Application Of Quality Management Systems in The Production of Concrete in Abakiliki and Afikpo, Ebonyi State, Nigeria

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Abstract: - This research examined the application of quality management systems in the production of concrete with a view of ensuring that quality of concrete is increased. Purposive sampling technique was used to deliberately select 91 respondents among construction professionals to whom questionnaires were administered. The research results showed that, carrying out daily inspection (RII = 0.88); on- site testing of concrete (RII=0.88); use of quality management system checklist (RII=0.88) ranked highly significant, as mostly used existing methods of increasing quality of concrete. The research established that conformance to quality standards and statutory regulations; adequate compaction with appropriate tools; engagement of qualified personnel are among the most important factors in increasing quality of concrete. Whereas, award of contracts to unqualified contractor; noninvolvement of concerned professionals at the design stage; lack of adequate supervision and inadequate technical knowledge, highly hinder implementation of quality management systems in the production of concrete. However, the research recommends for increased sensitization and retraining of Builders on the key elements of quality management systems, for effectiveness in the use of the existing methods of ensuring increased quality of concrete.

Key words: – *Quality Management Systems, Quality Management Plan, Quality Assurance Plan, Quality Control, Quality Audit, Concrete, Construction.*

I. Introduction

Construction may be seen as an art and science of forming objects, typically a large structure. However, construction generally means the process of building something. Okolie[1], states that construction is a complex process involving the use and application of resources, such as men, materials, machines, method /management and money to realize a given project. However, construction may also be viewed as a large, dynamic and complex industry sector that plays an important role in any nation's economy. This industrial sector oversees vast range of construction activities ranging from housing and infrastructural provisions; employment; social and economic development and involving a complex process of design and planning, financing, construction and maintenance of building throughout its lifecycle.

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According to Sylvester [2], the industry's construction activities account for more than 10% of Global Domestic Product (GDP) and employs almost 7% of global workforce which includes professionals such as the Architects, Builders, Engineers and others thereby contributing to global economic development. Ogala cited in [2], observes that the Nigerian construction industry just like its counterparts has remained a major contributor of the country's GDP and has continued to contribute to the national development and enriching the quality of life of the Nigerian people. It is therefore appropriate to assert that recent activities of construction enterprises and construction professionals in Ebonyi State have in no small measure contributed no less than their counterparts to the nation's GDP and quality of life.

Just as the success of any country's construction industry essentially depends on availability of basic construction materials. Concrete is a construction material which is widely used in the Nigeria construction industry and by extension in Ebonyi State for most building construction projects. Its wide acceptability may be on account of the fact that, concrete is a composite material, made from mixing together of several ingredients; such as cement, aggregates, water and at times, additives.

UNESCO [3], maintains that concrete is an artificial stone and has been recognized as an important, versatile and extensively used building material, easily manufactured on site. In a recent study, Shubham [4], admits that, concrete is the most widely used construction material in the world that cannot be easily replaced by any other owing to its economic and technical advantage. The production of this important material however involves some processes in which the various ingredients can be proportioned and mixed together to form a plastic mass which can be placed into its desired form and give a desired shape to the resulting artificial stone. More so, Ikechukwu [5], agrees that, its production usually involves, selecting desired ingredients; batching; mixing; ensuring workability of the mix; transportation; placing; compacting and curing of the concrete mass.

According to American Society for Quality, ASQ [6], "quality management system is a formalized system that documents processes, procedures and responsibilities for achieving quality policies and objectives of an organization". Alexander [7], has observed that, the purpose of quality management system is to ensure that every time, a process, (like the one involved in the production of concrete) is performed, the same information, methods, skills and controls are used and applied in a consistent manner; if there are process issues or opportunities, this is then fed into the quality management system for a continuous improvement.

Recent increase in population growth and technological development has led to a general increase in the demand for specialization; speed and volume of concrete desired for construction of more houses and facilities. Today, increase in industrial production of concrete and the number of construction enterprises has raised even more need for construction enterprises and professionals to consistently adhere to a system of managing quality by means of which predictable outcome; especially for large volume production of concrete, can be possible. Therefore, the need for application of quality management systems that is believed to be the only means by which production of increased quality of concrete across construction enterprises' value chain, especially in Ebonyi State and Nigeria at large can never be overstressed.

In an effort to increase commitment in producing increased quality of concrete for clients, construction enterprises often determine in advance, relevant quality management systems that often result in efficiently managing the activities that will result in producing concrete of increased quality for building construction. This is on account of recent understanding by these enterprises that quality management systems do have positive impact on all construction related activities. Possession of great strength and durability in concrete when it is fully set with its ability to be molded into any shape while in plastic emphasizes a greater need for allowing its production to be guided through a system that can ensure increase in its quality.

