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Correlation of the Knowledge and Application of Factors Affecting Time Control in the Nigerian Construction Industry

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Abstract
Time performance is essential to all parties who are involved in construction project that is owner, contractor and subcontractor. The delivery time of a construction project is a key factor to the owner as much as is for the contractor. A field survey research designed with forty variable factors affecting time control is the Nigerian construction industry was used to extract information from the respondents. Respondents, mainly construction project professionals tricked for both the awareness level and the application using the five point likert scale. The analysis showed a high level of correlation between the awareness factors and the application factors of time control. A level of preponderance was also established for both the awareness level and the application factors of time control in the Nigerian construction industry. The inaccuracy of material estimate was top in the list of awareness level while mistake during construction toped the list with a mean of 1.60 in the application level.

Keywords*: Construction, Time, Control, Application, Awareness*

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I. Introduction

This period of economic depression and rapidly rising labour and material costs in the construction industry gives concern for optimum utilization of available resources within the scheduled period. The construction project owner will always need a project completed within a specific time period, whether explicitly stated in the contract documents or not. Apart from achieving the time schedule in construction project, cost and quality objectives are important in the successful completion of the project. Achieving the time, cost and quality objectives will form an equilateral triangle popularly referred to as iron triangle. An increase or decrease in any of the three parameters will affect the other aspects of the project.

The project manager has the responsibility of planning, procurement and execution of a project in a defined scope, defined start and a defined finish regardless of the project.

The ability of the project manager to adapt to the various internal procedures of the client and to form close link with nominated representatives, is essential in ensuring that the key issues of cost, time, quality and above all client satisfaction are realized, this is according to Project Management Institute.

Construction project control involves constantly measuring progress; evaluating plans, and taking corrective actions when required (Kerzer 2003). Despite the availability of various control techniques and project control software many construction projects still do not achieve their cost and time objectives. The most common type of time planning and control technique in the Nigerian construction industry is the Gantt chart or Bar graph which is used by the contractors and the consultants. This is closely followed by the critical path method (CPM). The reasons for the popularity of these techniques might be due to the fact that they are the most established techniques in the construction industry and they are easy to use. The other type of control techniques in the construction industry but not common among the professionals in the construction industry include: Performance Evaluation Review Technique (PERT), Milestone Data Programming Technique, Precedence Network Diagram (PND), Elemental Trend Analysis/Line of Balance (LOB) and Simulation. The use of software support is widely spread. The three clear leading application of software include Microsoft Project, Asta power project and prireavera.

Mansfield et al (1994) carried out a questionnaire survey among contractors, consultants and client organizations in Nigeria. Kamiget et al (1999) also carried out a survey in Indonesia and identified design changes, poor labour productivity, inadequate planning among others as cause of time and cost overruns in construction project.

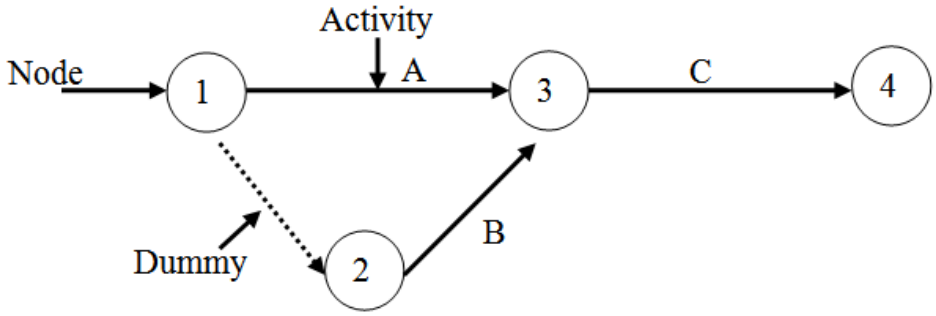
The time overrun occurs when there an extension of time beyond completion date traceable to the major stake holders in the construction industry. Completion of construction activities in the minimum time will reduce the contractor's site overhead and enable the contractor to pursue other work. The delay can also instigate negative effects such as increased cost, loss of productivity and revenue, many lawsuits between

owners and contractors including contract termination. Some of the construction project planning give inaccurate, inconsistent or unreliable predictions. They are based on either inappropriate variables or variables that cannot be measured at the beginning of the development process.

