Analysis of risk occurrence in projects executed by small and medium sized contracting firms

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Abstract. The performance of small and medium sized construction firms has attracted research attention in recent times because of the impact on sustainable economic growth. This study examined this category of firms as their performances in building project delivery are impacted by specific risk factors. The purpose is to provide empirical evidence that could enhance the choice of appropriate risk management approaches and improve the performance metrics of the projects executed by the firms. Primary data were obtained through a structured questionnaire targeted at 100 firms which is about 40% proportional sample of 245 registered small and medium contractors in Lagos state, Nigeria, as at 2016. A total of 53 questionnaires completed by; 17 engineers, 12 quantity surveyors, 10 architect, eight builders and 2 project managers provided valid responses for the analysis. Quantitative data collected were analysed using mean ranking, factor analysis, and t-test. While the results show; mistakes, changes in scope of project, price fluctuation, importing and customs and security risk factors, as the most frequently occurring variables, they nonetheless indicate no significant difference in the ranking of the occurrence of the factors by the operators of both small and medium sized contracting firms. Although findings are limited to occurrence indices of the factors, risk impact models based on severity indices of the individual variables on project performance executed by this category of contractors can be developed based on the empirical findings. The study also highlights implications for risk assessment and choice of appropriate management techniques that could help in improving the performance metrics of the projects executed by small and medium sized category of contracting firms.

Keywords: building, construction, risk factors, small and medium size firms.

1. Introduction

Small and medium enterprises, comprising construction organizations, account for about 96% of businesses that contribute to national employment in Nigeria [1]. Research into small and medium sized construction firms has therefore increased in recent times because of the contribution of this category of firms to job creation which is a significant socio-economic challenge in Nigeria [2], [1]. Performance of small and medium sized construction firms in project delivery is often influenced by a number of risk occurrences and impacts. Yearly, a number of this category of firms wind up and those which thrive have not fully developed the capacity for satisfactory performance metrics in project delivery.

Project performance defined by the extent to which the project objectives; time, cost, and quality are met [3], has been established to have a strong correlation to risk occurrences and impacts [4]. Hence risk management in the construction industry has continued to attract significant empirical assessment. Risk management mostly refers to the harmonization of activities aimed at controlling risk variables. The construction industry’s risk factors rank the highest when compared with other industries [5], [6]. Risk management is thus vital in construction project management to attain satisfactory performance. Previous studies have generally evaluated risk factors without bias for categories of construction firms. Risk management studies which have sufficiently isolated the small and medium scale contractors are generally limited in the Nigerian context. This raises the question of whether risk occurrences and management approaches that are suitable for larger firms could be...
generalized to small and medium firms which constitutes the indigenous operators and higher proportions of contracting organizations in Nigeria. Empirical assessment of this category of firms, especially how they are differently impacted by construction risk factors from the larger category, is expected to provide implications for choice of appropriate risk management approaches and improve the performance metrics of projects executed by the firms.

2. Literature review
Risk within the construction industry is generally perceived as variables that impact the performance of project objectives; cost, time and quality [7], [6]. The implication of this assertion is that project performance level could go far low beyond the desired level if the elements of risk are not appropriately managed.

Risk management involves a number of processes namely; identification, assessment or analysis, risk response and control. Risk identification is the most essential stage in risk management practice which involves gathering all possible risk factors that may be met during the course of implementation of a project [8]. According to [9], risk assessment is the assessment of occurrence and consequences of risk based on available data while risk response involves actions taken to prevent, reduce and avert risk and its consequences. On the other hand, risk control involves monitoring of variation aimed at reducing risk.