No little wonder that in an earlier study, Mulcahy and Project Management Professionals [6], observe that, a lack of attention to quality management may result to rework or defects in which, the more the defects, the more there will be loss of money and time, and the less likely that the project schedule and cost will be achieved. Quality management entails creating and adhering to organizational policies and procedures in effort to meet the needs of clients. In the context of concrete production, it may mean meeting clients' quality needs and expectations in concrete production through creating and adhering to organizational policies and procedures in compliance with the system for achieving qualified products and services. Lance [7], also agree that quality management also involves the coordination and collaboration of people, capital and materials.

The research is set to examine the application of quality management systems in the production of concrete, with a view of increasing the quality of concrete for building constructions. In line with this aim, the objectives to pursue will include: to examine the existing method of quality management in the production of concrete; to examine the level of awareness of quality management systems and quality standards in the production of concrete in the study area; to investigate factors hindering delivery of quality in concrete; to investigate factors hindering the implementation of quality management system and to determine the benefits of developing quality management system checklist in the production of concrete.

Data obtained from the questionnaire survey would be analyzed involving the use of both descriptive and qualitative statistics such as simple percentages, frequency distribution tables, content and narrative analysis, relative importance index (RII) and mean score index (Mx), to complement a successful data analysis and presentation of the result of this research.

II. Quality Management Systems

According to [6], "quality management system is a formalized system that documents processes, procedures and responsibilities for achieving quality policies and objectives of an organization". The purpose of quality management system is to ensure that every time, a process, (like the one involved in the production of concrete) is performed, the same information, methods, skills and controls are used and applied in a consistent manner. In line with this, Concrete Tips-Civil Engineering Home [8], states that quality management system is the management and control system document, having three elements, such as, Quality Assurance (QA) plans, implementation of Quality Control (QC) process and Quality Audit (QA) system of tracking and documentation of quality assurance and quality control programmes.

By means of the elements a systematic way of setting quality process, roles and responsibilities towards ensuring that quality

is increased or maintained in the production of concrete is established. It is used to set out the desired detailed guidelines from the point of selecting materials to the curing of the structural member and ensuring that each and every step involved in the delivery process is guided to conform to relevant quality standards. It provides insights into any necessary actions which may be taken to ensure effective production of concrete for building project delivery in conformity with relevant quality standard. Such an insight gained usually results to integrating these three elements into a single document, called quality management plan.

III. Quality Management Plan

According to CIOB [9], "a quality plan is a document, or several documents, that together specify quality standards, practices, resources, specifications, and the sequence of activities relevant to the delivery of a construction project. It usually includes service level expectations; the organization for the delivery of quality and reflects the aims of the organization's corporate quality policy." For quality management system plan to be standard, it should include in it; a quality policy statement (vision and mission); project quality structure and quality management system; quality objective; rectification of defects and prevention of future problems; testing procedures for construction materials such as cement, fine and coarse aggregates and admixtures if required and checklist for formwork, reinforcement, etc. during construction.

By means of a careful attention to this document, the intended degree of quality in the production of concrete can be attained. Although, the content of this document (system) may change just as the concrete technology changes, however, its early articulation and implementation on the processes involved in the production of concrete can prevent concrete structure from having existence of a porous member, corroded reinforcement and many other reasons that can affect the lifespan of the structure.

Quality management system has been viewed by many as; a set of documents which provides desired detailed guidelines on quality management processes through the establishment of systematic way of setting quality processes, roles and responsibilities aimed at improving quality. Its application in the production of concrete involves a careful articulation of quality processes and workmanship. An important consideration in the processes and workmanship in the production of concrete should be how to cooperation and collaboration with others in developing this set of documents required in guiding the processes and workmanship towards bringing about increased quality of concrete.

According to Gopal [10], the need for creating a quality management plan prior to the production of concrete cannot be overstressed, as the quality of concrete will be largely dependent on quality management of the activities involved from the start to the end of the production process; starting with sourcing and preparation of materials to the curing of placed concrete. In a recent quality management plan of Nomin Building Consult Ltd.[11], quality management plan has been seen as an effective tool of improving the means to establish; document and maintain a cost effective quality management system on project which is aimed at demonstrating that the works carried out shall conform to the production information issued on project; and to provide means by which the client may derive confidence that the project is being carried out in accordance with specified quality standards.

Early preparation and implementation of quality management systems by means of a quality management plan can prevent cost overrun and boosts client confidence, as it defines the various qualities- related activities and procedures which are to be implemented on a project; it sets down requirements, gives guidelines, provides information and indicates to all site team the procedure to be followed with respect to the project quality management plan [11].