The objective of this research paper is to identify, explore and rank the professionals concepts on the variable of causes of time overruns in the Nigerian construction industry. It also examines the knowledge level of the factors affecting time control and the application level of the factors affecting time control in construction projects. The type of relationship between the knowledge and application and the strength of the relationship is determined using the correlation statistics.

(a) Project Network

The project network diagram is a graphical display of a project's implementation logic, presented in a form that portrays all of the dependencies among the projects activities. The network diagram usually communicates a projects planned implementation programme sequence. An activity starts only after all activities preceding it must have been completed. Activities consume time and other resources for its accomplishment, it also start/originate from an event and terminates also at an event/node.



Activity 1-2 is a dummy; it has zero duration and consumes no resources. The network method of planning, scheduling and controlling of projects is a valuable management tool to project executors. Planning is a cumulative decision making process that determines in advance, the workable procedure or course of action that would, when implemented accomplish desired objective. The desired objective is the object of the planning exercises.

(b) Bar Chart

The bar chart is still the most used mode for planning and scheduling in the construction industry. It indicates the starting and completion dates for work units or project activities. A project activity represents an identifiable work item that consumes both time and other resources for its implementation.

Project Activity	**Activity Duration (days)**	**Time - Days**							
		1	2	3	4	5	6	7	8
Formwork Preparation									
Electrical Conduit pipes									
Steal Re-enforcement									
Concrete and Concreting									
Curing Concrete									

The respective cumulative progress at any point in time can be determined through the simple relationship.
Cumulative progress = ∑(activity % progress)……

Activity contribution may be weighted on any appropriate basis, such as relative time or cost.

(c) Work Breakdown Structure

The various construction activities can be identified by systematically developing a work breakdown structure. This is done by dividing the project work into areas, sector or task groups or a combination of these. These are further subdivided into work packages, activities and finally into operations or processes. This work breakdown process is continued till the desired level of activities is reached.

Engineers in simple projects can visualize and list out the activities necessary for execution of the project. Complex projects, identification of activities can be systematized by using certain methods. The commonly used methods depending upon the nature of activities can be categorized as follows.

NATURE OF ACTIVITY	**METHOD USED**
Construction Activities	work breakdown Structure
Functional Activities	Task matrix
Repetitive Activities	indexing methods, Specification standard.

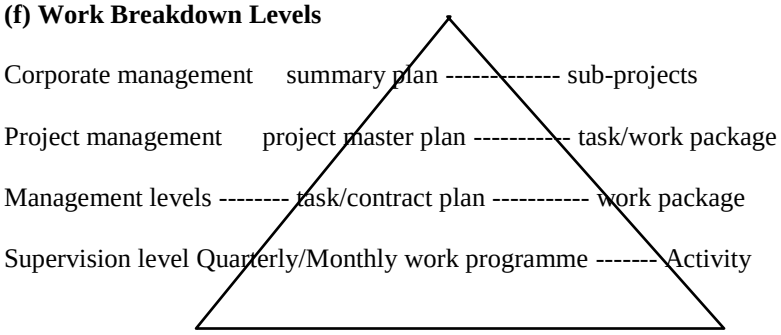
(d) Work Study

Work study is a technique aim at finding the optimum method of production with specified resources and the time required to perform the production task. This is to establish production norms of workers and production capacity of a machine. It involves investigation into various processes and procedures of utilizing the resources of production, manpower, materials, equipment and land economically in order to improve existing method.

(e) Work Measurement

Work measurement is defined as the systematic determination of the proper time to be allowed for the effective performance of a defined task carried out by a specified method. It sets standard for achieving the economic control of manpower by determining the time required for work to be done. Work measurement has been proved to provide means of costing and labour planning at project conception. This technique can be applied by engineering and building contractors because of its suitability for repetitive work, and based on the technique which include; predetermined time, standards, time study and synthesis on standard data. Applying the technique, a construction activity is divided into elements of work and the time to perform. Each element is measured including break period and provides a standard time to cover the works measured.

