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Design, Construction, and Post-Construction of a Residential Development Located at Orji, Owerri North in Imo State, Nigeria

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ABSTRACT: The objective of this paper is to highlight the architectural service delivery process in the design, construction, post-construction of a residential development located at Orji, Owerri North in Imo State, Nigeria based on the design stages spelt out by the Architects Registration Council of Nigeria (ARCON) Architectural Consultancy and Project Management Services, Conditions of Engagement, Charges and Agreement for the Professional Architect on 8th June, 2016 to evaluate the performance of projects in Nigeria. The outcome of this paper is tailored towards acquainting architects, town planners, surveyors, civil / structural engineers, project managers, and other players in the built environment on the need to measure their level of compliance with recognized standards in the course delivering building projects. It also x-rays the distinct solutions applied at different milestones in the design and construction of the Five Bedroom Duplex to address challenges thereof.

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The project performance could be improved to the great extent by selecting the suitable project delivery method (Hosseini *et al.*, 2018). Every project is unique and has its peculiar challenges. The selection of an applicable project delivery method was the basics that dictated the successfulness of a project, however, it might also lead to failure under distinct situations (Hosseini *et al.*, 2018). The risks and uncertainties that might come up in a project led to a complex decision-making process in selecting the appropriate project delivery method as the owner and stakeholders usually had slight information and insufficient design deliverables to make a judgment about the project (Tran and Molenaar, 2012). Therefore, choosing the best project delivery method was one of the most crucial decisions to be made and it should be started with a good understanding on the available choices (DBIA, 2015). The project delivery defined roles and responsibilities of the project stakeholders and it was a form of working relationship (Fong *et al.*, 2014).The different project delivery methods were differentiated based on the formation of contracts between the owner, designer and contractor as well as the technical relationships that developed gradually between each party inside those contracts (Touran *et al.*, 2011). Therefore, project documentation is a necessity to resolve issues which usually arises in the course of executing projects. This technical review is directed towards critically examining the stages of design, construction and post construction of a residential development located at Umuasonye, Orji, Owerri North in Imo state. It analyzes the different stages of building contract administration, draw out lessons learnt, ways to mitigate or eliminate lapses or improve

on the nature of deliverables utilized during the building process. Captured in this review is the nitty-gritty of the architects involvement and experience from inception to close out of the project. The audience of this report, besides architects, is policy makers, city officials, builders, project managers, engineers, planners, contractors, developers and those who wish to build or renovate building facilities in the tropical climate (Shady et al., 2019).

MATERIALS AND METHODS

Description of the Project location: The project was carried out in the suburb town of Orji (at Umuasonye community), Owerri North in Imo State. Owerri North is a Local Government Area of Imo State, Nigeria. Its headquarters are in the town of Orie Uratta. It has an average area of 198 square km and a population of 175,395 at the 2006 census. The postal code of the area is 460. Owerri North is semi-urban government area. It encircles Owerri Municipal like a peninsula. Six major roads that lead out of the municipal cuts across Owerri North Communities. In the North, Orlu road leads to Amakaohia and Akwakuma communities. In the East, Okigwe road leads to Orji Community. In the West, MCC road off Wetheral to Obibi Uratta and Ihitaoha communities. In the South, Mbaise road leads to Egbu and Emekuku communities, while Aba road leads to Nazi, Agbala and Ulakwo communities.

Fig. 1: Existing Site Situation captured during the briefing process

Orji is a village in southeast Nigeria. It is located in the Owerri North Local Government Area of Imo State. This region is part of the ancient kingdom of Uratta. Orji is one of several settlements along the Owerri-Okigwe road, including Umuchoke, Umuogowerem, Umuogii, Umukehi, Umuodu, 'Umuimeka, Umundula, Umuasonye, and Aro (*NIPOST, 2012*).

