JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

THE IMPACT OF CONSTRUCTION DRAWINGS ON BUILDING PROJECT EXECUTION

[1]Joseph Chukwuka Okah[*] [2]Samson A. Ajiboye [3]Iyenemi Briggs
[1]Senior Lecturer, Civil Engineer, HOD, [2]Lecturer II, Architect, [3]Lecturer II, Electrical Engineer
[1]Department of Building Technology,
[2]Department of Architectural Technology
[3]Department of Electrical Engineering
Captain Elechi Amadi Polytechnic, Rumuola, Port Harcourt, Rivers State, Nigeria
***Corresponding author Email:** engineerjoeciv@yahoo.com

Abstract

Construction drawing serves as a communication medium graphically designed to convey the technical and design information from the drawings to the physical structure. Construction drawings have become necessary because of project complexity and the need for plan approval and contract agreement. However, some developers still build without construction drawings today just to cut cost. This study investigates the Impact of Construction Drawings on Building Projects. To achieve this, a collection of the contract drawings of Polytechnic Port Harcourt Faculty of Engineering Building was done to ascertain their roles in building project. Also, opinions of 61 stakeholders from the public and private sectors of the industry were randomly sampled on the subject matter. The collection was analyzed while simple %, mean score (M_s) and chi-square, χ (for hypothesis test) were used to analyze the survey data. At the end, the study identified Architectural, Structural, Electrical, Mechanical Engineering (Building services) and finishing drawings as basic construction drawings for building project. Findings also showed that construction drawings communicate the intent of professionals in a universal language by providing spatial organization (plan), defining shape, orientation and landscape, displaying sections, detailing of structural members, ensuring stability and easy setting out. They also provide power distribution, lighting and power point details which ensure easy wiring, display water supply, wastewater disposal routes, HVACs installation guides and clear finishes which accurately transfers the design information to the physical building. These impacts were confirmed by the survey result (M_s>2.5). Chi-square test at 5% significant level show that $x^2_{sample} > x^2_{0.95,\,1}$, (18.24 > 3.84) thus accepting $\boldsymbol{H_1}$ that construction drawings have positive impact on building project and rejecting $\boldsymbol{H_0}$. Amongst the recommendations are; punishment of offenders and the imprint of personnel registration numbers and seals on the construction drawings as a pre-requisite for plan permit/approval.

KEY WORDS: Architectural drawing, spatial organization, plan, elevation, section, structural, Electrical, mechanical/Building services, finishing, layout

1.0 INTRODUCTION

Construction drawings have become a necessary requirement for the execution of a building project because of the intrinsic information embedded in it. Construction drawing is defined as a communication medium whose purpose is to graphically convey the design requirement of a construction project to a physical project. The interpretation of drawings and conversion into practical reality is one of the herculean tasks confronting professionals. Therefore, construction drawings must be sufficiently detailed to be translated into a tangible reality. Different types of construction drawings such as; architectural, structural, electrical, building services and finishing drawings are used to execute building projects. These drawings provide clear information in terms of the concept for design shape, size (dimensions), layout, orientation and space management, aesthetics, cost and stability of the building. A drawing that lacks these basic ingredients is expectedly bound to fail during construction due to confusion.

Interestingly, Okah (2022) [1] noted in his famous publication on the causes and effects of building collapse in Rivers State that a major cause of building collapse is poor design and incomplete drawings. He noted that 'you cannot give what you don't have', because when the design drawing is not detailed, the building project is bound to fail. The matter is made worse by the use of quacks to 'save cost'. Consequently, the quacks cannot properly produce or interpret drawings, resulting to errors, mistakes and blunders and subsequent building collapse [2] [3]. Similarly, Okah (2022) [1] writes that incomplete project drawing impedes the site productivity because they introduce errors and alterations and cause delays in the job. In the same vein [4] discovered that design changes due to inconsistent drawings and its complexity has introduced serious errors into construction that may be expensive to rectify. As earlier stated, this study intends to unravel the impact of construction drawings on project execution and how the challenges thrown up can be controlled

1.3 Objectives of Study

i. To identify the basic type(s) construction drawings used for a building project
ii. To determine the impact of construction drawings on building project execution
iii. To determine how construction drawings impact building project execution
iv. To determine the extent to which construction drawings impact building project execution
v. To recommend solutions addressing the challenges of building without construction drawing

1.4 Research Questions

i. What type(s) of construction drawings are used for building project?
ii. What is/are the impact(s) of construction drawings on building project execution?
iii. How do construction drawings impact building project execution?
iv. To what extent do construction drawings impact building project execution?
v. What remedies can address the challenges of building without construction drawing?

1.5 Research Hypothesis

The hypotheses for test are: $\mathbf{H_0}$ is the null hypothesis while $\mathbf{H_1}$ is the alternative hypothesis:

Hypothesis I – Objective II
$\mathbf{H_0}$: Construction drawings do not have impact on building project execution
$\mathbf{H_1}$: Construction drawings have impact on building project execution
Hypothesis II – Objective III
$\mathbf{H_0}$: Construction drawings negatively impact building project
$\mathbf{H_1}$: Construction drawings positively impacts building project
Hypothesis III – Objective IV
$\mathbf{H_0}$: Construction drawings do not significantly impact building project execution
$\mathbf{H_1}$: Construction drawings significantly impact building project execution

2.0 LITERATURE REVIEW

The influence of construction drawing has come a long way. The concept and functions of construction drawings are shown in fig 1.0. Allen and Iano, (2002) [5] writes that these drawings provide clear information in terms of the concept of design shape, size (dimensions), color and texture, orientation and space management, aesthetics, cost and stability of the building. [6] noted that the design and quality of a finished work is a major product of the contract document. Construction drawing may be Schematic or Working drawing

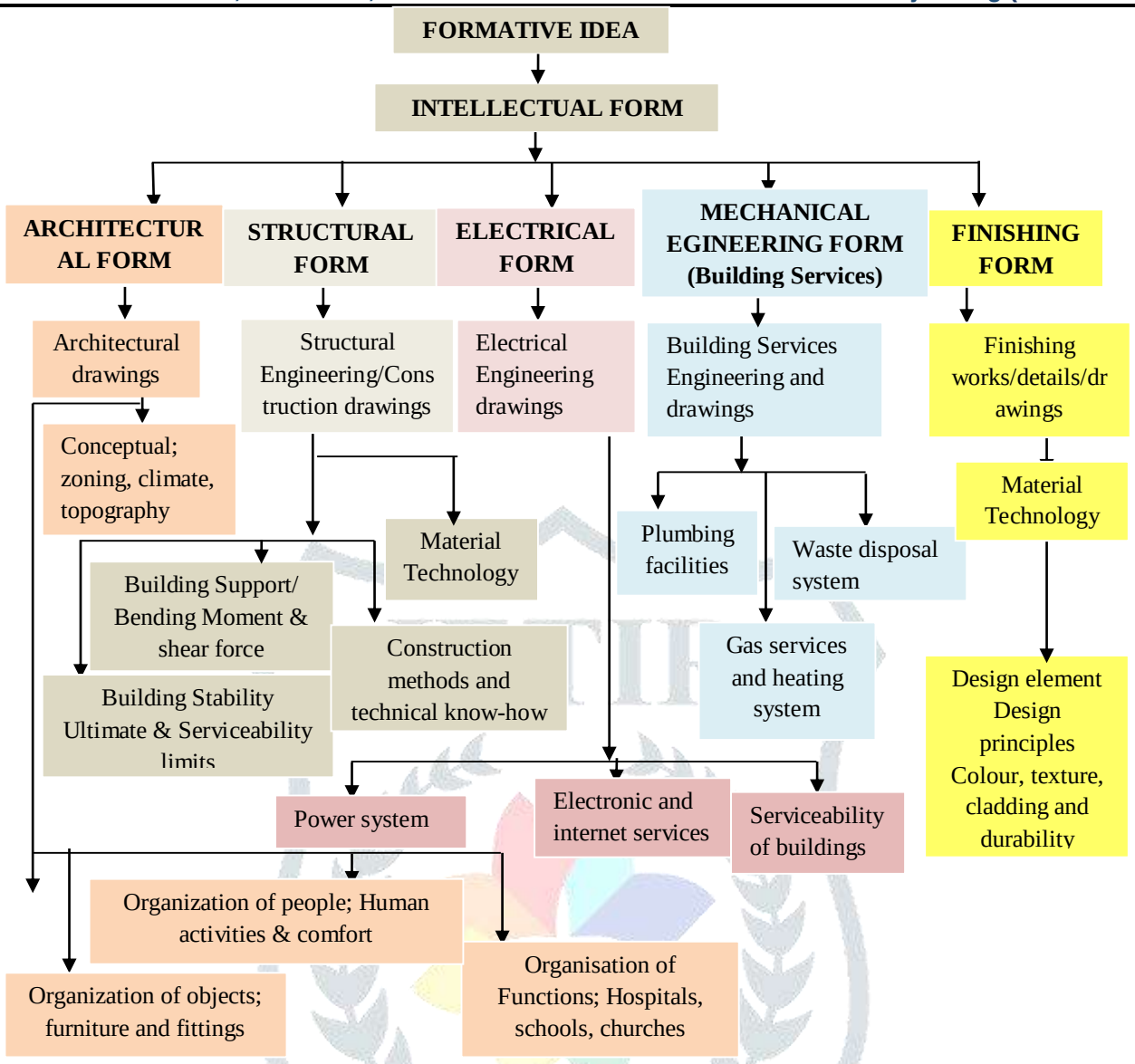

Fig 2.0 Concept and functions of construction drawing (Source: Field work, 2024)

