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# Appraisal of Construction claims Management Practices in Nigeria

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***Abstract***: In developing countries, effective construction claim management practices can help project owners and contractors resolve claims easily. Existing studies have been centred on the nature, frequency, severity, causes, magnitude and the effects of claims in Nigeria but less has been done to holistically examine various construction claims management practices. This study examines the level of usage and effectiveness of existing claims management practices by gathering quantitative data from 323 respondents engaged in building projects construction. The collected data were analysed using the percentile, mean item and Kruskal-Wallis K-test. Among the three groups, owners mostly use the construction claims management process and framework. In total, 64% and 21% of the participants had used the claims management process and framework respectively. Furthermore, among the seven sub-processes, owners were most effective in the documentation whereas contractors and consultants were most effective in the use of identification and evaluation, respectively. An implication of these findings is that stakeholders are yet to embrace an innovative methodology, such as available frameworks, to improve the management and settlement of claims. As such, adequate sensitization of the stakeholders in the use of a framework can be implemented to eliminate the cost of litigation, which is often the result of disputed claims.

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***Keywords***: Construction claims, Claims management process, Dispute, Project success.

## 1. Introduction

Claims management is a knowledge area in project management. Studies by researchers all over the world have shown that there are two main approaches in claims management, namely the use of the claims management process and the use of an innovative methodology, such as frameworks. Abdul-Malak et al. (2002) advocated that for successful claims management, contractors submitting claims must clearly follow the steps stipulated in the contract conditions and that the owners must follow an overall comprehensive procedure for tracking and managing the claims submitted by the contractors. Bakhary et al. (2013) stated that the idea of a construction claim is not new, but what has been lacking is a practice that can help construction claims administrators in assessing the level of their construction claims process. Therefore, Bakhary et al. (2013) stressed the need for an organised instrument (framework) for auditing contractor's claim process. Singh and Sakomoto (2001) also concluded that all parties to a construction contract should understand the claim management process so as to ensure proper claims management practice.

Construction claims management practices vary from country to country. Bakhary et al. (2013) reviewed the means of improving the claims management process in Malaysia and developed a framework for improving this process, which implies that claims are managed in Malaysia through a claims management process and framework. Aibinu et al. (2008) investigated the role of perceived fairness in the process of managing construction claims in Singapore and the study confirmed that the client-appointed contract administrator assesses and decides on the genuineness of claims presented by the contractor. The study explained further that any disagreement on the recommendation of the administrator may be corrected or negotiated by the parties to the contract. The study concluded that when negotiation fails, claims may be resolved through alternative dispute resolution techniques or litigation, implying that the Singapore approach to claims management is different from that used in Malaysia.

Studies have been conducted in many countries, such as Moshin (2012) in Oman, Scott and Harris (2004) in United Kingdom, Chovichien and Tochaiwat (2005) in Thailand, Enshassi et al. (2009) in Palestine and Hassanein and Nemr (2008) in Egypt have concluded that construction claims management is managed through the procedure outlined in the conditions of the contract. Oyegoke (2008) researched on building competence to manage contractual claims by Finish contractors. The study concluded that in Finland applications, the procedures and management of claims are not clearly defined, and claims require little documentation/correspondence with prompt reimbursement by owners. The above studies confirmed that approaches

in construction claims management practices vary from country to country.

In Nigeria, the majority of previous research efforts have been on the nature, causes, magnitude and effects of construction claims. Among these studies were Kehinde and Aiyetan (2002), who studied the nature of contractual claims in building contracts in Nigeria; Aibinu and Jagboro (2002), who evaluated the effects of delays on project delivery in Nigerian construction industry; Aibinu and Odeyinka (2006) worked on construction delays and their causative factors in Nigeria; Ameh et al. (2010), who studied noticeable factors causing cost overruns in telecommunication projects in Nigeria; Oke and Makinde (2011), who modeled the extent of contract claims on building projects; and Oladapo (2007), who performed a quantitative assessment of the cost and time impacts of variation orders on construction projects in Nigeria.

Although a considerable number of researches have been conducted in the aforementioned areas, no study is known to have attempted to address the general approaches in construction claims management in Nigeria. It may be argued that such research has been performed in other countries; however, because of the differences in business cultures from one geographical location to another, there is a need to fill this knowledge gap. Therefore, the current research aims at appraising the existing construction claims management practices in Nigeria. The specific objectives are as follow: (1) to assess the level of usage of existing construction claims management practices and (2) to evaluate the effectiveness of stakeholders in the use of the construction claims management process. In line with the second objective as stated above, a null hypothesis was postulated that will help determine statistically the effectiveness of stakeholders in the use of construction claims management sub-processes. The null hypothesis is as follows:

**Ho1:** There is no significant difference among the perceptions of the clients, consultants, and contractors regarding their effectiveness in the use of construction claims management in each sub- process.

## 2. Literature Review

Tochaiwat and Chovichien (2004a) described Construction claims management as the process of relating with or controlling changes by one of the parties involved in the construction process. Kululanga et al. (2001) observed that management of construction claims is the greatest difficult task that is facing contractors in today's unstable business environment. This study equally asserted that construction projects are becoming increasingly susceptible to a variety of factors that give rise to time extension and cost recovery. Kululanga et al. (2001) concluded that even though the construction business has moved toward partnering arrangements in recent years, difficulties in claims management continue to increase. Rooke et al. (2004) asserted that claims are sometimes planned at the tender stage or during the course of a project. The study affirmed that one practice at the tender stage is the pricing technique, which minimizes

the tender prices while maximizing the out-turn cost of a contract by exploiting mistakes in the bill of quantities. Another practice is the programming of work to maximize its vulnerability to delay. This strategy of tendering by contractors is referred to in many studies as opportunistic bidding. Ren et al. (2001) and Aibinu (2007) observed that over the past three decades, the construction industry has experienced increases in claims, liability exposures and disputes, along with increasing difficulty in reaching reasonable settlements in an effective, economical and timely manner. Oyegoke (2006) stressed the importance of claims management in the construction industry, because it is vital for the successful implementation of the project, brings about fair dealing between the project owner and the contractor, improves the contractor's cash flow and discourages disputes and project abandonment.

Several studies, such as Oke and Makinde (2011) and Ameh and Osegbo (2011), have shown that in Nigeria construction projects are not usually completed without cost and time overruns. Kehinde and Aiyetan (2002) observed that this phenomenon has been attributed to a series of complex inter-relationships between project variables, the design, the method of construction, the mode of payments, availability of materials, a lack of harmony among the building team members, environmental conditions, and other factors. The implication of these complex variables may not be known at the pre-contract stage, but results in several claims in the cost of executing the contract by the contractors. The study of the existing approaches will also assist construction industry participants in solving the problems that are associated with construction claims management in Nigeria.

Aibinu et al. (2008) opined that a normal process for administering construction claims involves three major stakeholders, namely the client, the main contractor and the client-appointed contract administrator/representative. The study explained further that the employer is the owner or financier of the project, the main contractor is the organization that undertakes the construction of the project in accordance with the contract documents, the appointed client representative is responsible for assessing and certifying the genuineness of the contractor's claims. Enshassi, et al. (2009) postulated that the key objective of the claims management process is to resolve certain difficulties in an efficient manner to avoid litigation and arbitration in settlement of claim. Tochaiwat and Chovichien (2004a) opined that to address or control claims effectively, all parties should establish good construction claim management processes in their organizations. Kululanga et al. (2001) concluded that the components that form the construction claim process comprises six sub-processes, namely, identification, notification, examination, documentation, presentation and negotiation.

Levin (1998) and Mbabazi (2004) supported this standardization and stated that the solution to the continuous occurrence of claims in the construction

industry is the claims management process, which includes proper identification, notification, documentation, presentation and resolution. Enshassi et al. (2009) also supported this standardization and professed that the solution to the problem of claims management is claim management process, which includes identification, notification, examination, documentation, presentation and negotiation. Almost all the previous studies on claims management agreed that to avoid disputes that may arise, it is better to follow the claims management process. Several instruments (i.e., frameworks) have been developed for the management of construction claims. These frameworks can be grouped into four groups according to their approaches in managing construction claims: the "bid your claims" group, which includes opportunistic bidding behaviour according to Mohamed et al. (2011) and the analytical model for analysing construction claims and opportunistic behaviour according to Ho and Liu (2004). This group opined that the contractor can bid low if there is opportunity to recoup his losses through claims during the execution of the contract.

Another group is the "step-by-step procedure", which includes the construction contractor claim process by Kululanga et al. (2001); claims administration model by Abdul-Malak et al. (2002); the framework of systems for managing employers' claims by Chovichien and Tochaiwat (2006) and the framework on claim analysis by Nguyen (2009). This group also opined that construction claims management practices should follow the procedures as set out in the conditions of the contract. The next group is the "multi agent negotiation", which includes the use of a multi-agent system for construction claims negotiation by Ren (2002) and the general negotiation framework by Fidan et al. (2010). This group affirmed that once it is established that the contractor is entitled to claim(s), independent agents should be appointed by both parties to negotiate the cost and time due to claimant on their behalf.

The last group is those who developed the framework for "a particular type of claim", which includes the variation order sub-model by Abdul-Malak et al. (2002) and the analysis of weather-related construction claims by Moselhi and El-Rayes (2002). This group developed frameworks that can be used to manage a particular type of claim. In conclusion, those who developed the aforementioned grouped frameworks opined that the use of the framework is an important practice in managing construction claims.

## 3. Research Methodology

To address the objectives stated above, data were collected using a well-structured questionnaire administered to clients, contractors, consultants, architects and quantity surveyors. The respondents were stakeholders who were involved in claims management on various building projects executed between 2009 and 2014 in Ondo state. The population for the study was 323 respondents; they included 53 clients, 168 contractors, 52 architects and 50 quantity surveyors. The building

projects used for this study were owned by Ondo state government while the contractors and consultants involved were widely spread across the country. Census method was adopted because the population falls within a manageable size and locations. Therefore, the results of the study can be generalized. The questionnaire was structured into three sections, and questions were asked on a 4-point Likert type, with 4 being the highest rating. The first section was on the background information about the respondents, whereas the second section was mainly on the respondent's levels of awareness and usage of the identified practices. The third section was on the effectiveness of the respondents in the use of the practices. Out of the questionnaires administered, 197 of them were returned and found suitable for analysis, representing about 61% response rate, which is above the usual rate of 20-30% for questionnaire surveys in construction management studies, as suggested by Akintoye and Fitzgerald (2000) and Fellows and Liu (2008). The data collected were analysed using percentiles and mean scores. Kruskal-Wallis K-test KW was also adopted in determining the level of agreement in the respondents' opinions because the data collected were ordinal. Fellows and Liu (2008) asserted that KW can be used when there are three or more samples.

In order to check the internal reliability of the instrument used for the study, Cronbach's alpha was calculated. Tan (2004) suggested that for a scale to be reliable Cronbach's alpha must be at least 0.7 and that if the questions are uncorrelated, Cronbach's alpha = 0. Field (2005) concluded that a value of 0.7- 0.8 is an acceptable value for Cronbach's alpha and that value that is substantially lower indicates an unreliable scale. From the result of the reliability test performed on the scale used in the questionnaires for this study, as presented in Table 1, it is evident that the Cronbach's alpha value ranges from 0.828 to 0.941. Hence it can be considered acceptable and good, based on Tan (2004) and Field (2005) criteria. Therefore, it can be concluded that the instruments used for this study are significantly reliable.

**Table 1. Reliability Coefficients for the Data Collection Instrument.**

| Scale of Measure | Cronbach's α |
|---|---|
| The level of awareness of the existence of the construction claims management process | 0.866 |
| The level of awareness of the existence of frameworks (structured instruments for managing construction claims) | 0.938 |
| The use of the construction claims management process | 0.902 |
| The use of the frameworks (structured instruments for managing construction claims) | 0.941 |
| Effectiveness in the use of the construction claims management process | 0.828 |

## 4 Findings and Discussion

### *4.1 Background Information on the Respondents*

About 53% of the respondents were corporate or registered members of their professional bodies and with up to ten years of post-registration experience, whereas 20% and 27% were junior and senior members of their professional bodies, respectively. Senior professional members had over 25 years of post-qualification experience, whereas the junior members had less than 5 years of post-qualification experience. These experience levels imply that the respondents were well educated, professionally qualified and competent to answer the questions, and their opinions are reliable.

### *4.2 Level of Awareness of Existing Construction Claims Management Practices*

As stated earlier, two major practices were identified in literature and the results of their analyses were as follow:

#### *4.2.1 Level of Awareness of Construction Claims Management Process*

In assessing the level of awareness of the stakeholders of the construction claims management process as a practice, three groups of respondents were involved. From Table 2, 11.11%, 22.22% and 35.56% of the clients were somewhat aware, aware and very aware of the construction claims management process as a practice, respectively suggesting that 68.89% of the clients were generally aware of this practice. The overall point of view of the contractors indicates that 69.12% of them were aware of construction the claims management process as a practice for managing construction claims at diverse levels.

In the case of consultants, 13.10% of them were somewhat aware of this practice, whereas 39.29% and 42.85% of the consultants were aware and very aware of this practice, respectively. These findings signify that 95.24% of the consultants were aware of this practice at various levels. The general views of the respondents show that 80.20% of the respondents were aware of this practice at varying levels. The overall point of view of the respondents indicates that the stakeholders' awareness of the construction claims management process as a practice was fairly high, because 80% of them were aware of this practice at various levels.

The Kruskal-Wallis K-test was performed to examine whether respondents differed in their perception based on their type of organisation (i.e., clients, contractors and consultants). An asymptotic significance value of 0.566 was generated, which is greater than 0.01 and 0.05. This result implies that there is no significant difference among the respondents' response to this aspect of the study, which confirmed statistically that the results of the descriptive analysis are reliable.

**Table 2. Levels of Awareness of the Existing Construction Claims Management Practices.**

| Practice | Clients | | Contractors | | Consultants | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | Freq. | % | Freq. | % | Freq. | % | Freq. | % |
| *Construction claims management process* | | | | | | | | |
| Not aware | 14 | 31.11 | 21 | 30.88 | 4 | 4.76 | 39 | 19.80 |
| Somewhat aware | 5 | 11.11 | 6 | 8.82 | 11 | 13.10 | 22 | 11.17 |
| Aware | 10 | 22.22 | 15 | 22.06 | 33 | 39.29 | 58 | 29.44 |
| Very aware | 16 | 35.56 | 26 | 38.24 | 36 | 42.85 | 78 | 39.59 |
| Total | 45 | 100.00 | 68 | 100.00 | 84 | 100.00 | 197 | 100.00 |
| *Frameworks (Structured instruments for managing construction claims)* | | | | | | | | |
| Not aware | 39 | 87.00 | 59 | 87.00 | 46 | 54.76 | 144 | 73.10 |
| Somewhat aware | 1 | 2.00 | 4 | 6.00 | 9 | 11.00 | 14 | 7.11 |
| Aware | 2 | 4.00 | 2 | 3.00 | 12 | 14.00 | 17 | 8.62 |
| Very aware | 3 | 7.00 | 3 | 4.00 | 17 | 20.24 | 22 | 11.17 |
| Total | 45 | 100.00 | 68 | 100.00 | 84 | 100.00 | 197 | 100.00 |

### *4.2.2 Level of Awareness of the Frameworks (Structured Instruments for Managing Construction Claims)*

In examining the level of awareness of the stakeholders of the frameworks as a practice, owners, contractors and consultants were asked to indicate their level of awareness of the frameworks. Table 2 shows that 13% of the clients were aware of the frameworks at classed levels as a practice for managing construction claims. The general point of view of the respondents shows that 13% of the contractors were aware of this practice at various levels. In the case of the consultants, 45.20% of them were aware of this practice at classified levels. The general view of the respondents indicates that 26.90% of them were aware of this practice at diverse levels. The analysis shows that consultants have the highest level of awareness of the framework as a practice in managing construction claims (approximately 45%). A further analysis was performed using the Kruskal-Wallis K-test to examine whether respondents differed in their perception based on their type of organisation (clients, contractors and consultants). An asymptotic significance value of 0.248 was generated, which is greater than 0.05. This result implies that there is no significant difference among the groups of respondents in this aspect of the study. This finding also confirmed statistically that the results of the descriptive analysis are reliable.

### *4.2 3 Level of Usage of Construction the Claims Management Process*

This section examines the level of usage by the respondents who were aware of

the construction claims management processes as a practice. In assessing this aspect of the study, the respondents who were aware of the existence of construction claims management processes were asked to rate the practice according to their level of usage. As shown in Table 3, 80.64% of the clients used the construction claims management process at various levels. The analysis also shows that 78.52% of the contractors used this practice at various levels, and 80.00% of the consultants used this practice at classified levels. The general opinion of the respondents indicates that 79.70% of them used this practice at varying levels, which is 64% of all respondents. Thus, clients used the construction claims management process most among the three groups, with approximately 81% of them aware of this practice at various levels. A further analysis was conducted using the Kruskal-Wallis K-test to examine whether respondents differed in their perception based on their type of organisation (clients, contractors and consultants). An asymptotic value of 0.093 was generated, which is greater than 0.05. This finding indicates that there is no significant difference in the opinions of the respondents regarding the use of the construction claims management process and confirms that the results of the descriptive analysis can be relied upon statistically.

### *4.2.4 Level of Usage of the Frameworks (Structured Instruments for Managing Construction Claims)*

The respondents who were aware of the existence of the frameworks were asked to rate this practice according to their level of usage. As shown in Table 3, 83.33% of the clients used the frameworks at varying levels. In addition, 77.78% and 78.95% of the contractors and consultants used this practice at diverse levels, respectively. The general opinion of the respondents shows that 79.25% of the respondents used the frameworks at varying levels, which is 21% of the total respondents. The results also indicate that clients used the frameworks most among the three groups, with 83% of them aware of the frameworks at various levels.

To analyse the level of usage of the frameworks, the Kruskal-Wallis K-test was performed to examine whether respondents differed in their perception based on their type of organisation (i.e., clients, contractors and consultants). An asymptotic value of 0.171 was generated, which is greater than 0.05. This finding indicates that there is no significant difference in the opinions of the respondents regarding the level of usage of the frameworks. Therefore, it can be concluded that the three groups concur on this aspect of the study.

**Table 3. Level of Usage of Existing Construction Claims Management Practices.**

| Practice | Clients | | Contractors | | Consultants | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | Freq. | % | Freq. | % | Freq. | % | Freq. | % |
| *Construction claims management process* | | | | | | | | |
| Not used | 6 | 19.36 | 10 | 21.28 | 16 | 20.00 | 32 | 20.25 |
| Somewhat used | 2 | 6.45 | 7 | 14.89 | 4 | 5.00 | 13 | 8.23 |
| Often used | 7 | 22.58 | 11 | 23.40 | 18 | 22.50 | 36 | 22.78 |
| Always used | 16 | 51.61 | 19 | 40.43 | 42 | 52.50 | 77 | 48.74 |
| Total | 31 | 100.00 | 47 | 100.00 | 80 | 100.0( | 158 | 100.00 |
| *N = 158* | | | | | | | | |
| *Frameworks (Structured instruments for managing construction claims)* | | | | | | | | |
| Not used | 1 | 16.67 | 2 | 22.22 | 8 | 21.05 | 11 | 20.75 |
| Somewhat used | 1 | 16.67 | 1 | 11.11 | 4 | 10.53 | 6 | 11.32 |
| Often used | 1 | 16.67 | 2 | 22.22 | 9 | 23.68 | 12 | 22.64 |
| Always used | 3 | 50.00 | 4 | 44.45 | 17 | 44.74 | 24 | 45.94 |
| Total | 6 | 100.00 | 9 | 100.00 | 38 | 100.00 | 53 | 100.00 |
| *N =53* | | | | | | | | |

### *4.3* Assessment of the Participant's Effectiveness in the Use of the Construction Claims Management Process

In assessing the effectiveness of the use of construction claims management sub-processes, clients, contractors and consultants were asked to indicate their level of effectiveness in the use of the construction claims management process. From the clients' perspective, they are most effective in the documentation sub-process, with a mean value of 3.29, whereas they are least effective in the examination sub-process, with a mean value of 2.90, as shown in Table 4. Contractors rated identification, with a mean value of 3.24, as their most effective sub-process. From consultants' points of view, they are most effective in the evaluation sub-process, with a mean value of 3.08. Clients and contractors unanimously agreed that they are least effective in the use of the examination sub-process, with a mean value of 2.90 and 2.76, respectively. These findings are in contrast to the view of the consultants, who opined that they are least effective in the use of the negotiation sub-process, with a mean value of 2.79.

The general view of the respondents reveals that they are most effective in the use of the evaluation sub-process, with a mean value of 3.11, followed by the documentation sub-process, with a mean value of 3.10. The respondents are least effective in the use of the examination sub-process, with a mean value of 2.79. The least effective sub-process is examination, with a mean value of 2.79 out of the maximum 4.00 point Likert scale used, indicating that

they are above the average level of effectiveness in the use of each sub-process and implying that all the participants are effective in the use of all sub-processes. This result may foster successful construction claims management in Nigeria.

The Kruskal-Wallis K-test was performed to determine whether the respondents differed in their general perception based on their type of organisation (i.e., clients, contractors and consultants). The analysis yielded an asymptotic value of 0.134, which is greater than 0.05. This finding indicates that there is no significant difference among the respondents in their overall ratings of their effectiveness in the use of the construction claims management process and confirms that statistically, the overall results of the descriptive analysis can be relied upon in this aspect of the research.

