# Managing Residential Building Project Retention Money Using Building Informatics Parameters

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## Abstract

In recent times there have been paradigm shift in the management of finance on project sites, especially the retention money that client usually release to the contractor after the end of defect liability period.  Improper management of retention money often results into crisis on site among client and professionals which can lead to delay in project completion. It is against this background that this study was centered on managing construction project retention fee in residential building projects in Nigeria. A random sampling technique was adopted in carrying out the study, while population size of 100 residential building projects was used.

Also, a structured questionnaire in Likert Scale 1-5 was used for data collection. Parameters for scope of retention fee, challenges of retention practice, impact of retention fee on projects, and model for managing retention money were generated using Building informatics generated  parameter. Mean Item Score was used to generate the agreement index for parameters obtain from influencing the retention fee management process, while Factor Analysis in Regression Analysis of SPSS software was used  to generate factors for a suitable fee management model by reducing the factors to their minimum Coefficients and Eigen Values. The building informatics generated model if adopted could assist in managing retention money on residential building projects.

**Keywords:** Informatics, Retention, Project, Decision, Parameters.

## INTRODUCTION

### Understanding Building Informatics and the Retainage Concept

Retention could be described in layman language as process of holding back something not giving out all that is in a system. It refers to the quantity of money often held back for period of six (6) months after the completion of a building project. In [1] [2] it was described as, as the percentage amount of payment money held back from contractors' project fee. The amount of money to be held back is often determined by the parties to the contractual agreement. Also,

[3], [4] viewed retention money as amount of money earned by contractors but not paid out immediately.

However, Building informatics could be described as the field of study that utilizes information about building to solve challenges in building design, construction, management and entire life project life cycle.  In  [2], Building cost informatics was defined as a body of knowledge that involves application of Computer, Information and Communication Technology, Digital system, Building information modeling and state of art software in solving  issues in building works. Building informatics contributes to sourcing, generation and dissemination of information in the aspect of computational intelligence for design, construction and management of building systems.  However, this study adopted building cost-informatics system in developing a model.

### Delimitation of Performance Retention Package

Performance retention bond is a package that defines the amount of money kept aside by mutual agreement of parties to a contract for a contractor which is often released after satisfactory performance of the contract. It is a formal agreement among the client, contractor, subcontractors and site professionals and a third party. A panel of arbitrators is often appointed as custodian of the retention money while the performance retention packages act as a guarantee of performance by the contractor and sub-contractor. According to [5]; [6], retention bond allows contractor the opportunity to rectify any identified defects within an agreed period which is usually 6-8 months.  However, it is a good thing to include performance retention package project administration; however, it is not applicable in construction materials administration.    Finally,   retention   package   excludes operations of material suppliers since their activity precedes commencement of construction works.

## REVIEW OF RELATED LITERATURES

### Research Method Statement

Literature search was conducted to trace the line of contribution in the application of building informatics

parameters in solving management and cost issues on construction projects. Econometric approach in Building informatics was used to generate qualitative model of in this context, it toes the line of submission of the following researchers in econometrics: [8] and [6]. The informatics parameter model generated in this context is similar to hedonic model with parametric equations.

## RESERCH METHODODLOGY

A random sampling technique was adopted in carrying out the study, while population size of 100 residential building projects was used. Similarly, a structured questionnaire in Likert Scale 1-5 was used for data collection. Parameters for scope of retention fee, challenges of retention money practice, impact of retention fee on projects, and model for managing retention money were generated using Building informatics.  Mean Item Score was used to generate the agreement index for parameters obtain from influencing the retention fee management process, while Factor Analysis in Regression Analysis of SPSS software was used  to generate factors for a suitable fee management model by reducing the factors to their Coefficients and Eigen Values. A platform was set for the research through comprehensive literature search to establish the current state of knowledge in order to put the work into proper perspective.   Random sampling technique was used to collate information from population of site managers, project directors, construction managers, maintenance engineer and facility manager. Samples of respondents were taken from Lagos state, Ogun state, Abuja (F.C.T.) and Portharcourt.  These locations were notable and therefore selected on account of high volume of construction activities.   The administered questionnaire was structured in Likert scale 1 to 5, the respondent were requested to express their opinion in the degree tabulated on the questionnaires. A scale 1 to 5 was adopted, with 1 representing "strongly disagree (SD)" 2 – being disagree (D) 3 – being neither agree nor disagree (N), 5- being strongly agree (SA).

