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# Assessment of Compliance to Quality Management Plan in The Nigerian Construction Industry

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***Abstract:*** *Quality of building, especially those executed by indigenous construction firms and professionals in Nigeria cannot be measurable with those of developed countries. This ugly situation has been attributed to many factors including dearth of skilled tradesmen, non-existence of national quality standards and code of practice and ineffective government regulatory policies. It was established that the level of awareness of the regulatory policies was not synonymous to the level of compliance and implementation of quality control measure which was found to be only a little below 53 percent. These were fingered as being responsible for quality works and high rate of building collapse in the country. Implementing the recommendations made in this research work will not only reduce considerably the timeline, but also enhance the effectiveness in the quality control of building production processes.*

***Keynotes:*** *Compliance, Non-conformity, Quality Management Plan, Quality Control, Quality Management, Building, Project, Construction.*

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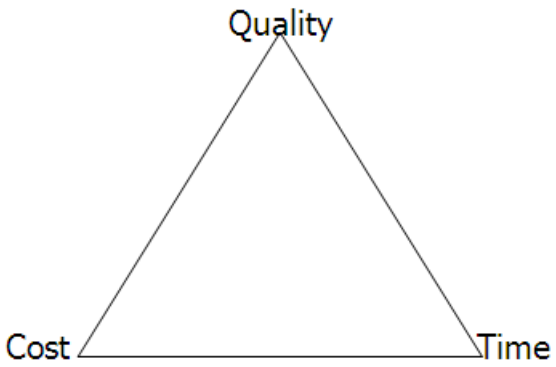
## I. Introduction

Construction projects are usually designed to achieve three basic objectives namely cost, time and quality. These three basic objectives are interdependent on each other. Dennis (2002) used Figure 1 to illustrate the relationship between these three objectives.




**Source**: Dennis, L. (2002)

If there is pressure to keep cost down, quality may be affected. If there is considerable time pressure, both cost and quality will be impacted. Ideally all three goals can be met, as quality is done correctly the first time, then cost and time will be optimized as well.

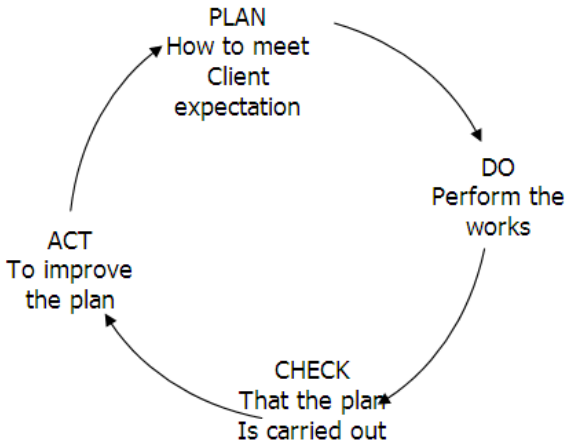
Arora (2009) opines that quality management is the aspect of the overall management function that determines and implement the quality policy. its objectives is to achieve zero defect in all areas of actives like wastage, breakdowns, rejections, accidents, industrial disputes, construction method. The quality management processes include the quality management plan, quality control, quality assurance and quality improvement. The quality compliance is the most important measure of quality during the construction process. The specification of quality requirements in the design and contract documentations is very important. Quality requirements should be clear and verifiable so that all the parties in the project can understand the requirements for compliance.

Successful quality management programme can be achieved by top management of the construction industry by obtaining quality management programme goals and developing a plan for implementing the goals. The objectives of the quality management plan will

a. Increase and maintain clients satisfaction with the construction work
b. Decrease defects in the construction work
c. Maintain quality work consistently from project to project and crew to crew
d. Obtaining efficiency in the construction work and consistently doing it right the first time.

These objectives need to be clearly defined initially, the objectives need to relate to what the plan, is intended to accomplish. The objectives are not usually examined to see if success can be realistically achieved with the objectives. The objectives are not also defined and measured in the same way to determine if success has been achieved.

The plan phase include the full plan for the company programme as well as the plan for the particular project quality management. Mincks and Johnston (2010) stated that quality management programme uses a continuous Plan-Do-Check-Act as shown in figure 2.




The quality management programme most of the time does not address the process of the quality management plan, identification of relevant codes and standard for the work, materials needed for the construction work, procedures for sub-contractors to comply with the quality management programme.

Failure of construction projects in the broad sense of non-compliance with the designers intent or specification and include defects of position, alignment, dimensions, wearing surfaces and the like as well as partial or total collapse.

It is the purpose of this research to discuss these failure whose primary cause is found in errors or deficiencies of the construction process, whether they occur while construction is actually in progress or not.

