AWARENESS AND EFFECTIVENESS OF QUALITY FUNCTION DEPLOYMENT (QFD) IN DESIGN AND BUILD PROJECTS IN NIGERIA

INTRODUCTION

Presently, Nigeria is pursuing a project tagged “vision 2020” as one of its strategies to become one of the top leading twenty economies in the world by 2020. In order to achieve this vision, Nigeria is focussing on the development of five key sectors that includes a massive construction of residential buildings and other infrastructure that will be contracted to Design and Build Companies. Large scale construction of low-cost residential buildings is on-going to provide houses at reduced cost for citizens and for Government activities. The Government in its effort to encourage indigenous contractors to be part of this vision 2020 has introduced a mobilisation fee clause which allows contractors to be paid ten per cent of the total contract sum before commencement of work on site (Adegoke, n.d.). Despite the efforts by the Government, there are still cases of building distress and serious defects to a degree that these structures are unable to safely perform their intended purposes due to defects in construction, resulting in serious dissatisfaction from end-users and Government. Some very common defects identified includes wall cracking as a result of poor construction materials, foundation settlement as a result of failure to carry out soil tests, improper foundation types, roof buckling, compromise and misplacement of clients priority. Other factors resulting in dissatisfaction include delays, cost over-run, misuse of materials during construction and collapse of structures (Yates and Lockley, 2002). These defects mostly occur as a result of poor design, faulty construction from “cowboy” engineers, use of low quality materials, lack of proper supervision, involvement of ethical standards or benchmarks, poor management, omissions in design specification, inadequate information from clients (Customers), and lack of technical measures to transform these specified requirements into objectives and targets (Olabosipo and Adedamola, 2010). Certainly these weaknesses result in cost overrun, late delivery in project completion time, low quality structures with low life span. These in turn result in the construction of residential buildings that do not meet requirements.

The construction industry in Nigeria is being viewed as one with poor quality emphasis compared to other sectors. Many criticisms have been directed at the construction industry for inferior workmanship especially in the aspect of trained manpower, technology, design quality, durability, life span and sustainability of residential homes, as well as lack of systematic setting of standards and benchmarks and prioritisation of customer needs (Windapo and Martins, 2010). Hence, this study considers whether client requirements are considered from design, planning and execution stages and to investigate the awareness of Quality Function Deployment (QFD) and its effectiveness in aiding design and build companies in identifying and prioritising client requirements as well as the accomplishment of these requirements in the Nigerian Construction Industry.

QFD has been found to ensure quality from design to construction stages, by translating client requirements into appropriate technical objectives and targets (Pheng and Yeap, 2001), resulting in client satisfaction, infrastructural development of nations and continuous improvement in the construction industry.

In countries such as Japan, United States of America, United Kingdom and Canada, QFD has become a tool for translating customer requirements into objectives and targets through quality of thought, quality of processes and quality of action (Windapo and Martins, 2010). In these developed countries, Quality Function Deployment is seen as a pro-active customer driven planning process (Chan and Wu, 2002) that enables problems to be identified and solved at the very beginning of a construction project. The application of QFD is encouraged not only at the usual product planning and process planning stages (Geiger and Steger, 1995), but also applicable to strategic planning and other specific types of planning (Chan and Wu, 2002). However, in Nigeria, the application of QFD in construction has not been identified in any accessible literature, hence this research is significant in investigating the awareness and effectiveness of QFD in the planning stage, design specifications, procedures to set objectives and targets as well as how these objectives are prioritised within design and build projects in Nigeria.

QUALITY MANAGEMENT IN THE NIGERIAN CONSTRUCTION INDUSTRY

Effective quality management in the design and construction of building projects is an important factor in the successful management of building projects that ensures the