**Table 4. Assessment of the Effectiveness in the Use of Construction Claim Management Sub-Processes**

| Construction claims management process | Client | | Contractor | | Consultant | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | MS | Rank | MS | Rank | MS | Rank | MS | Rank |
| Evaluation | 3.04 | 5 | 3.18 | 2 | 3.08 | 1 | 3.11 | 1 |
| Documentation | 3.29 | 1 | 3.16 | 3 | 2.96 | 3 | 3.10 | 2 |
| Identification | 3.13 | 2 | 3.24 | 1 | 2.83 | 4 | 3.04 | 3 |
| Presentation | 2.91 | 6 | 3.04 | 5 | 3.03 | 2 | 3.01 | 4 |
| Negotiation | 3.09 | 3 | 3.15 | 4 | 2.71 | 7 | 2.95 | 5 |
| Notification | 3.07 | 4 | 2.99 | 6 | 2.79 | 5 | 2.92 | 6 |
| Examination | 2.90 | 7 | 2.77 | 7 | 2.76 | 6 | 2.79 | 7 |
| *Average* | *3.06* | | *3.08* | | *2.88* | | *2.99* | |

### *4.4 Test of the Hypothesis*

#### *4.4.1 Effectiveness of the Clients, Contractors and Consultants in the Use of Each Sub-Process of Construction Claims Management*

The Kruskal-Wallis K-test was performed to examine whether respondents differed in their perception on the effectiveness of the use of each sub-process of construction claims management based on their type of organization (i.e., clients, contractors and consultants). This analysis was performed to assist in decision making with respect to the null hypothesis.

**The Null Hypothesis:**

**$H_0$1**: There is no significant difference among the perceptions of clients, consultants, and contractors on their effectiveness in the use of each construction claims management sub-process.

The results of the Kruskal-Wallis K-test (Table 5) indicate that the asymptotic value for two sub-processes is 0.000, whereas the p-value of four sub-processes is less than 0.05, which implies that there are significant differences in the perceptions of the respondents in respect to six out of seven sub-processes. Hence, the null hypothesis is rejected, which implies

that there are significant differences among the perceptions of the clients, contractors and consultants on their effectiveness in the use of construction claims management sub-processes.

**Table 5. Perceptions of the Clients, Contractors and Consultants on Their Effectiveness in the Use of Construction Claims Management Sub-Processes.**

| Process | Overall rating | | Chi-square value | Kruskal-Wallis sig. p | Remark |
|---|---|---|---|---|---|
| | MS | Rank | | | |
| Evaluation | 3.11 | 1 | 4.805 | 0.187 | No Significant Difference |
| Documentation | 3.10 | 2 | 10.285 | 0.016* | Significant |
| Identification | 3.04 | 3 | 15.153 | 0.002* | Significant |
| Presentation | 3.01 | 4 | 10.285 | 0.015* | Significant |
| Negotiation | 2.95 | 5 | 21.724 | 0.000* | Significant |
| Notification | 2.92 | 6 | 12.615 | 0.006* | Significant |
| Examination | 2.27 | 7 | 32.679 | 0.000* | Significant |

### *4.5 Discussion of the Results*

#### *4.5.1 Level of Awareness of Existing Construction Claims Management Practices*

Concerning the two identified practices for construction claims management, it can be concluded that consultants are most aware of the construction claims management process and structured instruments for managing construction claims (frameworks) among the three groups, possibly due to their professional exposure and higher educational background compared with other groups. This finding corroborates the assertion of Kululanga et al. (2001), who stated that Malawian contractors were not aware of the organised practice for construction claims management. In contrast, in a similar study in Thailand, Chovichien and Tochauwat (2014) concluded that construction companies' representatives were not aware of the claims management process.

#### *4.5.2 Level of Usage of Existing Construction Claims Management Practices*

Concerning the two identified practices for construction claims management, clients are best able to use construction claims management processes and frameworks among the three groups, possibly because the clients handle the largest number of building projects among the three groups. In support of this finding, Enshassi et al. (2009), in a similar study in Palestine, concluded that the staff of the clients and contractors does not understand the issues involved in the use of the construction claims management process. On a general note, stakeholders used construction claims management processes rather than frameworks. This result is in support of Kululanga et al. (2001), who concluded that some practitioners have used the construction claims management process, whereas their exposure to the framework is not widely known in the literature. This

finding corroborates the assertion of Enshassi et al. (2009), who noted that claims in Palestine are managed through the construction claims management process, with the objective of resolving certain difficult task effectively and efficiently.

### *4.5.3 Effectiveness of the Clients, Contractors and Consultants in the Use of Construction Claims Management Sub-Processes*

The findings indicate that among the seven sub-processes for construction claims management, the clients are most effective in the documentation sub-process, possibly because the clients are more interested in the documentation submitted by the contractors in support of their claims. Chovichien and Tochaiwat (2005) noted that public clients have high efficiency in assessing the documentation of changes because they have more power to access the information from their contractors. Contractors are most effective in the identification sub-process among the seven sub-processes for construction claims management. Chovichien and Tochaiwat (2005) stated that contractors can easily identify changes in their work because they are so close to the project progress and can notice the changes occurring. In contrast, consultants are most effective in the evaluation sub-process among the seven sub-processes for construction claims management, possibly because consultants (architects and quantity surveyors) are solely responsible for the evaluation of claims submitted by contractors. Verster (2006) stated that evaluation is claims adjudication, including checking the validity of claims and complying with contractual terms and the possible outcome, which is the amount to be paid to the claimant.

The overall view of the respondents reveals that stakeholders are most effective in the use of the evaluation sub-process among the seven sub-processes for construction claims management. This result is in support of Aibinu's (2008) assertion that in the process of administering claims, the claims certifiers are expected to form an opinion on the authenticity of the contractor's claims and to make recommendations about the evaluated quantum of the contractor's entitlements.

## 5. Conclusion and Recommendation

Construction claims management practices were appraised with a view of determining the existing practices in Nigeria. The findings of this research should be interpreted in the context of construction in the area of study. Each geographical location has its own local construction culture, social-economic factors and political background that will determine its practices. The findings from the analyses show that the two major practices for managing construction claims in the area of study are the use of the construction claim management process and frameworks (structured instruments for managing construction claims). The results of the research further indicate that among the three groups, owners are the best at using the construction claim management process and frameworks, whereas contractors are the worst. These findings may be due to the owners' exposure to the largest number of construction projects among the three

groups. Generally, 64% of the respondents have used the construction claims management process at varying levels, and 21% of the respondents have used frameworks at modifying levels, while the remaining 15% of the respondents have not used either of the two practices. These results imply that the participants use the construction claims management process more than the frameworks.

In addition, the research findings reveal that among the seven sub-processes, owners are most effective in the documentation sub-process, possibly because clients were interested in the documents submitted by contractors in support of their claims, while the contractors viewed identification as their most effective sub-process. The overall view of the respondents concurred with that of the consultants – they were most effective in the use of the evaluation sub-process among the seven sub-processes for construction claims management. To improve the participants' level of usage of the frameworks as instruments for construction claims management, adequate and proper sensitization should be realized by government agencies and professional bodies, which can encourage the use of innovative methodologies by participants, such as frameworks. These measures will also ensure efficient construction claims management practices and will reduce or eliminate the cost of litigation that usually results from disputed construction claims. These data were collected from respondents involved in construction projects executed by a state government, and thus, these findings can be extended to projects performed in other states in Nigeria. Future research can also focus on construction claims management practices considering construction projects procured through partnering and public private partnerships.

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# A Review of the Effects of Sick Building Syndrome on Property and the Occupants

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***Abstract***: Sick Building Syndrome (SBS) is a situation where occupiers of a particular building complain of severe health problems or discomfort and get relieved shortly after leaving such a building. It is an issue that has been on for almost four decades now and has implications on the value of a building as well as its occupants. In this study, a comprehensive systematic review of paper published in journals and conference proceedings in the area of sick building syndrome was carried out. This was done to harmonise and also provide a comprehensive literature review of the previous research efforts on the types, causes, effects and remedies to issues relating to sick building as it affects the occupants and property value. The review concluded that many have health issues as a result of the building they occupy either as an office or residence. Likewise any building tagged 'sick' may not recover from the stigma, even after remediation.

***Keywords***: Sick Building, Syndrome, Property, Occupants, Health Problem, Discomfort

## 1. Introduction

According to Rostron (2008), "Sick building syndrome (SBS) is recognised by the World Health Organization as 'a syndrome of complaints covering nonspecific feelings of malaise, the onset of which is associated with occupancy of certain modern buildings".

In the early 1980's, the term 'Sick Building Syndrome (SBS) was introduced as "building sickness" by a

Canadian tobacco consultant named Theodor D Sterling. "Tight building syndrome" was used to describe the same phenomenon by his counterparts. It was believed that sick building syndrome was not caused by smoking, but inadequate ventilation. This may be close to the truth as the energy conservation of the 1970's resulted in sealing up of buildings to reduce energy consumption, reduction of air flow into the buildings, increased use of chemicals in carpet and paint, poor lighting, increased use of computers, including high level of stress in the workplace (Edmund, 2017). Sick building syndrome became a household name in 1985, when it was associated with Legionnaire's Disease (a form of pneumonia which was first noticed in an air conditioning system in an hotel in Philadelphia during a conference). Gray Robertson and associates at Air Conditioning and Ventilation associates (ACVA) which was later renamed Healthy Buildings International (HBI) identified bacteria in an air conditioning system. This gave rise to the term "Sick Building Syndrome" in order to support the false impression about the effects cigarette smoke on secondary smokers. The effects of volatile organic compounds in artificial rugs, photocopier emission and so on were overstated because the experiment and the publications were financed by the cigarette industries. The air conditioning companies sponsored the ACVA mission as they promote their product by recommending very expensive air conditioning system in offices and popularised "Sick Building Syndrome" (Sourcewatch, 2017). It has been used interchangeably with other terms like 'Indoor Air Quality Syndrome', 'Closed Building Syndrome' and 'Tight Building Syndrome'. Sick building does not necessarily mean that the building is diagnosed for a particular ailment, but a situation where occupiers of a particular building complain of severe health problems or discomfort and get relieved shortly after leaving such a building. There is no particular source of the ailment or traceable cause. Most of the time the effects of sick building is short-lived, but some symptoms can persist. The symptoms may be peculiar to an apartment or region, or may be predominant in a building. On the contrary, when the ailment is diagnosable and the signs are acknowledged, it is referred to as "Building Related Illness" (BRI) (United States Environmental Protection Agencies, 1991). The major contaminants/ pollutants resulting in sick building syndrome are: formaldehydes, dust mites, cigarette smoke, VOCs (Volatile Organic Compounds), mold and pollen (Edward, 2015). The common symptoms are: nausea, itching eyes, watery nose, nose bleeding, weakness, fatigue and so on.

According to the report of a World Health Organization Committee (1984), it was discovered that globally, three out of ten new and renovated buildings may likely have issues of indoor air quality (IAQ). It can be associated with poor maintenance, conversion of building from the original plans, poor design or sometimes indoor air problems as a result of activities in the building

(Seltzer, 1994). Another essential aspect likely to be affected by sick building is the occupants' health and the property value. Investors in real estate always seek to maximize profit while minimizing risk. Investment in real estate is capital intensive, therefore, investors as well as the property managers must guaranty that the investment is in good condition in order to achieve investment objectives which are to: preserve capital, enhance capital value and secure maximum returns (Emoh, 2004). Hence, property managers should ensure that investment in property continues to command value and at the same time, the occupants must have value for their money. It is based on this foregoing that this study seeks to investigate the effect of sick building syndrome on occupants' health and property.

## 2. Literature Review

Sick Building Syndrome has been an issue for almost four decades. It was as a result of energy conservation that led to closing up of buildings to prevent energy loss and reduce cost of energy consumption in addition to intensive use of upholstery, computers, photocopiers, air conditioners, carpets and wallpapers (Fotoula, 2011). There has been few research efforts conducted on Sick Building Syndrome /Building Related Illness around the world, even moreso in Nigeria where there exist a paucity of research. For instance, the work of Joshi (2008) identified problems associated with sick building syndrome in 206 buildings. It was discovered that 18 % were toxic element from indoor of the office space; these elements include; methyl alcohol from an old photocopy machine, methacrylate from a copier, sulfur dioxide from a heating system, amines used in a humidification system, chlordane used as a pesticide. 10% of the buildings got exposed to pollutants from outdoors such as dust, exhaust. 3% of the buildings were contaminated as a result of the type of building materials used (formaldehyde, fiberglass), while 48% suffered symptoms as a result of poor ventilation and 3% experienced problems due to the biological contaminants in the environments.

In Malaysia, Yau, Chew and Shaifulla (2012) researched on four pharmaceutical companies to determine workers` comfortability in such laboratories. It was discovered that two out of four laboratories had high levels of Volatile Organic Compounds (VOC) which can impair health of the workers in such buildings, while the air conditioning systems provide thermal comfort to the occupants.

Ogunde, Amusan, Tunji-Olayeni, Obembe, Adekeye (2015) carried out a collaborative research as a building technologist with Micro Biologists to examine the stains on the wall. The purpose of the research is to determine whether micro-organisms are present in wall stains. The researchers collected samples from the affected walls which were taken for analysis. It was revealed that active microbes such as staphylococcus aurens, Bacillus spp, and Pseudomonas spp (bacteria), Aspergillus Flavus, Mucor, Penicillium spp, and Cladosporium spp (fungi) were present in the

samples. These microorganisms were found growing on cracks in the walls and wooden parts of the building and the researchers concluded that these microbes are injurious to the health of the occupants and are responsible for sick building syndrome.

According to the World Health Organisation (2009), three out of ten newly-built or redeveloped buildings suffer Sick Building Syndrome or Building Related Illness (BRI) as the case may be. This determines productivity, absenteeism and general well-being of workers, invariably reduce productivity of an organization and as such incur more cost (Burge, 2004). According to the National Institute for Occupational Safety and Health, SBS is better referred to as 'Indoor Air Quality', and is was said to occur if two out of ten workers in an office space report symptoms like watering eyes, hoarseness and headaches. Other symptoms include dry itchy skin; dizziness; nausea; heart palpitations; miscarriages; shortness of breath; nosebleeds; chronic fatigue; mental fogginess; tremors; swelling of legs or ankles; and cancer. Provided the symptoms subside when they are away from the building, Joshi (2008). Meanwhile human beings react to stimulus differently, while in some the symptoms disappear immediately, after leaving such building, while this linger in others. Hence, this makes it difficult to determine the cause of the symptoms. (Sarafisa, SotIrIadoub, Dallasc, Stavrakakisd, Chalarise, 2010).

## 2.1 Types/Categories of Sick Building Syndrome (SBS)

Building associated disease can broadly be categorized into two, namely Sick Building Syndrome (SBS) or Tight Building Syndrome (Non -specific) and Building-related Illness (specific).

### 2.1.1 Sick Building Syndrome (SBS) or Tight Building Syndrome (Non - specific)

The term Sick Building Syndrome (SBS) does not connote a building diagnosed of an ailment but a phenomenon used to describe a situation where the occupiers of a particular building experience ill health or acute discomfort that subside sooner or later after leaving the premises (Burge, 2004; Abdul-Wahab, 2011). The symptoms can be limited to a particular section of a building, the whole building or a particular zone. It is a universal problem and occurs more frequently in, but is not limited to air conditioned environments, public places (hospitals, schools, departmental stores, library etc.), residential buildings and factories with heavy equipment (Molina, Pickering, Valbjbrn and DE Bortoli, 1989). It is reported that on the average human beings spend hours indoors daily. The common symptoms are: headache, skin rashes, running nose, watery eye, lethargy, tiredness and so on. It is referred to as sick building syndrome / Indoor air tight when symptoms is not traceable to any causal factor.

### 2.1.2 Building-related Illness (specific)

This is when the symptoms of a diagnosable illness are identified and attributed directly to airborne building contaminants (Seltzer, 1994;

Purusottam, 2001; Abigail, 2018). According to Seltzer (1994), building-related illnesses refers to reasonably well characterized human illnesses caused by indoor environmental factors that can be related to the clinical and laboratory findings in those building.

## 2.2 Causes of Sick Building Syndrome

Several researchers have worked on the subject of 'Sick Building Syndrome' and associated factors are identified.

### *A. Poor Ventilation*

This occurs when the quantity of fresh air from outdoors allowed indoor is inadequate to neutralize the indoor polluted air. It could also be as a result of poor air circulation of heating, ventilation and air conditioning systems (HVAC).This can be as a result of energy conservation, poor design or change of use of a building (Joshi, 2017). Poor ventilation in air-related problems in buildings such as headache, running nose, dizziness, fatigue, shortness of breath, cough, irritation (nose, eyes, throat, Skin) and sometimes nausea (EPA, 2012).

### *B. Chemical Contaminants from Indoor Sources*

This is as a result of exposure of the building occupants to some chemicals or materials containing volatile organic compounds (VOCs), smoke either from tobacco or incomplete combustion of fuel (from sources such as kerosene stove, gas stove, wood stove) or other toxic compounds. Examples are pesticides, carpeting, paints, cleaning agent, upholstery and so on.

Chemical Contaminants from Outdoor Sources; - Incomplete combustion of fuel from vehicular exhaust or generators, nearby factories and so on.

### *C. Biological Pollutants*

Presence of stagnant water in the air conditioning duct, humidifier, drain pans or blocked drainage could give room for breeding of pathogens such as bacteria, molds, pollen, viruses and animal dungs from pet or domestic animals (EPA, 2010, Joshi, 2017).

Biological pollutants cause fever, joint pain, cough, panting and allergic symptoms. Contagious diseases spread easily and faster in a confined environment such as Legionnaire's disease caused by legionella microbes (Breiman, 1992).

### *D. Electromagnetic Radiation*

Appliances such as microwaves, televisions and computers emit electromagnetic radiation, which ionizes the air. Extensive wiring without proper grounding also creates high magnetic fields, which have been linked to cancer.

### *E. Psychological Factors*

i. Frustration, poor interpersonal relationships and poor communication are often seen to be associated with SBS.
ii. Poor and inappropriate lighting with absence of sunlight, bad acoustics, poor ergonomics and humidity may also contribute to SBS.
iii. The nature of particular jobs also can be associated with SBS. Low cadre workers or people with menial job are more susceptible, (Redlish, 1997)
iv. Gender can be another factor. 'Females experience the SBS

symptoms more than their male counterparts', this may be as a result of their sensitivity to contaminants.

v. SBS is more pronounced in confined buildings than in public places (Finnegan, Pickering, Burge)

Many people have abandoned their property, left their job, and destroyed their properties as a result of SBS or Building Related Illness, (Shayla, 2018). It is therefore imperative to educate people especially real estate investors, tenants, property developers, Estate surveyors and valuers, facility managers, property agents and the public on the causes of SBS or BRI, its effects and the remedies.

***F. Lighting***

There is a generally accepted indoor lighting standard according to the Chartered Institution of Building Services Engineering (1994). The importance of indoor lighting is to provide illumination that enables safe movement, aid productivity and enhance appearance. Excess or inadequate lighting could result in eye itching, eye discomfort, eye strain and tiredness (Rostron, 2008).

2.3 Effects of SBS on the Occupants and the Property

***G. Hygrothermal Factor***

These include temperature, humidity and air flow. The interactive effect of these elements produces Indoor Air Quality. Thermal effect of naturally ventilated spaces produces better satisfaction than air conditioned rooms (Rostron, 2008).

***2.3 Effects of SBS on the Occupants and the Property***

The effect of SBS has been a serious issue especially to the affected people and has serious repercussions. This includes:

1. Reduction of productivity - According to Tong (as cited in Rostron, 2008), most of the people affected report that their productivity level has reduced to 80%.
2. Increased absenteeism.
3. Increased cost on the part of employer in case of litigation against them from the sufferer.
4. Lack of dedication and commitment on the part of employees.
5. Replacement of building elements that require remediation - such as air conditioning system ceiling, walls, windows, fittings and fixtures may require serious remediation attract additional cost.
6. Demolition may be the only option to correct the effect of SBS (Goldman as cited in Rostron, 2008). For instance, The Inland Revenue gave up 19-storey building for demolition in Bootle, Merseyside in 1995 as a result of 1,000 staff suffering from SBS in the space of five years.

**2.4 Remedies/ Preventions**

Facilities managers play a dual role in prevention of SBS as the agent of both the property own and the occupants. According to (Redman, Hailton, Malloch and Kleymann, 2010). ……"Treatment of SBS involves both attention to the people….and the building itself. Both of these

aspects……., are all too often ignored by managers"

According to the EPA (1991), Rideout (1995), Rostron (2008) and Fotoula (2011), the following are the ways through which Sick Building Syndrome can be controlled or prevented:

1. Removal or amendment of the source of contamination. For instance, periodic cleaning of HVAC (Heating, Ventilation Air Conditioning) systems or replacement of old filters.
2. Stained ceiling and carpet as a result of leakages should be replaced.
3. Smoking should be restricted to a designated area.
4. Noxious odours from indoor should be expelled outside through vents.
5. Chemicals such as paints, adhesives, solvents, and pesticides should be kept in a well-ventilated area.
6. Chemicals with low VOC should be encouraged or use of chemicals should be done during void period.
7. New or refurbished buildings should not be occupied immediately to allow contaminated gas to escape from the building.
8. Increase in air circulation and distribution to local standards should be encouraged.
9. HVAC systems should be operated to designed standards and to ASHRAE Standard 62-1989 if possible.
10. Local exhaust ventilation is an option in removal of contaminant gases in specific areas such as rest rooms, copy rooms, and printing facilities.
11. Ventilation and particles control could be aided with the use of air cleaning, this can require additional cost in order to be applied effectively.
12. Education and communication are important elements in both remedial and preventive indoor air quality management programs. When building occupants, management, and maintenance personnel fully communicate and understand the causes and consequences of IAQ problems, they can work more effectively together to prevent problems from occurring, or to solve them if they do.
13. HVAC systems must be properly maintained regularly.
14. Adequate ventilation must be ensured to allow free air flow from outdoor to neutralize the contaminated air indoor.
15. Use of chemicals indoor should be minimized and where necessary, there must be adequate air supply.
16. Products with low content of Volatile Organic Compound should be adopted e.g. carpet, furniture, paint etc.
17. Sources of indoor air should be located far from contaminants.
18. Estate managers must ensure routine inspection and prompt repairs where necessary, such as leaking roof.
19. The installation of building elements such as air conditioning systems should be done to

encourage easy cleaning and maintenance.