## II. Methodology

Fifty public building projects were observed to ascertain the level of compliance to the National building Code Quality Management Plan. The assessment was done on a 3-point Likert scale: Full compliance (F) as 2, Partial Compliance (P) as 1 and Non-compliance (N) as 0

The areas of building assessment were as follows:

| | | | |
|---|---|---|---|
| 1. | Setting out | - | 5 components |
| 2. | Foundation/Basement | - | 8 components |
| 3. | Superstructure | - | 5 components |
| 4. | Roofing and Closing up | - | 5 components |
| 5. | Finishing | - | 10 components |
| 6. | Electrical Installation | - | 9 components |
| 7. | Mechanical Installation | - | 5 components |

The mean score (index) for each component of the area of the building was determined. The mean score index is mathematically represented as

$$I_{imp} = \frac{\sum a_i x_i}{N} \quad (0 \leq \text{index} < 2)$$

$I_{imp}$ is the index of preponderance
ai the respective weighting factor of compliance
xi the number of observations
N the total number of buildings observed
$\sum$ capital Greek sigma which means summation i.e sum of index

The computed index of the items were compared to summarize the information.
The summarized information of the Full compliance, Partial compliance and the non-compliance were subjected to statistical analysis using 2 tailed paired samples test at 6 degree of freedom.

## III. Results And Discussions

### 3.1 Setting Out

The data in Table 1 shows the index of quality control compliance actions on setting out. Out of the five setting out components, site plan recorded mean score of 1.18 ranking first followed by building line/set back with mean score of 1.06 as second. The components that call for serious improvement are adherence to plan and datum level. Part of the consequences of not maintaining the datum level is the cause of soil erosion within the buildings. It affects safety against undermining and flood water because the road construction is based on the datum and the building construction is supposed to be based on the datum level as well. The probability of achieving full compliance on the setting out is 21.2 percent, non-compliance is 18.8 percent and partial compliance is 60 percent. This implies that a lot of work needs to be done to improve the partial compliance to full compliance.

**Table 1: Field Result of Compliance to Quality Control on Setting out**

| Setting Out Actions | Full Compliance (2) | Partial Compliance (1) | Non-Compliance (0) | Sum | Number of Project | Index | Rank |
|---|---|---|---|---|---|---|---|
| Site Plan | 15 | 29 | 6 | 59 | 50 | 1.18 | 1 |
| Building line/Set Back | 12 | 28 | 10 | 52 | 50 | 1.04 | 2 |
| Profile line | 11 | 30 | 9 | 52 | 50 | 1.04 | 3 |
| Datum level | 7 | 30 | 13 | 44 | 50 | 0.88 | 5 |
| Adherence to Plan | 8 | 32 | 10 | 48 | 50 | 0.96 | 4 |
| **Total** | **53** | **150** | **48** | **256** | **250** | **5.12** | |
| **Probability** | **21.2%** | **60%** | **18.8%** | | | | |

Source: Author's fieldwork, 2018

### 3.2 Foundation/Basement

Among the component of foundation and basement quality control plan, dimension was observed to rank first with mean score of 1.18. Foundation walls ranked second with mean score of 1.1 as shown in Table 2. The probability of achieving non-compliance in foundation/basement according to NBC quality control management plan is 25.7 percent. Partial compliance is 52 percent and full compliance 22.5 percent. 77.75 percent work need to be done in foundation/basement in order to achieve full compliance. In the ranking of foundation/basement, post concreting was the least in the ranking. Post concreting (curing) process is one of the most essential operations in concrete works. Post concreting in foundation replenishes the loss of moisture from the concrete due to evaporation, absorption and heat due to hydration of the cement. Post concreting can be achieved naturally by curing with water or covering with damp medium (sand, sack, etc). Artificial curing can be achieved with the help of steam or hot water, resulting in rapid development of strength in precast concrete components and impounding water in earthen or sandy bungs in grids over concrete slabs.