accomplishment of client's requirements (Achi et al, 2007). Quality management in the construction industry encompasses; quality control, quality assurance, quality improvements, and quality standards (Olatunji et al, 2012). In Nigeria, efforts have been made by the Government and its established agencies such as the Standard Organisation of Nigeria (SON), Nigerian Society of Engineers (NSE), Institute of Civil Engineers (ICE) and the Nigerian Institute of Building (NIOB) to enforce quality practices in the construction industry. This has led to the adoption of the International Organization for Standardization's ISO 9000 series to ensure proper quality management in the industry. However, the responsibility to meet these standards lies with the design and build consultants and companies (Idrus and Sodangi, 2010). The last decade however exposed the low level of client satisfaction from built facilities in Nigeria as a result of poor quality performance in addition to the perennial problems of time and cost over-run (Idrus and Sodangi, 2010). A survey conducted by Achi et al (2007) asserts that the construction industry in Nigeria has demonstrated an inability to identify and discuss client requirements and transform these into objectives and targets through the use of techniques like QFD (Achi et al, 2007). Similarly, Mbachu and Olaoya (1999) (cited by Ameh and Osegbo, 2011) opined that the Nigerian Construction industry is beleaguered by projects that are completed much later than mutually planned, with results from research conducted by Odusami and Olusanya (2000) showing that most residential building projects in Lagos metropolis experienced an average time over-run of 51% on their planned duration (Ameh and Osegbo, 2011). The National Bureau of statistics (NBS) further asserts that the economic performance of the construction industry has been very poor. For example, the Nigerian Construction Industry's contribution to employment has consistently remained at 1.0 per cent over the last decade as against the World Bank's average observation of 3.2 per cent in developing countries (NBS 2010; Idrus and Sodangi, 2010). Additionally, the Nigerian Institute of Building (NIOB, 2008) noted that eighty four buildings had collapsed within the past twenty years in Nigeria, claiming over four hundred lives. Hence, the Nigerian Construction industry is associated with poor quality performance (Okpachui et al, 2010).

THE CONCEPT OF QUALITY FUNCTION DEPLOYMENT

Quality Function Deployment (QFD) was conceived in Japan in the late 1960s (Akao, 2004) during the period of transformation within Japanese industries from their product

development which was based on imitation and copying towards product development based on originality (Cohen, 1995). This concept was targeted towards quality development in new products by means of designing customer requirements into products before manufacturing. This was done under the umbrella of Total Quality Control with the sole aim of satisfying customers by transforming customer demands into design targets and major quality assurance points to be used throughout the stages of production (Akao, 2004). In 1972, the effectiveness of QFD was demonstrated at the Mitsubishi heavy industries Kobe shipyard (Oakland, 2003) and in 1978 the first book on the subject was published in Japanese and later translated to English in 1994 (Cohen, 1995).

According to Cohen (1995), QFD is a method for structured product planning and development that enables a development team to specify clearly the wants and needs of customers and evaluate each proposed product capability systematically in terms of its impact in satisfying those set wants and needs. The ultimate goal of QFD as described by Akao (2004) is to translate subjective quality criteria into objective ones that can be quantified and measured as a means of determining how and where priorities are to be assigned during product development (Reilly, 1999). Project Management Body of Knowledge (PMI, 2009) describes QFD as an example of a facilitated workshop technique that helps determine critical characteristics for new product development. Similarly, Liu and Wu (2008), define QFD as an effective quality tool that ensures the fulfilment of customer requirements in terms of achieving customer's expected and exciting qualities in a product, hence improving customer satisfaction and ensuring continuous improvement (Bossert, 1991).

QFD METHODOLOGY

The methodology of QFD involves constructing one or more matrices or quality tables (Gargione, 1999), the first of which is called the House of Quality (HOQ) (Cohen, 1995) as shown in Figure 1. The phases involved in QFD are broken down into four respective phases (A, B, C and D) as discussed below:

Phase A: This is known as the planning phase. It consists of customer requirement identification and documentation, strategic planning on how to execute a project, a statutory check on the strength and weakness of the organisation, as well as the technical ability of the organisation to meet each requirement. This is followed by structuring these identified needs

in order to place needs in a hierarchy (Cohen, 1995). This phase is the first step in building the House of Quality, hence it is sometimes referred to as the House of Quality Stage.

Phase B: This phase is called the Design Phase. Every design requires high creativity and innovative team ideas to identify multiple construction options to satisfy clients' requirement (Day, 2009). Hence, the need for a good engineering team in an organisation. In the construction industry, the design department consists of Quantity Surveyors, Architects, Mechanical, Electrical and Structural Engineers, Project Manager, as well as Health and Safety personnel or CDM Coordinator (Kubal, 1994). Others may include; Interior Designer, Legal Advisor, Ecologist, and Fire Engineer. It is the purpose of this team to guide, support, and educate employees on matters relating to the company's quality improvement process program (Day, 2009).

Phase C: This phase is referred to as Process Planning phase (Akao, 2004). In this phase, plans are made on the best means to execute a project.

Phase D: This is called the Process Control phase (Cohen, 1995). In this phase, performance indicators are created to monitor the effectiveness of the processes involved in production of a certain product or service. In the construction industry control measures may include proper training, specification, benchmarking, proper scheduling and risk analysis.

The purpose of QFD extends to providing product developers with a systematic means of deploying the voice of the customer into; product design in planning a new product, design a product requirement, determine process characteristics, control manufacturing process, and in documentation of already existing product specification (Akao, 2004).

