which each of the sixty-seven factors listed in the questionnaire impacted on the costs of projects they had executed in the past, using a 5-point Likert scale where 1 represented "Very Low Impact" and 5 represented "Very High Impact." The respondents were further requested to base their rankings on both the probability of occurrence as well as the magnitude of the impact of each of the variables (RF's).

A pilot study was first carried out to test the response rate, comprehensibility, relevance and comprehensiveness of the questionnaire before a full-scale survey was conducted. The pilot study was conducted on 60 respondents. The respondents in the pilot survey were personally contacted and informed of the purpose of the research. Upon obtaining their consent, the questionnaires were administered on them.

The respondents were also requested to critically review the design and structure of the survey instrument. All the comments received were positive. As a result, only minor adjustments were made to the questionnaire. The final survey package comprised the questionnaire and a cover letter explaining the purpose of study.

A total number of 360 survey packages were administered. The respondents were given a choice of being interviewed face to face or self-administer the questionnaires and return to the researcher. All the questionnaires were self-administered, which therefore precluded personal verification of responses by the researcher.

To ensure the relevance of the responses, only the questionnaires completed by experienced respondents were considered useful for the analysis. A total of 198 questionnaires were considered valid for the analysis. This represented a response rate of 55%. This response rate was considered adequate for analysis when considered against the assertion by Fellows and Lui (2008) that the result of a survey can be said to be biased and of little value if the return rate is lower than 40%.

The data obtained from the survey were subjected to statistical analysis using the Statistical Package for Social Science (SPSS) software. Overall means were and standard deviations were computed. Both t-tests and chi-square tests were conducted on the data.

Data Reliability

Data reliability is related to data source, and the identification of the position of the person who completed the questionnaire (Oppenheim 2001). Thus it was important that the personnel who completed the questionnaire had detailed knowledge about the execution of a construction project. The questionnaires were administered on the senior personnel within the organisations that participated in the survey.

All the respondents in the 198 questionnaires used in this research provided their business details, which revealed that they held senior positions in their organisations. 165 respondents representing 83.33% of the total number of those whose responses were considered valid for the analysis were university graduates. Also, based on the position titles of the respondents, the objective of reaching those who were closely involved with delivering construction projects was achieved. Moreover, the valid responses used in the analysis indicated that 92.93 % of the respondents who completed the questionnaires had over five years of working experience. Furthermore, they were either of professional or executive grades. These responses ensured the reliability of the data.

Response Rate

A total of 360 sets of questionnaires were administered on the respondents from the construction firms involved in the study. A total of 198 valid responses were received representing a rate of 55%. Upon evaluation, both the response rate and the sample size were considered acceptable for a survey focusing on gaining responses from industry practitioners (Alreck and Settle, 1985).

General Findings

The summary of the respondents' experience is presented in Table 1. The greater majority of the respondents (92.93 %) have more than five years experience in the construction business. 140 of the respondents (70.70 %) are Bachelor's degree holders. A total of 25 respondents representing 12.63 % have Master's degrees while the remaining 33 respondents (16.67 %) possess Diplomas. The foregoing details show that the respondents have sufficient educational background as well as the relevant experience needed to make the value judgement required by the research.

Table 1. Work Experience of Respondents.

Experience (years)	№ of respondents	Percentage	Cumulative %
3 ─ 5	14	7.07	7.07
6 ─ 10	65	32.83	39.90
11 ─ 15	54	27.27	67.17
16 ─ 20	36	18.18	85.35
> 20	29	14.65	100.00

Analysis of The Survey Instrument

The results of the survey were first analysed by calculating the mean and standard deviation (SD) of the responses to each of the sixty-seven variables (RF's) listed under each phase of a construction project. The higher the mean, the greater is the variable's impact on the project budget. Tables 2 — 5 show the results of the survey.

The number of columns in Tables 2 — 5 was reduced from five to four due to the high number of zeroes appearing in the column for scores of 1 (Ostle and Malone, 1988). Therefore, the first column was configured to represent the number of responses scoring "≤ 2." The second column contains the number of responses scoring a "3." The third column contains the number of responses scoring a '4," and the fourth column contains the number of responses scoring a "5." The scale values of agreement for the final analysis were then computed as follows: "≤ 2 = Low," "3 = Moderate," "4 = High" and "5 = Very High."