20. Systems should be installed properly to avoid early break down.

### 2.5 Implications of Sick Building Syndrome on the Property and the Occupants

- Litigation: Selling a property with mold may attract a serious penalty, therefore it should not be handled with levity.
- Drop in property value: Mold problem in a property reduces its market value. It is obvious that most times, mere sight of mold in a building is enough to drive away prospective buyers even with promises of remediation. This reduces marketability of such property and prolongs void period in rental properties.
- Cost Implication: Any property with sick building syndrome attracts additional cost of repairs and maintenance. This in a way reduces the income on such investment.
- Total loss: Many home owners have abandoned their properties, while many quit their job as a result of sick building syndrome to recover from the symptoms.
- Health Issues: The effect of sick building syndrome may impact the health of the occupants negatively which they may live with for the rest of their life, (Bill, 2013, Abdul-Wahab, 2011, Rostron, 2008).

## 3.0 Recommendations

Based on the findings from literature, the following recommendations were made:

- Routine inspection and proper maintenance culture must be imbibed by the property owner or the real estate agent to reduce rate of depreciation of a property and to preserve property value.
- There should be orientation about sick building, as most human activities result in sick building syndrome such as: smoking of cigarette, inappropriate use of chemicals, and use of materials with high VOCs.
- Materials with low VOCs should be encouraged such as rug, paint, upholstery and so on.
- Natural air is more preferable to conditioned air, therefore indoor ventilation should be standard especially in offices

## 4.0 Conclusion

It is obvious that sick building is not just a phenomenon but its effects are glaring and proven by researchers globally. The effects of SBS is not limited to discomfort of the sufferer, reduced productivity, increase in absenteeism, wasting of productive time and resources in attending to issues relating to complaints of the affected staff. Moreso, any building tagged ‘sick’ may not recover from the stigma, even after remediation (Tong, 1991; Rostron, 2008).

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# An Evaluation of the Appropriateness of Methods of Valuing Residential Properties in Sub-Urban Areas of Ondo State, Nigeria

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***Abstract***: The study examined the approaches often adopted for the valuation of rural residential properties of Nigeria using Ugbe and Arigidi Akoko areas of Ondo State, Nigeria as the case study. The study was set out to determine which of the method(s) of valuation is the most appropriate for valuing residential properties in rural areas in the developing economy such as Nigeria. To achieve the aim of the study, the physical inspections of two residential properties were carried out, one in Arigidi Akoko and Ugbe Akoko in Ondo State. The data collected via the inspections were used in calculating the values using different methods. The study reveals that of all the methods of valuation, investment method is the most appropriate because the value derived is a function of the rent. Comparative method is inappropriate because property rarely changes hand in the rural areas while the cost method jack up property values to a level that the market cannot support. The figure of year's purchase which is a multiplier is difficult to calculate because the yield which determines the years purchase is a function of analysis of sales transaction which is rare. There is little difference in construction cost in rural and urban areas whereas values between the two show wide disparity. The study recommends even distribution of projects by governments, organisations, religious bodies etc. Development projects act as catalyst which speeds up the rate of development which brings about influx of people thereby resulting in upward movement of rent and property values.

***Keywords***: Valuation, residential properties, Arigidi Akoko, Ugbe Akoko, Ondo State

## 1. Introduction

Among the attributes of landed properties is fixity of location. It is one of the unique characteristics of real estate. Estate Surveyors and Valuers being the only professional legally recognised to carry out the valuation of such properties for various purposes, are more often than not commissioned to undertake the exercise in whatever location; urban, semi urban and rural. Values of properties are directly related to the location of such properties as corroborated by Knaap (1998) who observes that location of property and value are strongly interrelated.

Ogunba (2013) describes valuation of landed property or real estate appraisal as a process of establishing an opinion of value for an interest in landed property/real estate. The Royal Institute of Chartered Surveyors (2006) describes valuation as 'a professional individual's opinion of the capital or rental price or value of a property on a defined basis'. Valuation according to Millington (1982) can be defined as the estimation of the monetary worth of an interest in landed property for a specific purpose and at a particular point in time having in mind all the features of the property and the underlying economic factors of the property market with the range of alternative investments. Ajayi (1998) citing Baum and Crosby (1988) describe valuation as 'the estimation of the open market value or the prediction of the most likely selling price'. Analysis refers to the 'estimation of worth to an individual'. It may be expressed as a price or alternatively a rate of return on outlay necessary to secure the acquisition of an investment property. Appraisal covers both aspects. It is 'an assessment of a particular property's potential cash flow to determine the suitability (at any given price) to a particular investor or purchaser. It should closely predict selling price or assess worth to an individual correctly. Baum and Mackmin (1989) describe valuation as 'The art or sciences of estimating the value of interests in property. International Valuation Standard (2011) views valuation as the estimated value (valuation conclusion) or to refer to the preparation of the estimated value (the act of valuing). Richmond (1985) defines valuation as the estimation of the capital or rental value of land and / or buildings at a certain time. An estate surveyor and valuer will need to know the purpose for which the valuation is required and the intentions and circumstances of the client or employer on whose behalf it is being prepared. This information is essential, because it will affect the calculation of value. Ifediora (1993) explain valuation as both an art and science that solve problems by undergoing rational and measured investigation and reasoning, in addition to the systematic collection and analysis of data and the application of the result to reach a conclusion or decision. Wikipedia defines property valuation or land valuation as the process of developing an opinion of value, for real property

which is usually market value. The American Institute of Real Estate Appraisers (AIREA) equates valuation to appraisal which can be described as an estimate, an opinion of property values. In the opinion of Babcock (1963), he views valuation as appraisal which is 'The determination of the monetary value, at some specific date, of the property rights encompassed in an ownership' Real estate transactions often require appraisal because they are carried out infrequently and every property is unique (especially their condition a key factor in valuation), unlike corporate stocks which are traded daily and identical. However, location also plays a key role in valuation. However, since the property cannot change location, it is often the upgrades or improvement to the home and the environment that can change its value.

## 2. Purposes and Methods of Valuation

Prior to the consultation of an Estate Surveyor and Valuer to carry out valuation of a landed property, a client must have it in mind the purpose of that valuation exercise. Aluko (1999) describe purpose as the client's objective of the valuation exercise; and, this determines what value is to be sought. It will also assist the valuer to determine the appropriate basis and method(s) of valuation to be adopted. As soon as a valuation purpose is ascertained, it makes no difference to the valuer what use the client makes of the value conclusion. There are different purposes or reasons of carrying out a valuation exercise. A single property may have a whole range of different values at a particular moment depending on the purposes of valuation. The purpose of valuation determines the method of valuation. Purposes of valuation include for sale, purchase, rent determination, mortgage, insurance, compulsory acquisition, betterment and worsement charges, balance sheet, probate, acquisition and merger, rating, going concern etc.

Ajayi (1998) opine that there are five standard methods of valuation recognised by most standard textbooks. The methods include: comparative method, investment method, profit method, contractors (cost) method and residual method. This is the traditionally method of classification in the United Kingdom. Both the residual method and cost method would be grouped in the United States under the cost approach. International Valuation Standard framework recognises three approaches in arriving at the valuation figure defined by the appropriate method of valuation. These are sales comparison approach; cost approach; and income approach. They are all based on the economic principles of price equilibrium, anticipation of benefits or substitution. In most cases, the valuer needs to apply two or more methods for crosschecking purpose.

Comparative method is based on noting similarities and the differences with a view to determining appropriate value for the property in question. It is based on comparison of like with like and reliable when properties are: similar and are in the same area; there are sufficient records of many transactions which are fairly recent; the property market is stable; the

underlying economic factors underlying the pattern of prices in the property market must be studied; and the properties should have similar income flows. Two properties are hardly similar but each property is unique because of architectural design and style; age and condition; amount of floor space; number and arrangement of rooms; size of plots; position; tenure; purpose and time. The method is limited in application because of special characteristics of each property and the hindrance these pose in adopting the method.

The investment method is applicable in some properties where ownership and occupation are separated. The properties are for residential, industrial, commercial etc. The properties are majorly occupied under a contract by the occupier in return for the rent paid to the owner. This is attractive for those who wish to invest capital and obtain a return thereon and the property market is a major source of such investment opportunities. The value is a function of the rent which an occupier is ready to pay in return for occupation and the level of return an investor would require on his capital. Thus, the present capital value (CV) is derived from a future income flow (Y) i.e. CV = f(Y). The equation appears simple but in the real sense of it is complex because of a number of independent, yet intricately interwoven factors such as the present and future income, the expected return on the particular investment, the strength of tenant's covenant, the lease terms and the tenure of the property determine the capital value. Various inputs in the model such as the net income, the full rental value, taxation and capitalisation rates need to be understood before the mechanics of the equation is appreciated.

The contractors method is applied in determining the value of property by reference to the cost of replacing or producing an acceptable substitute. The method comes handy in valuing some properties which are used for special purpose to meet specific requirements which are outside the general range of commercial and residential uses e.g. churches, town halls, schools, police stations, hospitals, fire stations, chemicals and oil plants. These types of properties hardly change hand in the property market. Therefore, there are neither investment market activities nor comparable to draw inferences from. They are referred to as no market properties. The approach consists of: estimating the replacement cost of the building; deduct allowances for age and obsolescence; add the value of land thereon. This produces a total figure which represents the value of land and building.

The profit test or account method is used to value properties used for productive trade and do not change hands very often to generate market evidence. Examples of such properties include hotels, restaurants, cinemas, theatres etc. They scarcely have, if any, market comparison with other properties and are not commonly available for sale in the market. Therefore, the value of business carried out in the property provides a basis for determining the return, in rental terms, due to the property. The process of valuation involves:

estimating the gross earnings of the business for which the property is used; deduct the working expenses of production including interest on capital, if any, assumed provided by the tenant and remuneration for tenant's risk; the residue called divisible balance is the income due to land and building and return to tenant or owner. The applicability of this method depends on accurate and detailed account of business.

The residual method is used to value property with re-development potentials or a building which has become less suitable for occupiers business for a variety of reasons (which may include functional or physical obsolescence) and which therefore requires redevelopment or refurbishment. The method is used where a change in the use of land or building is being contemplated to release its latent value. The development potential or latent value is present when a property can be improved so that the value will be increased by more than the expenditure. The purposes of residual valuation are to: determine the maximum price payable for a site given acceptable profit margins and development costs; calculate the probable level of profit a product of development where the costs of land are known and total construction costs can be estimated; established a cost ceiling given minimum acceptable profit and land values. The basic approach to residual valuation include: estimating the 'value of completed development' and deduct there-from the 'estimated total costs of development' to arrive at the 'residue'. The residual value represents the maximum amount available for the purchase of the site by a particular developer. The method assumes that optimum development is known and that it is possible to estimate costs of development accurately. This may not be true because demand changes overtime and development cost may exceed the original estimate due to unforeseen circumstances.

## 3. Methodology

Detailed physical inspection and measurement were employed to ascertain the construction cum technical details, accommodation and details of services whilst clients supplied information on title details and cost/date of acquisition of the properties. A survey of the neighbourhood was undertaken to facilitate the description of the locational details, sketching of the locational plan and carrying out of market survey. The latter was embarked upon to collate information on current rental values, obtain evidence of recent sales of plots/properties and ascertain trends of values in the locality.

Analysis of information/data collected immediately revealed that 3(No) possible methods of valuation come handy in determining the values of these residential properties: comparative, investment and depreciated replacement cost. In assessing the appropriateness of the comparative or market data method for instance, consideration was given to the fact that the information was collected from local practitioners (agent) of the real estate market at Arigidi Akoko and Ugbe Akoko in

Ondo State since there was no real estate firm(s) in the town.

Similarly, evidence supplied with respect to sales of plots/properties could not totally be dependable due to the low incidence/volume of sales transactions. In other word, evidence of sales transactions is low. Furthermore, these evidences were not documented whatsoever.

## 4. The Study Areas

Arigidi Akoko is located in Akoko North West Local Government Area of Ondo State and is rich in cultural values with many prominent spiritualists. The descendants migrated from Benin and settled in the present day Arigidi Town in 1819. There are three major settlements in the town which are Imo Arigidi, Arigidi Oja and Agbaluku. In terms of political composition, Arigidi has two out of ten political wards in Akoko North West Local Government Area namely Arigidi Iye Ward 1 and Agbaluku Imo Ward 2. The people of this town are predominantly farmers. Other occupation of the people include trading, blacksmith, dyeing. The religions being practised by the people of Arigidi include Christianity, Islam and Traditional Religion.

Ugbe Akoko is located close to Oyin Akoko in Ikare Rural District of Akoko North East Local Government Area of Ondo State. It is one of the towns bordering Oka Akoko the administrative headquarter of Akoko South West Local Government in the north. The town belongs to Owo-Akokos, one of the five groups into which Akoko region is sub-divided on the basis of dialectal spoken categories. The means of livelihood of the people in the town include farming, trading and hand craft.

## 5. Data Analysis and Discussion

The residential properties whose valuation approaches are being x-ray comprise a frontal 4-bedroom bungalow and a rear 3-bedroom bungalow located in Arigidi Akoko and tenement bungalow of 8(No) rooms in Ugbe Akoko all in Ondo State.

**Comparative Method Analysis**

| Serial No | Location | Description | Rent p/a (₦) | Capital Value (₦) |
|---|---|---|---|---|
| 1 | ARIGIDI AKOKO | 4-BDR BUNGALOW | 65,000-70,000 | 1,200,000-1,300,000 |
| 2 | ARIGIDI AKOKO | 3-BDR BUNGALOW | 55,000-60,000 | 1,050,000-1,150,000 |
| 3 | UGBE AKOKO | 8-ROOM TENEMENT | 48,000-96,000 | 920,000-1,800,000 |

**Investment Method Analysis**

| | | | |
|---|---|---|---|
| Actual Rent (4 Bdrm) | 70,000 | Rent per room/month = | 800 |
| Actual Rent (3Bdrm) | 60,000 | Total number of rooms = | x 8 |
| Gross Rent | 130,000 | | 6,400 |
| Less outgoings @10% | x 0.9 | No of months in a year = | x 12 |
| | 117,500 | Gross Rent | 76,800 |
| YP for 47yrs @ 5% and 3% | 16.67 | Less outgoings @ 10% | x 0.9 |
| | 1,950,390 | Net Rent | 69,120 |
| | | YP for 47yrs at 5% and 3% | x 16.67 |
| | | | 432,086 |

**Depreciated Replacement Cost Analysis**

| | | ₦ | ₦ |
|---|---|---|---|
| 4-Bedroom Bungalow | | | |
| GFA – 184.71m$^2$ @ ₦50,000/m$^2$ | = | 9,235,500 | |
| Less depreciation and obsolescence @ 40% | = | 0.6 | |
| | | 5,541,300 | |
| 3-Bedroom Bungalow | | | |
| GFA – 111.18m$^2$ @ ₦50,000/m$^2$ | = | 5,559,000 | |
| Less depreciation and obsolescence @ 40% | = | 0.6 | |
| | | 3,335,400 | |
| External Works | | | |
| Fence wall | | | |
| Perimeter = 2(L+B) | | | |
| 2(18.45 + 67.00) = 170.90 meter run | | | |
| 170.90 meter run @ ₦10,000/meter run | = | 1,170,000 | |
| Less depreciation @ 20% | | x 0.8 | |
| | | 1,367,200 | |
| Land Value | | | |
| Area (1,230.15) m$^2$ | | 400,000 | |
| | | | 10,643,900 |

**Depreciated Replacement Cost Analysis**

| | | | |
|---|---|---|---|
| Tenement Bungalow | | | |
| GFA – 251.33m$^2$ @ ₦40,000/m$^2$ | = | 10,053,200 | |
| Less depreciation and obsolescence @ 40% | = | 0.6 | |
| | | 6,031,920 | |
| Land Value | | | |
| Area (354.48) m$^2$ | | 115,264 | |
| | | 6,147,184 | |

## 6. Discussion of Findings

In the process of valuing the case study properties, relevant issues indicating the non-applicability of some of the existing methods of valuation to rural based residential properties arose, hence the need to review the suitability of each method as follows:

a) Comparative or Direct Capital Comparisons Method: entails an analysis of current sales prices of similar properties. The value of property inspected is arrived at by comparing with the price level of similar properties in the neighbourhood adjusting for differences in location, plot size, age and condition, amount of floor space, number and arrangement of rooms, etc. However, the application of this method is hindered by concealment of sale transactions which makes information that leak become doubtful. Also, quacks that are mainly in charge at the local level may be shielded

from the conclusion of the transaction and therefore take the asking prices as the final consideration. Furthermore, low incidence/volume of sales makes it difficult to establish trends as conclusions draw from the few and far between transactions may not be very authentic.

b) Investment Method: This method is based largely on current rentals and the current rate of interest and the desired profit of the investor. Each of these factors was obtained from the landlord and financial market sources, which to a large extent conferred authenticity on the figures. The measure of confidence in applying this method to the rural based residential properties was quite high especially where the value derived is a function of the rent. However, the determination of the 'appropriate years purchase' poses challenges in the context of data collected from the neighbourhood. Similarly, the rent to be capitalised is impacted upon by the imperfect property market situation especially in the local areas.

c) Profit or Account Method: This method is used in valuing properties which are specialised and have limited potential for conversion to alternative uses other than for operating a business outfit. It is the trade that is carried on in the premises that is the vital factor, which directly affects its value. The profit method (also known as the account method) is used to value such properties such as petrol filling station, a cinema or hotel premises. Properties, which were inspected and valued in the rural areas of Ondo State, were mainly residential. Therefore, this method is not appropriate due to its limiting/restricting factors.

d) Contractors' or Depreciated Replacement Cost Approach: The cost method may be described as a method of determining the value of property by reference to the cost of replacing it or procuring an acceptable substitute.

The method appears to be simple and direct, hence, its being dubbed the 'lazy man's method'. This method ignores a very basic fact that whilst differences in costs of construction in urban and non-urban areas are negligible, the same thing cannot be said of values. For example, a 3-bedroom bungalow at Isolo, Lagos and Arigidi-Akoko, Ondo State may attract almost similar cost of construction of say ₦4.0 million but the differences in values between the two locations may range from ₦6.0 million at Isolo and less than ₦3.0 million at Arigidi-Akoko. Obviously, land value is not the only factor responsible for the disparity. Cost differs from value but there are few instances where cost and value are equal. Our experience showed that this method tends to produces unnecessarily high figure that cannot be supported by the market.

e) Residual Method: This method is appropriate in valuing properties with re-development potentials e.g. bare land or for a building which has become less suitable for the occupier's business for a variety of reasons (which may include functional or physical obsolescence) and which therefore requires redevelopment or refurbishment. This method could not be employed in valuing the case study properties in Ondo and Ekiti States when there was no discernible value that could be harnessed then.

## 7. Conclusion

The following are the conclusion drawn out from the study:

i) Property hardly changes hand in the rural areas and as a result there is scarcity of data regarding evidence of property transactions that are recent. The only source of data is from the local agents whose data are neither documented nor reliable. Besides, the data is not a true reflection of values in the area. So therefore, comparative or market data technique is less suitable in valuing such properties.

ii) Since an investor is sure of the rent his property commands, the investment method will give him at least a value that is realizable when the net income is capitalized with the appropriate years purchase.

iii) Because cost of construction sourced from our data bank is the same for both rural and urban areas, the depreciated replacement cost method jack up property values in the rural areas to a level that the market cannot support.

iv) Three methods of valuation could be adopted in determining the values of rural residential properties namely; comparative, investment and depreciated replacement cost.

v) The figure of years purchase is difficult to arrive at in case of those properties. This is because the yield, which determines the years purchase, is a function of analysis of sales transaction. However, properties hardly change hand in the rural areas

vi) There is little or no difference in cost of construction in both urban and non-urban settings.

vii) Low incidence/volume of sales makes it difficult to establish trends, as conclusion drawn from the few and far between transactions may not be authentic.

## 8. Recommendation

The followings are recommended:

i) Development projects which act like catalyst and speed up the rate of development in areas sited should be embark upon by different tiers of government, organisations and religious bodies. Such projects include higher institutions, industries, farm settlements and religious retreat centres which act like magnet and draw people to areas located. This will result in demand for accommodation and thus the springing up of apartments. There will be an upward movement in rent and

property values due to influx of people. Transactions in property become frequent resulting in the activation of property market and boosting of property values.

ii) There is the need for centralised body for Estate Surveying and Valuation profession to have a department that will be overseeing the collection of data in respect of sales and letting of properties for both rural and urban areas. Data collection is essential because it enhances sales/rental values projections. It is possible to project into properties' values/rent accurately by studying the trends of past transactions.

iii) There is a wide gap in the construction costs rate available in the market. In actual fact, tenders and quotations of construction companies are unreliable and are made worse by variations, abandonment of project site and non-release of fund. Unreliability of construction costs rate is due to: loading to take care of delays in payment to allow for negotiations to make arrangement for gratifications and the like and also to take care of unexpected price fluctuations and outright demand for bribes; excessive profit expectations; unpredictable prices of construction materials due to fluctuating inflation rates and other economic indicators and poor attitude to work of professionals. The consequence is that construction rates are inflated and may vary widely with actual costs.

iv) Most of the owners of the property are sentimentally attached to them. This is linked to their empowerment. The bond of attachment is strong where development is not being experienced. Where the rate of development is rapid, it will impact positively on property values and thus severe the bond of attachment to property. Because of the big money involved, which is needed to improve their standard of living, the owners of the property will be forced to sell. Furthermore, some people in these areas regard selling of landed property as a taboo or sign of decline fortune.

v) There should be competitiveness between the rural and urban areas in the provision of infrastructure. An area with good infrastructural facilities such as network of good roads, effective communication system, portable water, health facilities, etc. will always attract development ventures. Their availability will provide enabling environment for developments to thrive. This will indirectly impact positively on property values. A good example is Ikorodu in Lagos State which has been playing host to many projects because of availability of infrastructure. Property values/rent has been on the increase too.