2.1 Schematic Drawing

Schematic drawing indicates functional and practical consideration of a design [7]. It is more detailed than only a conceptual design drawing. Schematic drawing describes the functional design as a progression from the conceptual design to the practical reality [8]

2.2 Working Drawing

Working drawings are a set of comprehensive architectural drawings used in building construction. It represents the location, orientation, site's topography, landscaping utilities and site work [7]. Working drawings provide a greater detail of the work in different sheets for easy referencing.

2.3.1 Architectural drawing

Lefaivre and Tzonis (2021) [9] states that any brilliant architectural design should describes the most significant aspect of artifacts work, how they are made, their function with respect to expectation, environmental impact and their relationships with the immediate environment. It showcases all details such as; location site plan, elevations and sections. Hendrix (2012) [10] writes that there is a distinction between two functions of architecture which are; a communicative function which involves expression and representation as fulfilled by perceptual and conceptual forms, and an instrumental function, which is expressed in terms of utility and technology through spatial and structural forms respectively. There's no defined classification criteria for types of architectural working drawing but the representations of the parts of structure can be used to classify.

Plan: This represents aerial views of the part of the building. They view the structure at some point above the floor level cut horizontally. Plan could be ***Excavation Plan*** which shows the layout or of the

excavation while ***Roof Plan*** is the aerial view of the different elements of a roof. ***Elevations*** are orthographic, exterior views which show external height, size and shapes of the building. Elevations are designated as 'Front', 'Side' and 'Rear view' or direction such as 'East' or 'West' [11]. ***Sections*** show hidden features inside a wall or part by imaginary cuts through them which are not clearly shown in the plan or elevation and designated AA', BB', etc. [12]. ***As-built Drawing*** compares the current appearance or state of a new building to its original plans or blueprints. It is very helpful in adjusting plans in current structure when unforeseen circumstances arise by working from the original design and track progress [9]. ***Spatial function*** is prominent architecture**.** Spatial function provides the plan, elevations, side views and sections to analyse the requirements well and put the space to better use [7]. Zoning of spaces makes the drawings unique because spaces are first conceptualized and perceived to be sufficient before adding other components

2.4 Structural Drawing

A structural drawing is an engineering drawing with details of the ultimate and serviceability limits of the structural member. Geotechnical investigation is key because it is the first thing to be done to ascertain the suitability of the soil engineering properties and upon which the structural drawing is designed. Structural members such as column, foundation, beams, cantilever, slabs, roofs layouts etc are drawn to scale, detailed with bars and dimensioned according to the design consideration such as; loads, deflections, cracking etc [13]. The essence of structural drawing is to ensure design consideration is implemented to the later to prevent building failure [14]. To analyse the element, the structural drawing is subdivided into ***Structural Element Layout*** and **Details** producing: Foundation Plan, Floor plan, Beam and Roof plan. A layout showcases the plan, elevations or section of each layout with dimensions while a detail shows the bar arrangement before concrete placing.

2.5 Electrical Drawing

Singh, (2018) [15] writes that electrical drawing shows the technical information about power supplies, lighting and communication (signal) to a building. It represents a detailed diagram of all the electrical connections, Power supply, outlets, fixtures, switches, sockets, lighting, fans, etc. and their loading capacities, ratings etc. all represented by their symbols [17]. The types of electrical drawings in a building are; Lighting Point, Power Points and Control Unit drawings and thunder arrestor represented by their symbols [16]. Lighting points showcases the positions of bulbs and lighting is obviously a visual subject and it may be treated as such of a design purposes.

2.6 Mechanical Engineering/Building Services drawing

Plumbing drawing consists of piping of fresh water supply system, waste and foul water discharge system, drainage, storm water system and fuel gas lines and the installation of sanitary appliances and fittings. The drawing consists of Riser diagram, symbols, HVACs, Legends and notes. Others are inspection chambers, fixture and fittings units, pump and their capacities, slope and bend.

2.7 Finishing drawing

This illustrates the finishing details and appearance of the building. Finishing drawings include details of painting colours and patterns, tile patterns, terrazzo, Door and Window (Almaco) design, hanging ceiling, POP, plastering texture (rough and smooth, screeding etc.), woodworks, motifs and designs, cladding etc. [7].

3.0 RESEARCH METHODOLOGY

3.1 Study Area – Location and Demography

This study was carried out in Port Harcourt metropolis comprising the eight Local Government Areas (LGAs) that make up the Greater Port Harcourt City Development Authority (GPHDA). The reason being that these LGAs have witnessed the highest rate of private and public property development in recent times [18]. The population of these LGAs as gazetted by NPC was projected from 2006-2022 at an annual increase rate of 2.3% [19] up running till 2024 as shown in table 1.0.

Table 1.0: Population distribution in GPHDA, (2006-2024) [19]

S/ No	LGA	Areas surveyed	Co-ordinates		2006 Census	Projection	
			Latitude	Longitude		2022	2024
1	Port Harcourt City	Port Harcourt	4.777777	7.022222	538,558	774,600	810,950
2	Obio-Akpor	Obio-Akpor	4.778525	7.130245	462,350	665,000	699,870
3	Ikwerre	Igwuruta, Omagwa& Aluu	4.954654	7.020962	188,930	244,098	255,455
4	Eleme	Akpajo & Refinery	4.799645	7.121404	190,194	245,587	257,014
5	Etche	Igbo-Etche	5.134391	7.141932	249,454	320,942	335,875
6	Oyigbo	Oyigbo	4.886592	7.124565	122,687	180,300	188,689
7	Emohua	Emohua	4.884429	6.863702	192,059	289,200	302,656
8	Okrika	Okrika	4.754381	7.077253	212,315	319,700	334,575
Total					2,156,547	3,039,427	3,185,084

Source: Author's field work (2024)

3.1 Design of Study

This section describes the mode of data collection, sampling design and analysis

3.1.1 Method of Data Collection

The study was designed such that two methods were used to obtain data. The design methods are:

i. A collection of the contract (construction) drawings of Polytechnic Port Harcourt Faculty of Engineering Building by the authors (professionals). The authors designed and developed the construction drawings and are part of the contract team executing the Faculty of Engineering building. Amongst information sought are practical experiences from the project.

ii. Survey method to randomly sample the opinions of stakeholders in the building industry on the subject matter through structured questionnaire. These stakeholders are drawn from the public (certified professionals in the ministry of housing and Physical planning) and private (registered professionals, building contractors and craftsmen) sectors in Rivers state

3.2 Population of Study

The population target is 72 (N) drawn from public and private sectors of construction industry. The public sector participants encompass; Housing and Physical Planning and Urban Development ministries while that of the private sector were: Nigeria Society of Engineers, Nigeria Institute of Builders, Nigeria Institute of Architects and the Registered Building Contractors in Rivers state.

3.3 Sampling size distribution

The sample size was determined from the Taro Yamine population reduction formula:

$$n = \frac{N}{1+N\,(e^2)} \text{ ---------- (I)}$$

Assuming the confidence level of 95% N = Desired Population

N= Population size = 72 n = Sample size e = Accepted tolerable error = 5%

Therefore, $\frac{72}{1+72\,(0.05^2)} = 61\ (approx.)$. The sampling size will be 61

3.4 Research Instrument

A total of 61 structured questionnaires were administered to the respondents, 30, to the public sector while 31 were administered to the private sector.