Many approaches for managing project risks abound in literature. For instance, [10] suggests that risk management strategies may include conducting site investigation of field survey to prevent design risk. In the same vein, the research conducted by [11] in China which focused on political risk management strategies in international construction projects recognized making precise decision, carrying out good negotiations, shaping a good and conducive business environment, completing full preparations, minimizing needless errors and obtaining a logical response, as political risk management strategies that are most effective for international construction projects. Other closely related studies include [12] which assessed strategies used in managing site related risk from the perspective of cost. In South Africa, [13] conducted a study which was limited to occupational health and safety regulation measures. The study was limited to risk management strategies for injuries to site workers. [14] evaluated risk at the project conceptual/feasibility stage and found that although there is a widespread knowledge of risk management among construction professionals, the level of application is at low ebb.

Various studies on risk management which were generalized to construction industry at large have enabled a number of risk factors to be identified (such as [15], [16], [7], [6], among others). However, evidence of relative occurrence of the risk factors along the large and small and medium sized contractors, especially on how the variables impact project performance by these categories is very limited. This study is therefore an attempt to relate the profile of small and medium construction firms to the risk factors occurrence as they impact project performance by this category of firms.

3. Research methodology
This study adopted a qualitative descriptive analysis which was based on primary data obtained through a questionnaire survey. The structured questionnaires were administered to professionals comprising architects, estate surveyors, quantity surveyors, engineers, builders and project managers, who are major operators of small and medium construction firms in Lagos State. The structured questionnaire provided a suitable instrument because of the quantitative nature of the assessment [17]. The questionnaire was divided into two sections. Section A identified the profile of the respondents and section B identified various risk factors evaluated. The questionnaire consisted primarily of closed-ended questions with the provision for respondents to rate their opinions on an interval scale of 5 and 1, where 1 represents the least rating and 5 the highest. This provision enabled the completion of the questionnaire on average of 20 minutes by the respondents.

A total of 82 copies (out of 100 proposed) were administered due to time constraint. Out of these, 60 were retrieved (62% response rate) and of 53 copies were found to be properly completed and considered suitable for the analysis. Data collected were analysed using mean item score (MIS) and factor analysis (FA). Suitability of the data collected for the factor analysis was tested using Kaiser-
Meyer-Olkin (KMO). KMO measure of sampling adequacy and Bartlett’s test of sphericity. KMO indicates the proportion of variance in the variables which is common that might be caused by similar underlying factors [18]. The Bartlett’s test of sphericity was used considering the medium sample size of the study population.

4. Results and analysis
The profile of the respondents, their organizations and the discussion of the results are presented in three subsections as below.

4.1 Profile of the respondents
The result of the analysis of the corporate profile of the firms investigated shows that about 21.6% of them were owned as sole proprietorship, 29.4% were partnership firms while the largest at 47.1% were limited liability. Skill labour assessment of the firms show average number of 12 employees. The number of years of establishment for more than 50% of the firms was 20 years, with 37.3% of the firms been incorporated for more than 21 years. Capital to labour ratio of the firms shows that 15.8% were indexed at 1:4, and 1:6 were indexed at 11.8%.

Table 1. Profile of the respondents.