QFD has the house of quality as its first planning step (Alarcon and Mardones 1998), it comprises of two basic groups of decision making processes (Liu and Wu 2008). These processes include; collecting customer requirements, and determining the relationship between these requirements; and technical measures needed to achieve the requirements by a cross functional team (Liu and Wu, 2008).

The House of Quality (HOQ) as shown in Figure 1 displays customer requirements, also known as the voice of the customer (Delgado-Hernandez et al 2007). It also contains the development team's technical response to meeting specified requirements (Cohen, 1995). Figure 1 is a typical illustration of the HOQ that shows the sections or sub matrices

constituting a House of Quality joined together in different ways, with each section containing information that relates to the others (Oakland, 2003). The alphabetic order (A to F) suggested in Figure 1 is a logical sequence for filling in the matrix and a structured systematic expression for a good understanding of an aspect of the entire planning process for a new product, service or process by a development team (Cohen, 1995).

2.5.1 House of Quality (HOQ)

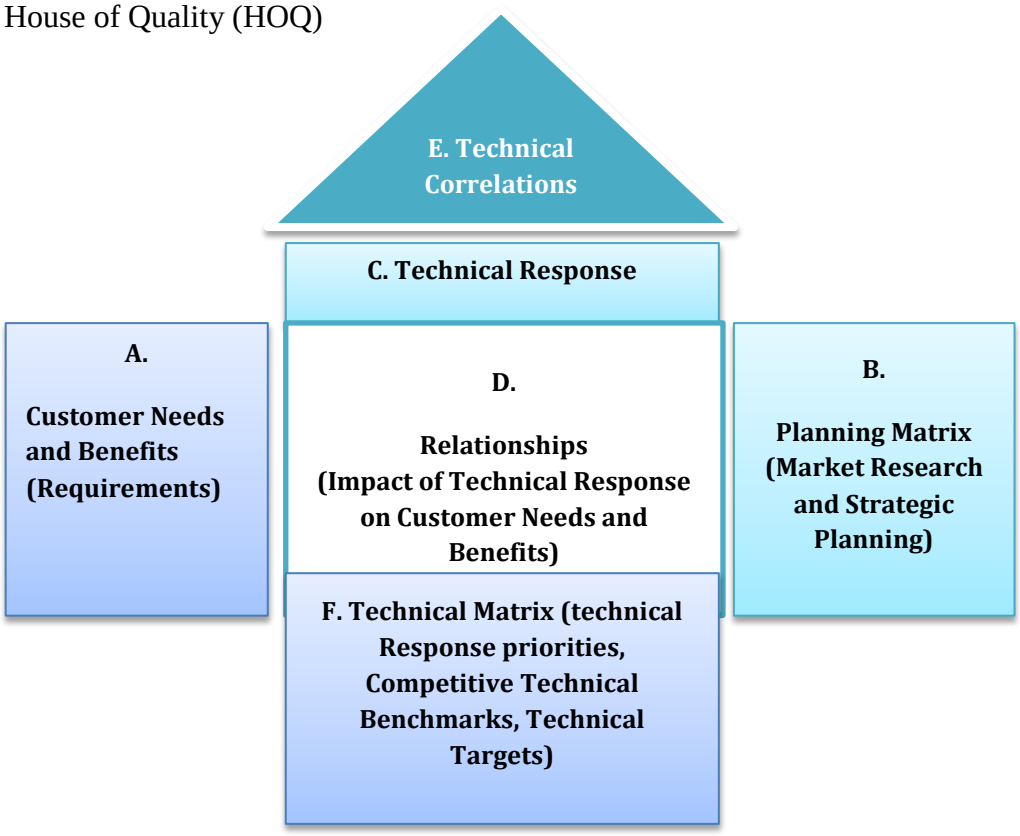

Fig. 1 House of Quality (Cohen, 1995)

From Figure 1, Section A contains a list of customer wants and needs systematically structured based on qualitative market research/survey (Delgado-Hernandez et al 2007). Section B contains three main types of information which includes; qualitative market data that specifies the relative importance of customer wants and needs as well as customer satisfaction levels with the organisation and what can be gained from competitors (Cohen, 1995). Secondly, it contains a strategic goal setting for a new product or service and thirdly, it

contains computations ranked in an orderly manner to prioritise customers want and need (Liu and Wu, 2008).