The instrument was divided into four sections**:**

(i) A elicited response on the type(s) of construction drawings required for building project execution

(ii) B elicited response on the impact of construction drawings on building project execution

(iii) C elicited response on the extent to which construction drawings impact building project

(iv) D elicited response on remedies to the challenges of building without construction drawing

3.5 Scoring of the Research Instrument

The questionnaire was designed to rank the answers in Likert scale

Table 3.0**a** Scoring of the instrument response

S/No	Response	Score
1	Strongly Agree (MA)	4
2	Agreed (A)	3
3	Disagreed (D)	2
4	Strongly Disagreed (SD)	1

Table 3.0**b**: Scoring of the instrument response

S/No	Response	Score	Mean range
1	Major (MA)	4	3.01-4.00
2	Moderate (MOD)	3	2.01-3.00
3	Minor (MN)	2	1.01-2.00
4	Insignificant (IS)	1	0-1.00

Research Survey; 2024

3.6 Method of data Analysis

Data will be presented in tabular form while analyses will be done with the following tools:

i. Simple % tool for the determination of respondents' percentage

$$\mathbf{F} = \frac{\text{Number of Respondents (R)} \times 100}{\text{Sample size (n)}} \quad \text{(II)}$$

Where F = % frequency, R = number of respondents n = Sample size = n

ii. The mean score was performed with the formula:

$$M_S = \frac{\sum_{k=1}^{4} \binom{4}{k} W_k \times n_k}{(n_r)} \quad \text{(III)}$$

Where M_s = Mean Score, $\mathbf{W_k}$ = Score attached to each response in the scale 1-4,
$\mathbf{n_k}$ = Response for each score, $\mathbf{n_r}$ = Total No of responses

Average mean (M_v) = 2.5 $M_s > 2.5$ = Accepted $M_s < 2.5$ = Unaccepted

iii. Testing of the Hypothesis

Chi-square will be used to test the hypothesis/significance.

$$Chi - square,\ x^2 = \sum_{i=1}^{N} \frac{(x_i - \bar{x}_i)^2}{\bar{x}_i} \quad \text{---------- (IV)}$$

Where x_i = Observed Frequency $\bar{x}_i$ = Expected frequency N = Total frequency

4.0 DATA PRESENTATION AND RESULT DISCUSSION

Result from the design and assemblage of contract drawings of Polytechnic Port Harcourt Faculty of Engineering Building project by the authors who executed the building project reveals the following:

4.1 Types of Construction Drawing

4.1.1 Architectural drawings:

Architectural drawings contain details about location, site plan, floor plans, elevations, sections, excavation plans and other pictorial representations. The different parts of the drawing are:

a) Plans: The plan represents the aerial views of the building parts. Below are different plans:

(i) **Site/working Plan:** The drawing shown in fig **4.0a** represents the location, orientation, site's topography and landscaping utilities such as access road (walkways), security, drainage, main building, recreation, vegetation and adjourning buildings in the surroundings. It describes the existing and proposed conditions (landscape). It is used to mark out the plan on the ground

(ii) **Floor Plan:** Floor plan in fig 4.0**b** represents aerial views of the main building. They view the building parts from the top with all the details in the interior. This view is obtained by cutting horizontally through the building immediately above the floor level. Floor plans help to: identify the shape, layout, dimensions, partitions, locate spaces and provide references for detailed information.

(iii) **Excavation Plan**: This plan basically shows the dimensions of the trenches to receive the foundation. Architectural excavation plan is quite different from structural foundation plan.

(iv) **Roof plan** is a plan that showcases the shape, orientation, size, dimension and position of the ridge, valley and other important features viewed from the top as shown in fig 4.0**c**

b) Elevations

The elevations are orthographic, exterior views which includes; external height, size and shapes of the building, doors, windows, chimneys and mouldings. The elevations may be designated as 'Front view', 'Side view' (Left or Right) and 'Rear view' as in figs 4.0**d** and fig 4.0**e** or direction of faces such as 'East' or 'West'. Interior elevations may be provided to show interior wall features too.

c) Sections

The sections show hidden features inside the wall, cabinets, staircases, wardrobes etc by imaginary cuts through the structural components which are not clearly shown in the plan and elevation. They viewed in a sliced form which may be designated AA', BB', etc [12] exposing hidden features depending on the nomenclature used as shown in fig 4.0**f**

4.1.2 Functions

Prominent amongst them is *Spatial Organisation and zoning*. Spatial function refers to the arrangement of spaces encompassing shape, size and layout and orientation within a building while zoning influences occupant's experience, interaction and use of building environment whilst still serving the occupants intended purpose of aesthetics, comfort, accessibility etc. through space allocation [7]. For example, a dinning is close to the kitchen, bedroom close to bathroom etc. Thus, *Spatial Organisation* makes the drawings unique because spaces are first conceptualized and perceived to be sufficient before other components are such as zoning (space allocation) is added. The dimensions encompassing; measurements, scales and cross-referencing provides a better understanding of the spatial function [7]. The drawing provides adequate platform for effective communication between stake holders. *Elevations* help in vertical proportioning, ambience and comfort. However, *Scope* provides pre-information of what is expected, hence the cost of the job which makes decision easier. *Aesthetics* at finishing involves fixing burglaries, rails, windows and doors, cladding, POP, screeding, painting and floor tiles, etc. are all aimed at giving the building a pleasing appearance, enhance amiability and social status. The drawings provide *feasibility* which entails the possibility of building the design in a practical environment within regulatory standards.

4.2 Geotechnical Report

Geotechnical investigation remains the first thing to do before building because the structural design is based on the report and the key parameter is the bearing capacity of the soil. The allowable bearing capacity of 69-138KN/m^2 was recommended at depths of (0.75–1.5) in order to ensure maximum settlement of 65mm for shallow foundation according to Skempton and Bjerrum [20]

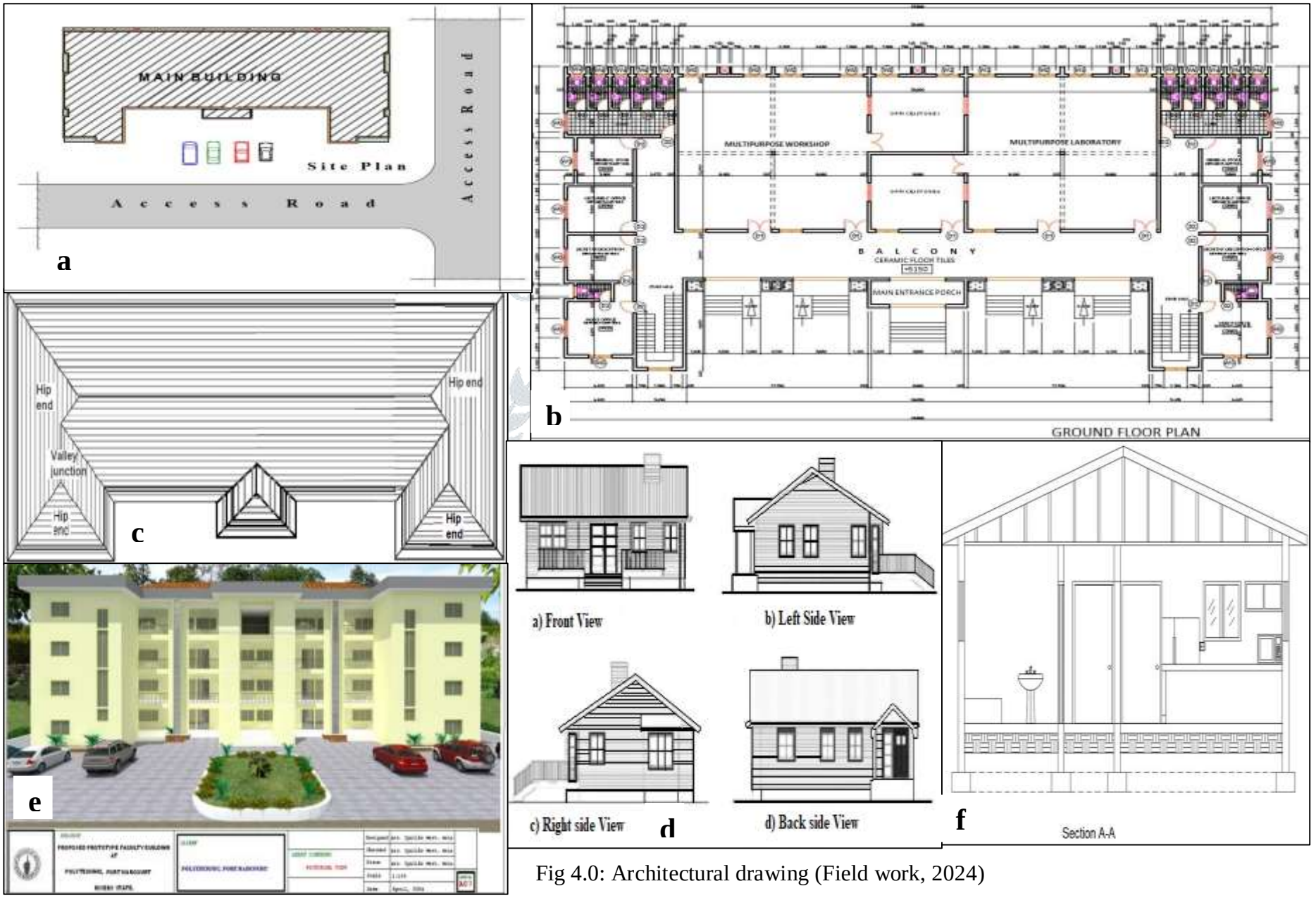

Fig 4.0: Architectural drawing (Field work, 2024)