(f) Work Breakdown Levels



A project planner uses activity as the common data base for planning projects. Activity duration form the basis for time planning and scheduling of project work.

II. Method of Study

Questionnaire was designed to capture the relevant factors affecting construction project time control in the Nigerian construction industry. Fifty questionnaires were administered to the various construction project participants ranging from the construction managers, project supervisor, clients, Architects, Engineers, Quantity Surveyors and construction project financers. The questions were based on a five-point Likert scale of rating. The respondents were advised to choose from strongly agree, agree, undecided, disagree and strongly disagree. The distribution of the questionnaire was carried out based on expert judgment to the construction professionals.

Percentages, Mean score, Standard deviation and Regression analysis were used in the data analysis. The data were reduced to the standard form with base equal to 100 through the use of percentages which in fact facilitates relative comparison. In the comparison of factors, the percentage rating, the higher or the comparatively more significant, the importance attached to the factor.

The mean is a value which is typical or representative of a set of data, with the mean score method, scores or numerical values were assigned to each of the statement that describes the factor of construction time control in order to measure the intensity or degree of agreement by the respondent for example 2 = strongly agree, 1= agree, 0 = undecided, -1 = disagree and -2 = strongly disagree. The mean score for each item or factor was then determined from the score. The mean score (MS) is mathematically represented as

Mean score M.S =$\sum a\ x_i(-2 \leq MS \geq 2)$
Where
MS is the mean score
a = the respective weighting of the factors
(2, 1,0,-2,- 1)
Xi = the number of respondent for each weighting
N = the total number of respondents
∑= capital Greek sigma which means summation that is the sum of

In investigating the factors of construction project time control, the weighted average formula was used in assessing respondent ranking of importance. The weighted average for each of the variables was obtained from the sum of the product of the proportion of the responses involved from each group compared to the total number of receipt n/N and the corresponding mean score of that group in respect of individual variable. The weighted average is given as

$$WA = \sum \frac{n}{N} x\ M.S.\ (-2 \leq MA \leq 2)$$

Spearman's Correlation Coefficient

This technique was used to determine the degree of correlation between the two variables, the awareness level of the factors affecting time control and the application of the factors affecting time control in the Nigerian construction industry. The main objective of the coefficient is to determine the type of relationship between the variables and also the strength of the relationship.

The test statistic of Spearman's rank order is expressed as:

$$r = 1 - \frac{6\sum d_1^2}{n(n^2 - 1)}$$

where

d_1 = is the difference between ranks of ith pair of the two variables

n = number of pairs of observations. The rank correlation coefficient, r range from -1 to +1. For a perfect direct relationship, r = +1 while for a perfect inverse relationship, r = -1. No linear relationship exits in case of zero 'r' value.

2.1 Data Presentation and Analysis

Fifty copies of the questionnaire were distributed to the construction professionals, forty two responded to the questionnaire representing eighty four percent of the respondents.

Table 1: Categorization of Respondents

Respondents	Number	Percentage
Client	7	16.67
Consultant	6	14.29
Contractor	23	54.76
Others	6	14.22
Total	42	100

The analysis of the data in Table 1 shows that more than 69 percent of the respondents are in the construction industry. The background of the respondents was deemed adequate.

Assessment of awareness level of the factors affecting time control in the construction industry.

The average index score is used to rank the awareness level or causative factors to time control in the construction industry.

Table 2: Awareness of Factors affecting Time Control

Awareness (Causative) Factor	STDV	MS	RANKING
Inaccuracy of material estimate	15.47	1.69	1
Lack of Pre-construction planning using modern techniques	14.47	1.67	2
Inadequacy of information provided	14.45	1.62	3
Inadequacy of the contractors time control (schedule)	13.81	1.60	4
Inadequate planning	12.34	1.52	5
Unrealistic contract durations	13.28	1.50	6
Programmes not prepared in different levels	12.72	1.48	7
Competent project mangers not appointed early enough	12.03	1.43	8
Unforeseen contingencies and their effect on schedule	11.65	1.40	9
Inadequate or incomplete designs	11.10	1.36	10
Selection of competent and experienced contractors and sub contractors	11.67	1.33	11
Delay on the part of the consultant in issuing instructions, approvals	10.78	1.31	12
Lack of information from consultants	10.06	1.26	13