Agreement index of the respondents was generated using the relation M.A.I = 5S.A + 4A + 3S.D + 2D + 1N/5(S.A+ A+S.D+D+N)    $M.A.I = \dfrac{1\left(\sum Aij\right)}{N \sum Aij}$   where M.A.I = Mean

Agreement Index      A= Agreement variable    i = Lower boundary, j = Upper boundary

N = Frequency of Variable  Σ = Summation Notation.

## Model Development

In this context, Building informatics tool of knowledge modeling is adopted in modeling retention money package parameters.  Different methods could be used in building informatics in modeling parameters, some of them include, STEP, IFC and XML. However, [9], combination of multiple

regression analysis and factor analysis was used in model development, [7] adopted weighted average, factor analysis, Pareto and stepwise multiple regression analysis while   [10]; 8] and [11] used calculated Pearson's correlation coefficient, and weighted average approach.   However in this study, stepwise multiple regression methods and factor analysis was used to reduce the data to minimum size. The questionnaire parameters was loaded onto the statistical package for social science students (SPSS) software, the factors were  subjected to factor rotation so as to ensure emergence of stable criteria which would be used in modeling and represent relationship among   retention money variables used as modeling parameters. The resultant factors were then subjected to stepwise multiple regression analysis to establish pattern of relationships among them taking into consideration their communality sizes and their Eigen Values.

## Factor Extraction

There is need to determine representative factors from the total factors presented as modeling parameters for the proposed informatics model.   In [9], Ruston and [7] two approaches was used to determine the factors to be included in the model.  Their study adopted Screeplot and Eigen value approach, [9] submitted that in Eigen value approach, and only variable with Eigen value greater than one (1) should be included in the model formation. In scree plot approach, there is differential relationship pattern among variables; there is always a distinct demarcation between large variables on steep slope and gradual trailing off scores of the rest variables. This usually occurs at the variable, where K is the true number of variables [9] and [2].  However, this study adopted Eigen value and regression coefficient approach as shown in Table 9. A total  number of  twenty(20) variables  with Eigen value of  one (1)  emerged,  which is equal to Eighty-two percent of (82%)  of the total variables used for the study, while remaining  twelve (12) variables account for only about 38.25% of the total variance.  The model with this magnitude of variables is considered a robust model.

## Factors Rotation

Factors rotation is often used to reduce a large amount of data to a sizeable magnitude suitable for model formation. In this study, factor rotation is used in generating data that could be used in modeling. This study used factor rotation to identify the relationship of individual variables to the set of common factor synthesized; one of such methods is Oblim rotation. Oblim rotation was used in this study in data reduction. However, there are other types of methods that could be used one example of this methods is the type documented in [7]. The study used variance rotation method to generate variable with a single factor. Table 7 shows the inter-relationship of the variables and common factors.  The new set of  sixteen (16) factors that emerged after rotation is presented in Table 9.