Before starting the actual production of concrete, it is crucial to prepare and present this document to all site team members as a documented means of guiding all the quality-related process towards ensuring that quality of concrete is increased and maintained throughout its production. Whenever, the quality management system plan is available, it serves as a quality management system for any construction work, as it contains the step-by-step procedure of carrying out all quality- related procedure to the work at hand. It may also serve as a standard for subsequent work; as it documents all the standard test procedures for materials like aggregates, cement and admixtures as well as provide checklist for formworks, throughout the production stages of concrete.

According to [9], a quality plan is a specification of the actions, responsibilities and associated resources for a specific project/object that is meant to be created as early as possible during the planning phase of any project by all the stakeholders, such as the project manager, site manager, project team, design team, client, and any people whose support is needed to carry out the plan. An important inclusion in the plan is the enterprise's quality policy which must demonstrate the company's commitment to quality at all levels as it is often considered in many cases, an important requirement of the client.

However, for effective implementation of quality management system, it is often important to also have in place, a standard operating procedure for every production step with key

performance indicators for checking the efficiency, deviations, etc. of the process such that any deviation from the standard operating procedures is considered non-conforming process and when found to be based on the procedures as per the standard, will be stated as a conforming process. However, corrective actions like, testing of concrete compressive strength; analyzing the strength of concrete structure; repairing defective concrete works arising from inadequate care and protection; adjusting the geometry of concrete elements and adjusting the consistency of fresh concrete should be quickly done whenever non-conformity occurs during concrete production.

ISO9001:2015 cited in[9], admits that quality management plan provides a framework for inspection; monitoring, and testing processes and assist the production team in the management of resources (people, materials, plant and equipment) to accomplish quality targets; including setting out the risks that affect quality. The quality plan needs to be dynamic; responding to changes during production and with any of such changes made in agreement with the stakeholders and communicated to the project team. It will also be necessary to ensure effective integration between project personnel, inspections /tests and audits, records and reports.

According to [9], "quality plan has many uses, for instance: ensuring conformance to customer requirements; ensuring conformance to external and internal standards and procedures; facilitating traceability; providing objective evidence in the event of a dispute and a basis for training." It will not be an exaggeration to assert that quality management plan remains a very important tool by means of which quality management systems can be applied in conformity with quality standards and objectives in the production of concrete. It is important that construction enterprises and contractors begin to see the bid stage for construction work as the starting point for preparation of quality management planning so as to have evidence to prove that a quality management system which can also be applicable to the supply chain is in place; since meeting the quality requirements can often be a pre-requisite for the selection criteria at the tender stage.

The quality management plan is also useful in guiding employees and subcontractor trade employees to fulfill the core quality value through the involvement of every project participant-owners, designers, suppliers, and subcontractors of every tier. Quality management plan aids in implementation of quality process; quality functions and quality tasks aimed at preventing defects through appropriate checks and controls. In using quality management plan, effort should not only be focused on getting a product right but also on getting all the processes that contribute to the realization of the product right as well as the product right, all the time. Problems associated with quality management implementation may include lack of technical skills; ineffective communication; poor linkage between research and practice; transient nature of workforce; time constraints and corruption.

However, these problems can be minimized by prioritizing commitment in providing the required level of quality, maintaining good reputation and high position in the industry as well as early preparation and use of a quality management plan that is based on quality standards, such as ISO standards. This is because, the ISO standards are directed towards improving a firm's production processes and ensuring that the quality management system plan is always prepared early enough so as to help to track the quality of the production activities from the start to the end of the production and be preserved to serve as reference for future production. The quality of construction works at the site, like handling works, curing of concrete, sampling and testing procedures will be improved and will help to reduce the chances of potential liability that can be imposed on the company or contractor.

IV. Quality Assurance Plan (QAP)

Quality Assurance Plan (QAP) is an element of quality management systems and a document created by the project team, which when judiciously followed can assist in ensuring that the finished product meets all criteria. In an earlier study, [5] states that quality assurance is a less costly but time-consuming exercise performed from the onset before the actual production. Such performance is usually a design that is based on one's experience in concrete design which may represents an attempt to say that what is designed can assure quality. Quality assurance is the responsibility of everyone involved in a project, but more especially, the project team. The aim of quality assurance is to improve processes and prevent defects. Quality assurance is a management tool that is process-oriented. It may be necessary to emphasize that quality assurance is a planned and systematic pattern of all actions necessary to provide adequate confidence that a product will conform to established requirements.

