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# Effect of bond administration on construction project delivery

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**Abstract:** Construction bond administration involves management of bond issues from inception of obtaining bond from guarantor to the point of release of contractor by the client. This process has posted a lot of challenges to construction stakeholders; it is therefore, necessary to examine the relationship between bond administration and project success. Archival data of completed bonded building projects were gathered through a pro forma developed for this purpose. Using Pearson product moment of correlation, it was revealed that the cost of securing a construction bond has a positive and significant effect on the initial and final costs of the project, while the number of days needed to secure a construction bond has no significant effect on the initial and final durations of the construction project. In order to establish the relationship between project delivery indices of cost and time and the construction bond administration variables, iteration of linear regression was adopted to arrive at the best-fit equation. Factors affecting the cost of securing construction bonds from guarantors should be identified and given adequate attention by construction stakeholders in order to minimize the effect of construction bond administration on project delivery.

**Keywords:** bond, construction bond administration, guarantee, project cost, project duration, project success, risk management

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## 1 Introduction

Clauses to cater for various bonds are always included in the invitation to tender for public projects. For instance, in a request for proposal for the provision of passive telecommunications infrastructure for the purpose of co-location of telecommunication companies in rural/unserved communities in Nigeria by the Universal Service Provision Fund (Fayomi 2009), it was observed that clause M allowed for a bid bond (or non-refundable tendering fee) of naira (₦) 100,000.00 and clause L also allowed for performance bond expected to be 15% of the subsidy amount. These bonds will surely have one or more effects – whether negative or positive – on the performance of such projects in terms of cost, time and quality. Sipasi and Onuma (2010), in a report on their perception on Corporate Guarantees Under The 2005 Nigerian Production Sharing Contracts (PSCs), observed that a contractor in the 2005 PSC is expected to submit two performance bonds, issued by a reputable international financial institution in the form indicated in Annex F of the PSC. The first bond is expected to cover the cost of the minimum work programme in the first phase of the two phases – 5-year exploration period, whilst the second bond is required upon commencement of the second phase. However, it was noted that this has not solved the problem of time overrun, cost overrun and low quality of construction projects.

In the administration of construction bonds, it is worthy of note that the following problems still persist (Adegboye 2004; Boswall 2010; Kangari and Bakheet 2001; Loosemore 2006; Mehmet et al. 2006; Ojo 2011): most times, the client insists on contractors securing bonds from a specified guarantor and such guarantor may not be easily accessible by the contractor; inability of contractors to secure the required bond from the guarantor within the appropriate period; conditions surrounding the bonds not fully read and understood by stakeholders; guarantors' requirements for bonding are sometimes beyond the capacity of the contractors; contractors not discharged/released by the client as at when due and appropriately; different approaches to administration of construction bond in various countries; dispute and claims as a result of unsuccessful bond administration; and unsuccessful bond administration affecting the overall project success in terms of cost, time and quality. Against this backdrop, this study is designed to examine the effect of administration of bond on success of construction projects.

## 2 Literature review

The completion of any construction project within the cost, time and quality limits should be the utmost goal of the stakeholders involved in the project. Despite the involvement of all stakeholders to achieve these project goals, Ogunsemi and Jagboro (2006) observed that the twin problem of cost and time overruns still characterize construction projects in most parts of the world, especially in developing countries such as Nigeria. Most of these projects are not delivered within the agreed time frame, the cost budget is always exceeded and quality is no longer considered important, especially for public projects, and this has led to the need for constant maintenance in order to keep such projects standing and fit for their purpose. El-Haram and Horner (2002), as well as Koushki et al. (2005), corroborated that time delays and cost overruns are among the most common phenomena in the construction industry of developing countries, for projects ranging from simple to complex. Construction projects in Nigeria are still experiencing time overrun (Ajibade and Odeyinka 2006; Aibinu and Jagboro 2002; Augustine and Mangvwat 2001; Elinwa and Joshua 2001) and a major yardstick for the control of this menace is the use of bonds. Hosie (2010) observed that bonds and guarantees provide a form of security for a contractor's performance, in addition to serving as a measure of protection against insolvency, while Jenkins (2009) concluded that in the construction industry, contractor insolvency delays projects, increases costs and may deprive the employer of remedies and third parties of meaningful warranty protection. In order to guard against this, it is essential to check a contractor's financial position thoroughly before entering into a contract. If the contractor is a subsidiary company, the employer should consider obtaining a parent company guarantee.