Fig. 2a: Site Location of Case Study using Google Map

This review x-rays the architectural processes involved in the design and construction of a five bedroom duplex. For the design of the building, Architectural Computer Aided Design software (ArchiCAD – version 22) was used while the photo-realistic projection/rendering was done with Artlantis Studio (version 6). For the construction stage, design and build method was adopted to manage the project.

Brief process: On the 4th of December, 2015 there came the need to develop a land for a private client who is desirous of embarking on the design and construction of a duplex. To achieve this, the architects demanded from the client the following documents: letter of engagement, survey plan of the total plot size, and irrevocable power of attorney etc. for sighting. Upon reception, a reconnaissance visit

was carried out to ascertain the existing features and prevailing climatic conditions of the site, consequent upon analyzing the site the architects conceptualized the design for a five (5) bedroom duplex for the client in the area allotted for the development. The client further briefed the architects on his expectations about the development and commissioned them to develop a functional and unique design for the five (5) bedroom duplex with effective space management. On the 6th of December, 2015, the architects engaged the client to discuss the type and nature of residential development he wanted. Deductions from the discussions shows he wanted a duplex consisting of lounges, dining area, kitchens, bedrooms and other supporting spaces for his family. In order to analyze the brief well and articulate its viability, the architects demanded to take a preliminary visit to the site. On the preliminary visit to the site the architects took note of the orientation of the proposed and existing buildings in the total land area, measurements of the proposed section of land for development, site configuration, size, adjoining properties, topography, and historic nature/event of the site as required.

Fig. 2a: Site Location Plan of Case Study

Table 1: A table showing the various Project timelines

S/N	Stages	Dates
A	**Inception / Brief Taking**	4th - 11th December, 2015
B	**Concept Design**	12th - 14th December, 2015
C	**Consultants Selection**	15th December, 2015
D	**Design Development/Coordination**	16th - 21st December, 2015
E	**Specifications**	22nd December, 2015 - 2nd January, 2016
F	**Budget Estimates**	3rd – 5th January, 2016
G	**Construction Documentation**	6th – 29th January, 2016
H	**Tender Process / Award of Contract**	30th January , 2016 – 2nd February, 2016
I	**Handover to Contractor**	3rd February, 2016
J	**Contract Management**	4th February , 2016 – 17th November, 2016
K	**Practical Completion / Snagging**	18th - November, 2016 - 2nd December, 2016
M	**Defects Liability Period**	3rd December , 2016 - 6th June, 2017
N	**Final Inspection**	7th – 23rd June, 2017
O	**Final Completion / Handover to Client**	24th – 27th June, 2017
p	**Close Out**	28th June, 2017