4.3 Structural Drawing

A structural drawing is an engineering drawing with details of the ultimate and serviceability limits of the structural member. Fig 4.1 show the structural members such as column, foundation, beams, cantilever, slabs, roofs layouts etc drawn to scale, detailed with reinforcement arrangements and well dimensioned to take care of the ultimate limit (load) and Serviceability limit (deflections, cracking etc) [14]. These drawings outline the size, material type, mix proportion, reinforcement, moment under loading to address stability unlike architectural details.

4.3.1 Types of Structural Drawing

The structural drawing is shown in layout and detail. The representations are:

(i) Foundation plan: This plan shows the basement, foundation walls, slabs, piers, and footings from top. It includes dimensions, column positions and grid lines as shown in fig 4.1**a** and 4.1**b** for foundation layout and column base details respectively. The layout shows the plan, elevation or section while the detail shows the arrangement of the steel bars in a structural member including the number of main and minor bars, spacing, sizes and specification (mild or H.Y steel) for proper concrete placing [13]. This plan helps the engineer to identify the lines, positions and dimensions of the blinding, footings and bar arrangement in column bases and helps in the setting out plan

(ii) Floor plan – Slab layout and details (Ground and suspended floor)

This layout in fig 4.1**c** shows the floor dimensions, area, orientation and detail of the floor slab. This enables the engineer know the scope and detail of the job which includes the arrangement of the bars

(iii) Staircase Layout and details

The drawing in fig 4.1**d** shows clearly the plan, sections and the details of the staircase. The drawing helps the engineer to mark out the angle of elevation (35^0), landings, headroom, riser, tread, stringer, total rise and run for easy construction. The detail is shown for proper placing and bar arrangement.

(iv) Suspended floor Beam

Beam layout as shown in fig 4.1**e** is a structural drawing that illustrates how and where the beams are positioned and located respectively. Beams are load bearing horizontal members running from one point to the other and supported by wall or columns. In structures, the limit state is reached when the load is excess, then the applied moment exceeds the moment of resistance of the concrete and the structure fails. Thus d >*L/250* below the level of horizontal supports or d>*L/350* after the erection of partitions (*L* = span) and cracks width > *0.3mm*, (BS 8110, 1997). So beams are designed and positioned to avoid this. Thus the drawing assists the engineer locate cantilever, simply supported, continuous, fixed-ended, overhanging or 'T' beams, their dimensions and detail.

(v) Roof beam layout and details

The roof beam layout shows the beam arrangement at the end of block work in the building. The roof beams layout is at the top mainly on strategic points where load is concentrated for transfer and distribution and must be professionally executed in line with design to avoid failure. The roof beam is similar to the suspended floor beam layout in fig 4.1**a** for this building and detailed in fig 4.1**f**

4.3.2 Functions

Structural drawing is the chief tool for *stability and safety* of the building only if the design consideration in the drawing is strictly translated to tangible reality. *Setting out dimensions* is key to the formation of the foundation whilst *layout and detailing* as contained in the structural drawings provide the visual/pictorial evidence to communicate the plan and details of the reinforcement in the member. It is also a tool for project planning and scoping of the work for costing.

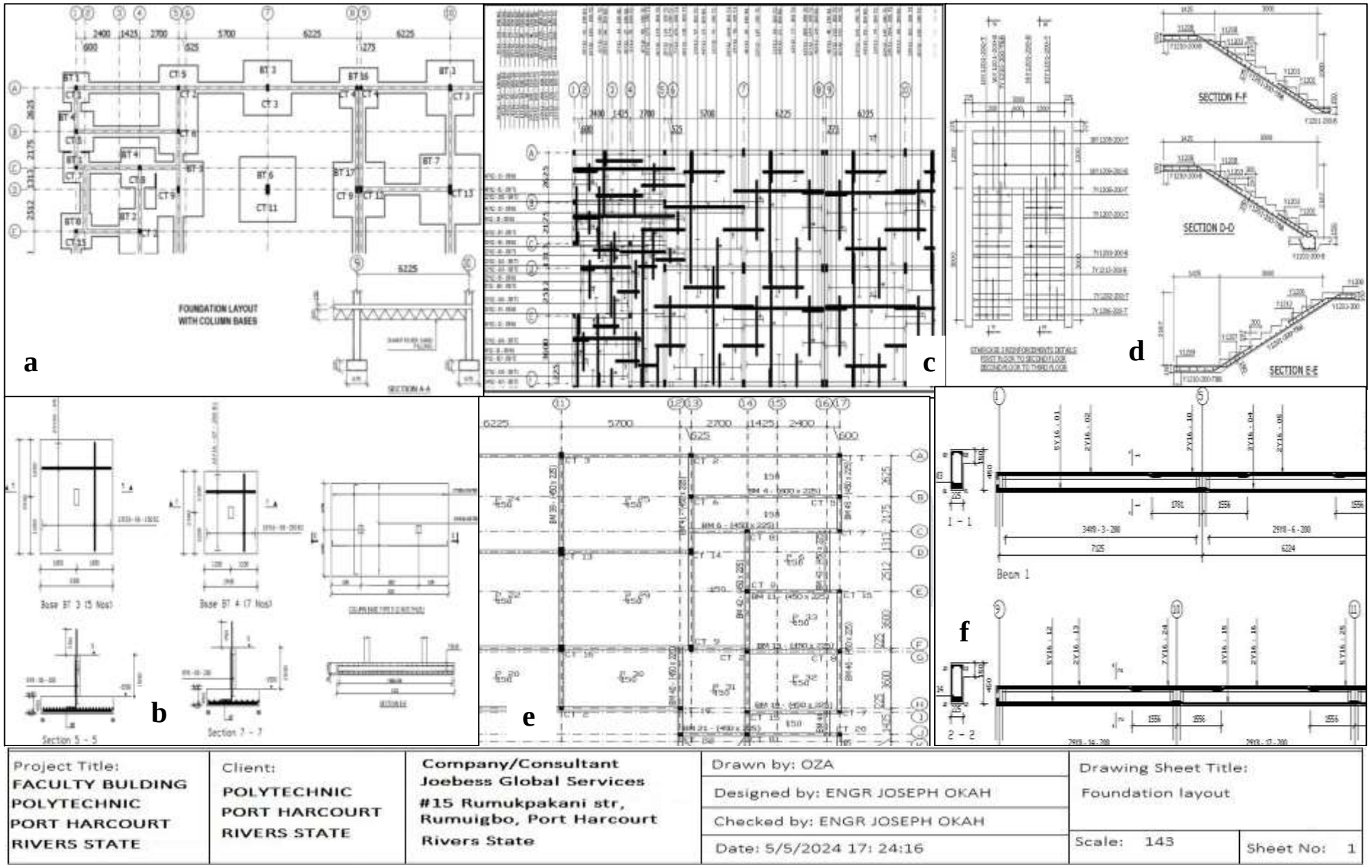

Fig 4.1: Structural Designs (Design work, 2024)

4.4 Electrical Drawings

The symbols are represented in the legend in fig 4.2 while the points, units and systems are represented in the electrical drawings as follows:

(i) Lighting Point: Lighting points consist of the positions of the incandescent bulbs, LEDs, halogen bulbs, florescent lamps and fans from where wire runs to a switch to control the flow of current. This position is mostly at the ceiling of a room or at a position of unhindered illumination is as shown fig 4.3**a**. These lighting positions help the electrical engineer/electrician efficiently locate points to position the bulbs in actual electrical work. These points are connected through wiring.