Specification of unsuitable/foreign imported material	10.14	1.19	14
Design team response time to request for information approval	9.91	1.14	15
Variations and change orders and their effect on schedule	10.21	1.12	16
Activities on the project	10.43	1.07	17
Unsuitable conditions of contract	9.45	1.02	18
Changes in site conditions	10.16	1.00	19
Attitude of project team towards delay	9.32	0.95	20
Deficiencies in contractor's organization	9.96	0.90	21
Lack of effective communication among parties involved	9.96	0.90	21
Clients attitude towards time control	9.34	0.88	23
Crew size and project staffing of crafts people	9.83	0.81	24
Slow decision making	9.69	0.74	25
Mistake during construction	10.09	0.69	26
Discrepancies in contract document	9.61	0.64	27
Equipment availabilities and failure	10.31	0.62	28
Procurement and contract type	9.81	0.57	29
Interrelationship of sub contract activities	9.81	0.57	29
Poor labour productivity	7.30	0.55	31
Subcontractors and nominated suppliers	7.30	0.55	32
Unpredictability/inclement weather	7.30	0.55	33
Inadequacy of time control systems by the design team	5.68	0.48	34
Design changes	7.92	0.45	35
Material shortages	3.58	0.38	36
Fluctuations in prices of construction material	4.39	0.36	37
Lack of funds to finance the project to completion	7.29	0.33	38
Financing and payment of completed work	5.81	0.31	39
Contractors insolvency	5.81	0.31	40
Average	9.92	0.96	

Source: Author's Field work

Table 2 shows the analysis of the factors affecting Time control in the construction industry. From the calculation, standard deviation for all the factors equals 9.918 which displayed good variations of the answers from targeted respondents. The minimum standard deviation is 3.58 and maximum standard deviation is 15.47. This justified the background of respondents as reasonable in their opinions towards the awareness of the factors affecting time control in the Nigeria construction industry. Aside from that the maximum and minimum mean score is 1.69 and 0.31 respectively and the overall average score is 0.96. The most ranked awareness factor is inaccuracy of material estimate. Following lack of pre-construction planning using modern techniques with a men score of 1.67. The least mean score is 0.31 that is contractor's insolvency followed by financing and payment of completed works with the same mean score of 0.31.

Table 3: Application of Factors affecting Time Control

	STDV	MS	RANKING
Mistake during construction	13.85	1.60	1
Inadequate planning	14.38	1.57	2
Change in site conditions	13.30	1.52	3
Inaccuracy of material estimate	13.76	1.50	4
Inadequacy of the contractor's time control	12.68	1.45	5
Poor labour productivity	13.30	1.43	6
Client's attitude towards time control	12.72	1.40	7
Equipment availability and failure	11.15	1.33	8
Crew size and project staffing of crafts people.	11.76	1.31	9
Unrealistic contract durations	10.11	1.21	10
Slow decision making	10.97	1.17	11
Deficiencies in contractor's organization	10.55	1.14	12
Inadequate or incomplete designs	10.16	1.10	13
Lack of effective communication among the parties involved	11.78	1.05	14
Lack of fund to finance the project to completion	9.10	1.00	15
Selection of competent and experience contractors and sub contractors	10.74	0.98	16
Lack of information from consultants	8.79	0.95	17
Design changes	9.02	0.93	18
Financing and payment of completed works	9.21	0.88	19
Inadequacy of information provided	9.42	0.88	20
Programme not prepared in different levels (master plan, monthly, weekly and daily)	9.56	0.79	21
Material shortages	10.31	0.74	22
Discrepancies in contract document	8.96	0.71	23
Unsuitable conditions of contract	8.38	0.69	24
Unpredictability/inclement weather	7.96	0.62	25