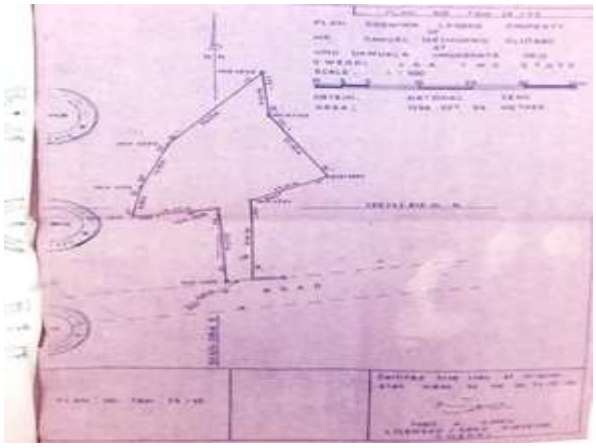

Fig 3: Survey plan of case study

Fig 4: Existing property adjoining the site by the South east

The outcome of the preliminary visit to the site shows that the proposed site area mapped out from the total plot by the client can accommodate a duplex of five (5) sizeable bedrooms, two (2) kitchens, two (2) lounges and other ancillary spaces for a family size of five (5) if properly managed. More so, there was the need to check the conformity of the project with the local building regulations in Owerri – North to ascertain the feasibility of this project. This made the architects to visit the Owerri - North Local Government Area (L.G.A) Planning and Development Board for enquires about the proposed site location. Hence, they informed the architects that the proposed site area lies within the area zoned out for residential development. Thereafter, the architects embarked on the project taking cognizance of the fact that the total land area houses an existing bungalow which prior to its construction has gotten all the necessary certifications and approval. The setbacks allowable for the building within the zone entail 2metres by the sides of a building, 3metres at the rear and 6metres from the font. After pre - assessment of the proposed site area the initial approval of the project was granted. Having gone through all these process the architects tendered the client a harmonized brief and got a sign off.

Project concept design: Sequel to the fine tuning of the design brief, the client approved the commencement of concept design stage on the 12th of December, 2015. Prior to the concept design stage, the proposed land area to develop was mapped out. In this stage, the architects generated the design concepts for the project. The site components included the main building and on-site facilities conceived and presented to meet the clients desires and satisfy standard building requirements prevailing in Owerri North

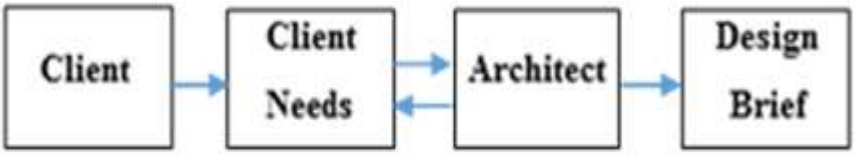

Fig. 5: Brief process

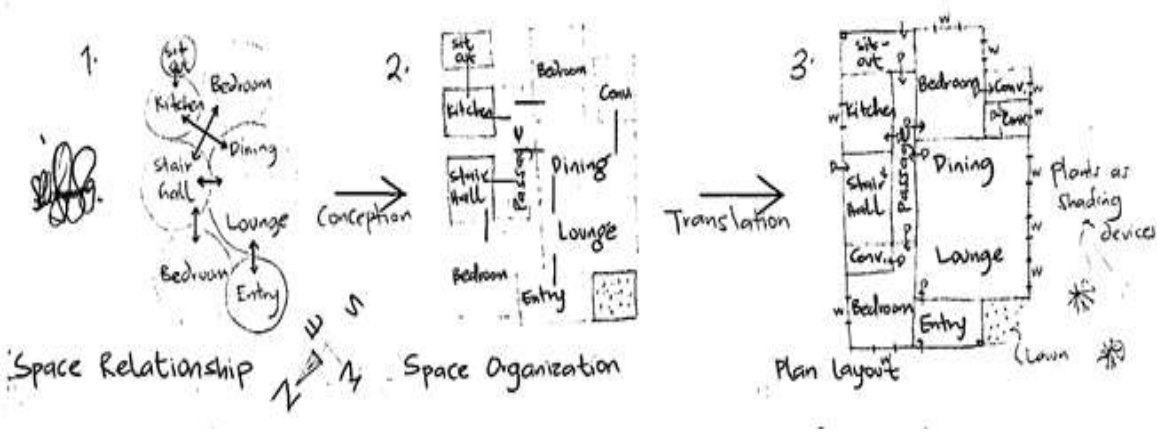

Fig 6: Development of the floor plan

Table 2: Accommodation schedule of spaces provided

Spaces	Unit	No. Of Users	Area Per User	5% Circulation	Total
Lounge	2	5	4.5	1.12	23.6
Dining	1	6	2.3	0.63	13.3
Bedroom	5	1	-	-	12.0
Kitchen	2	-	-	-	6.6
Convenience	6	1	2.1	0.1	2.2
Total	**16**	**13**	**8.9**	**1.85**	**57.7**