Section C contains the Technical response and competence of an organisation (Dikmen et al 2005), including information needed to transform customers' needs and wants into technical terms and the correlation between each customer wants and technical response. Section D contains the judgment of the development team's strength on the relationship between each element of the organisation's technical response based on each customer want and need (Liu and Wu, 2008). Section E, "the roof', considers the extent to which the organisation's available technical responses support each other or an assessment of the interrelationship in implementation between elements of the technical response (Delgado-Hernandez et al 2007). Section F contains three types of information; the computed and prioritised ordering of the technical responses based on the prioritisation of customers want and need from section B and the relationships in section D (Cohen, 1995), comparative data on competitors technical performance and lastly, it contains a technical performance target set by the organisation (Cohen, 1995).

According to Akao (2004), the benefits of implementing Quality Function deployment include:

- Prioritise spoken and unspoken customer wants and needs;
- Determine and Translate customer needs into technical characteristics and specifications;
- Build and deliver a quality product or service by focusing all employees towards customer satisfaction;
- Coordinate efforts and skills of an organisation from a project inception to its completion;
- Improve customer satisfaction;
- Improve Quality.

Early adopters of QFD in the USA included Ford Motor Company, Digital Equipment Corporation, Procter and Gamble, and 3M Corporation to improve the quality of their products (Cohen, 1995).

APPLICATION OF QFD

According to research by Chan and Wu (2002) on the application of QFD, its use was identified in twenty two countries worldwide in sectors such as telecommunications, transport, services and electronics, with only limited application in the construction sector. More recently, the construction industry has gained an improved image especially in developed countries as a result of the increasing trend to adopt QFD in construction projects (Delgado-Hernandez et al, 2007). The recurring theme in most literature is the achievement of quality competitiveness in a dynamic global market through development and research (Oke et al, 2006).

Figure 2, is a Quality Function Deployment diagram that shows the procedure for the conversion of quality requirements to design specifications through technological measures (Dikmen, et al, 2005). The left section contains quality requirements, which is usually a breakdown of different customer requirements that are systematically converted to technical quality elements or quality requirement weights or quality elements weight (Yamamoto et al, 2005). The application of QFD reduces the development lead-time of a new product by designing the quality of the product in such a way that it addresses the voice of every customer and also meets the requirements of the ISO 9000 series and ISO 14000 (Yamamoto et al, 2005). It also enhances communication and concurrency as well as reducing uncertainty.

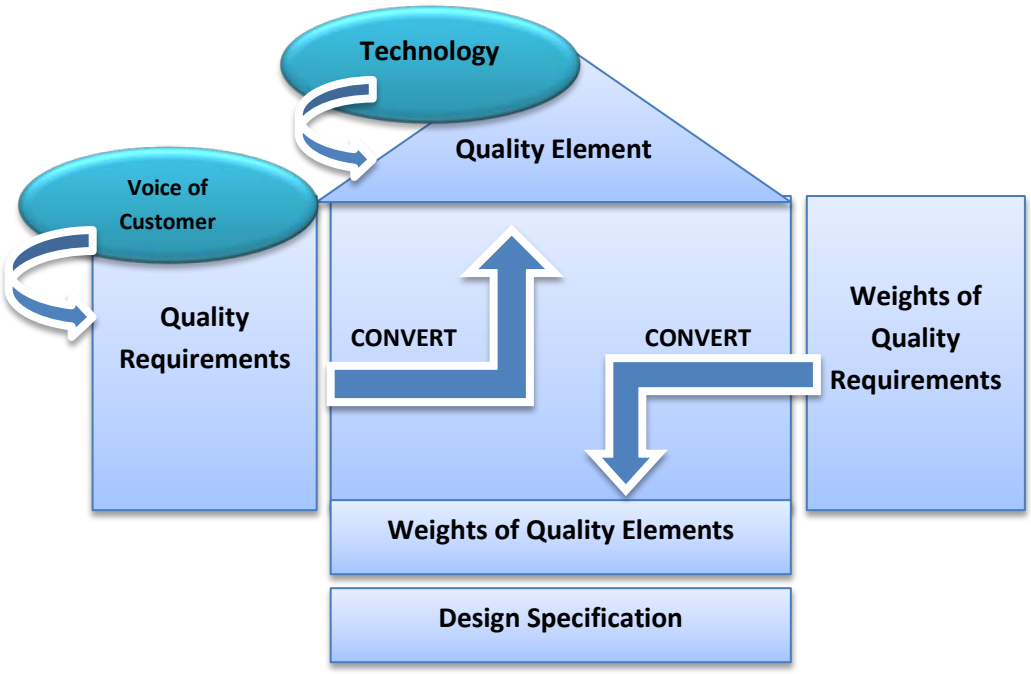

Fig. 2: Application/procedures of QFD (Yamamoto et al, 2005)