(**ii) Power Points**: Power Points drawing shown in fig 4.3**b** show sockets, switches and regulators. The socket supplies power to electrical appliances and cooling or heating systems. However, a switch controls the flow of current into a circuit/lighting point. These fixtures have ratings which enable the engineer to know the minimum power consumption in the building and then make adequate provision for it. Building regulations stipulates that, the base of a socket must > 450mm above the floor surface while the height of a switch on the wall should be 1200m

(iii)The Control Unit- Load Distribution Board: This unit showcases voltage regulation and safety. The Control Unit or Load distribution board/panel shows in details a complex electrical board that contain a circuit breaker to control power supplies or step-down transformers installed on a single-line power source to balance the voltage requirement of a building. It also houses various voltage level lines. The drawing in fig 4.3**c** gives the engineer an overview of the power supplies, the electrical distribution system and control and the installation position in the building.

(iv) Thunder Arrestor: A thunder arrestor is a highly conductive copper device installed on the building exterior to protect electrical installations and appliances from damages due to thunder strike or lightning. The spike is positioned at the roof connected to the earth as shown in fig 4.3**e**

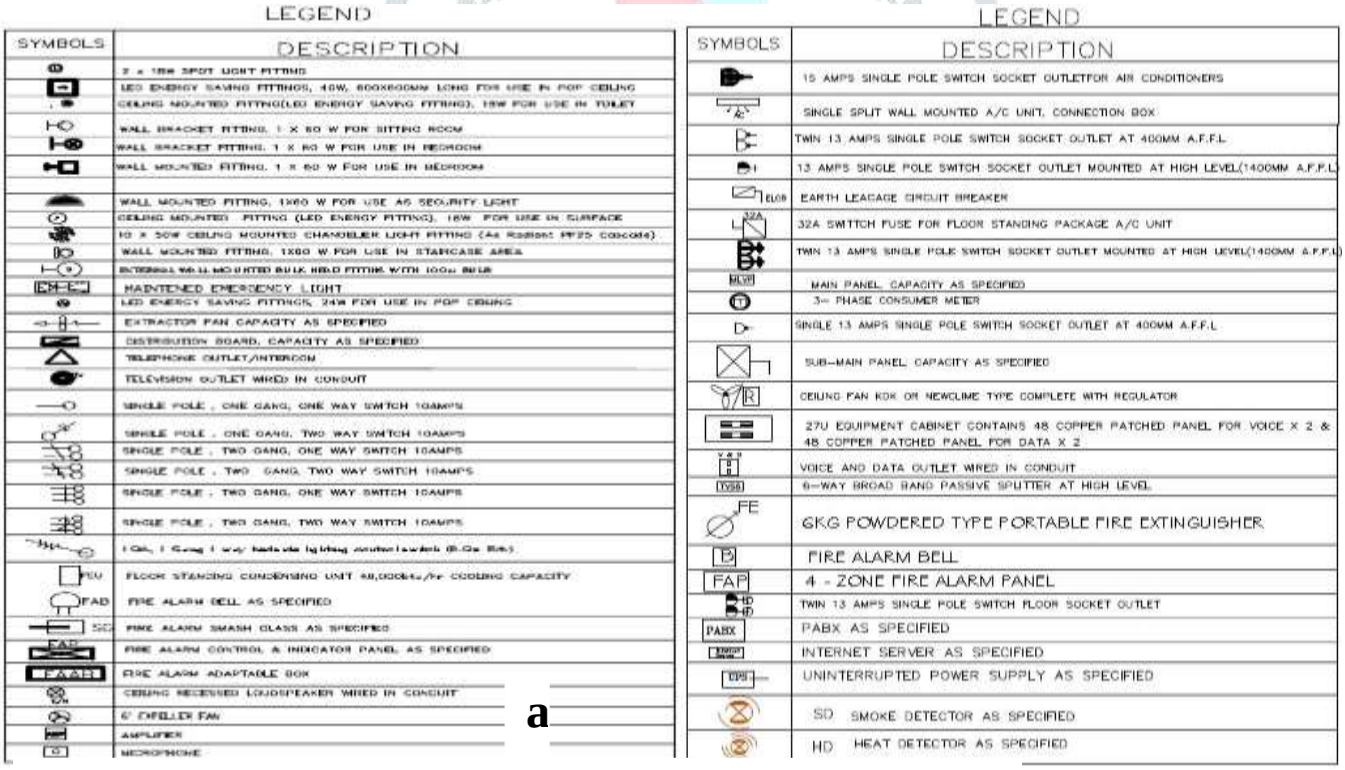

Fig 4.2: Electrical drawing components 1 (Design work, 2024)

(**v) Signal and Safety**: Signal drawing has to do with cable and satellite dish and telecommunication. The connection is contained in the diagram for efficient performance. For safety, the positions of fire extinguisher, fire alarm are close to the control unit as shown in fig 4.3**d**.

4.4.1 Importance of Electrical drawings

Power Supply: Electrical diagram provides technical information on the power supply and consumption in a building. It is designed to guide the electrical engineer on the type (socket, switch, regulators)

and capacity (13, 15amps etc) of the materials and positions of installation and the wiring route. It is done in consideration of the power supplied and consumed.

Lighting: The major function of electrical drawing is to locate lighting points and clear illumination without hindrance. *Connection between devices*: Electrical drawings provide technical information on the connection between component devices.

Installation guide and on-site troubleshooting: The drawing provides a guide on how and where installation units such as component devices and equipment such as batteries and solar panels, generators and HVACs. It is also a tool for on-site troubleshooting.

4.5 Mechanical Engineering/Building Services drawing

Plumbing drawing consists of water supply system, waste and foul water discharge system with sanitary appliances, drainage and storm water system from gutters and downpipes, fittings, water heater and irrigation system. It also includes fuel gas lines, HVACs etc. The drawing consists of Riser diagram, symbols, Installation details, Legends and notes.

4.5.1 Types of Mechanical Engineering/Building Services drawing

(i) Water Supply System

This type of drawing shows a piping system that conveys water from the mains or supply point into the house by direct or indirect supply method. The water supply system consists of a 40mm UPVC pipe conveying treated water from mains to a lift pump which supplies to a 3000ltrs overhead water storage tank (fig 4.**4a)** through and a 32mm uPVC pipe. The overhead tank supplies water through a 25mm uPVC discharge pipe reduced to 20mm at entry point into the building as shown in fig 4.4**b**.

(ii) Waste Disposal System

The waste disposal system in fig 4.4**c** consists of WC connected to 100mm PVC pipe conveying soil waste away from the WCs in toilets and 50mm PVC conveying wastewater from sanitary appliances all connected to a 100mm stack into the inspection chambers to the disposal facility.

(iii) HVAC – Air-conditioners and extractor fans

Heating, Ventilation and Air Condition (HVAC) system are mechanical cum electrical appliances that control temperature, humidity and ambience in the enclosure. Fig 4.4**d** shows the Gas lines, Air-conditioners (hybrid split units), out-door condensing units and extractor fans in the building.

4.6 Finishing drawing

Finishing drawings show the appearance of the building which consist of painting, tile patterns, doors and windows, incrite, POP, plastering texture (screeding), burglary, woodworks, motifs, cladding and general aesthetics

4.7 Fire Protection

Fire protection/safety drawing shows fire extinguishers, smoke detectors, fire alarm and sprinkler systems positioned at strategic points such as kitchens, lobby etc. and emergency exit routes.