Contractor's insolvency	8.68	0.57	26
Incompetent project manager appointed early enough from inception	7.40	0.52	27
Interrelationship of subcontract activities	8.20	0.50	28
Attitude of project team toward delay	8.05	0.43	29
Design team response time to request for information & approvals	7.30	0.40	30
Specification of unsuitable/foreign imported material	6.73	0.36	31
Procurement and contract type	6.99	0.31	32
Inadequacy to time control systems by the design team	4.72	0.29	33
Variations and change orders and their effect on schedule	6.54	0.24	34
Subcontractors and nominated suppliers	5.59	0.21	35
Fluctuations in process of construction material	3.51	0.17	36
Unforeseen contingencies and their effect on schedule	6.35	0.14	37
Lack of pre-construction planning using modern techniques	5.27	0.12	38
Delay on the part of the consultant in issuing approval	6.07	0.10	39
Activities on the project	4.98	0.095	40

The information in Table 3 shows the analysis of the application of the factors affecting time control in the construction project. The calculation made from the responses of the professionals in the Nigerian construction industry indicated that the average standard deviation is 9.195. The maximum and minimum standard deviations are 3.51 and 13.85 minimum and maximum respectively. The standard deviation shows that the respondents were reasonable in their responses. The maximum and minimum mean score is 1.6 and 0.095 respectively and average mean score is 0.810. The highest mean score of 1.6 is mistake during construction, followed by inadequate planning with a mean score of 1.57 and the third as 1.52 which is change in site conditions. The least mean score of 0.095 is activities on the project, followed by delay on the part of the consultant in issuing approval and the third from bottom of the table is lack of pre-construction planning using modern techniques.

Table 4: Descriptive Statistics of Application

Variables	N	Mean	S.D	STD Error
x_1	42	0.79	9.56	3.30
x_2	42	0.69	8.38	2.89
x_3	42	0.93	9.02	3.11
x_4	42	1.0	9.10	3.14
x_5	42	0.14	6.35	2.19
x_6	42	1.05	11.78	4.06
x_7	42	0.74	10.31	3.56
x_8	42	1.60	13.85	4.78
x_9	42	0.71	8.96	3.09
x_{10}	42	1.57	14.38	4.96
x_{11}	42	1.52	13.30	4.59
x_{12}	42	0.17	3.51	1.21
x_{13}	42	0.62	7.96	2.75
x_{14}	42	0.95	8.79	3.03
x_{15}	42	0.24	6.54	2.26
x_{16}	42	0.98	10.74	3.70
x_{17}	42	0.29	4.72	1.63
x_{18}	42	0.31	6.99	2.41
x_{19}	42	0.36	6.73	2.32
x_{20}	42	0.40	7.30	2.52
x_{21}	42	1.50	13.76	4.75
x_{22}	42	0.50	8.20	2.83
x_{23}	42	1.45	12.68	4.38
x_{24}	42	1.43	13.30	4.59
x_{25}	42	0.52	7.40	2.55
x_{26}	42	1.40	12.72	4.39
x_{27}	42	1.10	10.16	3.51
x_{28}	42	0.43	8.05	2.78
x_{29}	42	1.33	11.15	3.85
x_{30}	42	0.12	5.27	1.82
x_{31}	42	1.21	10.11	3.49
x_{32}	42	1.31	11.76	4.06
x_{33}	42	1.17	10.97	3.78
x_{34}	42	1.14	10.55	3.64
x_{35}	42	0.10	6.07	2.09
x_{36}	42	0.88	9.21	3.18
x_{37}	42	0.88	9.42	3.25
x_{38}	42	0.21	5.59	1.93
x_{39}	42	0.57	8.68	2.99