In line with this, [9] states that quality assurance is a way of preventing mistakes and defects in manufactured products and avoiding problems when delivering solutions or services to customers. Quality assurance may be considered part of quality management processes focused on providing confidence that quality requirements will be fulfilled. Quality assurance is thus the responsibility of the owner/user to ensure that consultants follow codes and sound engineering practices and that contractors and suppliers of materials comply with the contract requirements. Quality assurance programme is usually developed by each agency responsible to the extent of its contractual obligation and such programme must contain the policies, practices, procedures and method to be followed such that the quality objectives laid down by the owner in his quality assurance plan are fully met.

In line with this, [8], maintains that the quality assurance programme must be addressed fully (to the extent applicable) to the following aspects: organization set-up; responsibilities and authorities of various personnel involved; identification of coordinating personnel; quality control measures in design including field changes; establishment of control norms, acceptance and rejection criteria for materials; inspection programme for verification of contractual compliance including acceptance and rejection criteria; sampling, testing, documentation; corrective measures during non-complying conditions and non-conformance; resolution of technical differences, submission and maintenance of records at all stages of the work.

Quality assurance is intended to provide guidance for all operations related to quality of a product. Its activities include, identifying sources of materials suitable for use for the production of concrete prior to the start of the design and construction of buildings as well as, conducting all necessary investigations to evaluate the durability exposure condition of concrete, like sulphate attack.It may further include all related activities in the delivery process of a project such as, inspection, monitoring, sampling, checking, testing etc. by the client or the client representative, as an effort to monitor and assure that the contractor is in compliance with contract documents and fulfilling contractual responsibilities in performance of quality control, as is usually defined by contract. Therefore, specification requirements regarding excavation, formwork, and steel reinforcement and construction joints must be inspected before concrete is placed and those who are inspecting must be those, who are familiar with building drawings and specifications and should be able to prepare daily reports which document observations made during any inspection on placement of steel reinforcement and formwork. Also, required excavations are verified by inspection and testing in order to ensure that excavations meet project requirements, including removal of detrimental materials, such as excess dirt, debris, water, etc.

However, prior to placing concrete in formwork, the forms should be inspected to ensure they meet specification requirements, including size, location and dimensions. The forms should be clean of foreign materials, such as dirt, dried mortar, oil, grease, water etc. and must be free of excess quantities of form release agents. Forms need to be mortar-tight and sufficiently strong to maintain their position and shape. Forms should be monitored during concrete placement to ensure that no movement, leakage, or damage occurs. Before, reinforcement is placed, inspection of surfaces to ensure the reinforcement is free from objectionable materials, heavy corrosion.

Such inspection should be to ensure that any material that will impair bond to the concrete for reinforcement is removed, such as paint, oil, grease, dried mud and weak dried mortar. Inspection should occur throughout reinforcement placement to avoid costly mistakes. The types and sizes of reinforcing bars and their locations need to be verified prior to concrete placement. Proper reinforcement grade, size, bending, spacing, location, length and surface condition should be checked and approved or rejected as appropriate. In addition, the inspector needs to ensure that the reinforcement is positioned accurately in the forms and held firmly in place so that it does not move during concrete placement. Inspections need to verify the correct location of any embedded items to be in the cast-in-place concrete, such as water stop, conduits, piping and anchor bolts. Embedded items need to be securely fixed in place before concrete is placed and be held in position until concrete placement is completed. However, according to Ferguson and Clayton cited in Zubairu (2016), "Quality Assurance (QA) is a program covering activities necessary to provide quality in the work to meet the project requirements. It involves establishing project related policies, procedures, standards, training, guidelines, and system necessary to produce quality.

V. Quality Control

Quality control is a subset of quality management system plan that ensures that those actions necessary for conformance to quality standards or established requirements are impressed upon for implementation during any production process. Quality control is a product oriented; a re-active or a corrective tool at the disposal of the project manager or the contractor, towards ensuring that quality is maintained throughout a project delivery process. It may also mean a set of procedure and standards by means of which a contractor, supplier, manufacturer and other stakeholders monitor the properties of a finished work. Quality control includes a system to manage, control and document work to ensure compliance with contract requirements.

In line with this, [5], states that quality control is a feedback control and an exercise that is conducted, for instance by crushing the concrete cube in order to be sure that the quality of the product meets a specified standard." It entails testing and inspecting what has been produced before it is commissioned to ascertain to what degree there is conformity to relevant standard and required performance. Quality control is aimed at identifying and correcting defects as soon as possible.