| Profile of Respondents | Criteria | Frequency | Percentage |
|------------------------|----------|-----------|------------|
| Type of respondent     | Engineer | 17        | 33.3       |
|                        | Project manager | 2   | 3.9        |
|                        | Quantity Surveyor | 12  | 23.5       |
|                        | Architect    | 10       | 19.6       |
|                        | Builder      | 8        | 15.7       |
|                        | Others       | 2        | 3.9        |
| Academic qualifications| Higher National Diploma | 16  | 31.4       |
|                        | Master of Business Administration | 2   | 3.9        |
|                        | First degree | 18   | 35.3       |
|                        | Master of Science | 14  | 27.5       |
|                        | Doctor of Philosophy | 1   | 2.0        |
| Capital to labour ratio| Missing    | 27       | 52.9       |
|                        | 1:02       | 6        | 11.8       |
|                        | 1:04       | 8        | 15.7       |
|                        | 1:06       | 6        | 11.8       |
|                        | 1:08       | 3        | 5.9        |
|                        | 1:16       | 1        | 2.0        |
| Type of organization   | Missing    | 1        | 2.0        |
|                        | Sole proprietorship | 11  | 21.6       |
|                        | Partnership | 15   | 29.4       |
|                        | Limited liability company | 24  | 47.1       |
| Company worth          | Missing    | 13       | 25.5       |
|                        | 10000001 and above | 21  | 41.2       |
|                        | 500001-10000000 | 6   | 11.8       |
|                        | 50001-500000  | 7   | 13.7       |
|                        | 5001-50000   | 3   | 5.9        |
| Years of incorporation | Missing    | 5        | 9.8        |
|                        | 1-5        | 4        | 7.8        |
|                        | 5-10       | 1        | 2.0        |
|                        | 10-15      | 6        | 11.8       |
|                        | 15-20      | 5        | 9.8        |
|                        | 20 and above| 30  | 58.8       |
| Total                  |           | 51       | 100.0      |
Firms with capital to labour ratio of 1:2 were 11.8%, those with 1:8 were 5.9%, and 2.0% were indexed at 1:16. About 68.6% of the firms were worth more than N50,000,000 while 9.8% had a worth between N1,000,001 - N50,000,000, and 5.9% worth up to N1,000,000. Analysis of the profile of the respondents shows that engineers were represented at 33.3% while project managers and quantity surveyors were represented at 3.9% and 23.5% respectively. Builders were 15.7% of the sample, and architects were 19.6%. Other respondents were represented at 3.9%. The assessment of the highest academic qualifications of the respondents shows that Higher National Diploma (HND) certificate holders were 31.4%, Masters degrees (MBA and M.Sc.) holders were 3.9% and 27.5% respectively, while First degree (B.Sc.) holders were 35.3% and Doctorate (Ph.D.) degree holder represented 2%. The respondents were either associate or corporate members of various professional bodies or possessed some other professional qualifications. The average year of experience of the respondents is estimated at 12 years. The overall results indicated above provide a good criteria for the suitability of the data.

4.2 Analysis of risk factors occurrence

Table 2 shows the results of data analysis of the extent of risk factors’ occurrences in the delivery of various construction projects by the firms. The top risk factors include mistakes (e.g. of soil investigation), changes in scope of the project, price fluctuation, import and customs and security risks. These risk factors have mean scores ranging from 3.50 - 3.36 on a likert-type scale of 1-5. It is interesting to note that both the small and medium sized contractors were unanimous in their scoring of these risk variables as there were no statistical significant differences in their mean values ($p>0.05$). This suggests that both the small and medium size contractors need to be mindful of these top ranking risk factors. It is also evident from results that the risk factors comprising; poor facility turnover, excessive variation order and poor cash flow analysis ranked 7th, 8th and 9th respectively in the overall mean score and can be grouped under “financial risks”. The high ranking of these factors indicates that irrespective of the value of contracts, the extent of occurrence of those risks on construction project is high.

[19] opines that, the effect of financial risks on projects cannot be over emphasized, as these have a high propensity to affect the cash flow of projects which can result in delay. Similarly, the results in Table 2 indicate that four (4) risk variables that also ranked high in their extent of occurrences which can be grouped under ‘construction risks’ were; construction delivery method, operational shutdown and start-up, non-availability of utilities and basic infrastructures and corrupt business practices. These risk factors ranked 13th, 14th, 16th and 18th respectively. It is not surprising that both the small and medium sized contractors ranked the extent that these risks occurred fairly high in the delivery of various constructions. It is therefore instructive that both the small and medium sized contractors should be mindful of such risks and have pro-active management strategy in dealing with them.