QFD IN THE CONSTRUCTION INDUSTRY

Every industry has its specific activities or operations which may include large processes or groups of smaller processes known as the core business activities carried out by firms/companies in such industry (Oakland, 2003). The Construction industry is no exception, it is a project based industry (Fellows et al, 2002), characterised by complex operations of building or assembling of infrastructures onsite or offsite (Dubois and Gadde, 2001). Projects in the construction industry are mostly designed and built for a price established through a competitive tendering system involving different construction companies with the sole aim of awarding a construction project to the most qualified bidder (Fellows et al, 2002). However, the achievement of customer satisfaction when such project is awarded necessitates the need for systematic quality management, as well as the utilisation of quality tools and techniques (Dikmen, et al, 2005), that identifies a need, develops a structure that meets the need, checks conformance to the need and ensures that the need is satisfactorily achieved (Oakland, 2003). QFD is one of such techniques that enables construction companies to transform customer requirements into objectives (Dikmen, et al, 2005). This transformation is most appropriately done by the use of a series of 2D matrices to identify and evaluate the one-on-one relationship between sets of inputs and potential responses to those inputs (Pheng and Yeap, 2001). This is done by designing customer satisfaction and loyalty into construction products and services (Oakland, 2003), by the use of professional design teams, technological innovation in accordance to the ever changing trends in technology (Oakland, 2003). The inputs in executing the project “Whats” are cross checked against the related design, and production response “Hows” with an assessment made by the QFD team to evaluate the existing correlationship between the Hows and Whats (Pheng and Yeap, 2001).

The Design phase of every construction project is responsible for achieving client requirements (Oakland, 2003), and at this phase, construction companies strive to ascertain required quality through drawings and technical specifications (Kubal, 1994). According to

Mears (1995), project design and construction planning are carried out based on standards derived from relevant codes, client requirements, and the standard and competence of the design and build firm (Kelly, et al, 2002). Therefore, a careful balance between a client's requirement of the project cost and schedule, desired operating characteristics, materials of construction and the design professionals need for sufficient time and budget to meet those requirements during the design process is necessary (Odusami, et al, 2010).

Currently QFD is still scarcely utilised in the construction industry (Delgado-Hernandez, 2007). According to a survey conducted by Pheng and Yeap (2001), only 7% of their survey respondents were aware of QFD. A recent survey with slight improvement was conducted by Delgado-Hernandez and Aspinwall (2007) in the United Kingdom. The survey reveals that 18% of 72 respondents were aware of the existence of QFD (Delgado-Hernandez et al, 2007). In the United States a similar survey was conducted by Oswald and Burati (1992, cited by Delgado-Hernandez et al, 2007) which revealed that QFD improved the project definition process, aided in identifying major customer requirements and ensured cross-communication among team members especially in design build-projects.

Alarcon and Mardones (1998) utilised the House of Quality successfully in identifying improvement tools that could help in reducing design defects in construction projects (Delgado-Hernandez et al, 2007).

DEVELOPING THE QFD MATRIX AND PRIORITISING CUSTOMER REQUIREMENTS

The first stage in building the Quality Function Deployment in a construction project is by obtaining a list of "WHAT" customers require or voice of the customer "VOC" (Cohen, 1995). This is obtainable by means of asking questions, obtaining information through the use of questionnaires and interviews (Bossert, 1991). The information gained on customer requirements can be arranged in tabular form as shown in table 1 with degree of importance being represented as follows: 5 = Very Important, 4 = Important, 3 = Necessary 2 = Moderate, 1 = Minor.

[Insert Table 1 here].

QUALITY FUNCTION DEPLOYMENT IN DESIGN-BUILD PROJECTS

QFD in the Construction Industry has achieved a new image and huge importance with the increasing trend to adopt project procurement using the design and build method (Pheng and Yeap, 2001). Design-Build firms are normally placed with the tasks to provide design and build a structure based on the voice of the customer, i.e., D&B firms handle all phases of a project from conceptual level to planning, preliminary design to detailed design, and procurement through construction and operation with sole responsibility within the Design-Build firm (Pheng and Yeap, 2001).

QFD in D&B serves as a set of planning and communication techniques that coordinate skills across different specialties within a D&B organisation, and ensure the timely provision of design as well as build facilities that satisfy customer requirements (ReVelle, et al, 1998). QFD provides a systematic and comprehensive approach in the design and development of new products that meet or exceed customer requirements (Christiano, et al, 2001). According to Delgado-Hernandez et al (2007), the foundation of QFD approach is the information on the customer's wants, needs and demands as well as the customer's prioritisation of these needs. QFD converts these requirements into technical specifications using the nine management steps in project planning in fusion with the Plan-Do-Check-Act cycle (PDCA) as shown in Table 2.