According to [9] "quality control verifies the quality of output. It provides the tools and processes for quality management. Quality control should be focused on the main factors causing variations in concrete quality, such as the personnel, materials, equipment and the workmanship. Among the basic requirements to ensure the success of quality control in the production of concrete, is the deployment of experienced, knowledgeable and trained personnel at all levels on site, ranging from the designer to the site supervisor who with good

knowledge of construction processes ensures that the handling of aggregates; quality and quantity of water; capacity of equipment used for batching; mixing and transportation; placing; compaction and vibration of green concrete are properly considered.

More so, appropriate field control exercises, such as inspection and testing will be required on the fresh concrete while the opportunity offered by this should be harnessed to correct any defects before it becomes too late, by the time the concrete hardening is complete. The required quality control actions will include collecting samples of batches of freshly prepared concrete and putting into the test tubes for crushing and computing the required checks for its characteristics properties (Fx) and coefficient of homogeneity (K). The aim of these action and checks are to ascertain or ensure that the characteristics property or mean strength value which is considered the factor of safety for the sampled concrete is greater than the specified or stipulated characteristics strength of concrete to be produced which should be verified by the person with the responsibility of implementing the quality management plan on project.

In most cases, inspection (including activities related to its sub-contractors) is required to be carried out by the owner or the contracting organization, consultant or owner's representative. The owner or the contracting organization prepares the quality assurance programme manual, describing and establishing the quality assurance and control system to be used in performing design, purchasing, fabrication, production of concrete and other construction activities for the assigned contractual responsibilities while also indicating the application area, manages and documents the quality control programmes with clearly established and documented responsibilities and authorities in conformity with the scope and type of work and owner's policy decision.

However, in line with [9], overall effectiveness of quality control in concrete production can be facilitated by implementing the various stages concerned with pursuit of product-oriented quality control such as: stage1- preparatory (pre-commencement on site); stage2- Initial (first work-in-place) and stage3- follow-up (daily inspections) so as to allow the contractor plan, schedule and install work in an orderly, consistent way that minimizes rework. The first stage allows the project manager to prevent deficiencies as he considers early involvement of the contractor, specialty contractors, client and design team (and other interested parties), in conducting a pre-installation meeting during which documents such as: approved submittals; materials safety data sheets and shop drawings; manufacturer's installation instructions; applicable building regulations and codes; contract drawings; contract specifications; construction programme and schedules for the specialty contractors; safety hazard analysis; inspection checklists and inspection report forms are carefully examined with a view to ensuring effective project delivery. In the second stage, a meeting is summoned by the project manager, prior to commencement of the relevant activities in which the client (or their representative), a member of the design team, relevant consultants, the site manager / trades supervisor and a manufacturer's representative are invited with a view to ensuring significant construction activity. The third stage involves daily inspection, using an inspection checklist aimed at ensuring conformance, quality workmanship, testing, and safety considerations as well as making sure that any required certifications, calibrations and measurements are accurate.

However, additional pre installation and first work-in-place inspections will be carried out when any significant changes to personnel, supervision on site, periods of inactivity, or the quality of on-going work is observed to be unacceptable. It is important to carefully archived records of quality-related actions such as inspections, testing, compliance etc.in such a manner as to allow ease of access, and as to become part of the project's permanent records. Records on daily reports; inspection reports; test reports and logs; inspecting technician's certification and as-built drawings contain important information which becomes a valuable source of data for future activities.

VI. Quality Audit

Quality audit (QA) is a system of tracking and documenting quality assurance and quality control programmes. Quality audit is the responsibility of the owner, and has to be performed at regular intervals through the duration of the project. Quality audit covers both the design as well as the production phases.

VII. Result And Discussion

7.1 Section A- Discussion based on respondents' response on the existing method of quality management in the production of concrete.

This section considers the existing method of ensuring quality management in the production of concrete. It is intended to ascertain measures usually implemented by respondents in order to increase quality of concrete. Respondents were asked to rate well known existing methods of ensuring quality management in order of their application in Afikpo and Abakiliki.

Table 4.1. Existing method of quality management

Source: Field survey (2021)

Existing ways of quality management	SA5	A 4	N 3	D 2	SD 1	Na	Total Score	Mx	RII	Rank
Quality Management plan	21	26	4	4	0	55	229	4.16	0.83	2nd
Quality Control Checklist	25	18	4	8	0	55	225	4.09	0.82	3rd
Quality assurance programme manual	19	22	11	0	3	55	219	3.98	0.80	4th
Daily inspection	27	23	4	1	0	55	241	4.38	0.88	1st
Testing	29	21	3	2	0	55	242	4.40	0.88	1st
Pre-commencement on site meetings	0	35	12	8	0	55	192	3.49	0.70	6th
Keeping of records of quality related issues	19	26	9	1	0	55	228	4.15	0.83	2nd
Review of Process, Practices and Procedures.	29	20	6	0	4	55	243	4.42	0.88	1st
Loading/Offloading Supervision	12	23	12	8	0	55	204	3.71	0.74	5th
Carrying out corrective and Preventive actions.	24	16	11	4	0	55	225	4.09	0.82	3rd
Use of quality management systems Checklist for concrete production	26	25	4	0	0	55	242	4.40	0,88	1st