The results also reveal that inflation rate volatility, restricted construction area, communication and data transfer, poor quality of material, construction permit, site selection and clear title and logistics risk were ranked 20th, 22nd, 23rd, 24th, 25th, 28th, and 32nd respectively in overall mean score. The last thirteen (13) risk variables from the results indicate that respondents were of the opinion that, their extent of occurrence is ‘generally low’. Based on the 5 point Likert type scale that was used, none of these risk variables recorded a mean value greater than the overall benchmark of 3.50 in similar construction management studies adopting this index [20], [21]. The low ranking of these risk variables indicates that they have a very low extent of occurrence in the delivery of construction projects by this category of firms.
Table 2: Frequency of occurrence of risk factors in project delivery.

| Risk factors                                | Overall | MC  | R   | SC  | R   | t-value | Sig.  | Risk factors                                | \( \bar{t} \) | R   | MC  | R   | SC  | R   | t-value | Sig.  |
|---------------------------------------------|---------|-----|-----|-----|-----|---------|-------|---------------------------------------------|---------|-----|-----|-----|-----|-----|---------|-------|
| Mistake of soil investigation               | 3.50    | 1   | 3.29| 12  | 3.70| 1       | .859  | .395 | Access to fund at reasonable interest rate | 3.08    | 28  | 3.15| 18  | 3.00| 26  | -3.44   | .732 |
| Changes in scope of project                | 3.49    | 2   | 3.37| 11  | 3.60| 4       | .548  | .586 | Site selection and title risk               | 3.08    | 28  | 2.95| 33  | 3.20| 12  | .702    | .486 |
| Price fluctuation                          | 3.47    | 4   | 2.78| 1   | 3.20| 12      | 1.415 | .163 | Government participation and control        | 3.07    | 30  | 2.93| 36  | 3.20| 12  | .513    | .618 |
| Importing and customs risk                 | 3.38    | 5   | 3.05| 26  | 3.70| 1       | 1.669 | .102 | Operational safety                         | 3.05    | 31  | 3.20| 15  | 2.89| 34  | -6.73   | .504 |
| Security risk                              | 3.36    | 6   | 3.41| 6   | 3.30| 12      | -2.64 | .793 | Logistics risk                             | 3.00    | 32  | 2.90| 38  | 3.10| 24  | .496    | .622 |
| Poor facility turnover                     | 3.32    | 7   | 3.44| 5   | 3.20| 12      | -6.36 | .528 | Non comprehensive feasibility assessment   | 2.96    | 33  | 3.12| 20  | 2.80| 35  | -8.39   | .405 |
| Excessive variation order                  | 3.31    | 8   | 3.41| 6   | 3.20| 12      | -5.52 | .601 | Repudiation                                | 2.96    | 33  | 3.22| 13  | 2.70| 42  | 1.159   | .252 |
| Exchange rate volatility                   | 3.30    | 9   | 3.20| 15  | 3.40| 4       | .594  | .555 | Labour strike                               | 2.95    | 35  | 3.00| 30  | 2.90| 31  | -2.78   | .782 |
| Non availability of trained workforce      | 3.30    | 9   | 3.39| 8   | 3.20| 12      | -3.74 | .716 | Intellectual property violation             | 2.93    | 36  | 3.05| 26  | 2.80| 35  | -6.40   | .525 |
| Non availability of trained workforce      | 3.30    | 9   | 3.39| 8   | 3.20| 12      | -5.49 | .586 | Political instability                      | 2.88    | 37  | 2.85| 43  | 2.90| 32  | .119    | .906 |
| Logistics and warehousing                  | 3.30    | 9   | 2.90| 38  | 3.70| 1       | 1.953 | .057 | Workforce availability and skills           | 2.88    | 37  | 2.95| 33  | 2.80| 35  | -3.89   | .699 |
| Construction delivery method               | 3.25    | 13  | 3.10| 23  | 3.40| 8       | .788  | .434 | Geotechnical uncertainties                  | 2.84    | 39  | 2.88| 40  | 2.80| 35  | -1.94   | .847 |
| Operational shutdown and start-up          | 3.23    | 14  | 3.05| 26  | 3.40| 8       | .809  | .423 | Hazardous material requirement              | 2.84    | 39  | 2.78| 48  | 2.90| 32  | .306    | .761 |
| Workforce logistics and support            | 3.23    | 14  | 3.46| 3   | 3.00| 26      | 1.082 | .284 | Variability of tax and tariff               | 2.82    | 41  | 2.93| 36  | 2.70| 42  | -6.19   | .539 |
| Clients insolvency                         | 3.21    | 16  | 3.02| 29  | 3.40| 8       | .726  | .484 | Subcontractors insolvency                   | 2.82    | 41  | 3.05| 26  | 2.80| 35  | -.083   | .934 |
| Non availability utilities & basic infrastructures | 3.21   | 16  | 3.12| 20  | 3.30| 12      | .380  | .706 | Environmental, health and safety risk      | 2.82    | 41  | 2.83| 44  | 2.80| 35  | -.068   | .946 |
| Application of tax law & potential changes | 2.93 | 47 | 2.93 | 34 | 3.60 | 4 | 2.057 | 0.045 |
|-------------------------------------------|------|----|------|----|------|---|--------|-------|
| Delay in issuance of instruction by the consultant | 2.80 | 44 | 3.00 | 30 | 2.60 | 47 | -0.989 | 0.327 |
| Shortage of materials | 2.79 | 45 | 2.78 | 48 | 2.80 | 35 | 0.047 | 0.963 |
| Poor communication & coordination | 2.78 | 46 | 2.95 | 33 | 2.67 | 47 | -0.809 | 0.423 |