**ANALYSIS OF DATA/DISCUSSION**

**Table 1:** Information On Scope Of Retention Fee Application

| S/N | Retention Money Informatics Parameters | Agreement Index | Percentage | Rank |
|---|---|---|---|---|
| I | 10-15% and above for the contract sum of total sum | 34 | 30.00 | 3rd |
| II | Paying 10%-50% cost of work completed and 5% on the remainder | 50 | 43.13 | 1st |
| III | 10%-50% on the total project cost  then none on the remainder | 26 | 23.23 | 4th |
| IV | 5% on the contract sum of the elements throughout the contract duration | 44 | 38.33 | 2nd |
| V | 5%-50% on cost and then none on remainder | 18 | 16.37 | 7th |
| Vi | 3% on the contract sum of total elements throughout the contract duration | 19 | 17.30 | 6th |
| Vii | 1% on the total contract cost of total elements throughout the contract duration | 20 | 18 | 5th |

*Source: 2017 Survey*

In Table 1, scope of application of retention money is presented, paying 10% of the amount equivalent to the quantity of work till when 50% of the total quantity of work is completed, while 5% of the total initial cost is paid on the remainder of project cost. This parameter is ranked 1st by 43.13% of respondents.  Also, paying of 5% of the total project cost throughout the contract duration to the contractor is ranked 2nd by 28.33% of total respondents relative to 10% and above for the contract sum throughout duration to the contractor was ranked 3rd by 20% of the respondents. Similarly, disbursing 10% of total contract sum up to 50% on the remainder was ranked 4th by 13.33% of the respondent while paying 1% on the contract sum throughout the contract duration was ranked 5th with 8.33%. Also, the paying 10% till 50% completion and 5% on the remainder of the total project cost remain highly subscribed among respondents. Furthermore, the project sampled adopts payment of retention money on the work in stages until the 50% of the work is done, then the remaining 50% is left for payment during defect liability period. The 50% retained could be kept with an arbitrator which would later be then be released after the period. Also, in practice is the art of leveraging 5% on the total project cost and keep till the end of the project when it would be restored [2] and [11].

**Table 2:** Informatics Intervention Systems in Retention Money Management

| S/N | Informatics Intervention  Systems Parameters | Agreement Index | Rank |
|---|---|---|---|
| I | Replacing retention money with performance bond | 3.54 | 4th |
| II | Financial security bond | 3.50 | 6th |
| III | Application of credit letter | 3.56 | 3rd |
| IV | Deployment of payment performance bond | 3.00 | 8th |
| V | Escrowing retention money by lodging in escrow account | 3.50 | 6th |
| Vi | Application of  financial performance bond | 3.52 | 5th |
| Vii | Using line item method to release retention money | 3.58 | 2nd |
| viii | Release of retention money at early part of construction work. | 2.76 | 9th |
| ix | Payment of interest on retention fund when over delayed. | 3.67 | 1st |

Application of Informatics Intervention system in the release of retention money for site works is illustrated in Table 2. Payment of interest on retention fund when over-delayed was advocated by a great percentage of the respondents, thereby ranked 1st with mean score of 3.67. It refers to paying adequate compensation as retribution the money tied down during delayed payment by the client. The prospect of paying interest on tied down fund would serve as detraction to undue delayed retention fee payment. This as a matter of facts is an intervention approach on occasion of delayed retention money payment.

Also, releasing retention money on line item basis is also advocated.  Line item order refers to dividing works into different lines of categories for the purpose of financing for an effective disbursement. Line item order facilitates timely release of retention fee. It is a practice whereby funds are released when a separately identifiable portion of the work has been satisfactorily completed.

Serial release of the retention money for portions of the work which the task has been completed would be favored by this option which is ranked 2nd by the respondents.  According to Stockenberg (2002)[14], this intervention system would prevent undue delay in payment of works that have been completed early in the course of  project execution. Furthermore, introduction of letter of credit in place of retention money was ranked 3rd while Application of bond as alternative of retention fee was also ranked 4th.    Also, Performance bond can be used as a substitute to retained fund. Application of performance bond is ranked 5th and Escrowing

retention money account by lodging in escrow account is ranked 6th. Furthermore, retention fund can be lodged in an account called escrow account to prevent unwarranted expenditure or diversion of retained funds. This practices allows funds to be kept out of reach of creditor should the owner experience financial difficulties. An Escrow account generally involves two types of expense that must be borne by one of the parties. This includes the administration cost and cost of running or financing the escrowed fund.