[Insert Table 2 here].

The application of QFD using these nine steps in D&B projects ensures the following:

1. Collection and identification of client needs: Clear definition and understanding of a project scope is seen as the main element in the success of Design and Build projects, hence the application of QFD provides a systematic way of collecting information that defines the scope of a project, identifies the client's prioritised requirement, and establishes briefs to assist the D&B firm. Research by Arditi and lee (cited by Dikmen et al, 2005) reveals that QFD can be used to maximise the corporate service quality (C.SQ) of Design and Build firms because of the relationship it creates between clients (customers) and D&B firms, which makes collection and identification of client needs easier.

2. Transition from customer's jargon to technical specifics: QFD in Design and Build projects provides a well organised transition of customers requirement, which in some cases are not well defined due to lack of information, to well-structured technical specifications that Engineers and Technicians use in designing products (Design Team) as well as allocating resources towards accomplishing customer requirements with less risk and zero defects (Mak and Picken, 2000).

3. Rational representations of linkages between customers and design: QFD uses simple graphical and rationally structured linkages to relate customer requirements to technical measures in achieving set goals and targets. These linkages are simple to understand, for example, a typical House of Quality may seem like a busy set of matrices but the design team that built the House of Quality can easily walk a non-team member (customer) through the HOQ, room by room, area by area while explaining the background or reason for each decision that has been made and how each room links to the rest of the house.

4. Knowledge gained from a multi-functional, interactive design team: A typical Design and Build project in the construction industry consists of individuals from different professions. The more diverse the team, the more knowledgeable and interactive the QFD Design Team, and the more robust the resulting design (ReVelle, et al, 1998). Design team members gain insight from fellow team members both on a technical basis and in the team-building and joint decision-making processes. From the various, multi-functions represented by the design team, senior and middle management can identify areas to be improved upon in terms of what is to be provided by their functions to make production or execution of a project successful.

RESEARCH METHODOLOGY

This research focuses on three different areas: The Nigerian construction industry; awareness and effectiveness of QFD; and customer satisfaction. Therefore this research is designed systematically into three stages comprising of different closely related activities.

Stage One: A comprehensive literature review of relevant literature from text books, Institutional and statutory publications such as; International Standards, ISO 9000 Series, International Quality Journals, United States Agency for International development (USAID),

Code of practice for construction project management and reports from American society of Civil Engineers, as well as top quality construction management journals.

Stage two: Data collection was completed by means of telephone interviews and postal and web-based questionnaires. These questionnaires consisted of open and closed questions and were systematically constructed in stages. Two types of questionnaire surveys were carried out; the first to obtain data from construction professionals working in the construction industry in regards to their awareness of QFD and its effectiveness in design and build projects in Nigeria. A Likert scale of one to five (1 strongly Agree to 5 Strongly Disagree) was used to evaluate the level of QFD, benchmarking and other quality improvement practices. The second survey was targeted to obtain data from clients, the owners and occupants of these residential buildings to determine their level of satisfaction in the quality of their homes. Fifty questionnaires were sent to various D&B companies to be completed by Civil Engineers, Architects, Surveyors, Builders and the occupants of these residential buildings. Fifty questionnaires were administered to different building professionals within the Nigerian construction industry and sixty questionnaires were also administered to clients, therefore making a total of 110 questionnaires of which 42 were returned, 20 from the construction industry and 22 from clients. This indicates a response rate of 38.2% which represents a reasonable population for this study. Table 3 shows a breakdown of construction industry respondents by profession.

[Insert table 3 here].

Stage Three: This section ensures an accurate presentation of the narrative findings from the parallel analytical approach of this research. The data from respondents was analysed by means of editing where multiple answers are provided by the same respondent, followed by coding of raw data, classification of data, tabulation as well as diagrammatic representation and final analysis using Statistical Package for Social Sciences (SPSS).

FINDINGS AND ANALYSIS

Awareness and perceived effectiveness of QFD among construction professionals

The results shown in table 4 reveal that only four respondents out of twenty are aware of QFD. Most respondents assert to the fact that QFD aids proper documentation of customer

requirements as well as enhancing design solutions to bring about continuous improvement. This result shows that approximately 20% of the sample size is aware of QFD and its effectiveness, demonstrating a low level of awareness among building professionals in Nigeria. This result is in accordance with the findings of Pheng and Yeap (2001) in Singapore where it was reported that only one respondent out of fifteen (7%) was aware of QFD.

[Insert table 4 here].