Table 4.1 presents the existing methods of quality management that building construction professionals need to apply in increasing the quality of concrete in building projects. Daily inspection; on site testing of concrete; review of process, practices and procedures and the use of quality management systems checklist for concrete production have all been ranked as the highest with the relative importance index (RII) as 0.88. Whereas the use of quality management plan, and the keeping of records of quality related issues ranked second with relative importance index of 0.83 which are all assessed to be of very high significance. However, the use of quality controls checklist and carrying out corrective and preventive actions ranked third with relative importance index of 0.82, which is also assessed to be very high significance. Use of quality assurance programme manual ranked fourth with relative importance index of 0.80 which is assessed to be of high significance. However, as the results indicate, carrying out daily inspection; on site testing of concrete; review of process, practices and procedures; use of quality management systems checklist for concrete production; use of quality management plan and the keeping of records of quality related issues; are considered very essential ways of increasing the quality of concrete in the delivery of building construction project.

7.2. Section B- Analysis on respondent's response based on level of awareness of quality management systems and quality standards.

This section presents respondents responses on their level of awareness of quality management systems and quality standards. It was relevant to ascertain the respondents' awareness of quality management systems and quality standards in order to know the extent to which they apply the system in the production of concrete.

Table 4.2. Level of awareness of quality management systems and quality standards.
Source: Field survey (2021)

Level of awareness	**Frequency**	**Percentage (%)**	Rank
Low	20	36.4	2nd
Average	30	54.5	1st
High	5	9.1	3rd
Total	55	100	

From the results of table 4.2, it is clearly indicative that while only 9.1% of the respondents are well aware of the relevance of quality management systems and quality standards in the production of concrete and are interested in adopting quality management measures in order to increase the quality of concrete; 54.5% of the respondents are not very much aware of quality management systems and quality standards and have not demonstrated much willingness in adopting quality management measures in the production of concrete. Also, 36.4% of the respondents indicate a low level of awareness of quality

management systems and quality standards, which go to reveal that majority of the professionals in the study area, are yet to appreciate the full benefits of applying quality management systems and relevant quality standards in the production of concrete.

7.3. Section C- Discussion based on respondents' response on factors hindering delivery of quality in concrete.

This section focuses on the factors hindering delivery of quality in the production of concrete. It is aimed at highlighting the most important factors that have been hindering delivery of quality in concrete production. Respondents were asked to rate those factors in order of their degree of hindrance to increasing the quality of concrete in Afikpo and Abakiliki.

Table 4.3: Factors hindering delivery of quality in concrete
Source: Field survey (2021)

Factors hindering delivering of quality	SA 5	A 4	N 3	D 2	SD 1	Na	Total Score	Mx	RII	Rank
Use of damaged or poor-quality materials.	33	22	0	0	0	55	253	4.60	0.92	1st
Failure of suppliers and vendors	12	18	25	7	0	55	221	4.02	0.80	4th
Mishandling by sub-contractors	6	42	9	0	0	55	225	4.09	0.82	3rd
Failure to document observed changes and practices	18	33	4	0	0	55	234	4.25	0.85	2nd
Last minutes changes.	12	19	16	8	0	55	200	3.64	0.72	5th
Scope creep.	8	8	35	4	0	55	185	3.36	0.67	6th
Communication gap between teams	37	14	4	0	0	55	253	4.60	0.92	1st
Complexity of design.	13	29	13	0	0	55	220	4.00	0.80	4th
Lack of quality of management system. Ignored audits and testing.	24 8	24 9	4 33	3 5	0 5	55 55	234 185	4.25 3.36	0.85 0.67	2nd 6th

Table 4.3 presents the factors hindering delivery of quality in the production of concrete. Use of damaged or poor-quality materials and existence of communication gap between teams have been ranked as the highest with the relative importance index (RII) as 0.92. Failure to document observed changes and practices, lack of quality management system, ranked second and third respectively with relative importance index (RII > 0.8) which is assessed to be of very high significance. While mishandling by sub-contractors is ranked fourth with relative important index (RII) of 0.80 which is assessed to be of high significance. As the results indicate, use of damaged or poor-quality materials; existence of communication gap between teams; failure to document observed changes and practices and lack of quality management systems are key factors hindering delivery of quality in the production of concrete for building construction in the study area.