**Table 3:** Challenges of Retention Money Practice

| S/N | Challenges of retention money practice | Agreement index | Rank |
|---|---|---|---|
| I | Tendency for delay | 3.96 | 1st |
| II | Disparity in the pattern of fund release. | 3.55 | 7th |
| III | Release of retention fee is often dependent on circumstances beyond contractors' control | 3.95 | 2nd |
| IV | Employers often seek to withhold retention fee due to wrong interpretation of works information by contractors | 3.94 | 4th |
| v | Holding back of retention money can reduce the resultant payable amount on final contract payment | 2.60 | 9th |
| vi | Retention instigates mistrust between contractor and the contractor | 3.70 | 5th |
| vii | Introduction of Retention money could influence relationship on projects | 3.60 | 6th |
| viii | Retention money has tendency of reducing contractors' profit when kept in Escrow account | 3.50 | 8th |
| ix | Contractors could loose the retention money if all is used for repair work | 3.95 | 2nd |

*Source: 2017 Survey*

In Table 3 above certain peculiar challenges often linked to administration of retention money is presented. Tendency of retention money to cause delay in completion of projects is ranked 1st with mean item score value of 3.94 on scale 1 to 10. This could happen on account of poor management of the fund. Delay is one of the challenges encountered in retention money payment; it is often delay by days, weeks, months or even years. Similarly, on account of delay in handling over the contract within the project defect liability period contractors could lose the retention money if all is used for repair work, this is ranked second(2nd) with mean index value

of 3.95. Similarly, contractors don't often have control over the determination of the fate of the retention money, this is ranked 2nd with mean index value of 3.95. In the light of this the fund could be kept in an escrow account to prevent unwarranted expenditure as a way out.

Moreover, clients often seek to withhold retention fee on account of contractor defaulting in completing their part of project, the contractor would be made to pay for the remedy of such from the Escrow account. This is ranked 5th with mean index of 3.70, while Retention fee has tendency to instigate lack of trust in the contractor is ranked 6th with mean index value 3.65.

**Table 4:** Impact of Retention Fee on Projects and Project Participants

| S/N | Impact of retention fee on project and participants | Agreement index | Rank |
|---|---|---|---|
| I | Sharp practice by the contractors in a bid to cushion effect of retention fee in likely situation of non-payment of retention fee. | 3.99 | 4th |
| Ii | Retention fee has attendant consequence of reducing contractors' fee. | 4.00 | 2nd |
| Iii | Retention fee reduces contractors profit if all sent at defect liability period | 3.98 | 7th |
| Iv | Retention fee discourages potential contractor for a project | 3.60 | 8th |
| V | During defect liability period retained fund speeds up the rate of completion of works | 4.02 | 1st |
| Vi | Tendency to get retained fund speeds up the completion of defects by contractor | 3.99 | 2nd |
| Vii | Retention fee instills in contractor sense of responsibility to the client or professionals. | 3.90 | 6th |
| Viii | Retention fee creates awareness about constraint to perform maximally on a project | 3.99 | 4th |

In Table 4, while defect liability period subsists. Tendency to get retained fund often leads to speed on the part of contractor to complete the project. This is ranked 2nd with mean index value 3.99. Sharp practice by the contractors in a bid to cushion effect of retention fee in likely situation of non-payment was also ranked 4th with index magnitude of 3.99 among others. Panacea to the problems and challenges is following the path of standard practice.