The management of time, cost and quality within the project environment is often quoted as the main concern (and sometimes the only concern) of project stakeholders. A high level of optimism always accompanies the start of a construction project. The taste of success is sweet and anticipation thereof fuels an energetic beginning (Sanni 2007). The successful delivery of a project is supposedly dependent on many factors, including effective bond administration right from the inception of such a project. The Associated General Contractors of America (2006) noted that disagreements among stakeholders can become disputes, leading to breaches of contract, and these breaches can become defaults that justify termination of contracts.

Construction project performance is assessed by the ultimate delivery of construction project on time, at the estimated cost and with high quality (Kaming et al. 1997; Stuart 2001). It is believed that time, cost and quality of construction projects are the yardsticks that measure the performance of projects at any point in time. Coker (2008) stated that every construction project will have a definite duration of completion depending on a series of factors, chief among them being the complexity of the project and the available cash flow. Table 1 highlights the different authors' measures of construction project success.

Ogunsemi and Jagboro (2006) observed that construction time has always been seen as one of the benchmarks for assessing the performance of a project and the efficiency of the project organization. The ability to estimate the completion time of the project is a matter of individual intuition and its reliability depends on the skills and experiences of the planning engineer after consideration of all factors, such as constructional methods and transportation methods, among others. The quality of a project represents the standard of a project in accordance with the stated specification and instruction by the architects and the client (Seeley and Murray 2001). Specifications that comprise instructions regarding the quality of materials, standard of workmanship and the construction method to be adopted are expected to be given by the architects to the taste and financial ability of the client.

Construction cost is the expected financial implication of a proposed construction project (Seeley and Murray 2001). This is a major yardstick in determining the performance of a project in terms of overruns or otherwise. The ability to estimate correctly the cost of a construction is a function of a qualified quantity surveyor, whose professional duty is to accurately provide the materials and labour requirements of a proposed project by using mathematical manipulations as well as considerable appreciation of the project complexities.

## 3 Research methodology

This article examines the relationship between bond indices and project delivery indices. It entails testing the relationship between contract duration and cost of

**Tab. 1**: Project delivery indices and their sources

| Factors | Cost | Time | Quality | Cost saving | Time saving | Client's satisfaction |
|---|---|---|---|---|---|---|
| Aibinu and Jagboro (2002) | √ | √ | √ | – | – | – |
| Ajibade and Odeyinka (2006) | √ | √ | √ | – | – | – |
| Augustine and Mangvwat (2001) | √ | √ | √ | – | – | – |
| Doloi et al. (2010) | √ | √ | √ | √ | – | – |
| Elinwa and Joshua (2001) | √ | √ | √ | – | – | – |
| Koushki et al. (2005) | √ | √ | – | – | – | – |
| Love et al. (1998) | √ | √ | √ | – | – | √ |
| Seeley and Murray (2001) | √ | – | – | – | – | – |
| Ogunsemi and Jagboro (2006) | √ | √ | √ | – | – | – |
| Oyewobi (2010) | √ | √ | √ | – | – | – |
| Ramus et al. 2006 | √ | √ | √ | – | – | – |
| Wardani et al. (2006) | √ | √ | √ | – | – | – |

Source: Author's compilation.

identified bonds, contract duration and cost of securing identified bonds, contract duration and time taken to secure bonds, contract cost and cost of identified bonds, contract cost and cost of securing identified bonds, as well as contract cost and time taken to secure bonds.