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# Exploring the Potentials of Expanded Polystyrene (EPS) for Zero-waste Construction in Akure Nigeria

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***Abstract***: Construction and demolition wastes (CDW) pose serious challenges to the environment and as such creates so much concern in the Architecture, Engineering and Construction (AEC) industry. The challenges and impacts of construction in AEC activities are obviously avoidable. Practitioners in the industry have been slow to recognize that modern methods of construction (MMC) such as the use of Industrialized Building System (IBS) have the potentials to minimize wastes on job sites compared to the traditional methods of construction which are pointedly wasteful. This study reports a survey conducted in two residential estates where Expanded Polystyrene (EPS) – an Industrialized Building System (IBS) and conventional building materials and techniques were used. Stratified random sampling was adopted because of the different types of housing units within the two selected housing estates. It was found that the Industrial prefabrication of Expanded Polystyrene (EPS) wall panels, floor ribs, blocks and fascias enables components to be produced to exact specification thus significantly reducing waste on job sites. Also, the light weight nature of EPS facilitates easier handling and reduces labour and saves time for the installation. The study therefore seeks for the adoption of prefabricated building components such as standardized EPS as a modern methods of construction (MMC) in Nigeria.

***Keywords***: Construction and demolition wastes, expanded polystyrene (eps), job sites, sustainable construction, traditional methods of construction, zero-waste construction.

## 1.0 Introduction

The rate at which construction activities are adversely affecting man and his environment is alarming and this calls for serious attention. In response to this challenge, pragmatic measures are being taken globally to curtail the negative impacts of the construction industry on the environment (Ede and Oshiga, 2014). Studies have shown that the various challenges to man and his environment are sequel to the ways of construction of the modern world. Guy, Shell and Homsey (2002) asserted that construction activities in most developing countries are clearly characterized by wastes and toxicity, which is harmful to man and the environment. Reflecting on the Nigerian context, Adebayo and Iweka (2009) noted design and construction of infrastructure, particularly buildings have not been sustainable. These methods of construction, using traditional and conventional materials often results in the generation of enormous quantities of wastes which are detrimental and hazardous. The material waste produced from new construction, renovation and demolition is 25% to 30% of the total waste produced each year in the United States and UK (EPA, 1996; Pulaski, Hewitt, Horman and Guy, 2004). Similarly, waste generation through building construction and renovation is on the increase in many developing countries (Adedeji, Taiwo, Fadairo and Olotuah, 2013).

In Nigeria, like other developing nations, the need to minimize construction wastes on job sites has become imperative. With the increasing demand for infrastructure, a large quantity of construction wastes is being generated in the course of infrastructural development. To tackle this, the adoption of standardization of design and modular design, use of renewable, prefabricated building materials and dry methods of construction, among others have been recommended (Adedeji et al., 2013). Expanded polystyrene (or EPS) which offers these attributes has been widely adopted in developed countries to reduce waste and solve environmental challenges while giving adequate consideration to cost, time and energy (Olawuyi and Babafemi, 2009). Marhani, Jaapar, Azmi and Bari (2012) opined that EPS as an Industrialized Building System (IBS) may help ease the pressure of labour requirements, boosts quality and productivity, and serves as a means to overcome environmental problems associated with conventional materials and techniques.

This paper presents a study on the suitability of expanded polystyrene to reduce construction wastes on Nigerian construction job sites to the barest minimum level.

## 2.0 An Overview of Construction Wastes

The traditional methods of construction produce enormous wastes and consequently impact negatively on

the environment. The way in which the design and construction of buildings are carried out in developing countries today is irrational, disorganised and inefficient (Adebayo and Iweka, 2009). This wasteful nature of today's construction could be based on the fallacious notion that natural resources are free and inexhaustible (Papakyriakou and Hopkinson, 2012). It is noteworthy that the current menace of construction and demolition wastes (CDW) and its impacts such as resource depletion, energy waste, pollution, species and habitat loss, human health, and social issues (Crowther, 1999) are obviously avoidable (Adebayo and Iweka, 2009). Previous studies have shown that buildings utilize large proportion of energy and available natural resources and that worldwide 30 – 40% of all primary energy is used for the construction of buildings (Ramesh, Prakash and Shukla, 2010). Designers are crucial to mitigating the impacts of the construction activities. Architects and Engineers among other professionals are pointedly important to reducing waste. They are directly responsible for making design choices, specifying materials among other decisions at the design and construction stages (Guy, Shell and Homsey, 2002; Pulaski et al., 2004; Papakyriakou and Hopkinson, 2012). Studies have shown that the choice of appropriate building materials which are prefabricated offers opportunities for preassembly, modular construction, ease of handling without compromising workers' safety, are germane to minimizing wastes on construction job sites (Crowther, 1999; Pulaski et al., 2004; Adebayo and Iweka, 2009; Papakyriakou and Hopkinson, 2012).

### *2.1. Construction Wastes in Developed Countries and Nigeria*

The construction industry is one of the largest solid waste generators with 30 – 40% of natural resources exploited by the AEC industry (Adedeji et al., 2013). Sustainable development necessitates increase in the reuse and recycling of existing facilities. This implies that there will be increase in the reuse and recycling of existing materials, resources and facilities (Guy et al., 2002). Studies reveal that of the total 25 – 30% of material waste produced from construction, renovation and demolition generate waste of about 92% which is higher than the 8% generated by new construction (Pulaski, et al., 2004). In the United States, construction and demolition waste is about 143 million metric tons (MMT) annually (Chini and Bruening, 2003). In the United Kingdom, the construction waste is about 18 million tons (Akinade et al., 2016), while in Nigeria, an estimated 2.2 million tons of waste is generated per annum. If the challenges of construction waste of developed countries would serve as a lesson for Nigeria, it is imperative that the AEC industry in Nigeria embraces modern methods of construction (MMC) as a waste minimization strategy.

### *2.2. Modern Methods of Construction as Waste Minimization Strategies*

Lawson (2019) opines that waste minimization revolves around three R's as reduce, reuse and recycle. Reduce calls for using resources that are just enough to cater for the needs

of a construction work which is an effective way of conserving resources. It also lowers the costs. Reuse involves effective reclaim of existing materials and buildings thus lowering waste volumes and saving money. Recycle comprises using left over resources or those resources that have reached the end of their life. This minimizes the need for new materials as well as lowers the volume that ends up in landfills. Other strategies identified are optimization of resources, quality control improvement and process monitoring, exchange of waste, shipping to the point of use, zero waste and waste minimization for household (Lawson, 2019)

Akinade et al., (2016) remarked that conscious efforts are being taken by the AEC industry to understand the concept of sustainable construction and the long-term effects of construction activities on the environment. As a result, the focus of the practitioners is being shifted from the traditional methods of building disposal to modern methods of construction which include among others the use of Expanded Polystyrene (EPS) which is an Industrialized Building System (IBS). That the traditional methods of building construction generate up to 50% of the waste stream worldwide has made the paradigm shift from traditional to modern methods imperative (Akinade et al., 2016).

Waste and Resources Action Programme (2019) explains that modern methods of construction include improvements in the products or processes employed. This ranges from innovative components to be used on site to whole, off-Site Manufacturing - utilising prefabrication, factory assembly, preassembly, off-site assembly/manufacture, panelised or modular volumetric construction where possible, for example in staircases, lift assemblies, architectural steelwork and toilet blocks for hotels, prisons and student accommodation. Waste Minimization is realized due to the controlled environment and the type process where there is repeatability in construction building systems manufactured off-site.

## 3.0. Research Methodology

A survey of two case studies of residential building construction sites at Akure was undertaken to elicit primary data for the study. Data was gathered through physical observation of the construction sites and interview with the stakeholders involved in the design and construction about their awareness and level of involvement in the use of EPS and convectional method of construction. Also, interview was conducted with the specialist in the design, manufacture and marketing of polystyrene building systems. The first case study (Case A) is on-going and completed residential buildings' sites at Alpha 3D Estate located along Irese road, Akure. The estate engages the use of EPS – an Industrialized Building System (IBS) for the construction of walls, intermediate floors and fascias of its 506-housing unit scheme. Owing to the heterogeneous nature of the estate, stratified sampling was used to divide the estate into four mutually exclusive and collectively exhaustive building

typology strata. A building typology was randomly selected from each stratum for this study. The typology selected from each of the four categories of buildings includes
2-bedroom semi-detached bungalow,
3-bedroom detached bungalow,
4-bedroom detached duplex and
4-bedroom detached bungalow. The second case study (Case B) was selected from on-going and completed residential buildings' sites at Alagbaka Extension area of Akure where conventional building materials and techniques are engaged for construction. Conventional materials and techniques in this context refer to materials and methods of construction that are widely accepted and adopted for building construction in any particular geographical setting. While sandcrete masonry blocks of 225 x 225 x 450mm are predominantly used for walls, reinforced concrete is conventionally used for intermediate floors and fascias in the study area. The same method of sampling used for Case B was used to select 3-bedroom detached bungalow, 4-bedroom detached bungalow, 4-bedroom detached duplex and 5-bedroom detached duplex building typologies in the study area.

### *3.1 Design and Construction with Expanded Polystyrene (Walls, Intermediate Floors and Fascias)*

Expanded polystyrene (EPS) is a prefabricated modular material for walls, floors, stairs, fascias and ornamentation in construction. EPS for walling is produced as panels in standardized modular sizes of 'n x 1200 x 3000' (thickness x width x height) with varying thickness of between 50mm and 250mm depending on the overall thickness of walls to be achieved. The design of an EPS building is undertaken using the modular sizes and dimensions of the EPS components. The resultant design is therefore made up of modularly prefabricated EPS wall panels, EPS floor blocks and EPS fascias which are thereafter assembled on the site. The component EPS panels including those for openings and archways are properly coded on the plan to ease specification; and transferred to the factory for production.

The wall panels, floor ribs and fascias so produced were to exact specification which prevents further cutting on the job sites and hence reduced waste. In cases where cutting was unavoidable warranted by unforeseen circumstances the off-cuts of the EPS products were easily recycled via the use of recycler. It is noteworthy that in EPS wall construction, lintel and beams are not needed by virtue of design as the panels themselves are deep beams joined together to form a box-like structure. As a result of this, formwork associated with the construction of lintels, beams and archways were absent. Also, in the construction of EPS fascias, formwork was not used as the fascias were tied to each other and to the walls with meshes to ensure continuous reinforcement. The result of these is that waste commonly associated with formwork in the construction of walls and fascias were generally eliminated in the EPS construction. The formwork used for the suspended floors and columns were easily struck and reused.

The conventional masonry method is the predominant technique of walling construction in Nigeria particularly in Akure. The method involves the use of sandcrete block walls with sand-cement mortar as joints and bedding adhesives. The intermediate floor, stairs and fascias are conventionally constructed mainly with reinforced concrete. Usually, all the structural and non-structural components in the masonry method require enormous formwork many of which are neither reusable nor recyclable after use. The aftermath is usually heap of wastes found littered around the entire site in addition to wastes from walls.

## 4.0. Findings and Discussions

An assessment of the construction methods and materials adopted in the two case studies revealed that the techniques used in the construction of substructure are similar. Except for the insertion of dowel bars of 10mm diameter employed on the solid ground floor which was to receive EPS panels and provide an aligned anchorage for the panels. The thickness of the oversite concrete for the EPS building was also reduced to between 75mm and 100mm owing to the light weight attribute of the panels it was to receive. The thickness of the oversite concrete in the conventional building typologies is 150mm. This implies that concrete was saved in the EPS oversite concrete, hence a reduction in the cost of the foundation. On the superstructure however, the industrial fabrication of EPS wall panels, floor blocks and fascias enables the components to be produced to the exact specification of the design and thus significantly prevented wastes on the job sites, whereas in the conventional building typologies job sites, there were enormous wastes emanating from cutting of blocks and other materials that were not of required specifications.

The light weight nature of the EPS components facilitated easier handling and reduced number of employed labour and saved significant time for the installation (See Plates 1-10). On the conventional construction job sites, sandcrete blocks were found to be heavy and the substandard ones were easily damaged during handling. The traditional method required a large number of workers on the sites. Contrary to this case of masonry construction technique, EPS eliminated the use of formwork materials in lintels, beams, hoods, arches, beams and fascias. The enormous wastes associated with formwork in these and other structural elements were dramatically reduced in the EPS buildings.

Plate 1: The foundation for EPS same as convectional method

Plate 4: Same method of plastering for EPS and Convectional Sandcrete building

Plate 2: Starter Bars of Diameter 10mm are inserted At 500mm c/c before oversite concrete is cast

Plate 5: An EPS envelope ready to receive first stage of shortcreting (Spraying)

Plate 3: Same method of construction for the Doors and windows hoods

Plate 6: EPS Fascia (Cornices) are carefully strongly tied to the walls using wires and splice meshes

Plate 7: Roofing done same way as in the conventional method

Plate 8: An EPS house ready for painting

Plate 9: A Completed EPS House

Majority of the Architects and Engineers who are involved in the design and construction of buildings and specification of materials in Akure are fully aware of the use of EPS as modern method of construction but do not understand the technique of construction. This underscores the relevance of modularization of design that is expected in EPS. However, all the stakeholders displayed high level of understanding of conventional methods including the technique required at various stages of construction.

The specialist in the design, development, manufacture and marketing of polystyrene building systems in Nigeria are very limited. A large number of buildings constructed of prefabricated materials and EPS was prominent in cities like Abuja, Portharcourt and Akure. Polystyrene Industry Limited, Cubic Homes, CIBP Limited are located in Abuja while Zifax Global Services, E- Pack Polymers Private Limited are located

in Lagos. The only available company that deals with EPS in Ondo State is Alpha 3D Limited and it is located in Ikare – Akoko.

## 5.0. Implication for the Nigerian Building Industry

Total reduction or reduction of wastes on the Nigerian construction job sites has been identified as one of the ways to address the adverse impact of construction activities on the environment. Waste prevention, recycling and materials reuse on job sites are some of the ways to save embodied energy to achieve sustainable development. Sustainable development is development with low environmental impact. However, irrespective of the on-going global crusade on wastes minimization and energy efficiency in construction, and numerous disadvantages of conventional materials to the environment, a large percentage of the Nigerian building stock was erected with the use of conventional or traditional materials and techniques. This poor receptivity of the Nigerian construction industry to make a paradigm shift from the use of conventional method towards the application of alternative materials and techniques is one of the hindrances which may prevent it from achieving environmental sustainability goals.

The use of EPS which is an IBS is environmentally friendly and help minimize wastes associated with mismanagement of materials, miscalculation, poor supervision, poor design and detailing errors. It has been proven that its adoption gives the industry environmental sustainability gains as well as social and economic gains.

## 6.0 Conclusion & Recommendations

This paper has explored the potentials of expanded polystyrene (or EPS) for reducing construction waste on job sites to the minimum. With the use of case studies approach, two different construction sites which adopted traditional methods of construction and EPS as Industrialized Building System of modern methods of construction respectively were compared. It was discovered that contrary to the enormous wastes generated using traditional method of construction on job sites, the use of EPS – an Industrialized Building System, prevents wastes on the sites. Suffice it to say that a paradigm shifts from unsustainable traditional method of construction to a sustainable modern method of construction which encourages the use of modularization and industrialized building system to prevent wastes and reduce negative impacts of construction activities on the environment is a panacea to achieving not only environmental sustainability goals but social and economic benefits in Nigeria.

In view of the foregoing implications of wastes to the Nigerian industry, it is recommended that

1. the professionals especially the designers who are directly involved with the design of buildings and specifications should embrace modularization of components in design to prevent or minimize wastes on job sites.
2. The use of prefabricated building components such as standardized

EPS wall panels, floor blocks and fascias should be encouraged.

3. Currently in Nigeria, there are few and insufficient manufacturers of prefabricated components for walling, intermediate flooring and fascias. The establishment of factories for the production of these standardized components should be encouraged by the government by making policies that will create enabling and conducive environment for such factories to operate.
4. In addition, in the face of looming climate change, public awareness on environmental issues should constantly be raised at the Federal, state and local government levels through governmental and non-governmental organizations' initiatives. Through various sensitization programs, all stakeholders directly or indirectly involved in the design, construction and operation of buildings must be educated on the importance of waste reduction and the adoption of more energy efficient materials and techniques on job sites.
5. It is also recommended that the National Building Code incorporates the use of standardized prefabricated building materials, use of alternative building materials, energy efficiency, prevention of wastes through conservation of materials at both production and construction stages. Lastly, it is recommended that the principles of deconstruction and materials reuse should be widely encouraged and adopted by the various stakeholders in the industry.

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# Adaptation to Heat Stress within Housing Estates in Akure, Nigeria

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***Abstract***: Adaptation to heat stress, human behavior and heat resistant characteristics of the residential environment are critical to achieving resilient human settlements. Through a survey of households in mass-developed housing in Akure (Nigeria), complemented by semi-structured interviews, this study identifies behavioural responses to heat and housing adaptations made to deal with heat stress. Top behavioural responses by the residents include using fans, keeping themselves hydrated, changing to lighter clothes and relocating to shaded space. The common post-occupancy adaptation measures include installing cooling devices, using light curtains and installing nets for windows and entrance doors. Heat resistant features that residents would want to be part of future housing development also came to the fore. These findings show that mass housing development should consciously incorporate heat resistance features while also promoting lifestyle approaches in adapting to heat.

***Keywords***: Adaptation; Housing; Heat Stress; Retrofitting; Thermal Comfort

## 1. Introduction

Nigeria is regarded as a hot country, and it is getting hotter with the changing climate. Persistently high temperature and extreme heat with the accompanying physical and health impacts are becoming a common experience in urban areas (Nigerian Meteorological Agency, 2017). The impacts can be physiologically and psychologically or otherwise. Omonijo et al. (2011) analysis of climatic data for the whole of Ondo State for 11 consecutive years (1998–2008) shows

that 32.6% out of the study period was under strong heat stress - 36 – 42 degrees. This condition makes people prone to heat-related ailments and deaths. In their study of meteorological data from weather station on a university campus in Kano State, Alhaji and Ahmed (2013) revealed that thermal discomfort index (DI) values were 24.5, 26.5, 28.5 and 20 during the hot-dry, warm-wet, warm-dry and cool dry seasons respectively. These imply vulnerability to severe discomfort conditions, especially during the hot and humid season and in the afternoon when temperature is at peak. This potentially affects teaching and learning in the university. Morakinyo et al.'s (2016) study show that the period of consistently high temperature can affect occupational performance. Daniel (2015) have shown a positive significant relationship between increased monthly temperature and occurrence of heat rash in a Nigerian city.

Adaptation to heat stress, human behavioral responses and the heat resistant characteristics of the residential environment are critical to achieving resilient human settlements in Nigeria and beyond. Although human behavioral aspects are crucial to thermal regulation and adaptation during heat stress, it has received less attention in local and international literature compared with structural, institutional and technological mechanisms (Sawka et al., 2002; Zuo et al., 2015). Additionally, characteristics of the built environment, at home and elsewhere, affects adaptation to heat stress (Wilby, 2007) but is understudied in the Nigerian context.

There is knowledge gap in terms of the relationship between heat resistance features in housing and the built environment at large and adaptive capacity in Nigerian cities. Because of this, housing development is not substantively informed by adequate consideration for heat stress resistance in building (re)design, construction and management. This paper considers the behavioural responses and housing adaptations to heat stress. It is based on a study conducted in houses developed through government's mass housing scheme in Akure, Nigeria. The aim is to identify means of adapting to heat stress within mass-developed housing environment, thus providing insights for achieving thermal comfort in the context of increasing temperature associated with changing climate.

## 2. Bottom-up Adaptation, Human Behaviour and Heat Resistance in Housing

Increasing temperature and the associated impacts highlight the place of adaptation strategies. Some scholars explain that adaptation has generally utilized a top-down approach (Yeh, 2015; Mikulewicz, 2018). Government at different levels, at times together with some NGOs and consultants develop mitigation and adaptation strategies, without adequate attention paid to understanding what enhances individual and community resilience at the local level. This situation precludes the fact that approaches to coping with heat stress and other climate problems in Nigeria are largely individualised (Eludoyin,

2015). As Taiwo et al., (2012) argues, local knowledge based on perceptions, exposures and adjustments to seasonal heat waves can provide valid inputs into adaptation assessments. Hintz et al., (2018) analysed solutions to urban heat waves across some countries and covering different geographical context. Their review-based study 'emphasizes the importance of inhabitants as well as local governments as essential actors for adaptation to urban heat waves' (ibid:). Adaptation rooted in local knowledge within cities can be pursued at different spatial scales, starting from the building scale.

Human behaviour is critical in understanding adaptation at the building scale. People take different adaptive actions and exhibit thermal considerations in the use of space. Adebamowo and Olusanya (2012) identified behaviours that occupants within a student housing in Abeokuta, Nigeria adopt in response to heat. Opening windows and taking cold drink were the top two behavioural responses to heat. Going to the building's atrium, taking bath, changing cloth and switching on the air conditioner were other behavioural responses identified. Taiwo et al (2012) also found that switching on fans and/or air conditioner are the top responses in their study in Ibadan, Nigeria. Opening windows and doors as well as sleeping outside till late night are the least practiced responses. Similar studies conducted in the context of residential buildings outside Nigeria – in Australia (Soebarto and Bennetts, 2014; Hatvani-Kovacs et al., 2016), Taiwan (Hwang et al., 2009) and Japan (Rijal et al., 2015) also presents similar range of behavioural responses which include: doing nothing, wearing a sunhat, planning the day ahead, opening windows and/or doors to turning on the fans and/or air-conditioners.