**Table 2: Field Result of Compliance to Quality Control on Foundation/Basement**

| Foundation/Basement Actions | Full Compliance (2) | Partial Compliance (1) | Non-Compliance (0) | Sum | Number of Project | Index | Rank |
|---|---|---|---|---|---|---|---|
| Dimension | 18 | 23 | 9 | 59 | 50 | 1.18 | 1 |
| Shuttering/support | 12 | 29 | 9 | 53 | 50 | 1.04 | 4 |
| Blinding (thickness) | 13 | 26 | 11 | 52 | 50 | 1.06 | 3 |
| Reinforcement | 11 | 28 | 11 | 50 | 50 | 1.0 | 5 |
| Concrete and Concreting | 9 | 27 | 14 | 46 | 50 | 0.92 | 6 |
| Foundation walls | 14 | 27 | 9 | 55 | 50 | 1.10 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Back Filling | 6 | 33 | 11 | 45 | 50 | 0.90 | 7 |
| Post Concreting | 6 | 15 | 29 | 27 | 50 | 0.54 | 8 |
| **Total** | **89** | **208** | **103** | **387** | **400** | **7.74** | |
| **Probability** | **22.25%** | **52%** | **25.7%** | | | | |

Source: Author's Fieldwork, 2018

### 3.3 Superstructure

According to the data in Table 3, non-compliance had 22.8 percent in the superstructure, partial compliance - 48.8 percent and full compliance is 28 percent. This calls for the attention of the stake-holders in the building industry to improve on the level of building construction at the super-structure level. Attention of the engineer and builder is drawn to the non-compliance of the structural details of the drawing by contractors. A good level of awareness on the importance of steel reinforcement on building needs to be emphasized. The areas of concern where the building project supervisors will improve upon include bar bending schedule and ensuring that the required size and strength of reinforcement specified are provided at the project site. The spacing of the reinforcement in line with the drawings and concrete cover to reinforcement should not be neglected because it is part of the parameters for steel reinforcement design. Another area that calls for improvement according to Table 3 is the window opening. The ranking in terms of compliance of window openings in superstructure is 4$^{th}$ with mean score of 0.96. One major problem in the installation of window hoods in buildings is that all too often building project supervisors do not at the first time decide whether the windowhood will be precast or in situ. Most decisions during installation are usually abrupt without many technical considerations.

**Table 3: Field Result of Compliance to Quality Control on Superstructure.**

| Superstructure Actions | Full Compliance (2) | Partial Compliance (1) | Non-Compliance (0) | Sum | Number of Project | Index | Rank |
|---|---|---|---|---|---|---|---|
| Formwork/Support | 17 | 26 | 7 | 60 | 50 | 1.2 | 2 |
| Reinforcement | 12 | 20 | 48 | 44 | 50 | 0.88 | 5 |
| Concrete/Concreting | 11 | 29 | 10 | 51 | 50 | 1.02 | 3 |
| Walls | 21 | 20 | 9 | 62 | 50 | 1.24 | 1 |
| Window hood | 11 | 26 | 13 | 48 | 50 | 0.96 | 4 |
| **Total** | **72** | **121** | **87** | **265** | **250** | **5.3** | |
| **Probabilities** | **28.8%** | **48.8%** | **22.8%** | | | | |

Source: Author's Fieldwork, 2018

### 3.4 Roofing and Closing-up (Cladding)

The data in Table 4 shows that the mean score in roofing and closing up 0.952. The non-compliance recorded 27.6 percent, the partial compliance recorded 49.6% while full compliance recorded 28.8 percent. This aspect of the building construction still calls for improvement in order to achieve a full compliance. The least among the roofing and closing-up components is the post-installation with mean score of 0.64 which is below the average mean score. Post-installation enables corrective actions to be applied at the early stage before completion certificate is used. The supervisors and contractors of building projects should always insist on post-installation of roof installation work. Most of the time, the eaves, flashes, ridges and other accessories are not designed as part of the roof. The implication is that some of the accessories do not comply with roof slope which makes the installation difficult. The accessories are supposed to be of the same material specification with the roof covering material.

**Table 4: Field Result of Compliance to Quality Control on Roofing and Closing Up**

| Roofing and Closing Up | Full Compliance (2) | Partial Compliance (1) | Non-Compliance (0) | Sum | Number of Project | Index | Rank |
|---|---|---|---|---|---|---|---|
| Wall Plate and Holding down Bolt | 6 | 31 | 13 | 43 | 50 | 0.86 | 3 |
| Roof Frames and Structure | 14 | 29 | 7 | 57 | 50 | 1.14 | 2 |
| Roof covering material (thickness) | 21 | 25 | 4 | 67 | 50 | 1.34 | 1 |
| Eaves, Flashes, Ridges | 10 | 19 | 21 | 39 | 50 | 0.78 | 4 |
| Post Installation | 6 | 20 | 24 | 32 | 50 | 0.64 | 5 |
| **Total** | **57** | **124** | **69** | **238** | **250** | **4.76** | |
| **Probabilities** | **28.8%** | **49.6%** | **27.6%** | | | | |

Source: Author's Fieldwork, 2018

### 3.5 Finishing Works

The mean score of quality control on finishing is 0.912 as shown in Table 5. The components of the finishing works below the average mean score are window hood, cornices and staircase. The installation of cornice in building project is supposed to be carried out by specialized sub-contractors. Apart from the specialized sub-contractors, the cornice need to be incorporated in the initial design of the project. The construction of staircase is supposed to be as per design of the project. In most cases, the risers, the tread, the landing, flight, going and the nosing are not usually rounded off from architectural considerations. Observation shows that the locations do not provide early access to the occupant hence the need to improve on the 21.2 percent full compliance as indicated in Table 5.