Relevant and required data on completed bonded building projects were collected under the following headings: name of project, location of the project, method of contract, procurement method, cost of different bonds (bid, performance, advance payment and retention) of the project, delay in weeks in securing the bonds, source(s) of the bonds, bank/insurance company's commission on the bond, initial and final costs of the project, as well as the initial and final durations of the project. Two methods were used for this objective, that is, Pearson product–moment correlation and regression analysis.

For examining the causal relationship between construction bond indices (i.e. time and cost) and overall project success (measured in time and cost), Pearson product–moment correlation coefficient was adopted because the data are numeric, and all tests were taken at both 5% and 10% levels of significance. This method was adopted in this research to evaluate the strength of the relationship between contract duration and cost of identified bonds, contract duration and cost of securing identified bonds, contract duration and time taken to secure bonds, contract cost and cost of identified bonds, contract cost and cost of securing identified bonds, as well as contract cost and time taken to secure bonds.

For establishing the relationship between delivery of construction projects and bond administration indices, simple and multiple regression analyses were used. Regression analysis is a technique that finds a formula or mathematical model that best describes a set of data collected (Ashworth 1986). While simple linear regression models quantify the relationship between two variables, multiple regression models relate three or more variables. Hinkle et al. (1998) noted that regardless of the number of variables involved, there is always one dependent variable, while the others represent the independent variable(s).

In order to develop a suitable model that can predict the relationship between bond administration and project delivery, iteration of the linear, semi-log, double-log and exponential forms of the regression model was carried out (Kothari 2004). Thus, the models (variants of regression models used for this study) are as represented below:

The linear regression model is as indicated in Equation (1):

$$Y = a + bX \tag{1}$$

The semi-log regression equation is given as follows:

$$Y = a + b\mathrm{LN}X \tag{2}$$

The double-log multiple regression equation is thus written as follows:

$$\mathrm{LN}Y = a + b\mathrm{LN}X \tag{3}$$

Finally, the exponential equation for regression analysis is expressed as follows:

$$\mathrm{LN}Y = a + bX \tag{4}$$

where $Y$ is the dependent variable representing the final cost and time of construction projects and $X$ is the independent variable. $X$ ranges from $X_i$ to $X_n$ depending on the number of independent variables and it represents such factors as initial cost of construction project, initial duration of construction project, time and cost overrun, cost of bond, cost of securing bond and number of days taken to secure bond. From the iteration of the models, the equation with the greatest $R^2$ value is presumed to be the most appropriate for the study.

# 4 Findings and discussion

## 4.1 General information

On examining the general characteristics of the projects, the study revealed that only building and civil engineering projects were represented in the obtained historical data of completed construction projects and that the traditional method of procurement was used for all of them. The fixed method of contract was used for about two-thirds of the projects, while the cost-plus method was used for the remaining projects, indicating that target cost was not used for any of the project. Moreover, about 82% of the construction bonds used for the project were secured from banks, leaving those secured from insurance companies to be less than one-fifths of the projects.

## 4.2 Bond administration and project success

Pearson correlation was adopted to assess the relationship between measures of construction bond administration and project delivery indices. From Table 2, it can be deduced that there is a significant relationship between all bond indices and contract cost of construction projects at the 5% level of significance, though some are significant at 10%. However, the number of days to secure all the identified types of bonds has negative correlation with the initial cost of construction projects and this implies that the higher the initial cost of the project, the lesser is the number of days needed to secure bonds for the project. The study also revealed that the final cost of the construction project has a significant relationship with all identified bond administration indices. This indicates that cost performance of projects will be affected by construction bond administration if not properly managed. As for the initial cost, the final cost also has negative correlation with the number of days needed to secure bonds for projects.