Behavioral response to heat affects the use of different kinds of spaces – both indoor and outdoor, confirming that physiological comfort and the associated perceptions involve spatial and temporal variations (Eludoyin, 2015). This shows why Adunola and Ajibola (2016) found a correlation between the most thermally comfortable spaces and the most used spaces within the house at different periods of the day in their study of residential buildings in Ibadan. Hwang et al.'s (2009) work show that residents' choice of thermal adaptation behavior is generally influenced by their effectiveness, availability, cost among other factors.

Heat resistance features in housing and the built environment is also crucial to understanding adaptive capacity. This should start with the design approach for the residential building and its neighbourhood. In doing this however, Hatvani-Kovacs et al (2018) cautions that energy efficient design does not necessarily increase heat stress resistance in buildings. Conscious efforts are needed to shape the building form, its colour, orientation, furniture and fixtures, construction materials and methods as a means of resisting or adapting to heat stress. Literature includes some examples. In the tropics, it is common knowledge that ceiling insulation prevents excessive heat gain. In Nigeria, people

living in houses without ceilings are subject to and complain of excessive heat (Muoghalu, 1984; Taiwo et al., 2012). Reflective and light-coloured materials for roofs and facades are more effective than darker colours in terms of reducing heat gain (Abimaje and Akingbohungbe, 2013). Furthermore, building orientation, walling type and materials affects thermal mass and has thermal comfort implications on the occupants (Ajibola, 2001; Akande, 2010). Vegetation, including trees, grasses, shrubs either indoor or outdoor are also useful at reducing ambient temperature and consequently dealing with heat stress (Akande 2010; Adedeji et al., 2010; Morakinyo et al., 2013).

Existing buildings that do not have the appropriate heat resistant features can be retrofitted or remodelled to improve their thermal performance (Akande and Olagunju, 2016; Abdulkareem et al., 2018). In the case of mass developed housing, owners may undertake post-occupancy changes in their dwellings to personalise the way they deal with persistently high temperature. Nnodu et al.'s (2017) study in Abuja suggests that residents are interested in such retrofits, especially incorporating the goal of energy-efficiency.

## 3. Study Area and Research Approach

Akure is the capital city of Ondo State, Nigeria. It is located on latitude 7'25°N and longitude 5'20°E, lying about 250m above sea level. According to the National Population Census, the city contains around 484,798 people in 2006, which is projected to have grown beyond 588,000 at present (National Population Commission, 2006). The mean annual relative humidity is about 77.1%, based on 1980-2007 data from the Nigerian Meteorological Agency. Average rainfall is about 1500mm per annum (Balogun et al., 2012).

Residential and territorial expansions associated with the rapid growth pattern affects the local climate. The medium sized city is notable for its high temperature – though not the highest nationally. Temperatures range averagely between 21.4 and 34.19°C, but this could be higher in built up areas due to urban heat island (Alaigba et al., 2018). Akindode et al.'s (2008) analysis of temperature and relative humidity data for Akure from 1992 to 2001 shows that daytime urban heat island intensity ranged between 0.5 and 2.5 °C within the study period. The characteristics of the urban heat island and heat stress in Akure, investigated by Balogun et al. (2010), indicates higher frequencies of high temperatures towards the city centre, which suggests a significant health risk and possibilities of physiological disorderliness. Ogunrayi et al.'s (2016) recent analysis of temperature trends in the city builds on these earlier studies. There is clear evidence of increase that indicates warming throughout the year.

To understand adaptation to heat stress through local eyes, data for this study was collected through a survey conducted in October and November 2017 – two of the hottest months in the year. Questionnaires were administered to households in two housing estates. Each of the estate

contains housing typologies mass-developed, from 2006, through the federal or state government's public-private partnership housing programme. Seven of such mass-housing developments had taken place in Akure within the last decade (Adegun and Taiwo, 2011). Two of these were chosen due to their level of completion and high percentage of occupation as well as ease of conducting survey within the estates.

The questionnaire contained four sections which solicited for information about the respondents, the housing characteristics, personal responses to heat stress and heat resistant features in the built environment. 150 questionnaires were administered to randomly selected households in the estates. The household head or adult in the randomly selected households completed the questionnaire. Only 145 questionnaires were returned and used for analysis presented in this paper. To follow-up on the survey, semi-structured interviews were conducted with 3 residents in the estate. Result of the survey was briefly presented in course of the interviews. This helped to generate relevant nuances and complement the earlier findings.

## 4. Results and Discussion

Information about the age and level of education of those who responded to the survey is presented in figure 1. Of the 145 respondents, 27% were aged between 25 and 34 years while 30% were between the ages of 35 and 44 years. There is no one less than 18 years. Only 14 (10%) respondents were older than 55 years. Majority of the respondents (69%) were educated up to the tertiary level. There is no respondent without any form of formal education.

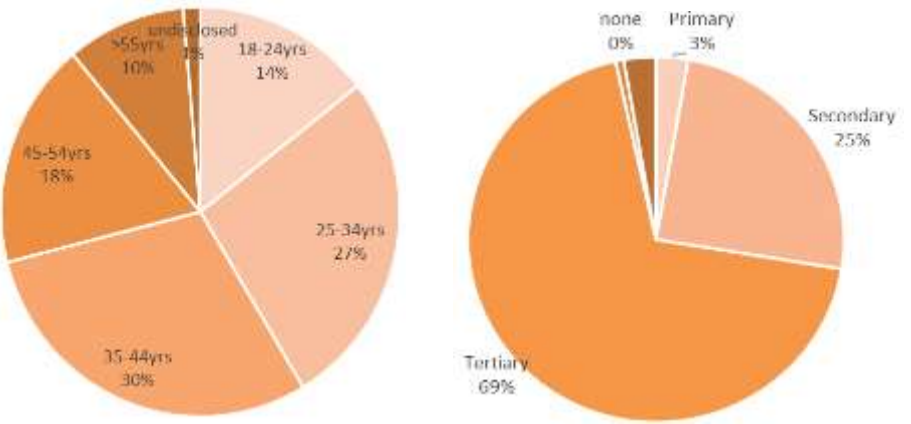


Figure 1. Age and educational level of respondents.

### *Housing Characteristics*

The survey sought to understand the material character of the respondents' dwellings and their contents. Table 1 shows the material characteristics, and colour, of houses where the respondents live. The external walls are majorly made from hollow

sandcrete blocks, being the common wall construction material in Nigeria while the roofs are majorly covered with corrugated aluminium/iron sheets (See Table 1). Pink, red and brown, at 26.2%, 21.4% and 16.6% respectively, are the top three colours for the roof covering. Most of the houses are sealed, with asbestos sheets (32.4%), PVC boards (32.4%) and POP (23.4%) being the top three materials used. Altogether, about 88% of the houses use these materials. Over half of the internal walls have a light colour – white (47.5%) and yellow (10.3%). Ceramic tile is the popular flooring material as majority (70.3%) of the houses are covered with it (See Table 1).

As stated earlier, housing construction materials are crucial factors in the heat resistance capacity of residential buildings (Akande, 2010; Hatvani-Kovacs et al., 2016a). The popular use of ceramic tiles is good in coping with heat because of the cold sensation they give to the bare feet. Light colours in the internal walls are good for reflection. Ceilings prevent excessive heat gain thus improving indoor temperature. The colours of the mostly aluminium/iron roofing sheet are not so light, and this is not good for heat reflection. These show that the housing features were not completely heat resistant. Their choices in course of architectural design must have been influenced by several factors, of which heat resistance is one and not necessarily a priority.

Table 1. Characteristics of the Respondents' Dwellings

| | **Types** | **No** | **Percent** |
|---|---|---|---|
| Material of External Walls | Sandcrete blocks | 132 | 91.0% |
| | Bricks | 9 | 6.3% |
| | Others | 4 | 2.7% |
| Colour of Internal Walls | White | 69 | 47.5% |
| | Blue | 27 | 18.6% |
| | Red | 7 | 4.8% |
| | Green | 13 | 9.0% |
| | Yellow | 15 | 10.3% |
| | Purple | 3 | 2.1% |
| | Brown | 5 | 3.4% |
| | Others | 2 | 1.4% |
| Roof Material | Iron sheet | 135 | 93.1% |
| | Tiles | 3 | 2.1% |
| | Concrete | 1 | 0.8% |
| Roof Colour | White | 8 | 5.5% |
| | Black | 6 | 4.1% |
| | Blue | 16 | 11.0% |
| | Red | 31 | 21.4% |
| | Brown | 24 | 16.6% |
| | Pink | 38 | 26.2% |
| | Others | 17 | 11.7% |
| | Undisclosed | 5 | 3.4% |

| | | | |
|---|---|---|---|
| Flooring Material | Ceramic tiles | 102 | 70.3% |
| | Mortar | 14 | 9.7% |
| | Timber | 6 | 4.1% |
| | Terrazzo | 7 | 4.8% |
| | PVC tiles | 1 | 0.7% |
| | Others | 15 | 10.3% |
| Ceiling Type | Timber boards | 12 | 8.3% |
| | POP | 34 | 23.4% |
| | PVC boards | 47 | 32.4% |
| | Asbestos | 47 | 32.4% |
| | Undisclosed | 5 | 3.4% |
| Material of Key Furniture | Cotton | 64 | 44.1% |
| | Plastic | 15 | 10.3% |
| | Furry fabric | 53 | 36.6% |
| | Non-furry fabric | 10 | 6.9% |
| | Undisclosed | 3 | 2.1% |
| | **GRAND TOTAL** | **145** | **100** |

***Behavioural responses to heat***

To understand personal adaptation, respondents answered questions about their behavioural responses, within and/or around the house, when persistently high temperature leads to heat stress. They chose from a list of responses presented in the questionnaire. Using a fan (electric or manual - by hand), hydration (drinking fluids), changing to lighter clothes and relocating to a shaded space outside the house are the top four behavioural responses (See Table 2). Putting on lighter clothes aids sweat evaporation and allows air flow into the skin. Hydration reduces excessive loss of body fluids. The top responses from this survey are similar to what Taiwo et al., (2012) and Adebamowo and Olusanya (2012) found out from their studies in two other Nigerian cities. These top responses are generally included in the list of tips publicised about dealing with extreme heat from government agencies such as the National Emergency Management Agency (NEMA, 2013) and Nigerian Meteorological Agency (NIMET, 2017).

Behavioural responses mentioned during the follow-up interviews concur with those emanating from the survey. An interviewee acknowledged that occupants in the same room/building will not respond in the same ways due to differences in physiological make-up and human experiences (personal communication, Ms W, August 2018). The statement 'I don't feel hot … though my wife enters the rooms and says she is feeling hot' by another interviewee (personal communication, Mr J, August 2018) confirms the earlier point on physiological differences in response to heat. Behavioural responses to heat also vary across the two seasons (wet and dry) in Nigeria.

The rarest forms of responses include doing nothing, searching for information from books or online(internet), listening to the weather forecast and asking for help

from others (See Table 2). In a study conducted in Adelaide, Australia, asking help from others was also one of the least things people do in response to heat stress (Hatvani-Kovacs et al., 2016b). Although majority of the respondents are educated up to tertiary (69%) and secondary levels (25%) (see figure 1), the study could not ascertain what is responsible for the situation where most of them do not search or seek for information from relevant sources indicated. Answers in this section show that behavioural responses to persistently high temperature are largely reactionary rather than proactive. The respondents would rather adjust to the heat – doing something when it comes - than anticipating and making adequately informed preparations to prevent the negative experience.

Table 2. Behavioural Responses to Heat Stress

| **Responses** | **Yes** | **No** | **N/Applicable** | **Undisclosed** |
|---|---|---|---|---|
| Use fan (ceiling, pedestal) | 133 | 11 | 2 | 0 |
| Drink plenty of water/fluid | 132 | 11 | - | 2 |
| Wear light or loose clothing | 131 | 11 | - | 3 |
| Seek/spend time in the shade | 124 | 19 | 1 | 1 |
| Fan yourself by hand/manually | 124 | 11 | 9 | 1 |
| Open doors/windows/curtains | 117 | 19 | 8 | 1 |
| Move outdoors | 113 | 27 | 2 | 3 |
| Go to shower | 111 | 21 | 12 | 1 |
| Avoid/reduce activities | 110 | 28 | 6 | 1 |
| Use natural ventilation at night | 108 | 27 | 7 | 3 |
| Draw curtains | 104 | 36 | 3 | 2 |
| Move to cooler room in the house | 101 | 32 | 10 | 2 |
| Use air conditioner | 95 | 40 | 9 | 1 |
| Go to sleep | 75 | 63 | 6 | 1 |
| Plan the day to stay out of heat | 47 | 42 | 55 | 1 |
| Go to swimming pool | 46 | 66 | 32 | 1 |
| Wear a hat/cover head | 45 | 69 | 30 | 1 |
| Apply sunscreen (sun cream) | 39 | 56 | 49 | 1 |
| Check/Listen to weather forecast | 31 | 52 | 61 | 1 |
| Ask for help from others | 31 | 45 | 68 | 1 |
| Search for coping information online or in books | 26 | 57 | 61 | 1 |
| Do Nothing | 20 | 43 | 80 | 2 |

### *Heat resistant features in housing*

This study investigated what might be considered as heat resistant features in and around the respondents' dwellings. Being mass housing typologies, one assumes that each of the buildings have similar features. Notwithstanding the survey checked what was available before respondents occupied the dwelling and captured features that were later installed or alterations made to the dwelling to provide heat resistance or help to cope during heat stress. The results are presented in Table 3.

Although the houses occupied included design features for some

form of passive cooling/thermal control, this wasn't enough as respondents made structural alterations primarily targeted at heat resistance. Based on the survey, residents majorly install and use different kinds of mechanical (e.g. air-conditioners, table/wall/ceiling fans) and non-mechanical cooling (e.g. hand fans) devices when there is persistently high temperature (See Table 3). Using lighter curtains and window/entrance door nets were also top on the list. Entrance doors and windows were installed with nets to keep away mosquitoes and other insects whenever the doors or windows are opened for improved air flow (ventilation). Painting internal walls with light colours is another notable post-occupancy measure. As earlier pointed out in literature (Abimaje and Akingbohungbe, 2013), the light colours are good for heat reflection, thus keeping it away rather than absorbing it. Double walling and insulated walling were largely not applicable, given the geographical context in Akure and Nigeria. It was observed that ceiling materials are also replaced to improve thermal insulation.

| Features | Available before occupation | Implemented after occupation | Not applicable | Undisclosed |
|---|---|---|---|---|
| Light coloured roof | 110 | 21 | 13 | 1 |
| Roof insulation | 64 | 22 | 57 | 2 |
| Roof Ceiling | 82 | 50 | 11 | 2 |
| Double walling | 14 | 21 | 106 | 1 |
| Insulated walling | 25 | 25 | 91 | 4 |
| Light coloured internal walls | 53 | 78 | 11 | 3 |
| Ceramic floor/wall tiles | 54 | 60 | 28 | 3 |
| Glazing | 42 | 47 | 54 | 2 |
| Air Conditioner | 29 | 87 | 26 | 3 |
| Ceiling/Wall fans | 33 | 99 | 10 | 4 |
| Standing/Table Fans | 10 | 111 | 21 | 3 |
| Outdoor shady plants in the garden | 47 | 52 | 45 | 1 |
| Solar panels | 39 | 56 | 46 | 4 |
| Verandah/balcony | 56 | 46 | 40 | 3 |
| Awning | 75 | 35 | 33 | 2 |
| External blinds or shade clothes | 51 | 30 | 60 | 4 |
| Pergolas/Outdoor living areas | 36 | 54 | 51 | 4 |
| Building orientation | 55 | 41 | 46 | 3 |
| Using energy saving bulbs | 97 | 35 | 10 | 3 |
| Lighter curtain material | 27 | 112 | 4 | 2 |
| Entrance nets | 21 | 104 | 18 | 2 |
| Window nets | 63 | 76 | 4 | 2 |

Through the interviews, residents identified and suggested what they consider crucial in making their houses more heat-resistant and possibly for future mass housing projects. These include vegetation (especially trees around the houses), plastering internal walls with POP

(Plaster of Paris), ceramic tiles and not just ordinary mortar, generous headroom (enough floor to ceiling height). In a notable situation, expressing his sentiment on generous headroom, an interviewee said 'I don't open windows. That cannot stop the house from being hot. For the room not to be hot, the height between floor and ceiling must be high' (personal communication, Mr J, August 2018). Others include using high quality construction materials, incorporating shading elements (e.g. terraces, longer eaves), proper building orientation, installing cooling devices (e.g. fans, air conditioners) and optimal internal arrangement.

These suggestions concur with known measures for passive and active thermal control for buildings in the tropics. That they are being mentioned by lay people shows that their incorporation in the design of individual and prototypical residential buildings need to improve and probably be enforced. Architects and allied professionals have a role to play in this regard.

## 4. Conclusion

Through the case of mass housing estates in Akure (Nigeria), this study shows what the residents have been doing themselves and what they think should be done in terms of adaptation to heat. These further understanding about adaptation to heat stress at the household level through local eyes. Material characteristics of housing in the study area and how they contribute to coping with persistently high temperature was shown. It became clear that negative impact of heat stress prompts post-occupancy alterations in the houses. These point to possible means of retrofitting existing housing stock to enhance capacity for heat resistance, as well as improving thermal comfort.

From the findings on behavioural responses taken to cope with heat stress, it can be inferred that lifestyle approach to adaptation can be enhanced, especially promoting preventive rather reactionary approaches. Additionally, housing design and development needs to incorporate more heat resistance features, so that occupants are saved the burden of making additional features later. This should take place at the design stage and architects have a role to play in this regard. Heat impact assessment can be carried in housing estates to comprehensively understand the effect of heat stress and how to further tackle it. Overall, coping with heat stress at the local level should receive more attention from residents and relevant stakeholders.

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# Builders' Supervisory Competencies and Productive Performance of Artisans: The Significance of Experiencein Nigeria Construction Industry

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***Abstract:*** The study provided insight into how Builders' supervisory competencies influence the productive capabilities of construction artisans with a view to enhancing construction projects outcome in Nigeria, by evaluating the application of builders' supervisory functions, productive knowledge utilisation of artisans supervised by Builders and the relationship between Builders supervisory functions and productive knowledge of artisans. The survey utilized data from 84 copies of structured questionnaire received from 140 project managers. Data were analyzed using descriptive and inferential statistics. It was found that Builders' supervisory functions vary among levels of experience, while productive knowledge of artisans varies among the various experiences of the supervisors. Significant correlations exist among some artisanal productive knowledge and supervisory functions of builders. It was concluded that the competencies of builders increase with increased job experience, while the productive knowledge utilized by artisans increased with increase in the supervisory competencies of supervisors, therefore if the experience of a builder is not considered before assigning complex jobs and if project managers ignore the level of the productive competence of artisans before assigning supervisors, the optimum project outcome may not be realized. It is recommended that developers and project managers should adequately assess the experience of a builder before assigning supervisory functions on complex jobs. They should take the artisans' productive competence into consideration before assigning supervisors, so as to achieve desired project outcome. Professional bodies should provide enabling

environment for retraining and increasing the experience and supervisory competence of builders.

***Keywords***: Artisans; Builders; Construction Industry; Experience; Productive knowledge; Performance; Supervisory functions.

## 1.0 Introduction

The construction industry has always been given important recognition both in developed and developing nations because of its role in providing safe accommodation for man and his activities. The industry in Nigeria impacts nearly every facet of the economy and is responsible for about 16% of Gross Domestic Product (GDP) and employment of approximately 25% of labour force in Nigeria (Bilau, Ajagbe, Kigbu & Sholanke, 2015). The industry utilizes the input of numerous resources managedby various stakeholders who are either professionals or non-professionals (Anyanwu, 2013; Owolabi & Olatunji, 2014). Owolabi and Olatunji (2014) noted that "the professionals involved in the cycle of a building which span from inception through design, construction, completion, maintenance and to terminal demolition includes but not limited to; Architects, Builders, Estate Surveyors and valuers, Land Surveyors, Quantity Surveyors, Town Planners, Civil, Electrical, Mechanical and Structural Engineers".

The Builder is the professional at the hub of the physical construction of buildings. He carries out his building production role by superintending over the undertakings on a building construction site to realize a physical structure through transformation of designs, working drawings, and other building production documents (Anyanwu, 2013). In Nigeria, The National Building Code (NBC) (2006)stated that "the management of the execution of the building works together with the supervision of artisans and tradesmen shall be carried out by a registered Builder". The labour intensive construction operations in Nigeria requires artisans and tradesmen who use their skills and dexterity directly in the technical aspect of the production process thereby contributing to the speedy delivery of construction projects (Bilau et al., 2015). Nevertheless, literature has shown that most of the craftsmen and tradesmen employed during construction do not have adequate skill and knowledge of construction operations (Alwi, Keith & Sherif, 2001; Shinde, Gupta & Magdum, 2014). In corroboration, Chukwuji (2012) observed that every construction operation especially in complex building projects usually have large number of craftsmen, artisans and labourers who must be properly supervised to ensure that they carry out their various jobs according to production drawings and specifications. Shinde, Gupta and Magdum (2014) opined that the quality of supervision is determined by the skill and competencies of the supervisor. In most cases , adequate accountability, authority and responsibility are usually given to the supervisor for planning, leading, coordinating and directing the work of others in order to achieve the overall

objective of the group. However, incidences of building failures associated with poor construction supervision have become an issue of foremost concern in Nigeria's major cities (Agwu, 2013). The study noted the frequent collapse of residential and commercial buildings under construction while, many others crumble while being occupied, resulting in the loss of many lives and destruction of properties worth billions of naira. Moreover, some of the poor construction supervision were attributed to poor incompetent personnel (Agwu, 2013). Hence, consultants and contractors must have competent persons on site to monitor work as it progresses during construction. The aim of this study therefore, is to provide an insight into the significance of experience in the assessment of Builders' supervisory competencies , which affects the capabilities of construction artisans in projects they have supervised in Nigeria.