7.4. Section D- Discussion based on respondents' response on factors hindering implementation of quality management systems

This section focuses on the factors hindering implementation of quality management systems in the production of concrete. It is aimed at highlighting the most important factors that have been hindering implementation of quality management systems in the production of concrete. Respondents were asked to rate those factors in order of their degree of hindrance to implementation of quality management systems generally in the country.

Table4.4.: Factors hindering implementation of quality management systems

Source: Field survey (2021)

Factors	SA 5	A 4	N 3	D 2	SD 1	Na	Total Score	Mx	RII	Rank
Lack of adequate sanction by Standard Assurance Organization	36	15	4	0	0	55	252	4.58	0.92	2nd
Non implementation of national building code	24	27	4	0	0	55	240	4.36	0.87	5th
Lack of proper inspection at every construction stage	29	26	0	0	0	55	249	4.53	0.91	3rd
Award of contracts to unqualified contractor	44	4	7	0	0	55	257	4.67	0.93	1st

Lack of construction control inspection programme	26	27	0	0	2	55	240	4.36	0.87	5th
Lack of effective quality policy implementation	33	22	0	0	0	55	253	4.60	0.92	2nd
Usurpation of role among professionals	24	28	3	0	0	55	241	4.38	0.88	4th
Inadequate personnel and craftsmen training	24	28	3	0	0	55	241	4.38	0.88	4th
Poor specification.	26	24	5	0	0	55	241	4.38	0.88	4th
Unrealistic project cost.	15	32	8	0	0	55	227	4.13	0.83	6th
Unrealistic project time	8	27	20	0	0	55	208	3.78	0.76	7th
Bribery and corruption	32	20	3	0	0	55	249	4.53	0.91	3rd
Lack of buildability analysis	40	10	5	0	0	55	255	4.64	0.93	1st
Inadequate and poor pre-design project meeting.	22	29	4	0	0	55	241	4.38	0.88	4th
Noninvolvement of all the concerned professionals at the design stage.	40	10	5	0	0	55	255	4.64	0.93	1st
Poor level of commitment to quality improvement among design professionals and construction team.	15	34	6	0	0	55	227	4.12	0.83	6th
Pilfering	8	18	18	11	0	55	188	3.42	0.68	8th
Lack of adequate supervision and inadequate technical knowledge	41	8	6	0	0	55	255	4.64	0.93	1st

Table 4.4 shows the factors hindering implementation of quality management systems in the study area. The highest ranked factors with the values of RII ≥ 0.80, which are regarded as factors with very high significance were: award of contracts to unqualified contractor; lack of buildability analysis; Lack of adequate supervision and inadequate technical knowledge; noninvolvement of all concerned professionals at the design stage; lack of adequate sanction by standard assurance organization and lack of effective quality policy implementation, ranked first and second with relative importance index (RII) of 0.93 and 0.92 respectively. While lack of proper inspection at every construction stage and bribery and corruption ranked third with relative importance index of 0.91. However, usurpation of role among professionals, inadequate personnel and craftsmen training, non-implementation of national building code, lack of construction control inspection programme, unrealistic project cost and poor level of commitment to quality improvement among design professionals and construction team ranked, fourth, fifth and sixth respectively with relative importance index (RII > 0.8) which is assessed to be of very high significance. As the results indicate, award of contracts to unqualified contractor; lack of buildability analysis; lack of adequate supervision and inadequate technical knowledge; noninvolvement of all concerned professionals at the design stage; lack of adequate sanction by standard assurance organization; lack of effective quality policy implementation; lack of proper inspection at every construction stage; bribery and corruption are among the key factors that mostly hinder implementation of quality management systems.

7.5. Section E- Discussion based on respondents' response on the benefits of developing and using quality management systems checklist in the production of concrete.

This section presents respondents responses on the benefits/justification for developing quality management systems checklist for the production of concrete**.** It was relevant to ascertain the respondents' view on the reasons offered by researchers for the development and the use of quality management systems checklist for the production of concrete.