Table 2. Mean and standard deviation values for Design Phase variables

Variables	≤ 2	3	4	5	Mean	SD
RF 01. Accepting client's request without management approval.	48	96	39	15	3.11	0.86
RF 02. Problems in client's communication channels and data items.	60	100	28	10	2.94	0.81
RF 03. Errors in drawings.	12	42	84	60	3.97	0.87
RF 04. Problems in design review meetings.	40	120	20	18	3.08	0.81
RF 05. Delay of information from designers.	44	101	29	24	3.17	0.91
RF 06. Incomplete design scope.	12	42	72	72	4.03	0.91
RF 07. Delay in receiving approvals.	18	72	36	72	3.81	1.03

Table 3. Mean and standard deviation values for Contract Award Phase variables

Variables	≤ 2	3	4	5	Mean	SD
RF 08. Client's requirements not well understood.	12	18	84	84	4.21	0.85
RF 09. Unrealistic appraisal of in-house capabilities.	39	114	27	18	3.12	0.83
RF 10. Underestimating time and labour requirements.	50	99	30	19	3.09	0.88
RF 11. Forcing a speedy compromise.	36	96	42	24	3.27	0.90
RF 12. Procurement ceiling costs.	42	90	36	30	3.27	0.96
RF 13. Negotiation team determined to win the "contract".	36	90	48	24	3.30	0.91
RF 14. Management reducing budgets or bids to remain competitive.	36	102	42	18	3.21	0.85
RF 15. Contractual discrepancies.	48	106	27	17	3.07	0.85
RF 16. Statement of work different from request for proposal requirements	46	105	27	20	3.11	0.88
RF 17. Proposal team different from project team.	24	30	66	78	4.00	1.17
RF 18. Unrealistic tenders.	42	120	20	16	3.05	0.80
RF 19. Unforeseen hitches & problems.	42	116	25	15	3.07	0.80
RF 20. Accepting unusual terms and conditions.	54	100	26	18	3.04	0.88
RF 21. Permitting a grace period for changing specifications.	30	102	42	24	3.30	0.87
RF 22. Project team formed after bid was prepared.	18	54	48	78	3.94	1.02

Table 4. Mean and standard deviation values for Planning Phase variables

Variables	≤ 2	3	4	5	Mean	SD
RF 23. Failure to assess and provide for risks and uncertainties.	38	104	36	20	3.19	0.87
RF 24. Inadequate work breakdown structure.	18	54	60	66	3.88	0.98
RF 25. Inadequate pre-planning.	48	90	42	18	3.15	0.89
RF 26. Omissions.	42	96	36	24	3.21	0.85
RF 27. Misinterpretation of information.	36	96	48	18	3.24	0.86
RF 28. Use of poor estimating techniques.	12	54	84	48	3.85	0.86
RF 29. Underestimating time and labour requirements.	48	102	24	24	3.12	0.92
RF 30. Failure to identify and concentrate on major cost elements.	18	60	42	78	3.91	1.03
RF 31. Deficiencies in scheduling.	30	96	36	36	3.39	0.95
RF 32. Inadequate formal planning.	36	90	42	30	3.33	0.94
RF 33. Poor work definition at lower levels of the organisation.	40	100	36	22	3.20	0.89
RF 34. Poor standards resulting in unrealistic budgets.	43	114	21	20	3.09	0.85
RF 35. Overestimating of company's capabilities.	38	106	31	23	3.20	0.88
RF 36. A missing PERT / CPM chart.	40	99	38	21	3.20	0.88
RF 37. Failure to assess and provide for risks and uncertainties.	12	24	60	102	4.27	0.90