For project time performance, it could be observed from Table 2 that there is no significant relationship between the final project duration of construction projects and the period of securing bonds for the projects. This indicates that regardless of the number of days taken to secure bonds from guarantor, the overall project time will not be affected.

The following inferences can be deduced: there is significant relationship between cost of securing bonds and initial cost of construction projects; there is significant relationship between cost of securing bonds and final cost of construction projects; and there is no significant relationship between cost of securing bonds and cost overrun of construction projects. In addition, there is no significant relationship between time taken to secure bonds and contract duration of construction projects; there is no significant relationship between time taken to secure bonds and final duration of construction projects; and there is no significant relationship between time taken to secure bonds and time overrun of construction projects.

In order to establish the relationship between bond administration and project delivery indices, iteration of linear regression equation was adopted. Considering project cost performance as a function of construction bond administration, Equations (5)–(8) denote the linear, semi-log, double-log and exponential regression equations for the relationship, respectively. The meaning of the terms in the equations are described in Table 1. Equation (5) has the highest $R^2$ value and this is considered the best-fit equation predicting the relationship between cost performance of construction projects and construction bond administration.

Final cost of project (FCP) as a function of bond administration indices

$$\begin{aligned} \mathrm{FCP} = {} & 31229550.10 - 1566.80(\mathrm{CSBb}) + 260783.78(\mathrm{NDb}) \\ & - 500.69(\mathrm{CSBp}) - 139535.89(\mathrm{NDp}) - 0.42(\mathrm{CABa}) \\ & + 0.97(\mathrm{CSBa}) + 229406.69(\mathrm{NDa}) + 4.02(\mathrm{CABr}) \\ & + 0.04(\mathrm{CSBr}) - 125186.23(\mathrm{Ndr}) + 1.22(\mathrm{ICP}) \\ & [R = 0.999, R^2 = 0.997] \end{aligned} \tag{5}$$

$$\begin{aligned} \mathrm{FCP} = {} & -5311037278.28 + 416750767.30(\mathrm{LinCSBb}) \\ & + 32426561.33(\mathrm{LinNDb}) - 146201808.76(\mathrm{LinCSBp}) \\ & + 63671927.65(\mathrm{LinNDp}) - 57003754.98(\mathrm{LinCABa}) \\ & + 6812397.64(\mathrm{LinCSBa}) + 95473481.69(\mathrm{LinNDa}) \\ & - 292656.60(\mathrm{LinCABr}) + 4333599.13(\mathrm{LinCSBr}) \\ & - 70985954.26(\mathrm{LinNDr}) + 201891779.66(\mathrm{LinICP}) \\ & [R = 0.993, R^2 = 0.985] \end{aligned} \tag{6}$$

$$\begin{aligned} \mathrm{LinFCP} = {} & 5.88 - 0.25(\mathrm{LinCSBb}) - 0.28(\mathrm{LinNDb}) \\ & - 0.09(\mathrm{LinCSBp}) - 0.15(\mathrm{LinNDp}) - 0.20(\mathrm{LinCABa}) \\ & + 0.13(\mathrm{LinCSBa}) + 0.03(\mathrm{LinNDa}) + 0.82(\mathrm{LinCABr}) \\ & - 0.13(\mathrm{LinCSBr}) - 0.17(\mathrm{LinNDr}) + 0.43(\mathrm{LinICP}) \\ & [R = 0.998, R^2 = 0.995] \end{aligned} \tag{7}$$