Table 3: Space Relationship Analysis

Spaces	Lounge	Dining	Bedroom	Kitchen	Convenience
Lounge		Serious Relationship	Weak Relationship	Serious Relationship	Weak Relationship
Dining	Serious Relationship		Weak Relationship	Serious Relationship	Weak Relationship
Bedroom	Weak Relationship	Weak Relationship		Weak Relationship	Serious Relationship
Kitchen	Weak Relationship	Serious Relationship	Weak Relationship		Weak Relationship
Convenience	Weak Relationship	Weak Relationship	Serious Relationship	Weak Relationship	

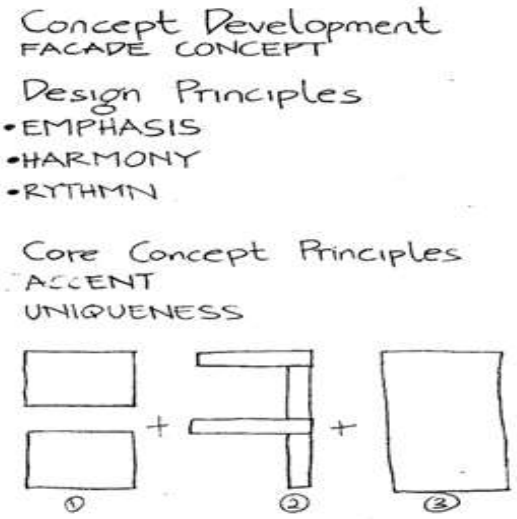

Fig 7: A sketch showing the composition of the design concept for case study

In the course of communicating the design concept to the client the architects observed that the client was not able to comprehensively articulate the basic concept for the project. To address this challenge, the use of CADD (Computer Aided Design & Drafting) to model the different design concepts required at different points was evolved. This was furnished with the use of descriptive freehand sketches in order to ensure the client understands the proposed project.

Consultants' selection and Coordination: In this stage, the architects conveyed to the client on the need to involve other consultants so that the consultants can analyze and synthesize the project in an integrated approach. However, the client opted for competent consultants to perform the tasks therein. The consultants for the project were also confirmed and urged to be team players for the success of the project.

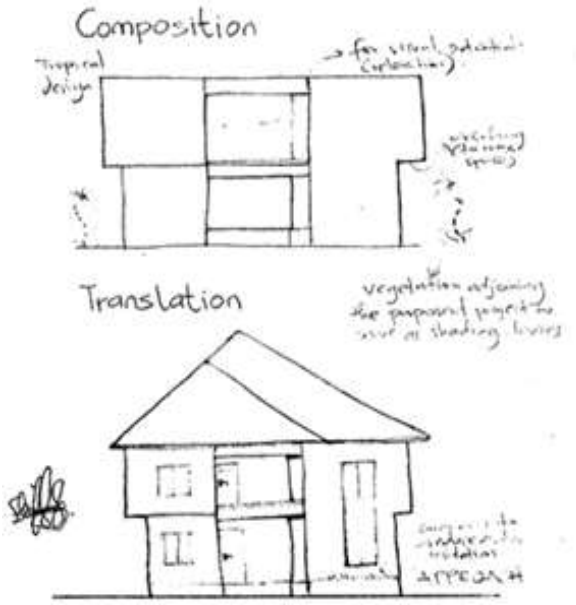

Fig 8: A sketch of developed design concept of case study

Design development process: Due to the approval of the design concept by the client on the 16th of December, 2015, the architects commenced the translation of the different concept into functional design elements. The different consultants were able to produce the architectural, structural, mechanical, and electrical designs of the project for the client. In collaboration with other consultants the architects presented the developed design to the client of which he made certain inputs which led to the modification of some parameters. More so, the architects notified the client on the need to make his final perusal of the developed design prior to the next stage. The building design was enhanced in three (3) consecutive times before the final design was signed off by the client.