Table 5. Mean and standard deviation values for Construction Phase variables

Variables	≤ 2	3	4	5	Mean	SD
RF 38. Fluctuation in the prices of materials.	33	98	45	22	3.28	0.87
RF 39. Late arrival of workers to the site.	41	86	50	21	3.26	0.91
RF 40. Shortage of qualified workers.	36	108	34	20	3.19	0.85
RF 41. Lack of equipment.	30	110	34	24	3.26	0.86
RF 42. Faulty plant /equipment.	30	104	36	28	3.31	0.90
RF 43. Inadequate reporting structure.	28	113	37	20	3.25	0.83
RF 44. Inadequate site supervision.	32	112	38	16	3.19	0.80
RF 45. Excessive wastage of materials.	42	105	33	18	3.14	0.85
RF 46. Poor comparison of actual and planned costs.	39	110	28	21	3.16	0.86
RF 47. No management policy on reporting and control. practices.	30	124	22	22	3.18	0.83
RF 48. Schedule delays that require overtime or idle time costing.	38	107	31	22	3.19	0.87
RF 49. Comparison of planned and actual costs at the wrong level of management.	36	112	34	16	3.15	0.81
RF 50. Out-of-sequence starting and completion of activities.	38	107	31	22	3.19	0.87
RF 51. Specifications that are not acceptable.	36	112	34	16	3.15	0.81
RF 52. Communication and coordination problems.	30	12	66	90	4.09	1.06
RF 53. Unforeseen technical problems.	41	98	36	23	3.21	0.91
RF 54. Unexpected natural and/or social events.	39	88	45	26	3.29	0.93
RF 55. Deficiencies in the contractor's organisation.	40	92	37	29	3.28	0.95
RF 56. Slow payment by client.	44	98	37	19	3.16	0.88
RF 57. Low productivity and inefficiency of equipment.	6	42	84	66	4.06	0.82
RF 58. Late material delivery.	28	108	49	13	3.24	0.78
RF 59. Changes (variations) being made deep into the projects life cycle.	40	104	35	19	3.17	0.86
RF 60. Quality expected beyond standard and specification.	32	112	30	24	3.23	0.87
RF 61. Interference from the client.	44	98	39	17	3.15	0.87
RF 62. Subcontractor unable to finish work on time.	45	106	32	15	3.01	0.96
RF 63. Low quality of subcontractor's work.	6	42	60	90	4.18	0.87
RF 64. Low productivity by subcontractor.	18	18	84	78	4.12	0.92
RF 65. Problems in coordination of subcontractor's work.	48	100	30	20	3.11	0.89
RF 66. Functional manager not having a clear understanding of what is to be done.	40	99	38	21	3.20	0.88
RF 67. Rework due to defective work.	12	30	54	102	4.24	0.93

Statistical t-test Results

A t-test of the mean was carried out with the help of the Statistical Package for Social Sciences (SPSS) software. The purpose was to determine whether the population would agree that the variable (RF) significantly impacts on a project budget during the implementation stage. For each variable, the null hypothesis (H_0) is that the variable does not adversely impact on the project budget (i.e. H_0: $\mu \leq \mu_0$). The alternative hypothesis (H_1) is that the variable has a significant impact on the project budget (i.e. H1: $\mu > \mu_0$), where μ is the population mean. The decision rule (DR) is to reject H_0 when the calculated p-value is less than 0.05 ($p < 0.05$). Thus if the calculated p-value is less than 0.05, the null hypothesis that the variable does not significantly impact on costs is rejected, and the alternative hypothesis that the variable significantly affects the project budget is accepted. It was then concluded that the variable is a high RF.

In this research, μ_0 was fixed at 3.75. The value of 3.75 was chosen as the cut-off point for the mean value of responses instead of 3.0 or 3.5, since a score of 3.75 or greater would be a higher-level indication of "moderate" (i.e. tending towards "high") than "low" on the five-point Likert scale. Thus scores above 3.75 indicate that the RF significantly impacts on the project budget; and adversely too!

The results of the t-test are provided in Tables 6 — 9.

Table 6. t-test results for Design Phase variables

Variables	Mean	SD	t-value	p-value
RF 01. Accepting client's request without management approval.	3.11	0.86	1.63	0.57
RF 02. Problems in client's communication channels and data items.	2.94	0.81	1.27	0.11
RF 03. Errors in drawings.	3.97	0.87	1.79	0.01•
RF 04. Problems in design review meetings.	3.08	0.81	1.58	0.06
RF 05. Delay of information from designers.	3.17	0.91	0.74	0.23
RF 06. Incomplete design scope.	4.03	0.91	12.57	0.00•
RF 07. Delay in receiving approvals.	3.81	1.03	9.00	0.02