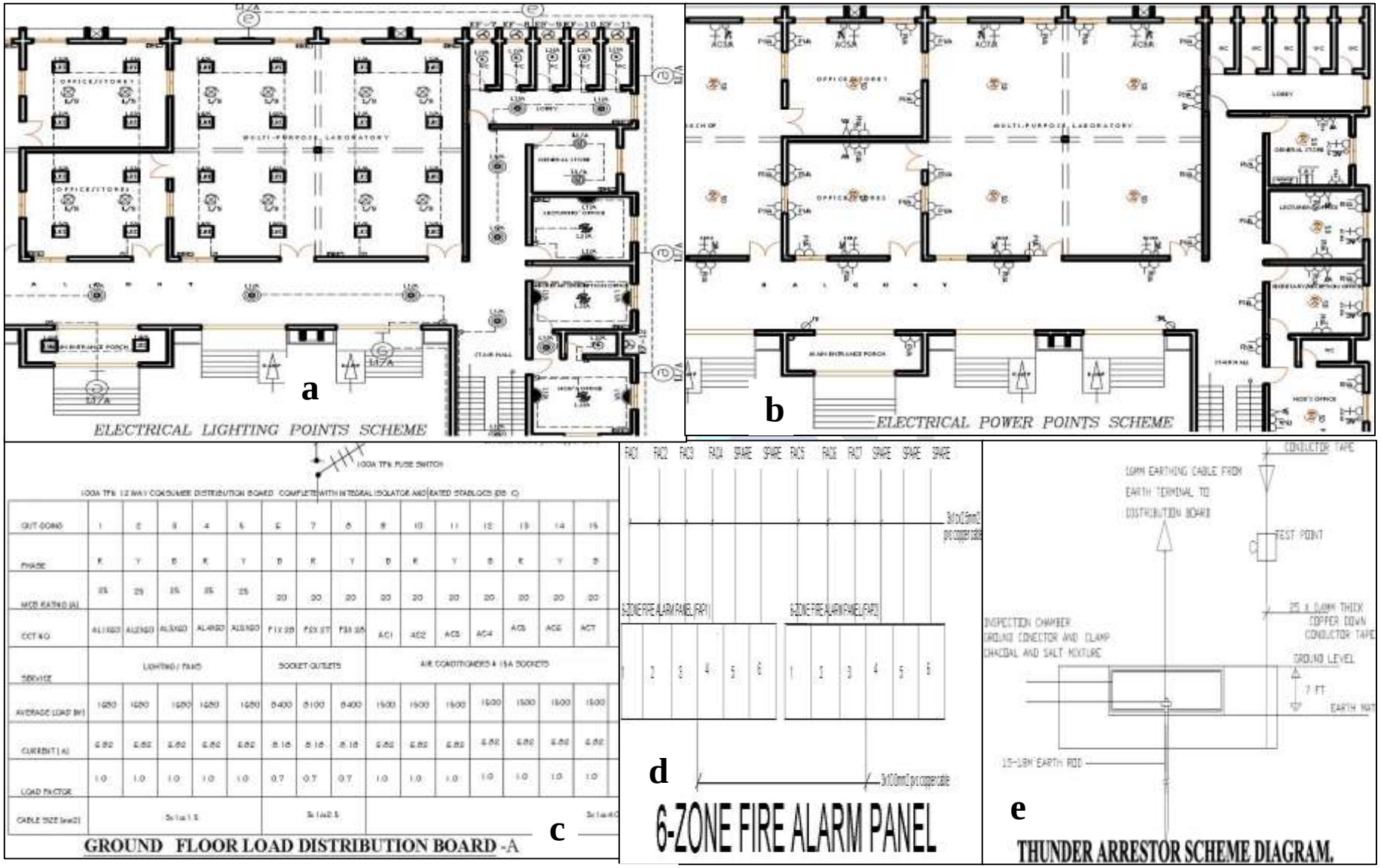

Fig 4.3: Electrical drawing components 2 (Design work, 2024)

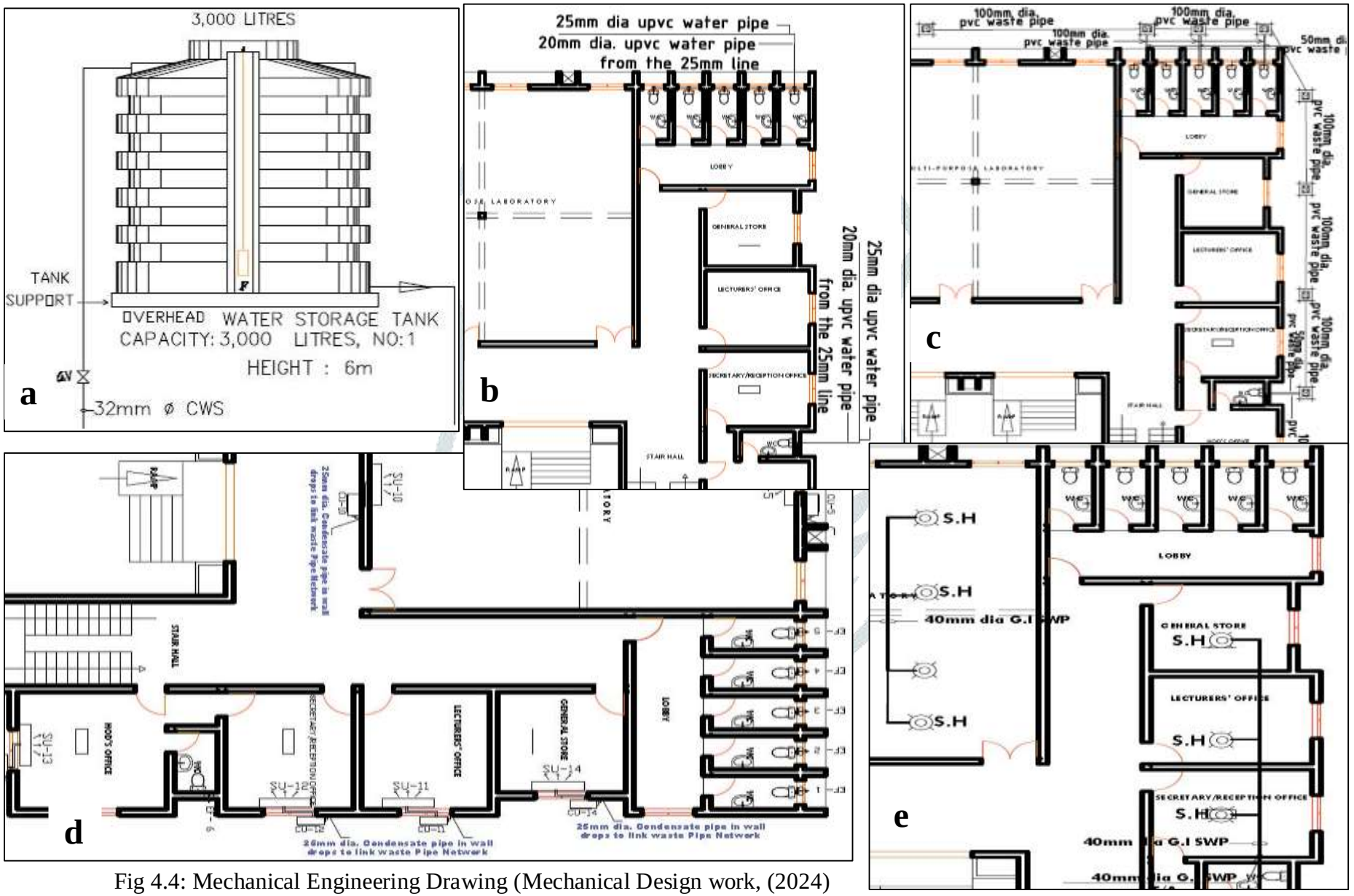

Fig 4.4: Mechanical Engineering Drawing (Mechanical Design work, (2024)

4.8 Result Analysis from Survey

4.8.1 Data Demography

Results show that out of the 61 questionnaires distributed, 59 entries were returned resulting in a response rate of 96.7% while only 1 from each sector was returned invalid. Thus, 28 were used for public while 29 were used for private sectors as stated in Table 4.0.

Table 4.0: Distribution of entries

S/No	Description	Frequency	(%)
1	Questionnaires Sent	61	100
2	Entries received	59	96.7
3	Invalid entry	2	3.4
4	Entries used	57	96.6

Research survey; 2024

Table 4.1: Age distribution of the respondents

S/No	Age Bracket	Frequency	(%)
1	18-25	8	14.0
2	26-40	28	49.1
3	41-55	16	28.1
4	56 – above	5	8.8
Total		**57**	**100**

4.8.1 Data Demography

Results show that out of the 61 questionnaires distributed, 59 entries were returned resulting in a response rate of 96.7% while only 1 from each sector was returned invalid. Thus, 28 were used for public while 29 were used for private sectors as stated in Table 4.0.