| Corrupt practices | 3.20 | 18 | 3.00 | 30 | 3.40 | 8 | 0.920 | 0.362 |
| Poor safety practice | 2.74 | 47 | 3.07 | 24 | 2.40 | 49 | 1.681 | 0.099 |

| Inflation rate volatility | 3.18 | 20 | 3.46 | 3 | 2.90 | 30 | 1.308 | 0.197 |
| Need to comply with new regulations | 2.74 | 47 | 2.78 | 48 | 2.70 | 42 | -0.169 | 0.866 |

| Change in government | 3.18 | 20 | 3.15 | 18 | 3.20 | 12 | .120 | .905 |
| Civil disturbance | 2.74 | 49 | 2.78 | 48 | 2.70 | 42 | -0.192 | 0.848 |

| Restricted construction area | 3.16 | 22 | 3.12 | 20 | 3.20 | 12 | .162 | .872 |
| Unfavourable climate | 2.64 | 50 | 2.88 | 40 | 2.40 | 49 | 1.161 | 0.251 |

| Communication and data transfer | 3.12 | 22 | 3.54 | 2 | 2.70 | 42 | 2.253 | 0.029 |
| Estimating uncertainty | 2.62 | 51 | 2.83 | 44 | 2.40 | 49 | 1.136 | 0.261 |

| Poor quality of material | 3.11 | 24 | 3.22 | 13 | 3.00 | 26 | -0.598 | 0.552 |
| Force majeure | 2.42 | 52 | 2.44 | 42 | 2.40 | 52 | -0.096 | 0.924 |

| Social unrest or violence | 3.09 | 25 | 3.17 | 17 | 3.00 | 26 | -0.424 | 0.673 |
| Poor quality of material | 3.11 | 24 | 3.22 | 13 | 3.00 | 26 | -0.598 | 0.552 |

| Construction permit | 3.09 | 25 | 2.88 | 40 | 3.30 | 12 | 1.059 | 0.295 |

*p-value is significant at 0.05*
Given the above, it is thus not surprising that respondents ranked the cited risk variables very low. A statistical test using student’s t-test carried out at 5% level of significance and 95% confidence level to compare rating of the variables by both small and medium sized contractors showed that this firm category together, were generally unanimous on the level of extent of occurrence of the 52 risk factors in the delivery of construction projects.