### 1.1 Objectives and Research Hypotheses of the Study

The objectives of this study were to; (i) evaluate the extent of application of builders' supervisory functions during building production management; (ii) assess the level of productive knowledge utilisation of artisans supervised by Builders', and (iii) evaluate the relationship between implementation of supervisory functions based on Builders experience and productive knowledge utilisation of artisans in Nigeria.

The hypothesis of this study, states that there is no significant correlation between the Builders' application of supervisory functions and the level of productive performance of artisans in the study area. The results of this hypothesis will provide an insight into the importance of experience and influence of Builder's supervisory functions on the productive performance of artisans in the study area. The results will also enlighten the stakeholders in the construction industry on the supervisory functions that can enhance the productivity of artisans in Nigeria.

## 2.0 Review of Related Literature

The literature review focuses on construction supervision, required competencies of construction supervisors and productive knowledge requirements of artisans.

### *2.1 Construction Supervision and Supervisory Competencies*

Studies have described construction supervision as planning, leading, coordinating and directing the work of others so as to ensure that the final product is in agreement with the conceived design (Ojo, Olabintan, Ojo & Salami, 2013; Shinde, Gupta & Magdum, 2014). For supervision to be effective, Ojo, Olabintan, Ojo and Salami (2013) posited that it must embrace all "inspections, observations and actions taking on site to ensure that an erected building conforms to design and specification at various sub-stages of construction process, involving numerous and complex activities that only well trained professionals can handle". Quality supervision ensures that resources are effectively and efficiently utilised, because the efficient way each phase of the construction process is managed, and the value of the end

product or services produced determines the effectiveness of supervisors' efforts (Alwiet al., 2001). According to Kadushin and Harkness (2002) supervisors can provide guidance which can aid workers efficiency and consequently lead to delivery of quality service. The functions of a supervisor are well documented in studies which includes; The Institute of Cost Accountants of India (ICAI) (2014), Hardison, Behm, Hallowell & Fonooni (2014), Shinde, Gupta & Magdum (2014) and, Ujene & Akpanamasi (2017).

### *2.2 Construction Artisans'Critical Productive Knowledge Requirements*

The processes of adequate skill attainment give rise to honing of certain productive knowledge required for efficiency of a worker based on dexterity, practical knowledge, theoretical knowledge and social ability (Winch & Clarke, 2003; Vokes & Brennan, 2013). These critical knowledge forms also known as the fundamentals of competence, ability and behaviour defines the way a worker can effectively execute a given task. Ujene and Umoh (2015) in corroboration with Scottish Further Education Unit (2005) and Vokes and Brennan (2013) identified some of the critical knowledge as "accuracy and precision, timeliness/time allocation competence, continuity/sustainability awareness, speed and efficiency competence, foundational competence, practical competence, creative competence, situational awareness, integration/reflexive competence, cross-discipline awareness, work development & promotion ability, teaching competence, communication competence, resource allocation competence, collaboration and team working ability, waste avoidance and minimization ability, leadership/control competence, safety consciousness, negotiation competence, flexibility and adaptability competence". Wachira, Root, Bowen and Olima (2008) referred to some of productive knowledge as generic skills whichtake on different meanings in different work contexts and are broadly transferable from one individual to another. The common types of generic skills acquired by craftsmen include; estimation, supervision of work, preparation of quotations, interpretation of documents, job management, determination of work method and material specification (Wachira, Root, Bowen & Olima, 2008).These previous studies served as sources of the critical knowledge used in this study.

### 2.3 Some Previous Studies on Construction Supervision

The importance of supervision on construction projects have been investigated in literature internationally and locally. Alwi, Keith, and Sherif (2001) evaluated the effects of quality supervision on rework in the Indonesian Context based on questionnaire administered on large contracting organisations in Jakarta and interviews held with ten project managers and supervisors from ten building construction sites. It was found that the quality of site supervision in Indonesia is directly related to the supervisor's level of experience gained through formal training. Hence, the study explored the

relationship between the quality of site supervision, expressed as training cost, and the rework cost borne by contractors in high-rise building construction, to suggest that the quality of site supervision, represented by the supervisors' level of experience gained from formal training, has a strong negative relationship with the rework cost on a construction project.

Hardison (2012) assessed the knowledge-based competencies necessary for the front-line construction supervisor, using survey based research that is administered through subsequent rounds of data collection that included controlled and anonymous feedback (Delphi-technique). The study used a panel of fourteen construction safety experts from American Society of Safety Engineers Construction Practice Specialty list served on LinkedIn.com to establish fifteen key knowledge-based competencies suggested to be most important to the construction supervisor with respect to improving construction site safety performance out of the thirty two identified knowledge-based competencies. Ojo, Olabintan, Ojo, and Salami (2013) investigated design and construction supervision as structurally sustainable tools for building failure/collapse in Nigeria. The records of some reported building failures/collapses, structural defects in some selected roofs and the extent of professional involvement in their design and construction in Nigeria were examined. The factors responsible for the failure of building design and construction supervision process were also identified. The paper concluded that structural sustainability can be greatly improved upon through design and construction supervision by depending on highly skilled professionals.

Hardison et al. (2014) carried out a study to prioritize the most important knowledge-based competencies for front-line construction supervisors for effective site safety in the United States using the Delphi technique. The study provided insight on additional competencies that should be included among the 30-hour Occupational Safety and Health Administration (OSHA) training topics for the construction site supervisor. The study concluded that for effective management of construction site safety by supervisors, they must possess both the baseline 30-hour training and other competencies relating to pre job planning, organizing of work flow, establishing effective communication, and a knowledge of routine and non-routine work tasks. Shinde, Gupta and Magdum (2014) investigated the impact of quality supervision on rework in the Indian construction industry based on a survey targeted on large contracting organizations in Pune and nearby area. The Study utilised questionnaire administered on contractors, designers, clients and interviews held with eight project managers and supervisors in order to supplement the findings of the questionnaire survey. The study found that unskilled site supervision is the principal cause of rework during construction, and concluded that supervision is more likely to be dependent on the experience, instead of the number of supervisors involved

in a project. Agwu (2014) examined the relationship between poor construction supervision and unsustainable building construction practices with regard to incessant building failures in six major cities in Nigeria between September 2012 and August 2013. The paper adopted descriptive research design using questionnaire administered on 397stratified randomly and area clustered selected registered members of Nigerian Institute of Building (NIOB) from six major cities in Nigeria. Results of the study indicated that significant relationship exists between poor construction supervision and unsustainable building construction practices (use of substandard designs, materials, manpower & procedures)/building failures in Nigeria.

Ling and Tan (2015) investigated the association between a site supervisor's attributes and project outcomes. The study identified the attributes of site supervisors that are significantly correlated with project outcomes (cost, time, quality and client satisfaction), and examined if site supervisors with different educational levels and job experience have different attributes. The study utilised questionnaire designed based on the attributes identified from the literature review and distributed among Singapore-based construction site supervisors. The results showed that site supervisors with IT skills are likely to have projects with good time, quality and satisfaction outcomes, while the projects of supervisors with longer work experience show significantly better time performance and higher client satisfaction. Ujene and Akpanamasi (2017) provided insight into the required supervisory competencies of selected professionals and factors influencing quality of supervision, with a view to enhancing productivity and construction projects delivery in Uyo, Nigeria. The study on the relationship between site supervisors' attributes and the productive performance of artisans is therefore scarce in the study area, hence this study.

## 3.0 Methodology

This study adopted a qualitative research design. It utilised the exploratory and deductive cross-sectional survey approach which quickly helped to expose, frequency and relationships (and non-relationships) among variables at a specific time without accentuating on processes or changes over time (Mann, 2003; Saunders, Lewis and Thornhill, 2009). After content validity and distribution through research assistants, the collected instrument was tested for reliability and found to be of high level with Cronbach α of 0.79 and 0.81 for the Builders' supervisory and artisans' productive knowledge questions respectively. These values were considered satisfactory, because the alpha values are greater than 0.6 (Gliem and Gliem, 2003).The population of the study comprised Construction project managers who have utilised Builders and artisans in the execution of building projects in Nigeria. The sample frame comprised eighty four project managers obtained from the questionnaire returned from mailed questionnaire sent to a total of 140

project managers in different construction firms in Nigeria. The choice of project managers as respondents is due to the view that the main role of the project manager is in the administration of the project. The project manager manages the clients' resources and co-ordinates all other stakeholders which requires adequate understanding of all the manpower related issues (Shibani & Sukumar, 2015). This study identified eighteen Builders' supervisory functions from Hardison (2012), The Institute of Cost Accountants of India (ICAI)(2014), Hardison, Behm, Hallowell and Fonooni (2014), Shinde, Gupta and Magdum (2014), Hardison et al. (2014) and Ling and Tan (2015), while twenty two critical knowledge requirements of artisans were identified from Winch and Clarke (2003), Scottish Further Education Unit (2005), Wachira, Root, Bowen and Olima (2008), Vokes and Brennan (2013) and Ujene and Umoh (2015). The project managers were requested to evaluate the extent of application of the identified supervisory functions by Builders' who have worked under them as well as the level of productive performance attained by artisans supervised by the Builders during production. The measurements were on a five point Likert-scale namely: poor=1, low=2, moderate=3, high=4 and very high=5. The total weight value (TWV) was arrived at from the summation of the products of the number of responses for the rating of each variable and the respective weight value for each rating. The relative importance index (RII) method was used in line with the formula used by Ugwu and Haupt (2007) and Enshassi, Mohamed and Abushaban (2009) as shown in equation 1

$$RII = \sum W / A \times N \quad \ldots\ldots\ldots\ldots (1)$$

W is defined as weight ascribed to each variable by the respondents, with values of 1 to 5; A represents maximum weight = 5; N represents the overall respondents.

A cut-off score of RII computed was determined by summing the weights and dividing by the total number of weighting items and highest weight respectively: (1+2+3+4+5)/5/5 = 0.60. Thus, events that have RII that are higher than 0.60 are defined as important, those with RII equal to 0.60 are moderate, while those less than 0.60 are less important. This study adopted a threshold of 0.60 representing above average, since there is no specific threshold of a RII available in the literature as authors use threshold of 0.6 or 0.7, while others select the top 5 or top 10 variables for explanation (Alashwal & Al-Sabahi, 2018). The correlations between the Builders supervisory functions among levels of experience and demonstration of productive knowledge of artisans were tested with spearman rank correlation.

## 4.0 Results, Analyses and Discussions

The result and discussion are presented in this section.

### *4.1 Characteristics of Respondents used for the Study*

For an understanding of the characteristics of the respondents, their sex, age, zone of operation, qualification and experience were

evaluated. The results are presented in table 1.

Table 1: Descriptive results of Project managers Features

| **Features** | **Sub features** | | |
|---|---|---|---|
| | | **N** | **%** |
| | Male | 78 | 90.7 |
| Sex | Female | 6 | 9.3 |
| | Total | 84 | 100 |
| | 1-17yrs | 0 | 0 |
| Age | 18-60yrs | 65 | 77.4 |
| | >60yrs | 19 | 22.6 |
| | Total | 84 | 100 |
| Zone of | North central | 15 | 17.9 |
| Operation | North west | 13 | 15.5 |
| | South west | 19 | 22.6 |
| | South east | 16 | 19.0 |
| | South south | 21 | 25.0 |
| | Total | 84 | 100 |
| | OND | 2 | 2.4 |
| | HND | 6 | 7.1 |
| Qualification | B.Sc | 42 | 50.0 |
| | M.Sc | 22 | 26.2 |
| | P.hD | 12 | 14.3 |
| | Total | 84 | 100 |
| | 1-5yrs | 10 | 11.9 |
| Experience | 6-10yrs | 16 | 19.0 |
| | 11-15yrs | 19 | 22.6 |
| | 16-20yrs | 24 | 28.6 |
| | >20yrs | 15 | 17.9 |
| | Total | 84 | 100 |

The result in Table 1 shows that majority of the project managers were male (90.7%,) who are adults (100% more than 18years) fairly spread across five out of the six geopolitical zones in Nigeria (over 15% in each zone). Majority of the respondents equally have the basic qualification (B.Sc-50%, M.Sc-26.2%), while those with more that eleven years' experience are over 69%. Hence, the results generally imply that the selected respondents have the required features to provide reliable information for this study.

### *4.2 Evaluation of Supervisory Competencies Application of Builders*

For the purpose of evaluating the extent of application of builders' supervisory functions during building production, eighteen supervisory functions identified were presented to project managers to evaluate among Builders of varying experiences. The result in Table 2 indicates that 41.12% of the supervisory functions attained more than the cut-off level among builders with 1-5 years of experience, 50% for builders with 6-10 years of experience, 55.55% for builders with

11-15 years of experience, 66.67% for builders with 16-20 years of experience and, 83.33% for builders with more than 20 years of experience. The result is an indication that there is variation in the level of application of supervisory functions among the various categories of builders investigated. The result shows that builders with 1-5 years' experience were better at selecting workers, knowing & enforcing quality and safety, builders with 6-10 years' experience were better at selecting the workers, having good knowledge of work routine and quality assurance; builders with 11-15 years' experience were better at interpretation of drawings, as well as safety and quality assurance. The result also shows that builders with 16-20 years' experience were better at directing worker tasks and responsibilities, knowing & enforcing quality and selection of workers, while builders with more than 20 years' experience were better at job planning & work flow organization, adequate knowledge of work routine and directing worker tasks and responsibilities.

Table 2: Project managers' evaluation of supervisory competencies application of Builders

| **Experience of Builders (years)** | **1-5** | | **6-10** | | **11-15** | | **16-20** | | **Above 20** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **No of respondents evaluated** | **N= 10** | | **N= 16** | | **N=19** | | **N=24** | | **N=15** | |
| **Supervisory functions of Builders** | **RII** | **Rank** | **RII** | **Rank** | **RII** | **Rank** | **RII** | **Rank** | **RII** | **Rank** |
| Job planning & work flow organization | 0.56 | 9 | 0.63 | 6 | 0.63 | 8 | 0.68 | 9 | 0.83 | 1 |
| Good knowledge of work routine | 0.60 | 6 | 0.65 | 2 | 0.64 | 7 | 0.70 | 6 | 0.80 | 2 |
| Directing worker tasks and responsibilities, | 0.50 | 15 | 0.61 | 8 | 0.66 | 4 | 0.77 | 1 | 0.80 | 2 |
| Knowing & enforcing safety | 0.64 | 3 | 0.63 | 6 | 0.71 | 2 | 0.68 | 9 | 0.77 | 4 |
| Reading & understanding the drawings | 0.62 | 4 | 0.64 | 4 | 0.73 | 1 | 0.72 | 5 | 0.77 | 4 |
| Effective communication of orders | 0.52 | 11 | 0.45 | 16 | 0.44 | 17 | 0.68 | 9 | 0.77 | 4 |
| Knowing & enforcing quality | 0.66 | 1 | 0.65 | 2 | 0.68 | 3 | 0.74 | 2 | 0.77 | 4 |
| Making the work interesting | 0.58 | 8 | 0.55 | 13 | 0.53 | 11 | 0.53 | 15 | 0.72 | 8 |
| Reading and writing reports for work | 0.60 | 6 | 0.64 | 4 | 0.63 | 8 | 0.69 | 8 | 0.72 | 8 |
| Selecting the workers, | 0.66 | 1 | 0.66 | 1 | 0.66 | 4 | 0.73 | 3 | 0.71 | 10 |
| Introduction of new work methods | 0.52 | 11 | 0.58 | 12 | 0.49 | 15 | 0.54 | 13 | 0.69 | 11 |
| Induction of new employees, | 0.40 | 18 | 0.44 | 17 | 0.40 | 18 | 0.41 | 18 | 0.68 | 12 |
| Training the employees | 0.52 | 11 | 0.59 | 10 | 0.51 | 13 | 0.54 | 13 | 0.67 | 13 |
| Enforcing discipline | 0.62 | 4 | 0.61 | 8 | 0.61 | 10 | 0.70 | 6 | 0.63 | 14 |
| Establishing positive team work | 0.54 | 10 | 0.59 | 10 | 0.52 | 12 | 0.66 | 12 | 0.61 | 15 |
| Assessing workers stress levels | 0.52 | 11 | 0.53 | 15 | 0.51 | 13 | 0.47 | 16 | 0.56 | 16 |
| Co-ordination between workers & managers | 0.44 | 17 | 0.44 | 17 | 0.65 | 6 | 0.73 | 3 | 0.49 | 17 |
| Handling grievances | 0.50 | 15 | 0.55 | 13 | 0.47 | 16 | 0.45 | 17 | 0.45 | 18 |

The results generally indicate that builders are generally proficient in work planning and organization, directing of workers task and ensuring quality and safety at work. The possible explanation for this finding is that in most institution of learning where building is offered in Nigeria, significant concern is placed on construction programme, construction methodology, and quality and safety management knowledge. However, it can be seen that the competencies of the builders increase with increase in job experience, and the implication of this is that if the job experience of a builder is not properly considered before assigning complex jobs (with

many artisans and activities) not so much will be achieved in terms of project outcomes, this is in line with the observation by Ling and Tan (2015) that experience of a supervisor has significant influence on project outcomes.

### *4.3 Evaluation of Productive Knowledge Utilization of Artisans Supervised by Builders*

The second objective assessed the level of productive knowledge utilization of artisans supervised by Builders' during production, For this purpose twenty two productive knowledge of artisans identified were presented to project managers to evaluate among artisans supervised by Builders of varying experiences. The result is presented on Table 3

.

Table 3: Project managers' evaluation of productive knowledge utilisation of artisans supervised by Builders

| **Experience of Builders** | **1-5** | | **6-10** | | **11-15** | | **16-20** | | **Above 20** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **No of respondents evaluated** | **N= 10** | | **N= 16** | | **N=19** | | **N=24** | | **N=15** | |
| **Critical knowledge of artisans** | **RII** | **Rank** | **RII** | **Rank** | **RII** | **Rank** | **RII** | **Rank** | **RII** | **Rank** |
| practical competence | 0.70 | 2 | 0.68 | 3 | 0.65 | 1 | 0.65 | 4 | 0.72 | 1 |
| leadership/control competence | 0.50 | 10 | 0.59 | 12 | 0.64 | 3 | 0.63 | 5 | 0.69 | 2 |
| speed and efficiency competence | 0.44 | 18 | 0.71 | 1 | 0.51 | 21 | 0.61 | 11 | 0.68 | 3 |
| resource allocation competence | 0.70 | 2 | 0.59 | 12 | 0.60 | 10 | 0.52 | 22 | 0.68 | 3 |
| safety consciousness | 0.66 | 5 | 0.64 | 8 | 0.60 | 10 | 0.68 | 1 | 0.68 | 3 |
| continuity/sustainability awareness | 0.46 | 12 | 0.56 | 17 | 0.47 | 22 | 0.53 | 18 | 0.65 | 6 |
| waste avoidance &minimization ability | 0.44 | 18 | 0.66 | 4 | 0.61 | 7 | 0.63 | 5 | 0.65 | 6 |
| Document interpretation | 0.52 | 20 | 0.52 | 19 | 0.58 | 13 | 0.53 | 18 | 0.65 | 6 |
| communication competence | 0.46 | 12 | 0.58 | 15 | 0.58 | 13 | 0.63 | 5 | 0.64 | 9 |
| Planning /organising competence | 0.44 | 18 | 0.56 | 17 | 0.54 | 19 | 0.60 | 13 | 0.63 | 10 |
| teaching competence | 0.44 | 18 | 0.59 | 12 | 0.61 | 7 | 0.58 | 15 | 0.63 | 10 |
| accuracy and precision | 0.46 | 12 | 0.56 | 17 | 0.62 | 6 | 0.61 | 11 | 0.61 | 12 |
| creative competence | 0.62 | 8 | 0.63 | 9 | 0.63 | 4 | 0.66 | 3 | 0.61 | 12 |
| work development & promotion ability | 0.70 | 2 | 0.60 | 10 | 0.60 | 10 | 0.55 | 17 | 0.61 | 12 |
| collaboration and team working ability | 0.72 | 1 | 0.66 | 4 | 0.65 | 1 | 0.68 | 1 | 0.61 | 12 |
| negotiation competence | 0.64 | 6 | 0.56 | 17 | 0.61 | 7 | 0.62 | 8 | 0.61 | 12 |
| foundational competence | 0.46 | 12 | 0.58 | 15 | 0.55 | 17 | 0.58 | 15 | 0.60 | 17 |
| situational awareness | 0.46 | 12 | 0.56 | 17 | 0.58 | 13 | 0.53 | 18 | 0.57 | 18 |
| cross-discipline awareness | 0.64 | 6 | 0.65 | 6 | 0.63 | 4 | 0.62 | 8 | 0.57 | 18 |
| Estimation competence | 0.48 | 11 | 0.56 | 17 | 0.54 | 19 | 0.62 | 8 | 0.57 | 18 |
| flexibility and adaptability competence | 0.42 | 22 | 0.65 | 6 | 0.56 | 16 | 0.60 | 13 | 0.56 | 21 |
| integration/reflexive competence | 0.46 | 12 | 0.69 | 2 | 0.55 | 17 | 0.53 | 18 | 0.53 | 22 |

Table 3 shows that the artisans supervised by builders with 1-5 years' experience utilized 36.36% of the productive knowledge identified, the artisans supervised by builders with 6-10 years' experience utilized 45.45% of the productive knowledge identified, while the artisans supervised by builders with 11-15 years' experience utilized 54.55% of the productive knowledge. The result also shows that the artisans supervised by builders with 16-20 years' experience utilized 63.64% of the

productive knowledge, while the artisans supervised by builders with more than 20 years' experience utilized 77.27% of the productive knowledge identified. The artisans supervised by the least experience builders showed better performance in collaboration and team work, work development & promotion and practical ability. Those supervised by builders with 6-10 experience performed better in speed and efficiency competence, integration/reflexive competence and practical competence. Artisans supervised by builders with 11-15 years' experience performed better in practical competence, collaboration and team working ability and leadership/control competence. The builders with 16-20 years' experience encourage artisans more on safety consciousness, collaboration and team working ability and creative competence, while the builder with more than 20 years' experience encourage artisans more on practical competence, leadership/control competence and speed and efficiency competence. The result showed increase in productive knowledge of artisans with increase in the job experience of the supervisors. This may be attributable to the variation in the supervisory attributes of the builders, an indication that the experience acquired on the job has influence on how productive knowledge is imparted on artisans. The implication of this is that if project managers do not take the level of productive competence of artisans into consideration before assigning supervisors, then the expected optimum project outcome may not be realized.