Table 4.0: Distribution of entries

S/No	Description	Frequency	(%)
1	Questionnaires Sent	61	100
2	Entries received	59	96.7
3	Invalid entry	2	3.4
4	Entries used	57	96.6

Research survey; 2024

Table 4.1: Age distribution of the respondents

S/No	Age Bracket	Frequency	(%)
1	18-25	8	14.0
2	26-40	28	49.1
3	41-55	16	28.1
4	56 – above	5	8.8
Total		**57**	**100**

Table 4.2: Educational qualification

S/ No	Educational qualification	Frequency	(%)
1	FSLC	Nil	Nil
2	O' Level	5	8.8
3	BSc/B.Eng/HND	30	52.6
4	MSc	17	29.8
5	PhD	5	8.8
Total		**57**	**100**

Research survey; 2024

Table 4.3: Demography of the respondents

S/No	Work Experience	Frequency	(%)
1	1-5	5	8.8
2	6-10	22	38.6
3	11-20	20	35.1
4	21 – above	10	17.5
Total		**57**	**100**

The demography in Table 4.1- 4.3 shows that the energetic working population age bracket of 26-40 participated most while the first degree/HND level of education was mostly involved in the survey. However, a high level of experienced professionals' (6-20yrs experience) participated.

4.8.2 Objective I: To identify basic construction drawings for building

Research question: What type(s) of construction drawing is/are used for building project?

Table 4.4: Types of construction drawing

S/No	Types of construction drawing	No of Respondents (n_k) for each Score (W_k)				n_r	M_s	Remark
		4	3	2	1	57	4	
1	Architectural drawings	39	17	1	0	57	3.67	Agreed
2	Structural drawings	43	11	1	1	56	3.71	Agreed
3	Electrical drawings	45	10	2	0	57	3.75	Agreed
4	Mechanical Engineering Services drawings	34	15	5	3	57	3.40	Agreed
5	Finishing drawings	21	8	15	12	56	2.68	Agreed

Research survey; 2024

Table 4.5 shows that both the participants agreed that the drawings in the table features prominently as the types of construction drawing used for building project execution

4.8.3 Obj. II: To determine the impact of construction drawings on building project execution

Research question: What is/are the impacts of construction drawings on building projects?

Table 4.5: Impact of construction drawing on building project

S/No	Impact of Construction drawing	No of Respondents for each Score (W_k)				n_r	M_s	Remark
		4	3	2	1	57	4	
A	**Architectural drawings**							
1	Enhance spatial organization and zoning – allocation of space based on intended use	35	16	5	1	57	3.49	Agreed
2	Maintain setting out dimensions	12	16	16	15	59	2.42	Disagreed
3	Communicate ideas in the plan, elevation, and sections in a universal language	35	14	6	2	57	3.44	Agreed
4	Ensure proper coordination and provide an insight on the final structure and As-built	31	19	3	4	57	3.35	Agreed
5	It's an effective means of cost estimation and material planning	33	21	1	1	56	3.54	Agreed
6	Enhances feasibility and defines aesthetics	27	23	4	3	57	3.30	Agreed
B	**Structural drawings**							
1	Maintains setting out dimensions and Span/dimension of structural members	23	22	7	5	57	3.11	Agreed
2	Ensures stability, safety and communicate properly the intent of structural engineer	31	23	3	0	57	3.49	Agreed
3	Display detailing of structural members	27	24	4	2	57	3.33	Agreed
4	Defines the Scope of work is properly	25	23	5	3	56	3.25	Agreed
5	A tool for construction planning, work schedule and project-time-control system	20	24	8	4	56	3.07	Agreed
6	Makes maintenance and retrofitting easy	16	13	15	13	57	2.56	Agreed
C	**Electrical drawings**							
1	Serves as an installation guide and ensures compliance to safety codes and standards	28	21	7	1	57	3.33	Agreed
2	Provide details of lighting, power points, power distribution and technical insight on connection between component devices	29	25	2	0	56	3.48	Agreed
3	Simplifies wiring and electrical piping and makes on-site troubleshooting easy	31	23	3	0	57	3.49	Agreed
4	Show the quantity and quality of materials to be used hence makes costing easy	14	16	15	12	57	2.56	Agreed
D	**Mechanical/Building Services drawings**							
1	Display Water supply, waste/foul water disposal, storm water and gas flow lines	32	24	0	1	57	3.53	Agreed
2	Provide details of proper arrangement of fittings and fixtures and pipe sizes	25	23	7	2	57	3.25	Agreed
3	Indicate water and gas lines' flow direction	11	14	20	12	57	2.42	Disagreed
4	Serve as an installation guide to the HVAC	17	15	18	7	57	2.74	Agreed
5	Help to identify positions of inspection chambers, drainage and sanitary appliances	27	23	5	2	57	3.32	Agreed
E	**Finishing drawings**							
1	A clear view of the tile pattern, painting cladding, textures and general aesthetics	18	16	14	9	57	2.75	Agreed
2	Detail of tile patterns, POP, plastering texture, paints, doors, windows etc.	24	19	6	7	56	3.07	Agreed

Research survey; (2024)

In Table 4.5 respondents agreed that construction drawing has impact on project execution except where they disagreed that architectural drawing maintains setting out dimension rather the structural drawing does and that building services drawings do not indicate the water and gas lines' flow direction. Thus Table 4.5 shows that construction drawing impact positively on construction project.

4.8.4 Obj III: To determine the extent to which construction drawings impact building project

With reference to *section 1.4(iv)*: To what extent do construction drawings impact building project?

Table 4.6: Extent of the impact of construction drawings

S/ No	Types of construction drawing	No of Respondents for each Score (W_k)				n_r	M_s	Remark
		4	3	2	1	57	4	
1	Architectural drawings	43	13	1	0	57	3.74	Major
2	Structural drawings	45	10	0	1	56	3.77	Major
3	Electrical drawings	39	16	1	1	57	3.63	Major
4	Mechanical drawings	34	15	5	3	57	3.40	Major
5	Finishing drawings	5	7	21	24	57	1.88	Minor

Research survey; (2024)

n_r = Total Number of respondents

4.8.5 Obj. V: **Research question:** What remedies can address the challenges of building without construction drawing?

The remedies in this context are suggested because of the experience and information gathered from the field that most players in the industry (quacks) do not use detailed approved drawings for building project, hence putting the stability or the success of the project in jeopardy.

Table 4.6: Remedies to building without construction drawings

S/No	Remedies	No of Respondents for each Score (W_k)				n_r	M_s	Remark
		4	3	2	1	57	4	
1	Mandatory construction drawings before plan approval/permit	30	19	5	3	57	3.33	Agreed
2	Personnel registration number and seal on the drawings before plan approval	31	22	3	1	57	3.46	Agreed
3	Brief interview and signing of bond with personnel who sealed the drawing	27	20	7	2	56	3.29	Agreed
4	Domestication of popular codes like National Building codes and standards	14	12	20	11	57	2.51	Agreed
5	Punishment of offenders e.g. withdrawal of practicing licenses	26	21	6	3	56	3.25	Agreed
6	Public awareness and sensitization campaign	15	16	18	8	57	2.67	Agreed

Research survey; (2024)

4.9 Test of Hypothesis

This section discusses the test of the hypothesis postulated in the study. As stated earlier, *Chi-square* will be used in testing the hypothesis. It is tested for the two groups of public and private participants

$Chi - square,\ x^2 = \sum_{i=1}^{N} \frac{(x_i - \bar{x}_i)^2}{\bar{x}_i}$ With 5% significant level, hence, 95% confidence level

x^2_{sample} = *Chi-square* calculated from the sample

$x^2_{0.95}$ = *Chi-square* percentile values from chi-square distribution table with v, the degree of freedom

If x^2_{sample} *is* greater than $x^2_{0.95}$, the Null hypothesis $\mathbf{H_o}$ is rejected and the alternative hypothesis $\mathbf{H_1}$ accepted otherwise $\mathbf{H_o}$ will be accepted and $\mathbf{H_1}$ rejected if $x^2_{0.95}$ is greater than x^2_{sample} with v

4.9.1 Analysis of Hypothesis

Table 4.7a: Public participants

S/ No	Response	Hypo-thesis I	Hypo-thesis 2	Hypo-thesis 3
		(x_1) F_1	(x_1) F_2	(x_1) F_3
1	Agree	24	26	25
2	Disagree	4	2	3
Total (n)		28	28	28

Table 4.7b: Private Participants

S/No	Response	Hypo-thesis I	Hypo-thesis 2	Hypo-thesis 3
		(x_1) F_1	(x_1) F_2	(x_1) F_3
1	Agree	23	26	25
2	Disagree	6	3	4
Total (n)		29	29	29

Research survey; (2024)

Degree of freedom v = k – 1 = 2 –1 = 1, The test is a one-tailed test. x_i= Observed frequency (O_i)

$\bar{x}_i =$ Expected frequency $(E_i) =$ np p = ½

Test of Hypothesis by Public participants.