Table 4.5: Benefits of developing quality management systems checklist for concrete production Source: Field survey (2021)

Benefits of Quality Management Systems Checklists for the Production of Concrete		A 4	N 3	D 2	SD 1	Na	Total Score	Mx	RII	Rank
Checklist serves as a common quality control and quality assurance tool	40	11	4	0	0	55	256	4.65	0.92	1st
Checklist provides a means of demonstrating that tasks will be completed as planned.	35	15	0	7	0	55	250	4.55	0.91	2nd

Development of checklist requires involvement of those who will participate in the use of it.	38	14	0	0	0	55	249	4.53	0.91	2nd
Use of checklist reduces any tendency to omit important steps in any task	34	21	0	0	0	55	254	4.62	0.93	1st
Development of checklist is usually tailored to take care of the needs of customers.	40	10	5	0	0	55	255	4.64	0.93	1st
A simple and easy to use checklist serves an ideal tool to for site operatives and managers	29	26	4	0	0	55	256	4.65	0.93	1st

Table 4.5 presents the benefits of developing quality management systems checklist for the production of concrete. Checklist serves as a common quality control and quality assurance tool (RII= 0.93); use of checklist reduces any tendency to omit important steps in any task (RII= 0.93); development of checklist is usually tailored to take care of the needs of customers (RII= 0.93) and a simple and easy to use checklist serves an ideal tool for site operatives and managers (RII= 0.93) have been ranked first as the major benefits of developing and using quality management systems checklist for the production of concrete. Checklist provides a means of demonstrating that tasks will be completed as planned and development of checklist requires involvement of those who will participate in the use of it, ranked second with relative importance index (RII) as 0.91which is assessed to be of very high significance. As the results indicate, checklist serves as a common quality control and quality assurance tool; use of checklist reduces any tendency to omit important steps in any task; development of checklist is usually tailored to take care of the needs of customers and a simple and easy to use checklist serves an ideal tool to for site operatives and managers are the key benefits of developing and using quality management systems checklist in the production of concrete.

VIII. Conclusion

In line with the pursued objectives of the research, the conclusions reached were that the mostly used existing methods of increasing quality of concrete include carrying out daily inspection; conducting on site testing of concrete; review of process, practices and procedures and the use of quality management systems checklist for concrete production.

The use of damaged or poor-quality materials; existence of communication gap between teams; failure to document observed changes and practices and lack of quality management systems highly hinder delivery of increased quality of concrete for building construction in the study.

Award of contracts to unqualified contractor; lack of buildability analysis; lack of adequate supervision and inadequate technical knowledge; noninvolvement of all concerned professionals at the design stage; lack of adequate sanction by standard assurance organization; lack of effective quality policy implementation; lack of proper inspection at every construction stage; non-implementation of national building code; bribery and corruption are among the key factors that highly hinder implementation of quality management systems in the production of concrete for building construction.

The key benefits of developing and using quality management systems checklist in the production of concrete, includes among others that: checklist serves as a common quality control and quality assurance tool; checklist reduces any tendency to omit important steps in any task; development of checklist is usually tailored to take care of the needs of customers and a simple and easy to use checklist serves an ideal tool for site operatives and managers.

REFERENCES

[1]. Okolie, (2016), Lecture Notes on Construction Management Principles for Postgraduate Diploma Students- Department of Building, Nnamdi Azikiwe University, Awka.

[2]. Sylvester, I. C (2013). An Assessment and Evaluation of Education on the Productivity of Construction Workers in South-East, Nigeria. Journal of echnological Research and Development-A Multi-Disciplinary Journal of Akanu Ibiam Federal Polytechnic, Unwana. JOTRED Vol. 2, No. 1, Feb.,2013. (Schreiber, 2021).

[3]. UNESCO (2008) Unesco-Nigeria Technical &Vocational Education Revitalization Project phase II. "What is the development impact of concrete?". Cement Trust. 24 October 2010. Archived from the original on 17 September 2012. Retrieved 10 January 2013.

[4]. Shubham, S.M (2019), Batching and Mixing of mortar and concrete ingredients.

[5]. Ikechukwu, U.F (2020). Lecture Notes on Advanced Concrete Design for Post Graduate Students-Department of Building, Nnamdi Azikiwe University, Awka.

[6]. American Society for Quality (2021); What is quality management system (QMS)?

[7]. Alexander, P. (2019); What is the purpose of a quality management system

[8]. Mulcahy R., PMP, etal (2018). PMP Exam Prep. Accelerated Learning to Pass the Project Management Professional (PMP) Exam. Ninth Edition. RMC Publications, Minnetonka, Minnesota. Page 319-321.

[9]. Lance, H. (2021); Types of Quality Management System. Concretetips- (2020).

[10]. CIOB and Lion, M (2019). Code of Quality Management. Guide to Best Practice Construction Quality Management-Chartered Institute of Building.

[11]. Gopal. M.(2009).Quality Management System in Concrete Construction.

[12]. Nomin, Building Consult Ltd. (2020). Project Quality Management Plan (PQMP) for the Proposed Four-Story Residential Building at Umuola Okpulor, Aba, Abia State, Nigeria.