### *4.4 Association between Builders' supervisory competence and artisans' productive knowledge*

To evaluate the association between builders' supervisory competencies and productive performance of artisans, the four most important builders' supervision functions which attained the cut of score of 0.60 were correlated with the five most important productive knowledge of artisans supervised by the different level of experience, in view of the significant variation observed among the level of experience. The four most important supervisory competencies represent about 20% of the identified competencies in line with Pareto rule that 20% of the causes are responsible for 80% effect (Callaghan, 2014). The hypothesis proposed for this study was tested with the spearman rank correlation, with similar decision rule that thehypothesis is accepted if p-value greater than 0.05, and the hypothesis is rejected, but if p-value is less than or equal to 0.05.The results in Table 4 show that among builder with 1-5 years' experience 'selecting the workers' correlated significantly with "collaboration and team working ability", "work development & promotion ability' and "safety consciousness" of artisans. 'Knowing & enforcing quality' correlated with 'practical competence' and 'resource allocation competence', while 'knowing & enforcing safety' correlated with 'collaboration and team working ability', 'work development & promotion ability' and 'safety consciousness'.

Table 4: correlation of artisanal productive knowledge and supervisory functions of builders with 1-5 years' experience

| Variable correlated | TWV | Mean | SD | R | P-value | Decision |
|---|---|---|---|---|---|---|
| **Selecting the workers,** | **33** | **3.300** | **1.160** | | | |
| collaboration and team working ability | 36 | 3.600 | 0.966 | 0.947 | 0.001 | Reject |
| work development & promotion ability | 35 | 3.500 | 0.850 | 0.980 | 0.001 | Reject |
| practical competence | 35 | 3.500 | 1.179 | 0.468 | 0.172 | Accept |
| resource allocation competence | 35 | 3.500 | 0.972 | 0.330 | 0.352 | Accept |
| safety consciousness | 33 | 3.300 | 1.160 | 0.838 | 0.001 | Reject |
| **Knowing & enforcing quality** | **33** | **3.300** | **1.160** | | | |
| collaboration and team working ability | 36 | 3.600 | 0.966 | 0.407 | 0.244 | Accept |
| work development & promotion ability | 35 | 3.500 | 0.850 | 0.470 | 0.170 | Accept |
| practical competence | 35 | 3.500 | 1.179 | 0.951 | 0.001 | Reject |
| resource allocation competence | 35 | 3.500 | 0.972 | 0.866 | 0.001 | Reject |
| safety consciousness | 33 | 3.300 | 1.160 | 0.301 | 0.399 | Accept |
| **Knowing & enforcing safety** | **32** | **3.200** | **1.317** | | | |
| collaboration and team working ability | 36 | 3.600 | 0.966 | 0.653 | 0.041 | Reject |
| work development & promotion ability | 35 | 3.500 | 0.850 | 0.776 | 0.008 | Reject |
| practical competence | 35 | 3.500 | 1.179 | 0.243 | 0.498 | Accept |
| resource allocation competence | 35 | 3.500 | 0.972 | 0.044 | 0.903 | Accept |
| safety consciousness | 33 | 3.300 | 1.160 | 0.997 | 0.001 | Reject |
| **Reading & understanding the drawings** | **31** | **3.100** | **1.287** | | | |
| collaboration and team working ability | 36 | 3.600 | 0.966 | 0.273 | 0.445 | Accept |
| work development & promotion ability | 35 | 3.500 | 0.850 | 0.399 | 0.253 | Accept |
| practical competence | 35 | 3.500 | 1.179 | 0.772 | 0.009 | Reject |
| resource allocation competence | 35 | 3.500 | 0.972 | 0.650 | 0.042 | Reject |
| safety consciousness | 33 | 3.300 | 1.160 | 0.422 | 0.225 | Accept |

'Reading & understanding the drawings' correlated with 'practical competence' and 'resource allocation competence'. These suggests that when builders with 1-5 years' experience are able to select good workers, enforce quality and safety, the artisans supervised would be more productive in terms of collaboration and team work, work development and promotion, safety at work, practical skill and resource allocation. The p-values less than the significant value of 0.05 indicated that the resulting associations were not by chance.

Table 5 shows that among builder with 6-10 years' experience 'selecting the workers' and 'reading and understanding the drawings' correlated significantly with 'integration/reflexive competence' and 'collaboration and team working ability' of artisans. 'Good knowledge of work routine' and' knowing and enforcing quality' correlated with 'speed and efficiency competence',

'practical competence', and 'waste avoidance & minimization ability'.

Table 5: correlation of artisanal productive knowledge and supervisory functions of builders with 6-10 years' experience

| Variable correlated | TWV | Mean | SD | R | P-value | Decision |
|---|---|---|---|---|---|---|
| **Selecting the workers,** | **53** | **3.313** | **1.195** | | | |
| speed and efficiency competence | 57 | 3.563 | 0.892 | -0.189 | 0.482 | Accept |
| integration/reflexive competence | 55 | 3.438 | 1.031 | 0.987 | 0.001 | Reject |
| practical competence | 54 | 3.375 | 0.885 | 0.003 | 0.990 | Accept |
| waste avoidance and minimization ability | 53 | 3.313 | 0.793 | 0.081 | 0.765 | Accept |
| collaboration and team working ability | 53 | 3.313 | 1.014 | 0.975 | 0.001 | Reject |
| **Good knowledge of work routine** | **52** | **3.250** | **0.842** | | | |
| speed and efficiency competence | 57 | 3.563 | 0.892 | 0.876 | 0.001 | Reject |
| integration/reflexive competence | 55 | 3.438 | 1.031 | 0.091 | 0.737 | Accept |
| practical competence | 54 | 3.375 | 0.885 | 0.953 | 0.001 | Reject |
| waste avoidance and minimization ability | 53 | 3.313 | 0.793 | 0.976 | 0.001 | Reject |
| collaboration and team working ability | 53 | 3.313 | 1.014 | -0.007 | 0.980 | Accept |
| **Knowing & enforcing quality** | **52** | **3.250** | **0.775** | | | |
| speed and efficiency competence | 57 | 3.563 | 0.892 | 0.793 | 0.001 | Reject |
| integration/reflexive competence | 55 | 3.438 | 1.031 | 0.209 | 0.438 | Accept |
| practical competence | 54 | 3.375 | 0.885 | 0.861 | 0.001 | Reject |
| waste avoidance and minimization ability | 53 | 3.313 | 0.793 | 0.870 | 0.001 | Reject |
| collaboration and team working ability | 53 | 3.313 | 1.014 | 0.099 | 0.714 | Accept |
| **Reading & understanding the drawings** | **51** | **3.188** | **1.047** | | | |
| speed and efficiency competence | 57 | 3.563 | 0.892 | 0.068 | 0.802 | Accept |
| integration/reflexive competence | 55 | 3.438 | 1.031 | 0.619 | 0.011 | Reject |
| practical competence | 54 | 3.375 | 0.885 | 0.273 | 0.305 | Accept |
| waste avoidance and minimization ability | 53 | 3.313 | 0.793 | 0.303 | 0.253 | Accept |
| collaboration and team working ability | 53 | 3.313 | 1.014 | 0.537 | 0.032 | Reject |

This suggests that when builders with 6-10 years' experience are able to select workers, interpret drawings with good knowledge of work routine and quality, the artisans supervised would be more productive in terms of adaptation to situations, collaboration and team work, speed and efficiency at work, practical capability and waste control. The p-values less than the significant value of 0.05 indicated that the resulting associations were not by chance.

Table 6 shows that among builder with 11-15 years' experience 'reading and

understanding the drawings' ,'knowing and enforcing safety' and 'knowing and enforcing quality' all correlated with 'practical competence', 'collaboration and team working ability' and 'creative competence', while 'directing worker tasks and responsibilities' correlated with 'practical competence' and 'collaboration and team working ability'.

Table 6: correlation of artisanal productive knowledge and supervisory functions of builders with 11-15 years' experience

| Variable correlated | TW | Mean | SD | R | P-value | Decision |
|---|---|---|---|---|---|---|
| **Reading & understanding the drawings** | **69** | **3.632** | **1.165** | | | |
| practical competence | 62 | 3.263 | 1.368 | 0.920 | 0.001 | Reject |
| collaboration and team working ability | 62 | 3.263 | 1.284 | 0.885 | 0.001 | Reject |
| leadership/control competence | 61 | 3.211 | 0.855 | -0.018 | 0.942 | Accept |
| creative competence | 60 | 3.158 | 1.344 | 0.917 | 0.001 | Reject |
| cross-discipline awareness | 60 | 3.158 | 0.834 | -0.064 | 0.795 | Accept |
| **Knowing & enforcing safety** | **67** | **3.526** | **1.124** | | | |
| practical competence | 62 | 3.263 | 1.368 | 0.959 | 0.001 | Reject |
| collaboration and team working ability | 62 | 3.263 | 1.284 | 0.925 | 0.001 | Reject |
| leadership/control competence | 61 | 3.211 | 0.855 | -0.070 | 0.776 | Accept |
| creative competence | 60 | 3.158 | 1.344 | 0.933 | 0.001 | Reject |
| cross-discipline awareness | 60 | 3.158 | 0.834 | -0.133 | 0.587 | Accept |
| **Knowing & enforcing quality** | **65** | **3.421** | **1.017** | | | |
| practical competence | 62 | 3.263 | 1.368 | 0.899 | 0.001 | Reject |
| collaboration and team working ability | 62 | 3.263 | 1.284 | 0.912 | 0.001 | Reject |
| leadership/control competence | 61 | 3.211 | 0.855 | -0.162 | 0.508 | Accept |
| creative competence | 60 | 3.158 | 1.344 | 0.869 | 0.001 | Reject |
| cross-discipline awareness | 60 | 3.158 | 0.834 | -0.134 | 0.583 | Accept |
| **Directing worker tasks and** | **63** | **3.316** | **1.108** | | | |
| practical competence | 62 | 3.263 | 1.368 | 0.459 | 0.048 | Reject |
| collaboration and team working ability | 62 | 3.263 | 1.284 | 0.474 | 0.040 | Reject |
| leadership/control competence | 61 | 3.211 | 0.855 | -0.232 | 0.339 | Accept |
| creative competence | 60 | 3.158 | 1.344 | 0.438 | 0.060 | Accept |
| cross-discipline awareness | 60 | 3.158 | 0.834 | -0.287 | 0.233 | Accept |

These suggest that when builders with 11-15 years' experience are able to interpret the drawings, enforce safety and quality with adequate knowledge of directing worker tasks, the artisans supervised would be more productive in terms of practical capability, collaboration and team work, and creativity at work. The results show that the resulting associations were not by chance as p-values were less than the significant value of 0.05.

Table 7 shows that among builder with 16-20 years' experience 'directing worker tasks and responsibilities' and 'co-ordination between workers and managers' correlated with, 'safety consciousness', collaboration and team working ability' and 'leadership/control competence'. 'knowing and enforcing quality' correlated with 'creative competence' and 'practical competence, while 'selecting the workers' correlated with 'collaboration and team working ability', 'creative and practical competences'

Table 7: correlation of artisanal productive knowledge and supervisory functions of builders with 16-20 years' experience

| Variable correlated | T W | Mean | SD | R | P-value | Decision |
|---|---|---|---|---|---|---|
| **Directing worker tasks and responsibilities,** | **92** | **3.833** | **1.007** | | | |
| safety consciousness | 82 | 3.417 | 1.100 | 0898 | 0.001 | Reject |
| collaboration and team working ability | 81 | 3.375 | 1.173 | 0905 | 0.001 | Reject |
| creative competence | 79 | 3.292 | 0.999 | 0.322 | 0.125 | Accept |
| practical competence | 78 | 3.250 | 0.989 | 0.283 | 0.181 | Accept |
| leadership/control competence | 77 | 3.208 | 1.285 | 0.933 | 0.001 | Reject |
| **Knowing & enforcing quality** | **89** | **3.708** | **0.859** | | | |
| safety consciousness | 82 | 3.417 | 1.100 | 0.143 | 0.506 | Accept |
| collaboration and team working ability | 81 | 3.375 | 1.173 | 0.159 | 0.459 | Accept |
| creative competence | 79 | 3.292 | 0.999 | 0.870 | 0.001 | Reject |
| practical competence | 78 | 3.250 | 0.989 | 0.863 | 0.001 | Reject |
| leadership/control competence | 77 | 3.208 | 1.285 | 0.116 | 0.588 | Accept |
| **Selecting the workers,** | **88** | **3.667** | **1.167** | | | |
| safety consciousness | 82 | 3.417 | 1.100 | 0.327 | 0.118 | Accept |
| collaboration and team working ability | 81 | 3.375 | 1.173 | 0.418 | 0.042 | Reject |
| creative competence | 79 | 3.292 | 0.999 | 0.575 | 0.003 | Reject |
| practical competence | 78 | 3.250 | 0.989 | 0.622 | 0.001 | Reject |
| leadership/control competence | 77 | 3.208 | 1.285 | 0.385 | 0.064 | Accept |
| **Co-ordination between workers & managers** | **87** | **3.625** | **1.096** | | | |
| safety consciousness | 82 | 3.417 | 1.100 | 0.775 | 0.001 | Reject |
| collaboration and team working ability | 81 | 3.375 | 1.173 | 0.781 | 0.001 | Reject |
| creative competence | 79 | 3.292 | 0.999 | 0.182 | 0.394 | Accept |
| practical competence | 78 | 3.250 | 0.989 | 0.132 | 0.539 | Accept |
| leadership/control competence | 77 | 3.208 | 1.285 | 0.869 | 0.001 | Reject |

These suggest that when builders with 16-20 years' experience are able direct worker tasks and responsibilities, co-ordinate between workers & managers, enforce quality with adequate knowledge of choice of workers, the artisans supervised would be more productive in terms of safety

consciousness, collaboration and team work, leadership/control, creative competence and practical capability. The resulting associations were found not to be by chance as p-values were less than the significant value of 0.05.

Table 8 shows that among builder with more than 20 years' experience 'job planning and organization of work flow', 'good knowledge of work routine' and 'knowing and enforcing safety' all correlated with, 'speed and efficiency competence', 'safety consciousness' and 'resource allocation competence', while ''directing worker tasks and responsibilities' correlated with 'practical competence' and 'leadership/control competence'. These suggest that when builders with more than 20 years' experience are able to plan, organize and direct work with good knowledge of work routine and safety the artisans supervised would be more productive in terms of 'speed and efficiency , 'safety consciousness', 'resource allocation, practical work execution and 'leadership/control ability. The resulting associations were found not to be by chance as p-values were less than the significant value of 0.05.

Table 8: correlation of artisanal productive knowledge and supervisory functions of builders with more than 20 years' experience

| Variable correlated | TWV | Mean | SD | R | P-value | Decision |
|---|---|---|---|---|---|---|
| **Job planning & organization of work flow.** | **62** | **4.133** | **0.915** | | | |
| practical competence | 54 | 3.600 | 1.298 | 0.195 | 0.485 | Accept |
| leadership/control competence | 52 | 3.467 | 1.407 | 0.226 | 0.419 | Accept |
| speed and efficiency competence | 51 | 3.400 | 1.056 | 0.896 | 0.001 | Reject |
| safety consciousness | 51 | 3.400 | 0.910 | 0.875 | 0.001 | Reject |
| resource allocation competence | 51 | 3.400 | 1.056 | 0.896 | 0.001 | Reject |
| **Good knowledge of work routine** | **60** | **4.000** | **0.926** | | | |
| practical competence | 54 | 3.600 | 1.298 | 0.195 | 0.480 | Accept |
| leadership/control competence | 52 | 3.467 | 1.407 | 0.239 | 0.392 | Accept |
| speed and efficiency competence | 51 | 3.400 | 1.056 | 0.783 | 0.001 | Reject |
| safety consciousness | 51 | 3.400 | 0.910 | 0.752 | 0.001 | Reject |
| resource allocation competence | 51 | 3.400 | 1.056 | 0.783 | 0.001 | Reject |
| **Directing worker tasks and responsibilities,** | **60** | **4.000** | **1.254** | | | |
| practical competence | 54 | 3.600 | 1.298 | 0.927 | 0.001 | Reject |
| leadership/control competence | 52 | 3.467 | 1.407 | 0.950 | 0.001 | Reject |
| speed and efficiency competence | 51 | 3.400 | 1.056 | 0.447 | 0.095 | Accept |
| safety consciousness | 51 | 3.400 | 0.910 | 0.404 | 0.135 | Accept |
| resource allocation competence | 51 | 3.400 | 1.056 | 0.447 | 0.095 | Accept |
| **Knowing & enforcing safety** | **58** | **3.867** | **0.990** | | | |
| practical competence | 54 | 3.600 | 1.298 | -0.134 | 0.635 | Accept |
| leadership/control competence | 52 | 3.467 | 1.407 | -0.113 | 0.689 | Accept |

| | | | | | | |
|---|---|---|---|---|---|---|
| speed and efficiency competence | 51 | 3.400 | 1.056 | 0.567 | 0.027 | Reject |
| safety consciousness | 51 | 3.400 | 0.910 | 0.582 | 0.023 | Reject |
| resource allocation competence | 51 | 3.400 | 1.056 | 0.567 | 0.027 | Reject |

## 5.0 Conclusion and Recommendation

The study provided insight into how well Builders can use their supervisory competencies to affect the productive capability of construction artisans for the purpose of improving construction projects outcome in Nigeria.

The study evaluated eighteen Builders' supervisory functions and twenty two critical knowledge requirements of artisans through the perception of project managers. It was found that the levels of supervisory functions which attained the cut-off level among builders vary increasingly in accordance with the years spent on the job. The result is an indication that the competencies of the builders increase with increase in job experience, and the implication of this is that if the job experience of a builder is not properly considered before assigning complex jobs (with many artisans and activities) not so much may be achieved in terms of project outcomes.

It was also found that the utilisation of productive knowledge identified by artisans supervised by builders vary somehow in accordance with the experience of the Builders who supervise them. The result is an indication that the experience acquired on the job has influence on how productive knowledge is imparted on artisans. The implication of this finding is that if project managers do not take the level of the productive competence of artisans into consideration before assigning supervisors, the expected optimum project outcome may not be realized.

It was found that significant correlations exist among some artisanal productive knowledge and supervisory functions of builders, which suggest that when builders with very few years of experience are able to select good workers, enforce quality and safety, the artisans supervised would be more productive in terms collaboration and team work, work development & promotion, safety at work, practical skill and resource allocation, when builders have acquired moderate years of experience are able to select workers, interpret drawings with good knowledge of work routine and quality, the artisans supervised would be more productive in terms of adaptation to situations, collaboration and team work, speed and efficiency at work, practical capability and waste control. When builders with many years of experience are able to interpret the drawings, enforce safety and quality with adequate knowledge of directing worker tasks, the artisans supervised would be more productive in terms of practical capability, collaboration and team work, and creativity at work. When builders with very many years of experience are able direct worker tasks and responsibilities, co-ordinate between workers & managers, enforce quality with adequate knowledge of

choice of workers, the artisans supervised would be more productive in terms of safety consciousness, collaboration and team work, leadership/control, creative competence and practical capability. When builders with more than very many years of experience are able to plan & organization and direct work with good knowledge of work routine and safety, the artisans supervised would be more productive in terms of 'speed and efficiency, 'safety consciousness', 'resource allocation, practical work execution and 'leadership/control ability. Consequent upon the findings of this study it is concluded that the competencies of builders increase with increase in job experience, while the productive knowledge utilized by artisans increased with increase in the supervisory competencies of the supervisors, therefore if the job experience of a builder is not properly considered before assigning complex jobs or if project managers do not take the level of the productive competence of artisans into consideration before assigning supervisors, the expected optimum project outcome may not be realized.

It is therefore recommended that developers and project managers should adequately assess thejob experience of a builder before assigning supervisory functions on complex jobs. They should also take the level of the productive competence of artisans into consideration before assigning appropriate supervisors, so as to achieve the expected optimum project outcome. It is also recommended that the professional bodies should provide enabling environment for retraining and increasing the experience and supervisory competence of builders.

## 6.0 Limitations of the Study

This study is limited to the eighteen Builders' supervisory functions and twenty two critical knowledge requirements of artisans selected from literature and the views of 84 project managers or their representatives who were considered as chief project administrators who returned their questionnaire. The result from this study can be improved upon by studying other construction stakeholders and more Builders' competencies not covered in this study. In spite of these limitations the result could provide reasonable insight into how Builders supervisory competencies can affect the productive capability of construction artisans for enhanced construction projects performance in Nigeria. It can also serve as guide for further studies.