The effectiveness of QFD in design and build projects has been investigated and discussed comprehensively in the manufacturing, food and education sectors, but little previous research has been conducted within the construction industry, perhaps due to low awareness and application. Nevertheless, the concept of QFD is beginning to gain acknowledgement gradually as its effectiveness is realised in the area of creating a better relationship between clients and construction companies thereby providing a more effective client brief, which is identified by 20% of respondents in this study. Table 5 presents findings on the effectiveness of QFD in ensuring easier identification of client needs. The table shows that 4 out of 20 respondents strongly agree that QFD ensures easy identification of client requirements. The remainder are either undecided or in disagreement. However, based on the results of the previous question, the majority of respondents are unaware of QFD and are, therefore, not in a position to answer this question accurately. It is assumed that the 4 respondents who strongly agree that QFD is effective are the same respondents who indicated awareness in the previous section, which would suggest that those who are aware of it also strongly believe in its effectiveness. Further research is required in this area to gain an accurate view on the effectiveness of QFD from those who are aware of it.

[Insert table 5 here].

Client satisfaction

Questionnaires were distributed to clients who have contracted a building project to Design and Build companies. Respondents include individuals from the private sector as well as Government Agencies in Nigeria such as Federal Roads Maintenance Agency (FERMA), Federal Housing Authority (FHA), Federal Capital Development Authority (FCDA) and Bayelsa State Housing Authority. A total of 22 valid responses was received, 17 of these from the private sector (77.3%) and 5 from Government Agencies (22.7%).

Clients were asked to rank their satisfaction level on key factors such as the relationship between client and contractor during and after construction of the building project, considering value for money and project delivery time as shown in tables 6 and 7. On the aspect of satisfaction regarding project delivery time, table 6 shows that five respondents (22.7%) are very satisfied, ten respondents (45.5%) are not satisfied and seven respondents (31.8%) are extremely not satisfied. In the same vein, table 7 shows that just four respondents (18.2%) are able to equate the contract sum to the satisfaction derived. One respondent is moderately satisfied (4.5%), seven respondents (31.8%) are not satisfied and ten respondents (45.5%) are extremely not satisfied.

[Insert table 6 here].

[Insert table 7 here].

The satisfaction index for each respondent was calculated using a 5 point Likert scale from strongly satisfied (1) to strongly dissatisfied (5). Table 8 shows an example of the individual satisfaction score for one respondent as used in calculating the weighting factor for each respondent by adding the individual satisfaction scores and expressing each score as a percentage of the total scores. Each satisfaction score is then multiplied by the corresponding factor to arrive at the weighted score for each respondent. Table 9 shows the ranking of clients' satisfaction index, which suggests 24.3% total satisfaction. Ranks range from 1, showing high dissatisfaction, to 4, showing satisfaction.

[Insert table 8 here].

[Insert table 9 here].

CONCLUSIONS

This study presents three key findings as related to the research subject. First is the low awareness of Quality Function Deployment in the Nigerian construction industry. Respondents in this research associated this low awareness to poor training and retraining of employees, poor management, and lack of proper measures to ensure self-improvement especially with the building professionals.

The second finding is the high effectiveness of QFD in design and build projects as shown only by four respondents. Its effectiveness is mostly identified in the area of creating mutual

relationships between a construction company and its clients, identification of client requirements and a systematic conversion of these requirements to technical objectives and targets. Therefore, the effectiveness of QFD as described by Delgado-Hernandez et al (2007), Akao (2004) and Ficalora and Cohen (2010) is true in the Nigerian context but this perception is not generally accepted by all professionals in the construction industry since the majority of the respondents in this study are not aware of QFD or its effectiveness.

The third finding is the low level of satisfaction clients currently derive from design and build Projects. Respondents associate this low satisfaction rate to the compromise with the voice of the customer (VOC) and poor design. It appears that most D&B companies lack the technical means to convert client requirements to expected and exciting objectives. This research analysed responses from twenty two respondents and only five respondents were satisfied with the finished products. An interesting finding is that the five satisfied clients contracted their projects to those companies that are aware of QFD and apply it regularly on design and build projects.

It is evident to say the findings from this research show that QFD ensures easy identification, prioritisation and satisfaction of customer requirements and that perception of QFD is not the same among building professionals in Nigeria. Twenty per cent (20%) of the respondents from construction Companies that are aware of Quality Function Deployment acknowledged its effectiveness in the following areas:

- Identification and Prioritisation of Customer Requirements: According to respondents from the construction industry, the voice of the client (VOC) is always considered in design and construction. However, thirty five per cent (35%) of the respondents argue that clients in most cases do not know exactly what they want and can hardly state them in clear terms. Proper documentation of the customer's voice (VOC) and the use of matrices to separate requirements make it easier to identify, improve and prioritise client requirements.