x_{40}	42	0.29	4.98	1.72

Source: Computer Analysis of Table 3

Table 5: Descriptive Statistics of Awareness

Variables	N	Mean	S.D	STD Error
x_1	42	0.74	9.69	3.34
x_2	42	0.81	9.83	3.39
x_3	42	0.88	9.34	3.22
x_4	42	0.69	10.09	3.48
x_5	42	0.38	3.58	1.23
x_6	42	0.45	7.92	2.73
x_7	42	0.57	9.81	3.39
x_8	42	1.43	12.03	4.15
x_9	42	0.33	7.29	2.52
x_{10}	42	1.60	13.81	4.77
x_{11}	42	1.07	10.43	3.60
x_{12}	42	0.55	7.30	2.52
x_{13}	42	1.12	10.21	3.52
x_{14}	42	0.31	5.81	2.01
x_{15}	42	1.14	9.91	3.42
x_{16}	42	0.55	9.78	3.38
x_{17}	42	0.48	5.68	1.96
x_{18}	42	1.31	10.78	3.72
x_{19}	42	1.26	10.06	3.47
x_{20}	42	1.50	13.28	4.58
x_{21}	42	1.48	12.72	4.39
x_{22}	42	1.67	14.47	4.99
x_{23}	42	1.62	14.45	4.99
x_{24}	42	1.00	10.16	3.51
x_{25}	42	0.57	9.81	3.39
x_{26}	42	0.95	9.32	3.21
x_{27}	42	0.90	9.96	3.44
x_{28}	42	0.31	5.81	2.01
x_{29}	42	0.36	4.39	1.52
x_{30}	42	0.62	10.31	3.56
x_{31}	42	1.33	11.67	4.03
x_{32}	42	0.55	7.30	2.52
x_{33}	42	0.90	9.96	3.44
x_{34}	42	1.36	11.10	3.83
x_{35}	42	1.40	11.65	4.02
x_{36}	42	1.02	9.45	3.26
x_{37}	42	1.69	15.47	5.34
x_{38}	42	1.52	12.34	4.26
x_{39}	42	0.64	9.61	3.31
x_{40}	42	1.19	10.14	3.50

Source: Computer Analysis of Table 2

Using the information in Table 1, the awareness to factors affecting time control in the Nigerian construction industry and the information in Table 2, the application of factors affecting time control in the Nigerian construction industry to run a regression analysis. The Persons coefficient was used in establishing the correlation using the application as the dependent variable and the awareness level as independent variable.

A positive linear correlation which means that the high value of x are associated with high values of y and low values of x are associated with the low values of y. If correlation (r) is close to 1 then x (awareness) and y application are positively correlated. If r is close to -1 then x and y are negatively correlated. A negative linear correlation means that high values of x are associated with low values of y, and low values of x are associated with high values of y, when r is close to 0 there is little relationship between x and y.

The result of the analysis indicated that a positive r (0.240643) that is not too close to zero, it shows that there is a positive linear relationship which is not too strong for the strongly agree option. The r(0.165823) was established for the agree option indicating that it is not too close to zero, meaning that a positive linear relationship which is not too strong exist. A negative r(-0.112080) that is not too close to zero, indicating that a negative relationship which is not too strong exist between the awareness of the factors affecting time control and the application of the factors affecting time control in the Nigerian construction industry. For the undecided option, a negative r(0.01713) that is close to zero which in a little negative linear relationship between the independent variables and the dependent variable of the factors affecting time control in the construction industry. A positive r(0.05385) that is close too zero exist in the relationship between the awareness and the application of the factors affecting time control in the construction industry in the strongly disagree option.

It needs to be emphasized that knowledge of the existence of the factors affecting time control in the Nigerian construction industry is a prelude to their eventual implementation.

III. Recommendation

1. Poor knowledge of construction material estimation is a great factor in the cause of time overrun in construction project and delivery.
2. Pre-construction planning is very necessary to maintain the schedule of construction project and it assists in construction time control.
3. Experienced and competent project managers appointed at the inception of the project will reduce mistakes in construction activities and time overrun.
4. Knowledge of the existence of the factors affecting time control in the Nigerian construction industry is a prelude to their eventual implementation. Therefore construction professionals are to be trained and retrained on the factors affecting time control in the construction industry.
5. Precautionary measures are to be put in place as a defense to the inhibiting factors of time control in construction project.

IV. Conclusion

The top four awareness factors affecting time control are namely; inaccuracies of material estimate, lack of pre-construction planning using modern techniques, inadequacy of information provided and inadequate planning of construction projects. While the top four application factors affecting time control are mistake during construction, inadequate planning, change in site construction and inaccuracy of material estimate. The research shows that there is a high level correlation between the awareness factors and the application factor of time control in the construction project delivery. Further research need to be done to uncover the other time control factors not mentioned in this work.

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