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# Safety Practices and Labour Productivity in Construction Projects

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***Abstract:*** Safety and productivity issues are become a vital concern in the construction industry nowadays. Low labor productivity and unsafe working environment have often been claimed to relate each other. Base on that reason, the aim of this study was to identify the most influencing safety practices on construction labor productivity. Questionnaire survey form with the Likert scale questions gave to the respondents to achieve research objectives. Then, the average index method, Kruskal Wallis test, and factor analysis technique were used to analyzed data. The result showed that the using of basic personal protective equipment (PPE) and the existence of safe guard device are the most influencing safety practices on labor productivity. The contractor result is the highest score compare to the client and consultant. This result can be useful to all the stake-holders in construction projects, from the initial to the end of project stages. The most important contribution of this study is the identification of the safety practices factors that give positive influence to the labour productivity. If these factors have been identified, it is easier to prepare the construction process. Construction projects expected to be more productive and also safer.

***Keywords***: Safety practices, Labor productivity, Construction projects, Personal protective equipment (PPE).

## 1.0 Introduction

Labor productivity is an important subject and dominant in a construction management process. It is influenced by the use of resources in order to be efficient and economically use, which will eventually affect all stages of the construction process. Labor productivity in construction industry is influenced by a lot of factors. Myers (2004), categorized the factors that influencing the productivity into four groups, namely: the quantity and quality of natural and man-made resources, the quality and extent of the education and training of the labor force, the levels of expectation, motivation, and wellbeing, and the commitment to research and development. Tucker (1986) also explained the factors that causing productivity loss, are as follows : relative influence of labor costs, more sophisticated labor demands, more complex and larger projects, more participants and communication, centralization and specialization, accelerated schedules, increased paper work, and lack of research. Other factors defined are containing congestion, sequencing, weather, supervision, plant status, information, equipment, tools, materials, and rework Thomas and Sakarcan. (1994).

Safety is one of the influencing factors on labor productivity in construction industry based on previous research by (Dai, Goodrum and Maloney 2009; Herbsman and Ellis 1990 and Liberda Ruwanpura and Jergeas 2003). Safety can included in the labor factor, in management factor, in supervision factor, and others. The National Audit Office report (2001) also identified the root cause of the inefficiency in construction industry. One of the problems is the industry demonstrates a poor safety record and an inability to recruit good staff. Construction industry has been experiencing chronic problems such as poor safety, inferior working conditions, and insufficient quality. This industry has earned the reputation of being dangerous or highly hazardous industry because of the disproportionately high frequency of accidents and fatalities that occur on construction sites (The Business Roundtable 1983; Churcher and Alwani-Starr 1996 and Smallwood and Haupt 2000). Being dangerous refers to being risky, hazardous, or unsafe.

This study will identify safety practices that give most positive influences to labour productivity. If the factors have been identified, the stake-holders in construction projects will be easy to prepare construction works to reach the optimum labour productivity.

## 2.0 Literature Review

In safety management, there are two terms related to safety practices, namely unsafe actions and unsafe conditions. Injuries are the result of a combination of unsafe actions and unsafe conditions. Unsafe actions may be the outgrowth of a number of causes, including lack of proper training, lack of the attention to the work, carelessness, macho behavior, and inadequate instructions. Unsafe actions may include actions taken by managers or the failure of managers in doing action to make the job safe. The mental environment prompts many unsafe actions. Unsafe actions by workers may also be influenced by management. It should be noted that unsafe actions can occur even though workers would prefer not to sustain any injuries Hinze (1997). According

to Abdelhamid and Everett (2000), an unsafe condition is a condition where the physical layout of the workplace or work location as well as the status of tools, equipment, and/or materials are in violation of contemporary safety standards. Examples of unsafe conditions include open sided floors, defective ladders, improperly constructed scaffolds, protruding ends of reinforcing rods, protruding nails and wire ties, un-shored trenches, defective equipment, overloaded tools or equipment, unprotected explosive materials, ungrounded electrical tools, flying materials, etc.

Safety and productivity issues have gained vital importance in the competitive global environment (Choudhry, Fang and Hinze 2008). Low labor productivity and unsafe working environment have often been claimed to relate to each other. It has been said that the improvement of the working environment lays the foundations for the improvement of labor productivity (Kemppilä, Laitinen and Mettänen 2004). In line with the increasing awareness of all parties involved in the construction industry about the importance of occupational safety to improve labour productivity, this study try to identify the safety practices factors that influence the labour productivity. It needs to identify the safety practices that give a positive influence to increase labor productivity. Indonesia as one of developing countries in Asia facing the both of safety and productivity problems in their construction industry. Therefore, this research aim is to determine the most influencing safety practices on labour productivity in construction industry in one of province in Indonesia. With respect to so many safety practices from various resources, this paper has been summarized the safety practices to be asked to the respondents in the questionnaire survey.

## 3.0 Methodology

In total, 144 questionnaires filled by the respondents. Respondents for this research were people who work as contractors, consultants, and owners in a middle management position. The reasons why choose the middle management staff are: because they have an important responsibilities for the continuity of works and almost every day stay tune at the project. They also have a power to the workers about safety and health matters. In accordance with the scope of the research, the work site was in the Pekanbaru City, Riau Province, Indonesia. The selected respondents were the people who worked at the contractor company with grade 5, 6, and 7 in Indonesian contractor grade system. The location of respondents was in the same city, so it was quite efficient when distributing the questionnaires by means of direct distribution.

For data analysis, there were three types of statistical method used, namely descriptive statistics, inferential statistics, and factor analysis technique. This study also tested the reliability and validity of the research instruments and results from the research questionnaire survey.

From Table 1 the Cronbach's Alpha values are 0.932 and 0.942. If alpha is bigger than 0.90, it means it has perfect reliability. Value of Guttman

Split-Half coefficient is 0.930; it is bigger than value of r product moment from product moment table. It was obtained from r table for $\alpha = 0.05$, and degrees of freedom (df = n-1 = 144-1 = 143), the value is 0.164. It can be concluded that all instruments used in these questionnaires meet the requirements of reliability. If an item is valid, it must be reliable. There are 31 items which will be tested whether they are valid or invalid. To declare that an item is valid must be proved through calculation.

To determine the level of validity, it should be noted the value of rcount compared to rtable. If the value obtained for rcount is greater than the value of rtable from product moment table, it means that each item in this research is considered valid. From the result, the value of rcount for all safety practice items is greater than the value of rtable. The value of r table = 0.164. This indicates that all of the research instruments meet the standards of validity.

Table 1. Reliability test

| | | | |
|---|---|---|---|
| Cronbach's Alpha | Part 1 | Value | 0.932 |
| | | N of Items | 16[a] |
| | Part 2 | Value | 0.942 |
| | | N of Items | 15[b] |
| | | Total N of Items | 31 |
| | | Correlation Between Forms | 0.870 |
| Spearman-Brown Coefficient | | Equal Length | 0.930 |
| | | Unequal Length | 0.930 |
| | | Guttman Split-Half Coefficient | 0.930 |

a. The items are: P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16.

b. The items are: P16, P17, P18, P19, P20, P21, P22, P23, P24, P25, P26, P27, P28, P29, P30, P31

Data was then analyzed using the statistical computing package SPSS (Statistical Package for Social Science) version.17.0. In descriptive statistic, the average index was obtained from the frequency analysis that was measured to rank each safety practices which is influence to labor productivity. This formulation was used to calculate average index by Al-Hammad and Assaf (1996).

Average Index (AI) = $\sum (a_i.x_i) / \sum x_i$ (1)

where, $a_i$ = constant expressing the weight given to i, and $x_i$ = variable expressing the frequency of response for i = 1,2,3,4,5. In this questionnaire, the choices are : 1 = not influence, 2 = less influence, 3 = moderately influence, 4 = influence, and 5 = very influence.

To specify the level of influence of safety practices on labor productivity as in questionnaire, this study applied the classification of the rating scales proposed by Abd Majid (1997) as the following, and was adjusted to the statements in the questionnaire. This also showed the strength of indices of respondents' options. Not Influence $0.00 < AI < 1.50$, Less Influence $1.50 \leq AI < 2.50$, Moderately Influence $2.50 \leq AI < 3.50$, Influence $3.50 \leq AI < 4.50$, and Very Influence $4.50 \leq AI < 5.00$.

For inferential statistic, Kruskal-Wallis test was used to compare three or more groups of data samples (*K* populations) and that might have different sample sizes. This technique is commonly used as an alternative if the assumptions in the ANOVA (Analysis of Variance) test cannot be met or data are not a normal distribution. Kruskal-Wallis test is a distribution-free test (Morgan, et al, 2007). The preparation of the Kruskal Wallis test hypothesis and the steps of hypothesis testing are as follows: If $H_0$ : All *K* populations are identical, and If $H_1$ : Not all *K* populations are identical.
This study examined whether the response of the three groups of respondents (owners, contractors and consultants) was significant.

The factor analysis technique was applied to reduce the large amount of data to a small number of factors (or components), showing the group of safety practices that has the most influence on labor productivity. The factor analysis technique is too complex to be described here, but can be read in most statistical texts. In short, it takes into account the weighting of the various variables (items), scored by the respondents, and combine them together to form a group of factors (group of safety practices).

Each safety practices for the questionnaire purpose named as P1 to P31. All statements given in the questionnaire are positive statements, or the opposite of the statements of "unsafe actions" and "unsafe conditions". It is intended that respondents think the positive influence of safety practices on labor productivity.

## 4.0 Results and Discussion

Discussion of the research findings was based on results of the average index and classification of rating scales and factor analysis technique which are shown in Table 2 to Table 6.

### 4.1. Descriptive Statistic

Table 2 is a summary for overall results from three types of respondents. In this table, P.1 and P.9 are considered as safety practices which are very influential to the labor productivity. The respondents choose that using personal protective equipment (PPE) and providing and installing safe guard devices give a positive impact to improve productivity. The remaining 29 safety practices are categorized as "influence" items.

### 4.2. Test of Differences of Mean Score (Kruskal-Wallis test)

This section will test whether there are differences in average scores between the three types of respondents using the Kruskal-Wallis test for several independent samples. The result is

given at Table 2. The assumptions for this test are; Ho: mean value of the three types of respondents is identical, and Ha : mean value of the three types of respondents is not identical. From the test results, it is obtained that α = 0.05, Sig = 0.00. Because Sig < α (0.00 < 0.05), then Ho is rejected or Ha is accepted. The conclusion is the average value of the three types of companies is not identical or not significant. There are differences among the three groups. There is a difference in opinions from the respondents in providing an assessment for each safety practice that influences labour productivity.

Table 2 Rank of safety practices from all types of respondents

| de | Safety Practices | Std Deviation | AI (N=144) | Rank | Class of Rating Scales |
|---|---|---|---|---|---|
| P1 | Using basic personal protective equipment and clothing, e.g. safety shoes, helmet, and gloves | 0.117 | 4.61 | 1 | Very Influence |
| P9 | Providing and installing safe guard devices e.g. safety net, guard rail, and safety sign board | 0.1**Co**66 | 4.52 | 2 | |
| P18 | Paying more attention to the dangerous works, like working in the roof, under ground work etc. | 0.157 | 4.49 | 3 | Influence |
| P4 | Supervisor should have safety knowledge, motivate, and push their workers to work safely. | 0.207 | 4.47 | 4 | |
| P22 | Paying more attention to the heavy equipment, e.g. tower crane, bulldozer, scrapper also operator's skill | 0.065 | 4.45 | 5 | |
| P2 | Using any other specialized protective equipment required for a specific task, e.g. respiratory, eye, face, and hearing protection | 0.081 | 4.40 | 6 | |
| P21 | Using appropriate equipment and tools | 0.136 | 4.36 | 7 | |
| P6 | Awareness of workers toward safety | 0.096 | 4.35 | 8 | |
| P7 | Working area is tidy and clean from the rubbish and waste material | 0.244 | 4.34 | 9 | |
| P31 | Strict / firm management toward safety practice on the project | 0.248 | 4.33 | 10 | |
| P23 | Paying more attention to the supporting work devices, such as ladder, scaffolding, platform, and safety harness | 0.124 | 4.31 | 11 | |
| P8 | Providing adequate worker facilities e.g. toilet and barracks | 0.151 | 4.31 | 12 | |
| P14 | Safety orientation for new workers | 0.150 | 4.28 | 13 | |
| P10 | Allocation planning at the site, and providing traffic line of workers and materials | 0.192 | 4.26 | 14 | |
| P30 | Designation of safety officer at the site | 0.275 | 4.26 | 14 | |
| P28 | Developing safety plan for the whole site and for each task | 0.080 | 4.26 | 14 | |
| P3 | Not taking an obvious risk when conducting the job | 0.070 | 4.26 | 14 | |
| P13 | Giving a short training when using new equipment or tools | 0.045 | 4.25 | 15 | |
| P16 | Safety inspection regularly at the site | 0.236 | 4.25 | 15 | |
| P20 | Checking condition of equipment and tools before using | 0.138 | 4.25 | 15 | |
| P19 | Maintenance and repair of equipment and tools | 0.080 | 4.24 | 16 | |

| | | | | |
|---|---|---|---|---|
| P29 | Communicating safety target / goal to the workers, such as "zero accident" target, safety first, etc. | 0.136 | 4.24 | 16 |
| P17 | Safety hazards inspection before starting the works | 0.147 | 4.22 | 17 |
| P12 | Conducting safety training regularly for the employees | 0.245 | 4.20 | 18 |
| P15 | Giving a short training about method and procedure of the work | 0.255 | 4.20 | 18 |
| P25 | Clear and written safety policy and regulation at the site | 0.195 | 4.19 | 19 |
| P24 | Conducting field safety meeting / toolbox meeting regularly | 0.135 | 4.17 | 20 |
| P5 | Executing hazard analysis and work analysis before working toward safety | 0.246 | 4.17 | 20 |
| P27 | Investigation of an accident to know the causes of the accident as a preventive and corrective action for the future | 0.172 | 4.14 | 21 |
| P11 | No adverse environment, such as noise, light, dust, and heat | 0.075 | 4.13 | 22 |
| P26 | Safety evaluation/monitoring program regularly | 0.227 | 4.07 | 23 |

Based on 'mean rank (for all companies)' at the Table 3, the high mean rank scores indicate that the respondents at that company have the high mean rank. In this case, the contractors have a mean rank 70.73 as the highest value, followed by consultants with 37.35, and client with 32.92. This also means that respondents who work in the contractor company assess safety practices as more influencing than the other two companies. This is accordance with the statement that contractor hold a very important role in the implementation of safety and health management system in their project (Hughes and Ferrett 2007). For consultant, unfortunately, a survey about designers revealed that "less than one-third of the design firms address construction worker safety in their design (Hinze and Wiegand 1992), and it is proven in this research, consultant got the score below the contractor. As well as the client, obtain a lower score below the value of the contractor. Although the owners involvement in construction safety can pay real dividends through reduced injuries. Before any construction contract is contemplated, owners should assess their commitment to safety

### 4.3. Factor Analysis Technique

The average index is used to identify the items that will be clustered into a number of factors that have the closest or similar characteristics. Mean score from each item is less than two (4.61 to 4.07), and almost close to each other; it means that respondents consider most items are in "influence category" on the labor productivity. This result shows that it is significant to analyze the finding using factor analysis

From Table 4, the value of KMO MSA test was 0.919, certainly and substantially exceeding the recommended value of 0.70. Meanwhile, the value of Bartlett's Test of Sphericity was 3278.997 and significant at 0.00. It means that the variables are correlated highly enough

to provide a reasonable basis for factor analysis.

Table 3. Kruskal-Wallis test result

| Ranks | | | | Test Statistics[a,b] | |
|---|---|---|---|---|---|
| **Company** | | **N** | **Mean Rank** | | **Mean** |
| Mean | 1 - client | 31 | 32.92 | Chi-Square | 36.401 |
| | 2 - contractor | 31 | 70.73 | df | 2 |
| | 3 - consultant | 31 | 37.35 | Asymp. Sig. | 0.000 |
| | Total | 93 | | Std Deviation | 0.185 |

a. Kruskal Wallis Test
b. Grouping Variable: company

Table 4: KMO and Bartlett's test

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | 0.919 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 3278.997 |
| | Df | 465 |
| | Sig. | 0.000 |

The factor analysis technique was utilized to help identifying the underlying cluster of factors that dominate safety performance. The research has applied the factor analysis on the 31 safety practices.. Test of factorability was performed using Kasier-Meyer-Olkin's measure of sampling adequacy. In order to give meaning to the results of the factor analysis, it is necessary to assign an identifiable name to the group of factors of high correlation coefficient. Table 5 shows that there are five factors obtained from the rotated factor matrix. The bold and italic value indicated that the item is included into the above component/factor. Example item P24 is in component 1; it has the greatest value contained in component 1.

**Table 5. :** Rotated factor matrix

| Item | Component | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| P24 | ***0.662*** | 0.281 | 0.190 | 0.228 | 0.196 |
| P5 | ***0.599*** | 0.482 | 0.060 | 0.096 | 0.158 |
| P11 | ***0.616*** | 0.168 | 0.160 | 0.168 | 0.443 |
| P1 | ***0.564*** | -0.079 | 0.212 | 0.343 | 0.361 |
| P13 | ***0.576*** | 0.281 | 0.261 | 0.249 | 0.268 |
| P12 | ***0.546*** | 0.211 | 0.214 | 0.544 | 0.169 |
| P16 | ***0.555*** | 0.296 | 0.248 | 0.485 | 0.115 |
| P17 | ***0.548*** | 0.302 | 0.400 | 0.204 | 0.212 |
| P3 | ***0.476*** | 0.044 | 0.359 | 0.058 | 0.312 |
| P29 | 0.194 | ***0.717*** | 0.179 | 0.404 | 0.164 |
| P28 | 0.225 | ***0.679*** | 0.262 | 0.135 | 0.185 |
| P26 | 0.431 | ***0.621*** | 0.261 | 0.236 | 0.265 |
| P27 | 0.120 | ***0.607*** | 0.429 | 0.252 | 0.226 |
| P25 | 0.220 | ***0.526*** | 0.250 | 0.389 | 0.435 |
| P20 | 0.296 | 0.320 | ***0.725*** | 0.097 | 0.196 |
| P19 | 0.255 | 0.293 | ***0.666*** | 0.061 | 0.371 |
| P21 | 0.246 | 0.205 | ***0.666*** | 0.324 | 0.044 |
| P22 | 0.097 | 0.084 | ***0.667*** | 0.457 | 0.239 |
| P23 | 0.196 | 0.455 | ***0.610*** | 0.112 | 0.194 |
| P30 | 0.206 | 0.502 | 0.201 | ***0.520*** | 0.115 |
| P4 | 0.288 | 0.305 | -0.033 | ***0.464*** | 0.480 |
| P31 | 0.065 | 0.407 | 0.057 | ***0.704*** | 0.326 |
| P18 | 0.211 | 0.036 | 0.367 | ***0.559*** | 0.363 |
| P15 | 0.441 | 0.280 | 0.282 | ***0.614*** | -0.014 |
| P14 | 0.407 | 0.245 | 0.251 | ***0.550*** | 0.129 |
| P9 | 0.300 | 0.140 | 0.104 | 0.176 | ***0.689*** |
| P10 | 0.266 | 0.382 | 0.242 | 0.045 | ***0.586*** |
| P8 | 0.106 | 0.309 | 0.308 | 0.210 | ***0.558*** |
| P2 | 0.501 | 0.192 | 0.114 | 0.116 | ***0.540*** |
| P6 | 0.256 | 0.390 | 0.324 | 0.058 | ***0.510*** |
| P7 | 0.145 | 0.016 | 0.365 | 0.381 | ***0.557*** |

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
Rotation converged in 25 iterations

Table 6 is a result of factor analysis for questionnaire about safety practices that influence labor productivity in construction. These are five factors that have been formed and have similar characteristics. The factors can be identified by delivering the group name based on their similar characteristics, such as in the column (3) of Table 5.

**Table 6 Result of extracted of factor analysis**

| Factor | Safety Practices | Name of the Group |
|---|---|---|
| (1) | (2) | (3) |
| 1 | P1, P3, P5, P11, P12, P13, P16, P17 and P 24 | Standard and Procedure |
| 2 | P25, P26, P27, P28, and P29 | Management |
| 3 | P19, P20, P21, P22, and P23 | Equipment and Tools |
| 4 | P4, P14, P15, P18,P30, and P31 | Personnel |
| 5 | P2,P6,P7,P8,P9, and P10 | Environmental |

## 5.0. Conclusions

Based on the analysis, some conclusions can be drawn as follows:

a. The aim of the research was to identify the most influencing safety practices on construction labor productivity has been achieved. All safety practices have been sorted by the highest value to lowest. "Using basic personal protective equipment and clothing, e.g. safety shoes, helmet, and gloves' and 'providing and installing safe guard devices e.g. safety net, guard rail, and safety sign board'
b. All respondents agreed that safety practices have a positive influence on labour productivity, it can be seen from the results, the answer given just two types, namely "very influence" and "influence"
c. Safety practices P1 (using basic personal protective equipment and clothing, e.g. safety shoes, helmet, and gloves) and P9 (providing and installing safe guard devices e.g. safety net, guard rail, and safety sign board, installing safe guard devices e.g. safety net, guard rail, and safety sign board) obtaining the highest average index (AI) score, so fall into the category of "very influence", the others (29 safety practices) fall into the category "influence".
d. Based on the results of the questionnaire, it was found that respondents from the contractors have a mean or average index higher than clients and consultants. It can also be interpreted that they are more aware and understanding of the influence of safety practices on labor productivity in construction field. The reason is the contractor is the direct executor of the construction work, so they should know the safety management.
e. There are 5 factors or groups that are formed from the results of the factor analysis technique, namely: standard and procedure, management, equipment and tools, personnel, and environmental. All the safety practices in the questionnaire survey form, which amounted to 31 items have been get into the groups that have similar characteristics.

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