**Table 5: Field Result of Compliance to Quality Control on Finishing**

| **Roofing and Closing Up** | **Full Compliance (2)** | **Partial Compliance (1)** | **Non-Compliance (0)** | **Sum** | **Number of Project** | **Index** | **Rank** |
|---|---|---|---|---|---|---|---|
| Internal Doors & Architraves | 11 | 27 | 12 | 49 | 50 | 0.98 | 4 |
| Rendering (internal) | 12 | 24 | 14 | 48 | 50 | 0.96 | 5 |
| Rendering (ceiling) | 9 | 32 | 9 | 50 | 50 | 1.0 | 3 |
| Flooring and skirting | 9 | 23 | 18 | 51 | 50 | 1.02 | 2 |
| Conics | 8 | 22 | 20 | 38 | 50 | 0.76 | 9 |
| Rendering (external) | 9 | 29 | 12 | 47 | 50 | 0.94 | 6 |
| Window Hood | 9 | 18 | 23 | 36 | 50 | 0.72 | 10 |
| Finishing ceiling | 14 | 24 | 12 | 52 | 50 | 1.04 | 1 |
| Painting | 13 | 20 | 17 | 46 | 50 | 0.94 | 7 |
| Stair case | 12 | 21 | 17 | 45 | 50 | 0.90 | 8 |
| **Total** | **106** | **239** | **154** | **462** | **500** | **9.12** | |
| **Probabilities** | **21.2%** | **47.8%** | **31%** | | | | |

Source: Author's Fieldwork, 2018

### 3.6 Electrical Installation

The data in Table 6 show the ranking of the compliance to quality control plan on various electrical installation components. Among the components, piping and conduit work ranked first, with an index of followed by wiring cable as second with mean score of 1.1. Distribution board ranked third with mean score of 1.08. The average mean score is 0.97. The components of electrical installation the mean index for electrical installation are checkings, testing, patxes box and switch gears. The components the mean index need to be improved upon. Specialized sub-contractors are recommended for this aspect of the work.

**Table 6: Field Result of Compliance to Quality Control on Electrical Installation.**

| **Roofing and Closing Up** | **Full Compliance (2)** | **Partial Compliance (1)** | **Non-Compliance (0)** | **Sum** | **Number of Project** | **Index** | **Rank** |
|---|---|---|---|---|---|---|---|
| Piping and conduct work | 13 | 32 | 5 | 58 | 50 | 1.16 | 1 |
| Distribution Board | 11 | 32 | 7 | 54 | 50 | 1.08 | 3 |
| Switch Gears | 8 | 23 | 19 | 39 | 50 | 1.78 | 9 |
| Change over switches | 10 | 33 | 7 | 53 | 50 | 1.06 | 4 |
| Patxes Box | 9 | 23 | 18 | 41 | 50 | 0.82 | 8 |
| Wiring Cable | 14 | 27 | 9 | 55 | 50 | 1.1 | 2 |
| Lighting Fitting | 9 | 31 | 10 | 49 | 50 | 0.98 | 5 |
| Checkings | 11 | 22 | 17 | 44 | 50 | 0.88 | 6 |
| Testing | 9 | 25 | 16 | 43 | 50 | 0.86 | 7 |
| **Total** | **94** | **248** | | **436** | **450** | **8.72** | |
| **Probabilities** | **20.89%** | **55.11%** | **24.0%** | | | | |

Source: Author's Fieldwork, 2018

### 3.7 Mechanical Installation

Data in Table 7 shows that fittings and fitting materials ranked first in the compliance level of mechanical installation with mean score of 1.02. The mean score for mechanical installation is 0.90. The full compliance on mechanical installation was only 20.8 percent, Partial compliance - 48.4 percent and non-compliance, 30.8 percent. More awareness should be created for safety system and the testing of mechanical installations. These two items fall under the mean score. Mechanical equipment installers in building projects should take these items seriously. Apart from improving on the level of conformance, it will assist in the saving of life and property within buildings, including fire outbreaks.