**Tab. 2**: Relationship between bond indices and project delivery indices.

| Bond type | Bond indices | Test statistics | Contract/initial cost of project (ICP) | Final cost of project (FCP) | Project cost overrun (PCO) | Initial duration of project (IDP) | Final duration of project (FDP) | Project time overrun (PDO) |
|---|---|---|---|---|---|---|---|---|
| Bid bond | Cost/amount of bond (CABb) | Pearson correlation | 0.915** | 0.914** | 0.914** | 0.258 | 0.418** | 0.422** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.000 | 0.108 | 0.007 | 0.007 |
| | Cost of securing bond (CSBb) | Pearson correlation | 0.915** | 0.914** | 0.914** | 0.258 | 0.418** | 0.422** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.000 | 0.108 | 0.007 | 0.007 |
| | No. of days to secure bond (NDb) | Pearson correlation | −0.382* | −0.402* | −0.113 | −0.055 | −0.090 | −0.091 |
| | | Sig. (two-tailed) | 0.015 | 0.010 | 0.741 | 0.735 | 0.579 | 0.575 |
| Performance bond | Cost/amount of bond (CABp) | Pearson correlation | 1.000** | 0.998** | −0.350 | 0.382* | 0.607** | 0.608** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.291 | 0.015 | 0.000 | 0.000 |
| | Cost of securing bond (CSBp) | Pearson correlation | 0.973** | 0.969** | −0.491 | 0.422** | 0.693** | 0.702** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.125 | 0.007 | 0.000 | 0.000 |
| | No. of days to secure bond (NDp) | Pearson correlation | −0.345* | −0.367* | −0.400 | −0.156 | −0.113 | −0.059 |
| | | Sig. (two-tailed) | 0.029 | 0.020 | 0.223 | 0.338 | 0.487 | 0.718 |
| Advance payment bond | Cost/amount of bond (CABa) | Pearson correlation | 0.922** | 0.919** | −0.363 | 0.323* | 0.551** | 0.582** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.273 | 0.048 | 0.000 | 0.000 |
| | Cost of securing bond (CSBa) | Pearson correlation | 0.879** | 0.880** | −0.069 | 0.286 | 0.522** | 0.569** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.839 | 0.082 | 0.001 | 0.000 |
| | No. of days to secure bond (NDa) | Pearson correlation | −0.246 | −0.271 | −0.085 | 0.035 | 0.092 | 0.113 |
| | | Sig. (two-tailed) | 0.137 | 0.100 | 0.804 | 0.833 | 0.583 | 0.499 |
| Retention bond | Cost/amount of bond (CABr) | Pearson correlation | 0.916** | 0.915** | 0.560 | 0.377* | 0.729** | 0.782** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.073 | 0.017 | 0.000 | 0.000 |
| | Cost of securing bond (CSBr) | Pearson correlation | 0.692** | 0.690** | 0.560 | 0.269 | 0.489** | 0.514** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.073 | 0.094 | 0.001 | 0.001 |
| | No. of days to secure bond (NDr) | Pearson correlation | −0.376* | −0.396* | −0.085 | −0.140 | −0.122 | −0.081 |
| | | Sig. (two-tailed) | 0.017 | 0.011 | 0.804 | 0.387 | 0.453 | 0.619 |
| Average (all bonds) | Cost/amount of bond (CABav) | Pearson correlation | 0.921** | 0.920** | −0.317 | 0.356* | 0.546** | 0.538** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.342 | 0.024 | 0.000 | 0.000 |
| | Cost of securing bond (CSBav) | Pearson correlation | 0.782** | 0.783** | −0.058 | 0.277 | 0.415** | 0.406** |
| | | Sig. (two-tailed) | 0.000 | 0.000 | 0.865 | 0.083 | 0.008 | 0.009 |
| | No. of days to secure bond (NDav) | Pearson correlation | −0.372* | −0.392* | −0.199 | −0.125 | −0.113 | −0.079 |
| | | Sig. (two-tailed) | 0.018 | 0.012 | 0.558 | 0.443 | 0.486 | 0.628 |

* Significant at $P < 0.01$, ** Significant at $P < 0.05$.

$$\text{LinFCP} = 14.90 + 0.00(\text{CSBb}) + 0.05(\text{NDb}) + 0.00(\text{CSBp}) - 0.02(\text{NDp}) + 0.00(\text{CABa}) + 0.00(\text{CSBa}) =).01(\text{NDa}) + 0.00(\text{CABr}) - 0.01(\text{NDr}) + 0.00(\text{ICP}) \; [R = 0.894, R^2 = 0.800] \tag{8}$$

From Equation (5), it can be deduced that the strength of the association between the dependent (final cost of construction project) and the independent variables is defined by the value of $R$ (99.9%), while the goodness of fit of the model ($R^2$) value is 99.7%. This, however, shows that the model is fit for predicting FCP.