Table 7. t-test results for Contract Award Phase variables

Variables	Mean	SD	t-value	p-value
RF 08. Client's requirements not well understood.	4.21	0.85	20.96	0.01•
RF 09. Unrealistic appraisal of in-house capabilities.	3.12	0.83	0.59	0.28
RF 10. Underestimating time and labour requirements.	3.09	0.88	0.39	0.35
RF 11. Forcing a speedy compromise.	3.27	0.90	1.25	0.11
RF 12. Procurement ceiling costs.	3.27	0.96	0.74	0.23
RF 13. Negotiation team determined to win the "contract".	3.30	0.91	1.70	0.55
RF 14. Management reducing budgets or bids to remain competitive.	3.21	0.85	1.59	0.29
RF 15. Contractual discrepancies.	3.07	0.85	0.68	0.32
RF 16. Statement of work different from request for proposal requirements	3.10	0.88	0.71	0.26
RF 17. Proposal team different from project team.	4.00	1.17	12.57	0.01•
RF 18. Unrealistic tenders.	3.05	0.79	1.29	0.12
RF 19. Unforeseen hitches and problems.	3.07	0.80	0.68	0.42
RF 20. Accepting unusual terms and conditions.	3.04	0.87	1.65	0.31
RF 21. Permitting a grace period for changing specifications.	3.30	0.87	0.48	0.44
RF 22. Project team formed after bid was prepared.	3.94	1.02	1.66	0.02 •

Table 8. t-test values for Planning Phase variables

Variables	Mean	SD	t-value	p-value
RF 23. Failure to assess and provide for risks and uncertainties.	4.27	0.90	22.89	0.00•
RF 24. Inadequate work breakdown structure.	3.88	0.98	9.68	0.04•
RF 25. Inadequate pre-planning.	3.85	0.86	8.62	0.03•
RF 26. Omissions.	3.21	0.85	0.59	0.28
RF 27. Misinterpretation of information.	3.24	0.86	1.67	0.58
RF 28. Use of poor estimating techniques.	3.15	0.89	0.76	0. 30
RF 29. Underestimating time and labour requirements.	3.12	0.92	1.58	0.19
RF 30. Failure to identify and concentrate on major cost elements.	3.91	1.03	0.94	0.01•
RF 31. Deficiencies in scheduling.	3.39	0.95	1.72	0.60
RF 32. Inadequate formal planning.	3.33	0.94	1.56	0.58
RF 33. Poor work definition at lower levels of the organisation.	3.20	0.89	1.49	0.27
RF 34. Poor standards resulting in unrealistic budgets.	3.09	0.85	0.84	0.24
RF 35. Overestimating of company's capabilities.	3.20	0.88	1.38	0.36
RF 36. A missing PERT / CPM chart.	3.20	0.88	1.42	0.35
RF 37. Poor programming procedures and techniques.	3.19	0.87	1.09	0.28