- Creation of a cordial relationship between clients and construction companies: Respondents from the construction industry accord the cordial relationship between clients and company during and after construction to the application of QFD, as it encourages regular meetings and discussions between parties. This regular communication makes it easier for the design and build company to gain a better

understanding of the client requirements and this helps to create an effective client brief for the design team.

- Enhances customer satisfaction: Twenty per cent of construction industry respondents revealed that the vision of their companies is founded on customer satisfaction. QFD has been identified to aid this process by systematically applying techniques and technologies that make processes easier.

- The application of QFD creates easy communication, inter-relationship and shared knowledge between QFD team members: Most respondents from the construction industry described QFD as a means of learning as it comprises of team members from different professions.

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Tables

TABLE 1: Prioritising Customer Requirements According to their Importance

WHATS Customer Requirement		Degree of Importance				
Kitchen	Create a kitchen with a peninsular unit	5				
	Create a C-Shaped Kitchen		4			
Living Room	Create space for a full size dining		4			
	Living Room walls must be tiled			3		
Master bedroom	Should be well ventilated		4			
	Must have a mini dining				2	
Flooring	Use wood flooring		4			
	Or Tiles				2	
Doors and Window	Sound Proof Panel doors	5				
	Steel Doors			3		

TABLE 2: Nine Management Steps in Project Planning in Combination With PDCA (Source: Petrolini and Walden, 2000)

PDCA	9 Steps in Project Planning	7 Steps in Project Planning
Plan	1. Describe project 2. Explore essentials/narrow focus 3. Establish matrix 4. Identify alternatives 5. Develop optimistic plan with obstacles and counter measures	1. Select theme 2. Collect and analyse data 3. Analyse possible causes of failure
Do	6. Develop, implement and monitor detailed plan	4. Plan and Implement solution

Check	7. Evaluate results	5. Evaluate effects
Act	8. Standardise 9. Reflect	6. Standardise 7. Reflect

TABLE 3: Breakdown of construction industry respondents by profession

Profession	**Frequency**	**Valid % Returned**
Civil Engineer	3	15
Architect	4	20
Surveyor	4	20
Builder	4	20
Project Manager	2	10
Electrical Engineer	2	10
Mechanical Engineer	1	5
Total	**20**	**100**

TABLE 4: QFD awareness among construction professionals

Aware of QFD	**Frequency**	**%**
Yes	4	20
No	16	80
Not Sure	0	0
Total	**20**	**100**

TABLE 5: Perception of QFD effectiveness in identifying client requirements among construction professionals

QFD is effective	Frequency	%
Strongly agree	4	20
Undecided	7	35
Disagree	2	10
Strongly disagree	7	35
Total	**20**	**100**

TABLE 6: Client satisfaction on project delivery time

Satisfaction	Frequency	%
Very satisfied	5	22.7
Moderately satisfied	0	0
Not satisfied	10	45.5
Extremely not satisfied	7	31.8
Total	**22**	**100**

TABLE 7: Client satisfaction on value for money

Satisfaction	Frequency	%
Very satisfied	4	18.2
Moderately satisfied	1	4.5
Not satisfied	7	31.8
Extremely not satisfied	10	45.5
Total	**22**	**100**

TABLE 8: Example of satisfaction index for respondent A

	Clients Satisfaction Score	Weighting Factor (%)	Weighted Score
Use of Voice of Client in Design	5	11.40	0.57
Documentation of Client Requirements	5	11.40	0.57
Design	3	6.80	0.20
Use of Materials in Construction	5	11.40	0.57
Technology	4	9.10	0.36
Project Management	4		0.36
Quality of Finished Building Project	5	11.40	0.57
Client/Contractor Relationship during construction	4	9.10	0.36
Client/Contractor Relationship After Construction	5	11.40	0.57
Value for Money	4	9.10	0.36
Project Delivery Time	5	11.40	0.57
Total Score	**44**		
	Weighted Average Satisfaction Index		**5.06 50.6%**

TABLE 9: Ranking of clients' satisfaction index

Clients	Satisfaction Index (SI%)	Rank
A	17.8	3
B	16.1	2
C	16.1	2
D	16.1	2
E	16.1	2
F	16.1	2
G	15.7	1
H	15.7	1
I	15.7	1
J	15.7	1
K	50.6	4
L	17.8	3
M	50.6	4
N	17.8	3
O	17.8	3
P	50.6	4
Q	50.6	4
R	50.6	4
S	17.8	3
T	17.8	3
U	16.1	2
V	15.7	1

Overall satisfaction =	**∑SI/N**
	534.9/22 = 24.3