The hypotheses for test are: **H_0** is the null hypothesis while **H_1** is the alternative hypothesis

Hypothesis I (refer to section 1.5 in the introduction)

$\bar{x}_i =$ np $=$ ½ $*$ 28 $=$ 14

$$x^2_{sample} = \sum_{i=1}^{N} \frac{(O_i - E_i)^2}{E_i} = \frac{(24-14)^2}{14} + \frac{(4-14)^2}{14} = 7.14 + 7.14 = 14.28$$

But $x^2_{0.95,\,1}$, = 3.84. Since, $x^2_{sample} > x^2_{0.95,\,1}$, (14.28 > 3.84), we reject the **H_o** and accept **H_1**.

Therefore, Construction drawings have impact on building project execution

Hypothesis II (refer to section 1.5 in the introduction)

$$x^2_{sample} = \sum_{i=1}^{N} \frac{(O_i - E_i)^2}{E_i} = \frac{(26-14)^2}{14} + \frac{(2-14)^2}{14} = 10.29 + 10.29 = 20.58$$

But $x^2_{0.95,\,1}$, = 3.84. Since, $x^2_{sample} > x^2_{0.95,\,1}$, (20.58 > 3.84), we reject **H_o,** and accept **H_1**.

Therefore, Construction drawings impact positively building projects execution

Hypothesis III (refer to section 1.5 in the introduction)

$$x^2_{sample} = \sum_{i=1}^{N} \frac{(O_i - E_i)^2}{E_i} = \frac{(25-14)^2}{14} + \frac{(3-14)^2}{14} = 8.64 + 8.64 = 17.28$$

But $x^2_{0.95,\,1}$, = 3.84. Since, $x^2_{sample} > x^2_{0.95,\,1}$, (17.28 > 3.84), we reject **H_o** and accept **H_1**.

Therefore, Construction drawings significantly impact building project execution

Test of Hypothesis by Private participants

Hypothesis I (refer to section 1.5 in the introduction)

Therefore, $\bar{x}_i =$ np $=$ ½ $*$ 29 $=$ 14.5

$$x^2_{sample} = \sum_{i=1}^{N} \frac{(O_i - E_i)^2}{E_i} = \frac{(23-14.5)^2}{14.5} + \frac{(6-14.5)^2}{14.5} = 4.98 + 4.98 = 9.96$$

But $x^2_{0.95,\,1}$, = 3.84. Since, $x^2_{sample} > x^2_{0.95,\,1}$, (9.96 > 3.84), we reject the **H_o** and accept **H_1**.

Therefore, Construction drawings have impact on building project execution

Hypothesis II (refer to section 1.5 in the introduction)

$$x^2_{sample} = \sum_{i=1}^{N} \frac{(O_i - E_i)^2}{E_i} = \frac{(26-14.5)^2}{14.5} + \frac{(3-14.5)^2}{14.5} = 9.12. + 9.12 = 18.24$$

But $x^2_{0.95,\,1}$, = 3.84. Since, $x^2_{sample} > x^2_{0.95,\,1}$, (18.24 > 3.84), we reject **H_o,** and accept **H_1**.

Therefore, construction drawings positively impact building projects execution

Hypothesis III (refer to section 1.5 in the introduction)

$$x^2_{sample} = \sum_{i=1}^{N} \frac{(O_i - E_i)^2}{E_i} = \frac{(25-14.5)^2}{14.5} + \frac{(3-14.5)^2}{14.5} = 7.60 + 7.60 = 15.20$$

But $x^2_{0.95,\,1}$, = 3.84. Since, $x^2_{sample} > x^2_{0.95,\,1}$, (15.20 > 3.84), we reject **H_o** and accept **H_1**.

Therefore, Construction drawings significantly impact building project execution

5.0 CONCLUSIONS

Based on the findings, it was concluded that the types of construction drawing needful in project execution are; Architectural, Structural, Electrical, Mechanical/Building Services and finishing drawings. Construction drawings are key to a successful project execution because, they communicate the intent of the

professionals in a universal language since it provides pictorial evidence. Importantly, construction drawings give an insight into the shape of building after construction hence, the basis upon which contract is signed when duly considered since it is developed from the scope of work to produce; cost estimate, project-time control mechanism, schedule-target, quality assurance, design considerations and material standard. The key impact is that in communicating the intent of the personnel, it helps to set out the building and transfer the existing drawing to the physical building on the ground. Thus, construction drawings positively impact building project. In suggesting the remedies, regulatory agencies of government and professional organisations need to enforce regulatory laws including a mandatory provision of construction drawing before plan approval, subsequent monitoring and punishment of offenders

5.3 RECOMMENDATIONS

The study recommends the following;

i. The domestication of the National Building Code 2006 in Rivers State which specifies that all plan permit must be approved based on a comprehensive construction drawings
ii. Enforcement of relevant regulations of the professional organizations such as; COREN, ARCON, CORBON etc to punish offenders and deter the activities of quacks.
iii. Personnel registration numbers and seals must authenticate the drawings before plan approval
iv. Professional organisations should punish offenders by withdrawing their practicing licenses
v. Government should blacklist contractors who build without approved construction drawings

REFERENCES

[1] Okah, J.C (2022) Investigating the causes, Effects and Remedies to Building Collapses in Rivers State, IIARD Intl Journal of Engineering and Modern Technology, 8(2),54-75.

[2] Omeife**,** C.A., & Windapo, O.A. (2013) The impact of national building codes on Professionalism. Building Conference, Abuja, pp. 1-12

[3] Adebowale P. A., Gambo, M. D., Ankeli, I. A., and Dabara, I. D., (2016).“Building Collapse in Nigeria: Issues and Challenges” Conference of the International Journal of Arts & Sciences, 9 (1), 99–108

[4] Ofori, G. (2000). “Challenges of Construction Industries in Developing Countries: Lessons from Various Countries”. 2nd Intl Conference on Construction in Developing Countries: Challenges Facing the Construction Industry in Developing Countries, 15-17 Nov Gabarone

[5] Allen, E. and Iano, J. (2019) Fundamentals of Building Construction: Materials and Methods 7th Edition. John Wiley and Sons, Inc., New York, USA

[6] Richard, T. (2022) Drawing Architecture. David and Charles, BC Paperback, London

[7] Allen, E and Rand, P. (2016) Architectural Detailing: Function, Constructability, Aesthetics, 3rd Ed. John Wiley and Sons, Inc., New York, USA

[8] Fitzpatrick, P. (2021) The Builder’s Companion Book 2: Start Building to Certificate of Occupancy,US/Canada Edition, manage and Build Your Home Paperback. Balcombe Bay Publishing, UK

[9] Lefaivre, L. and Tzonis, A. (2021) Architecture of Regionalism in the Age of Globalisation 2nd Edition. Routledge Taylor and Francis Group, New York

[10] Hendrix, J. (2012) Theorizing a contradiction between form and function in architecture. South African Journal of Art History 27(1), 9-28

[11] Ching, F.D. (2020) Building Construction Illustrated, 6th Ed. John Wiley and Sons, NY, USA

[12] Caroll, J., Lockhart, C. (2014) Complete Visual Guide to Building a House Hardcover – Illustrated, Taunton Press, UK

[13] BS 8110, (1997). Design of Reinforced Concrete Structures, British standard Institute

[14] ACI Committee 238 (2008) Report on Measurements of Workability and Rheology of fresh Concrete. American Concrete Institute, 238.1R-08

[15] Singh, S. (2018) Electrical Design and Drawing, 2nd Ed. Visionias New Delhi, India

[16] Scaddan, B. (2022). IET Wiring Regulations: Electric Wiring for Domestic Installers, 18th Edition. Routledge Taylor and Francis Group, New York

[17] Herres, D. (2021). The home owner's DIY Guide to Electrical Wiring, 1st Edition. McGraw-Hill Education Companies, US

[18] Ayotamuno, A. and Enu-Obari, N. E. (2017) "How has Population Growth and Demand for Housing Affected Land Use in Port Harcourt, Nigeria" Global Educational Research, 5(3), 563 –578

[19] National Bureau of Statistics, NPC. (web), (2022) Port Harcourt City Local Government Area in Rivers State in Nigeria. Retrieved October, 10th, 2024, from: https://www.citypopulation.de/en/nigeria/admin/rivers/NGA033022__port_harcourt/

[20] Garg, S.K. (2009). Soil Mechanics and Foundation Engineering, (7th Ed), Sh. Romesh Chander Khanna, Nai Sarak, Delhi – 110006