Table 9. t-test values for Construction Phase variables

Variables	Mean	SD	t-value	p-value
RF 38. Fluctuation in the prices of materials.	3.28	0.87	1.44	0.40
RF 39. Late arrival of workers to the site.	3.26	0.91	1.43	0.07
RF 40. Shortage of qualified workers.	3.19	0.85	1.32	0.32
RF 41. Lack of equipment.	3.26	0.86	1.25	0.08
RF 42. Faulty plant /equipment.	3.31	0.90	1.52	0.11
RF 43. Inadequate reporting structure.	3.25	0.83	1.50	0.08
RF 44. Inadequate site supervision.	3.19	0.80	1.40	0.26
RF 45. Excessive wastage of materials.	3.14	0.85	1.18	0.09
RF 46. Poor comparison of actual and planned costs.	3.16	0.86	1.26	0.21
RF 47. No management policy on reporting and control. practices.	3.18	0.83	1.30	0.10
RF 48. Schedule delays that require overtime or idle time costing.	3.19	0.87	1.39	0.28
RF 49. Comparison of planned and actual costs at the wrong level of management.	3.15	0.81	1.24	0.13
RF 50. Out-of-sequence starting and completion of activities.	3.19	0.87	1.36	0.14
RF 51. Specifications that are not acceptable.	3.15	0.81	1.22	0.22
RF 52. Communication and coordination problems.	4.09	1.06	9.02	0.02•
RF 53. Unforeseen technical problems.	3.21	0.91	1.33	0.09
RF 54. Unexpected natural and/or social events.	3.29	0.93	1.56	0.11
RF 55. Deficiencies in the contractor's organisation.	3.28	0.95	1.49	0.20
RF 56. Slow payment by client.	3.16	0.88	1.21	0.41
RF 57. Low productivity and inefficiency of equipment.	4.06	0.82	11.34	0.01•
RF 58. Late material delivery.	3.24	0.78	1.70	0.10
RF 59. Changes (variations) being made deep into the projects life cycle.	3.17	0.86	1.37	0.21
RF 60. Quality expected beyond standard and specification.	3.23	0.87	1.50	0.14
RF 61. Interference from the client.	3.15	0.87	1.28	0.39
RF 62. Subcontractor unable to finish work on time.	3.01	0.96	0.97	0.20
RF 63. Low quality of subcontractor's work.	4.18	0.87	12.57	0.03•
RF 64. Low productivity by subcontractor.	4.12	0.92	11.95	0.02•
RF 65. Problems in coordination of subcontractor's work.	3.11	0.89	0.39	0.35
RF 66. Functional manager not having a clear understanding of what is to be done.	3.20	0.88	1.21	0.08
RF 67. Rework due to defective work.	4.24	0.93	11.03	0.00•

The statistical t-test results showed that out of the 67 risk factors, 15 are significantly important ($p < 0.05$). The variables have been listed in rank order in Table 10 below.

Table 10. List of the significant variables (potential risk factors) in rank order

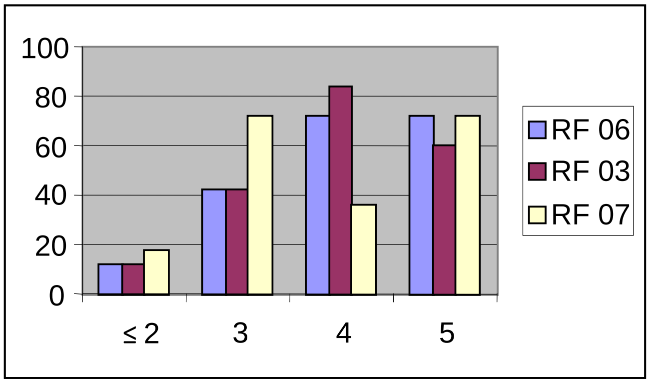
Variable	Mean	Rank
RF 23 Failure to assess and provide for risks and uncertainties.	4.27	1
RF 67 Rework of defective work.	4.24	2
RF 08 Client's requirement not well understood.	4.21	3
RF 63 Low quality of subcontractors' work.	4.18	4
RF 64 Low productivity by subcontractors.	4.12	5
RF 52 Communication and coordination problems.	4.09	6
RF 57 Low productivity and inefficiency of equipment.	4.06	7
RF 06 Incomplete design scope.	4.03	8
RF 17 Proposal team different from project team.	4.00	9
RF 03 Errors in drawings.	3.97	10
RF 22 Project team formed after bid was prepared.	3.94	11
RF 30 Failure to identify and concentrate on major cost elements.	3.91	12
RF 24 Inadequate Work Breakdown Structure.	3.88	13
RF 25 Inadequate pre-planning.	3.85	14
RF 07 Delay in receiving approvals.	3.81	15

The significant variables identified by the t-test (i.e. those variables that met the selection criteria) were selected to generate the frequency tables shown in Tables 11 ─ 14. A frequency table is a table with rows and columns. Each row in the tables (See Tables 11 to 14) represents a factor and each column represents a score on the 1 ─ 5 Likert scale.

Table 11. Descriptive Statistics for Design Phase variables.

Factor	≤ 2	3	4	5	Mean	SD
RF 06 Incomplete design scope.	12	42	72	72	4.03	0.91
RF 03 Errors in design.	12	42	84	60	3.97	0.87
RF 07 Delay in receiving approvals	18	72	36	72	3.81	1.03

A frequency distribution of Table 11 responses is shown in Figure 1.