Subsequently, the number of days taken to secure each of the identified construction bonds was considered the independent variable that is capable of predicting the time performance of construction projects. The expressions presented as Equations (9)–(12) indicate the linear, semi-log, double-log and exponential regression equations of the relationship. The meaning of the terms in the equations are described in Table 1. The best-fit model among the four is the double-log regression equation [Equation (11)] because it has the highest $R^2$ value.

Final duration of project (FDP) as a function of the number of days taken to secure bond (ND)

$$\text{FDP} = -2.62 - 2.04(\text{NDb}) + 1.81(\text{NDp}) - 0.85(\text{NDa}) + 0.18(\text{NDr}) + 1.65(\text{IDP}) \; [R = 0.838, R^2 = 0.702] \tag{9}$$

$$\text{FDP} = -257.57 - 17.62(\text{LinNDb}) + 85.77(\text{LinNDp}) + 10.52(\text{LinNDa}) - 16.70(\text{LinNDr}) + 37.86(\text{LinIDP}) \; [R = 0.785, R^2 = 0.616] \tag{10}$$

$$\text{LinFDP} = -2.61 - 0.37(\text{LinNDb}) + 1.47(\text{LinNDp}) - 0.04(\text{LinNDa}) - 0.19(\text{LinNDr}) + 1.08(\text{LinIDP}) \; [R = 0.908, R^2 = 0.824] \tag{11}$$

$$\text{LinFDP} = 2.38 - 0.03(\text{NDb}) + 0.16(\text{NDp}) - 0.002(\text{NDa}) + 0.002(\text{NDr}) + 0.04(\text{IDP}) \; [R = 0.843, R^2 = 0.711] \tag{12}$$

For the best-fit model in Equation (11), the strength of the association ($R$) between the dependent (final duration of bonded projects) and the independent variables is 90.8%, while the $R^2$ value stands at 82.4%. This therefore implies that the degree of fitness of the model to predict FDP is very high and that as low as 9.2% of the residual variation in the dependent variable is not included in the model, which may be outside the scope of this study.

## 4.3 Discussion of findings

The cost of securing a bond, which is a key factor of construction bond administration, can significantly increase the overall cost of a construction project. This implies that the higher the cost of securing bonds by contractors, the higher is the final cost of such projects. In agreement, Ojo (2011) and Adegboye (2004) believed that issues of management of construction bond can significantly affect delivery of any construction project. Moreover, Augustin and Constanta-Nicoleta (2015) concluded that construction works are generally susceptible to economic changes due to their cost-oriented nature. Boswall (2010) posited that construction bonds are effective tools for ensuring success of construction projects. However, this can only be achieved if the administration of the bonds are properly managed.

# 5 Conclusion and recommendation

Construction bond administration has significant relationships with cost and time performances of construction projects. The cost of such bonds and the cost of securing them have a positive effect in that the higher the bond cost, the higher is the project cost and duration. On the other hand, the higher the initial cost of the construction project, the lesser is the number of days taken to secure bonds for the project. However, the number of days needed to secure bonds has no significant relationship with the duration of the construction projects. There is, therefore, the need for concerned stakeholders to pay adequate attention to indices of construction bond administration –cost of bond, cost of securing bond and number of days needed to secure bond –in their quest to ensuring that construction projects are delivered to clients' satisfaction. Activities of guarantors in the fixing of cost of securing bonds as well as other charges (cost of project monitoring, cost of documentation, etc.) should also be checked.

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