**Table 6: Field Result of Compliance to Quality Control on Mechanical Installation**

| Roofing and Closing Up | Full Compliance (2) | Partial Compliance (1) | Non-Compliance (0) | Sum | Number of Project | Index | Rank |
|---|---|---|---|---|---|---|---|
| Piping and connection work | 13 | 23 | 14 | 49 | 50 | 0.98 | 2 |
| Fitting and fitting materials | 14 | 23 | 13 | 51 | 50 | 1.02 | 1 |
| Mechanical equipment | 11 | 25 | 14 | 47 | 50 | 0.94 | 3 |
| Safety system | 6 | 28 | 16 | 40 | 50 | 0.80 | 4 |
| Testing | 8 | 22 | 20 | 38 | 50 | 0.76 | 5 |
| **Total** | **52** | **121** | **77** | **225** | **250** | **4.5** | |
| **Probabilities** | **20.8%** | **48.4%** | **30.8%** | | | | |

Source: Author's Fieldwork, 2018

### 3.8 Hypothesis Testing

Public building projects in South-eastern states of Nigeria do not significantly comply with the quality management standards of building projects.

Conformity is the fulfilment of the specified requirement. With the attention to conformance as the measure of quality during the construction process, the specification of quality requirements in the design and contract documentation becomes extremely important. Quality requirement should be clear and verifiable, so that all parties involved in the project can understand the requirements for conformance.

Conformance testing is routine quality assurance/quality control functions. Through verification testing, one can monitor the quality of the products. Non-conformities may be identified through observation, utilization and or conformance testing.

Tricker and Algar (2006) suggested that part of the local authority's duty is to make regular checks that all building work being completed is in conformance with the approved plan and the building regulations. These checks would normally be completed at certain stages of the works. (Example excavation of foundations).

**Table 8: Compliance to Building Project Phases (Summary)**

| Building Project Phases | Full Compliance (FC %) | Partial Compliance (PC %) | Non Compliance (NC %) |
|---|---|---|---|
| Setting out | 21.2 | 60 | 18.8 |
| Foundation/Basement | 22.25 | 52 | 25.75 |
| Superstructure | 28.8 | 48.4 | 22.8 |
| Roofing and Closing up | 22.8 | 49.6 | 27.6 |
| Finishing | 21.2 | 47.8 | 31 |
| Electrical Installation | 20.89 | 55.11 | 24.0 |
| Mechanical Installation. | 20.8 | 48.4 | 30.8 |

Source: Author's Fieldwork, 2018

Having analyzed the various phases of quality control actions in public building projects in South-eastern states of Nigeria from where data were collected, it becomes necessary to produce a summary of the probabilities as shown in Table 1 - 7. This is done in Table 8.

It should be recalled that the hypothesis in this study states that some public building projects in South-eastern states of Nigeria do not significantly comply with the quality control management standards of building projects. The data analysed in Table 1 – 7 were subjected to statistical analysis using 2-tailed paired samples test at 6 degrees of freedom. A summary of the computation is shown in Table 9.

**Table 9: Paired Samples Test**

| Differential Probability | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | Calculation | | | 95% Confidence Interval of the Difference | | | | |
| | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | | | |
| FC - NC | .77143 | 10.64295 | 4.02266 | -9.07166E0 | 1.06145E1 | .192 | 6 | .854 |

Source: Author's Analysis, 2018

Based on the data in Table 9, it was found that the t-statistic is 0.192, the critical value at 95 percent level of significance at 6 degrees of freedom is 0.854. Since the critical value is greater than the t-statistic, the null hypothesis is accepted. It is therefore affirmed that some public building projects in South-eastern states of Nigeria do not significantly comply with the quality management standards of building projects. This revelation

calls for concern among the stakeholders in the building industry. To ensure that the issue of building collapse is arrested, those who supervise public building projects should insist on full compliance of the approved standards.

## IV. Recommendations

1. Completion certificate issued by consultants (Architects, Engineers, builders, Quantity Surveyors) should be based on full compliance to the relevant requirement of the building regulations and codes.
2. like most other aspects of construction technology and management quality control has to be planned. Planning seeks order and a quality control system for a construction project reflects this sense of order.
3. The supervisors of Building project should insist on full compliance of relevant codes and standards in accordance with international best practices in order to reduce or eliminate the incidence of failed building projects including building collapse.
4. Plan for remediation on non-conforming activities prior to completion of the projects
5. Quality audit of projects to be part of the quality management plans.

## V. Conclusion

The research affirmed that those change with quality management in the South-eastern states of Nigeria do not fully comply with procedure as set out by the National Building Code. The issue of building collapse can be arrested, those who supervise public building projects should insist on full compliance of the approved standards using the national building code as standard.

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