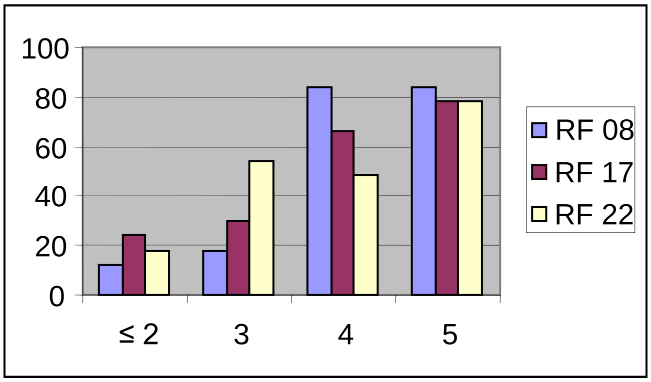
Five-Point Likert Scale.

Figure 1: Frequency distribution for Design Phase variables.

Table 12. Descriptive Statistics for Contract Award Phase variables.

Factor	≤ 2	3	4	5	Mean	SD
RF 08 Client's requirements not understood	12	18	84	84	4.21	0.85
RF 17 Proposal team different from project team	24	30	66	78	4.00	1.17
RF 22 Project team formed after bid was prepared	18	54	48	78	3.94	1.02

A frequency distribution of the Table 12 responses is shown in Figure 2.



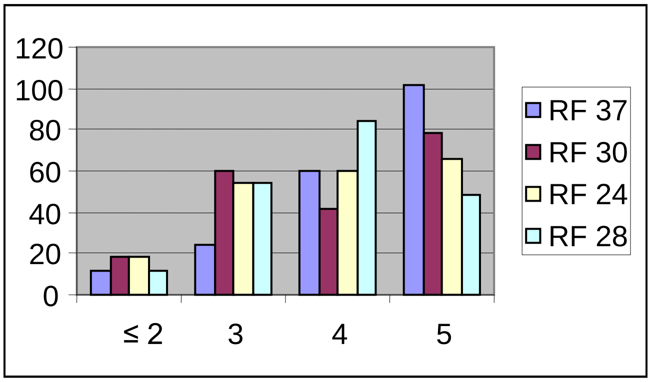
Five-Point Likert Scale.

Figure 2: Frequency distribution for Contract Award variables.

Table 13. Descriptive Statistics for Planning Phase variables 3

Factor	≤ 2	3	4	5	Mean	SD
RF 23 Failure to assess and provide for risks and uncertainties	12	24	60	102	4.27	0.90
RF 30 Failure to identify and concentrate on major cost elements.	18	60	42	78	3.91	1.03
RF 24 Inadequate WBS	18	54	60	66	3.88	0.98
RF 25 Inadequate pre-planning.	12	54	84	48	3.85	0.86

A frequency distribution of Table 13 responses is shown in Figure 3.



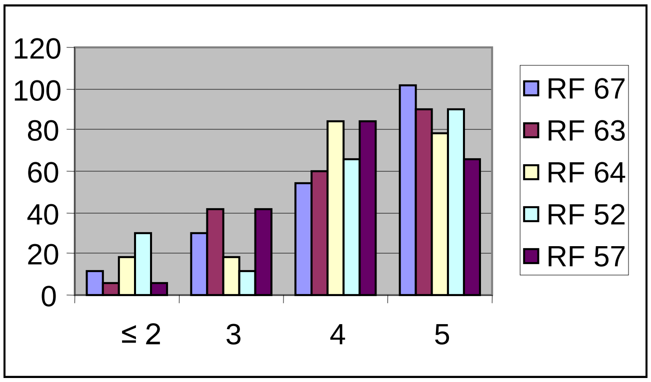
Five-Point Likert Scale.

Figure 3 Frequency distribution for Planning Phase variables.

Table 14. Descriptive Statistics for Construction Phase variables.

Factor	≤ 2	3	4	5	Mean	SD
RF 67 Rework of defective work.	12	30	54	102	4.24	0.93
RF 63 Low quality of subcontractors' work.	6	42	60	90	4.18	0.87
RF 64 Low productivity by subcontractors.	18	18	84	78	4.12	0.92
RF 52 Communication and coordination problems.	30	12	66	90	4.09	1.06
RF 57 Low productivity and inefficiency of equipment.	6	42	84	66	4.06	0.82

A frequency distribution of the Table 14 responses is shown in Figure 4.