**Table 5:** Informatics Model For Managing Retainage Money On Building Construction Projects

| S/N | Informatics model parameters | Agreement index | Rank |
|---|---|---|---|
| I | Payment of retention money as at due | 3.92 | 4th |
| II | Retention money should be released in accordance with the contract agreement | 2.82 | 17th |
| IIII | Contractors situation to be considered in the release of retention money | 2.60 | 16th |
| IV | Correct interpretation of works information by employer to prevent undue delay of contractors fund | 3.93 | 2nd |
| V | Non-holding back of retention money to maintain the amount of resultant payable amount on final contract payment to contractor | 2.88 | 15th |
| VI | Administration of Retention money should engenders trust in the contractor | 2.99 | 12th |
| VII | Introduction of Retention money improves relationship on project | 3.93 | 2nd |
| VIII | Timely payment of Retention money has tendency of enhancing contractors' profit | 3.92 | 4th |
| Ix | All Contractors retention money should not be used for repair work | 3.92 | 4th |
| X | Application of bond as alternative to retention money | 3.90 | 7th |
| Xi | Financial security package could be administered in exchange of retention money | 3.99 | 8th |
| Xii | Introduction of letter of credit in place of retention fee | 3.97 | 10th |
| Xiii | Deployment of payment bond to replace retention fee | 3.98 | 11th |
| Xiv | Escrowing retention fee by lodging in escrow account | 2.95 | 13th |
| Xv | Application of performance bond to activate retention money | 3.90 | 7th |
| Xvi | Release of retention money on line item basis | 3.95 | 1st |
| Xvii | Release of retention money at early part of construction work. | 2.92 | 14th |

*Source: 2015 Survey*

Information Parameters for modeling retention fee is presented in Table 5 above. The parameters were analyzed for their respective Agreement Index. It was discovered that releasing retention fee on line item basis has highest Agreement Index of 3.95. The rate of subscription to the release of retention fee on line item basis has the highest frequency. Respondents supported the fact that retention fee should be paid on those items that are lined up for execution and has experienced remarkable progress and success[12],[13] Also, respondents are of the opinion that introducing Retention fee would improves relationship on project and that correct interpretation of works information by employer could prevent undue delay of contractors fund, therefore the two factors were ranked 2nd respectively with agreement index of 3.93. Retention fee would to a great extent, improve level of relationship among clients, and their contractors or builders. Contrary to the pre-retention fee era whereby contract are executed based on mutual trust, which makes enforcement for compliance to remedy defect difficult, thereby causes tension, introduction of retention fee has been widely believed to improve relationship on projects, particularly the agreement to the limit of individual responsibility as far as the brokerage and administration of the fee is concerned.

Similarly, Timely payment of Project retention money has tendency of enhancing contractors' profit, therefore it is advocated that all contractors retention money should not be used for repair work, Prompt payment of retention fee were analyzed and all rounded off with agreement index of 3.92 and therefore were ranked 4th

Similarly, it was revealed from the analysis that timely payment of retention money and prompt payment of retention money has tendency of enhancing contractors' profit. Time and money are two indivisible project variables that are closely dependent, therefore there is a school of thought that believed that "Time is Money and Money is Time". Therefore, the more a builder stayed on a project the more money being tied down and liable to lose value or depreciate. Therefore, if the retention money is paid as at when due it relieves the builder the pain of money depreciation, and enhance builders profit, therefore ranked fourth.

Finally, application of financial bond as alternative to Retention fee and application of performance bond to activate retention fee were scored with agreement index of 3.90 and ranked 7th It was advocated that Performance bod can be used as alternative to retention or retention money. Performance bond is project package that could serve as compensation in lieu of default in project performance. The bond could be in place which depicts the intention to perform by the builder and could be administered legally depending on term of agreement. The mode of performance bond management is unique relative to the retention or retention money.