4.3 Factor Analysis of the variables

Factor analysis of the 52 factors reduced them to nine (9) components for better explanation of their significances. The extent of adequacy of the data loaded for the study was tested using of Kaiser-Meyer-Olkin (KMO) and Bartlett’s test. The Bartlett’s measure tests the null hypothesis that the original correlation matrix is an identity matrix. For factor analysis to be adequate, Kaiser recommends accepting values > 0.5 [22].

Eight principal components were identified with Eigen values greater than > 1.000 at the points on the screed plot where the curve starts to level off. Based on the above criteria, twelve (12) of the variables loaded on factor 1 was named ‘project regulation and administration risks’. These were; poor cash flow analysis, workforce availability and skills, environmental, health and safety risk, approval, permits and licensing risk, civil disturbance, importing and customs, logistics risk, non-availability of trained workforce, non-availability  of trained workforce, labour strike, restricted construction area, hazardous material requirement , repudiation and poor quality of material. This component has a total variance of 13.080%.

Similarly, seven risk variables loaded onto component 2 were; inappropriate construction delivery method, shortage of materials, exchange rate volatility, poor safety practice, inflation rate volatility, access to fund at reasonable interest rate and estimating uncertainty. This is named ‘construction and finance related risk’ with the component having a total variance of 10.053%. Thus, components 1 and 2 accounted for 23.133% cumulative percentage.

The five items that load onto component 3 relate to ‘politics and regulation related risks’. Loaded on this component were delay in issuance of instruction by the consultant, need to comply with new government regulations, intellectual property violation, change in government and political instability, with the component having a total variance of 8.295%. The four items that load unto component 4 relate to the ‘social and environmental related risks’. Loaded on this component were; mistake of soil investigation, social unrest or violence, security risk and non-availability of utilities and basic infrastructures, with the component having a total variance of 7.383%. Four items loaded unto component 5 which is named ‘logistics related risks. These were; logistics and warehousing, construction permit, operational shutdown and start-up as well as and clients insolvency. This component has a total variance of 6.841%.

Component 6 has a total variance of 6.237% with four items loaded into it as; subcontractors insolvency, force majeure, variability of tax and tariff, workforce logistics and support. This
component is much related to ‘force majeure and economic related risks’. The items that load unto component 7 are much related to ‘business environment’. These were; unfavourable climate and poor facility turnover, with the component having a total variance of 5.860%. Finally, component 8, much related to ‘project management’ is loaded with excessive variation order, communication, and geotechnical uncertainties. Component 8 has a total variance of 5.860% and this combined with component 7 accounted for 57.75% cumulative percentage.

5. Conclusions and Recommendations
This study showed that small and medium sized contractors are impacted by multiple occurrences of specific risk factors which could be classified into nine components. These were; project regulation and administration, construction and finance, politics and regulation, social and environmental related, logistics, force majeure and economics, business environment, and project management. Among the top frequently occurring factors in the delivery of construction projects by this category of firm are; mistake of (e.g. in soil investigation), changes in scope of the project, price fluctuation, importing and customs and security risk factors. Absence of statistically significant differences in the mean values (at \( p > 0.05 \)) of ranking of the factors among respondents from small and medium sized firms suggests that contractors in this category are most likely to be impacted in similar ways. This does suggest appropriateness of similar management techniques. With slight deviation of the findings from previous studies on risk management which were generalized to construction industry at large, this category of firm may be exposed to different impacts of risk occurrence and suitable management techniques based on project characteristics by this firm category may be specifically evaluated. Small and medium contractors need to be mindful of the identified top risk factors in order to improve performance metric in project delivery. Moreover, risk discussions should be started early in the project and most frequently occurring risk factors should be communicated at a detailed level among the actors and the project’s phases. This study can be further extended to risk impact models based on severity indices of the individual variables on project performance executed by this category of contractors.

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