Five-Point Likert Scale.

Figure 4: Frequency distribution for Construction Phase variables.

Chi-Square Tests Results

The data generated from Tables 11 — 14 were then used to run the chi-square tests for each phase of a construction project identified in this research. The chi-square statistic test is a test that shows the "goodness of fit." In other words, the chi-square test is a statistical indication of whether or not the responses are similar enough to conclude that they are statistically the "same." That is, the chi-square test on each table would confirm if the responses have been properly classified under the various phases of a construction project or not. This would result in a set of variables for each of the phases of a construction project identified in this study. Therefore the variables common to any of the phases identified in the survey would pass the chi-square test. The table values were entered, and the chi-square tests were performed.

Put more appropriately, the chi-square test determines whether there are statistically significant differences among the variables selected under each heading (phase) or if there are no differences. The null hypothesis (H_0) is that the variables are the same. In other words, if they are the "same", then the variables become the proposed common set for that phase (i.e. Design, Award, Planning and Construction). The alternative hypothesis (H_1) is that the variables are not the same and do not represent a common set of variables.

The chi-square test generates a value for χ^2, which in this work is referred to as χ^2 calculated. The calculated χ^2 is a measure of the distance of the observed counts from the expected counts. This value is always zero or positive. It is zero only when the observed counts are exactly equal to the expected counts. Large values of χ^2 are evidence against H_0 because they say that the observed counts are far from what we would expect if H_0 were true.

In order to test the null hypothesis using the chi-square test results, the χ^2 calculated is compared to a standard table value of χ^2 found in a statistical reference (Bello and Ajayi, 2000), which is referred to as the χ^2 table value. The following decision criteria were used to test H_0 and H_1:

1. If χ^2 calculated is greater than χ^2 table, then we reject the null hypothesis that they are the same and accept the alternative hypothesis that they are different (i.e. they do not form a common set of factors for the phase being tested.

2. If χ^2 calculated is less than χ^2 table, then we accept the null hypothesis that they are the same, or form a common set of factors for the phase being tested.

Additionally, in order to use the chi-square table, a confidence interval had to be established and the degrees of freedom had to be determined. A confidence interval of 95% was used. Therefore, the table entry for "p," which is defined as the probability of rejecting the null hypothesis if it is in fact true, was equal to 0.05. The level of $p = 0.05$ is a common rule of thumb. The degrees of freedom (df) are calculated from the frequency table by multiplying the number of rows (r) minus one by the number of columns (c) minus one. That is, $(r - 1)(c - 1) = df$ (Aluko 1999).

The variables that met the selection criteria were selected to generate the frequency table for the Design Phase variables shown in Table 11. The chi-square test for the variables listed under the Design Phase resulted in a χ^2 calculated value of 5.69. The table value for the Design Phase variables (χ^2 table) is equal to 12.60, with "p" equal to 0.05 and "df" equal to 6. Therefore, since $5.69 < 12.60$ (i.e. χ^2 calculated < χ^2 table), we must accept H_0, which indicates that they are the same and form a common set of variables (highly significant factors) under the Design Phase.

The variables that met the selection criteria were selected to generate the frequency table for the Contract Award Phase variables shown in Table 12. Following the same procedure previously detailed, the chi-square test for the variables listed under the Contract Award Phase resulted in a χ^2 value of 5.98. The table value for χ^2 with "p" = 0.05 and "df" = 6 is equal to 12.60. Therefore, since $5.98 < 12.60$ (χ^2 calculated < χ^2 table), we must accept H_0 which is that they are the same. Since they are the same, it implies that they form a common set of factors that affect a contractor's budget and are attributable to actions and decisions taken during the Contract Award Phase.

The variables that met the selection criteria were selected to generate the frequency table for the Planning Phase variables shown in Table 13. The chi-square test for the variables listed under the Planning Phase resulted in a χ^2 value of 5.57. The table value for χ^2 with "p" = 0.05 and "df" = 9 was equal to 17.00. Again, since $5.57 < 17.00$ (i.e. χ^2 calculated < χ^2 table), we must accept H_0 which is that they are the same. Again, since they are the same, it means that they form a set of factors that impact on costs at the implementation stage of a project and are attributable to decisions taken during the Planning Phase.