**Table 7:** Factor Rotation of informatics Parameters for Retention Fee Management Model

| S/n | Variables | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 |
|---|---|---|---|---|---|---|---|---|---|
| A | Prompt payment of Retention fee | 1.00 | | | | | | | |
| B | Contractor situation should be taken into consideration | | 1.00 | | | | | | |
| C | Correct interpretation of work information by client/employer | | | 1.00 | | | | | |
| D | Non-holding back of retention fee | 0.984 | | 0.988 | 1.00 | | | | |
| E | Administration of retention fee should engender trust in contractor | | | | | 1.00 | | | |
| F | Introduction of Retention fee | | | | 0.988 | | 1.00 | | |
| G | Introduction of retention fee to improve relationship | | | 0.999 | | | 0.999 | 1.00 | |
| H | All contractors' retention money should not be used for repair work | | | 0.999 | | | 0.999 | | 1.00 |
| | | F9 | F10 | F11 | F12 | F13 | F14 | F15 | F16 |
| I | Application of bond as alternative to retention fee | 1.00 | | 0.997 | | | 0.997 | 0.999 | 0.999 |
| J | Financial security in exchange of retain- age fee | | 1.00 | 0.982 | | | 0.987 | 0.984 | 0.989 |
| K | Introduction of letter of credit in place of retention fee | | | 1.00 | | | | | |
| L | Deployment of payment bond | 0.985 | | | 1.00 | | | | |
| M | Escrowing of retention fee in escrow account | | | | | 1.00 | | | |
| N | Application of Performance bond | | | | | | 1.00 | | |
| O | Release of retention fee | | | | 0.986 | | | 1.00 | |
| P | Release of retainage fee at early stage of work | | 0.971 | | | | | | 1.00 |

*Source: 2015 Survey*

Factor Rotation of Parameters for Retention Fee Management Model **is** presented in Table 7. The  table contain the benchmarked parameters that could be used to manage Retention fee on a project. The parameters had been analyzed for their respective agreement index already and ranked. The parameters were further reduced to a sizeable number using Factor analysis. The resultant factors were examined, considering the magnitude of their Eigen Value using Co-efficient of 0.9 to 0.1 as boundary limit.  [14].

The following factors emerged with reference to the Eigen values and variables  with the   0.9 -1.0 Eigen coefficient dichotomy; $F_1,F_2,F_4,F_6,F_9,F_{11},F_{14},F_{15},F_{16}$.

$$0.980F_1 \text{ ---------------------------------------------------(For Optimum Retainage Fee Management Performance)}$$

$$0.988F_4+0.985F_9 + 0.982 \; F_{11}\text{----------------(For Moderately Retainage Fee Management Performance)}$$

$$0.99F_3 + 0.99F_6 + 0.99F_{14} + 0.99F_{15} + 0.99F_{16} \text{ ------(For High Retainage Fee Management Performance)}$$

**Figure 1:** Benchmarked Model Parameters for Result Oriented Retention Fee Management

**Model Interpretation**

The interpretation of Factors F1 to F16 as contained in the structure of the model is as  follow:

F1 ------------ Correct interpretation of work information by client/employer

F3------------- Non-holding back of retention fee; Introduction of retention fee to improve

relationship, All contractors' retention money should not be used for repair work

F4------------- Application of bond as alternative to retention fee;

F6 ------------ Introduction of retention fee to improve relationship; All contractors' retention

money should not be used for repair work

F9 ------------- Deployment of payment bond

F11 ----------- Financial security in exchange of retain- age fee

F14, F15,F16 ------------ Financial security in exchange of retain-age fee; Application of performance bond as alternative to retention money.

## CONCLUSION

The aim of the research work has been achieved; the study has presented issues that border on the management and administration of retention fee on selected construction projects. In Table 7.1 it was discovered that most deducted retention percentage is 5% of the project cost. Also, the type of intervention system often used as alternative intervention system was studied. Payment of interest on the retention fund on occasion of delayed payment was advocated to be remedied with interest on the delayed fund. There should be adequate compensation for the fund tied down.  However the following intervention system could be used: Release of retention fee on line item basis, Introduction of letter of credit, application of bond as alternative of retention fee, application of performance bond, financial security package, the use of escrow account for retention fee, use of payment bod and performance bond among others.

The combination of two or three or all of them guarantee adequate management of the fund. However, there are challenges often encountered in the fund administration these includes; delay in the release of fund, reduction in contractors fee and  retention fee reduces contractors profit if all the retained fund is used to remedy bad work among others. Finally, the model presented could be of help in managing retention money on site projects.

## ACKNOWLEDGEMENT

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