The variables that met the selection criteria were selected to generate the frequency table for the Construction Phase variables shown in Table 14. The chi-square test for the variable listed under the Construction Phase resulted in a $\chi 2$ value of 11.91. The table value for χ^2 with "p" = 0.05 and "df" = 12 is equal to 21.00. Therefore since $11.91 < 21.00$ (i.e. χ^2 calculated < χ^2 table) we must accept H_0, which is that they are the same and they establish a set of factors that impact on a contractor's budget during the execution of a construction project.

Table 15 presents a summary of the results of the chi-square tests conducted on the data presented in Tables 11 — 14.

Table 15. Results of the chi-square tests

Phase	df	χ^2 table	χ^2 calculated	Decision
Design	6	12.60	5.69	Accept H_0
Contract Award	6	12.60	5.98	Accept H_0
Planning	9	17.00	5.57	Accept H_0
Construction	12	21.00	11.91	Accept H_0

Summary Of Findings

The testing of the research hypotheses has enabled those key potential risk factors that can wreak havoc on a construction project and thereby reduce a construction firm's profit margin to be isolated. In doing so, construction firms can now focus their prevention strategies on those fifteen variables identified by this research.

Of quintessential importance is the finding that construction firms do not undertake comprehensive risk assessment before the commencement of a project undertaking (RF 37: Mean = 4.27, SD = 0.90).

Another important finding is that rework of defective work (RF 67: Mean = 4.24, SD = 0.93) significantly impacts on a contractor's project budget. This can be attributed to the fact that Quality Management (QM) activities are generally not being utilised during the construction process. Both prime contractors as well as subcontractors are guilty in this regard.

Conclusions

The findings in this study are pertinent and helpful to Nigerian construction firms in several ways. The testing of the research hypothesis has enabled those key potential risk factors that can wreak havoc on a construction project and thereby reduce a construction firm's profit margin to be isolated. Thus, construction firms can now focus their prevention strategies on those fifteen variables identified by the research.

Effectively addressing and managing the fifteen factors would enable them to improve upon their cost control practices with a view to remaining profitable. This is because the continued survival of a construction firm depends on a steady stream of successfully managed projects. The findings therefore underscore the need for construction firms to take a hard look at their processes.

Although the research presented herein is primarily focused on the Nigerian construction industry, it is envisaged that the outcome of the research would be widely applicable in other countries because according to Love and Edwards (2004), an inherent synergy exists between contractors and the like internationally.

Recommendations

1. There should be increased emphasis on the integration of design and construction processes. If this is done, most design-related errors would be eliminated.

2. Project Managers (PM's) should ensure that every project member understands that they have to react, respond and take action when deviations are observed.

3. Construction firms should analyse critical risk factors to determine how they will affect the project before commencement. PM's need to conduct "what if" games to develop contingency plans.

4. Subcontractors should be appointed early in the project so that they can participate in developing the project plan.

5. Every project should be hierarchically structured in a Work Breakdown Structure and all participants

at the work package level should be monitored. Besides, the characteristics of each work package must be thoroughly perceived and the management plan well defined at the beginning stage of a construction project.

6. Planning should be in the short term because having a few key objectives at a time focuses the project team on target and creates commitment and agreement about project goals. Plans should be kept simple with the appropriate level of detail that can encourage a project to be reviewed regularly.

7. QM tools and techniques should be used by construction firms to eliminate waste, typically in the form of rework, thereby improving the effectiveness of their processes. The benefits of establishing a QM department will more than outweigh the setting up costs.

8. Project Managers should ensure that an effective information system is established for every construction project. They should equally ensure that information is realistic and that the means for measuring progress is determined very early in the project.

9. Proper attention should be paid to the maintenance of equipment and the use of skilled equipment operators during site operations. This is because the use of appropriate equipment during the site operations will not only improve productivity at the site, it will definitely shorten construction time. In the long term, this can help construction firms to improve their competitiveness and even outperform their competitors.

Recommendation For Further Research

Further research is now required to expand this research by developing a computer program with a comprehensive checklist of RF’s that are likely to impact a project budget during the implementation stage and a risk prevention strategy toolkit that can be used by members of the Nigerian construction industry.

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