Fig 9: Exterior three dimensional models of the five-bedroom duplex

Specifications: Owing to the need to describe the materials and workmanship required for this development in such a way that there will be no uncertainty about what the contractor would be pricing during the tender process and his construction works if selected, the architects commenced the specification writing for the project on 22nd, December, 2015. Performance specification was adopted for the project to enable the description of the result that is required from particular items and leave it to the contractor or supplier to satisfy that requirement. Prior to choosing the Performance specification, the architects verified standards of products and workmanship by testing, inspection, sampling, and documentation. The specifications for this project was structured according to work packages mirroring the separation of the works into sections such as general requirements, site preparation, concrete construction, timber construction, block construction, insulation and pliable membranes, roofing, doors and windows, cladding and lining, suspended ceilings, rendering and plastering, joinery and fixtures, tiling, painting, floor coverings, plumbing and drainage, electrical installations, mechanical installations, fixtures schedules, fences, paving, landscape, referenced standards, acts, regulations, authorities and codes. For concrete construction, the architects inspected the termite barrier and damp proof membrane, completed formwork, and reinforcement, fixed cores and embedment, placed concrete and carried out tests. Foreign materials such as oils, grease, waxes, form release agents, curing compounds, efflorescence, sealers, salts, laitance, or other contaminants were removed. Abrasive blasting was also used to prepare surfaces. All debris were removed and disposed of in an appropriate waste facility. Furthermore, the architects made provision for a Vapour Barrier (V.B) and Damp Proof Membrane (D.P.M) under slabs on ground including integral sub-structural walls and footings. The minimum concrete cover for external surfaces was kept at 40mm while the internal surface at 20mm. Concrete was placed in layers not more than 300 mm thick, compacted simultaneously before previous layer has taken initial set. The concrete grade used for footings and internal slabs on ground was M20, for exposed slabs on ground was M25, for Columns & suspended slabs was M35. After placing the concrete mix we kept minimum curing time in ground footings at 3 days for exposed footings, beams and slabs were for 7 days, and 7 days for other surfaces. For block construction, we selected fine aggregate with low clay content and free from efflorescing salts, selected for colour and grading. All the masonry units had a minimum 15 MPa and generally grey in colour. All general blocks were rendered with mortar mix of 1:1:6 cement, lime, sand. This mix was measured in volumes accurately to achieve the minimum. Generally, the rate of construction was regulated to eradicate joint deformation, and instability. For doors, a minimum clear opening of 750 mm was adopted for smaller spaces like the conveniences, and 900mm was adopted for other spaces such as the lounge, dining, bedrooms, kitchens and sit-outs. For external doors, we Installed flashings, weather bars, drips, caulking and pointing so that water is prevented from penetrating the building between frames and the building structure. During installation we Installed door sets so they are plumb, level; are sufficiently anchored to the building structure; allow for thermal movement, and will not carry building loads, including loads caused by structural deflection. Wooden doors were selected for interior or exterior applications. The doors were designated as D1, D2, and D3 respectively. D1 is an external framed and paneled door (double door leaf), D2 is an internal framed and paneled door (single door leaf), and D3 is an internal framed and paneled door (single door leaf). At the roofing level we kept, the roofing and rainwater system free of debris and loose material during construction, and left them clean and unobstructed on completion. The attic space of the roof was kept at 3.6m to allow for thermal movement

and efficiency in the roof and the building as a whole. The roof covering material selected was a profile aluminum sheet of thickness 0.50mm (long span) to rest on hardwood trusses. The roof fasteners were characterized by self-drilling screws completed with washers and black, non- conductive seals. The Architectural drawings also specified certain materials and quantities in the form of door and window schedules, finishes schedules and also proprietary names of potential vendors were also specified.

Table 4: The batching ratio of concrete used

Grade	Proportion	Fine Agg.	Coarse Agg.
M20	1	1.5	3
M25	1	1	2
M35	Design Mix		

Development of preliminary and approved Budgets: Prior reviewing the budget estimate at this stage the architects communicated the client the preliminary estimates at the briefing and concept stage. Furthermore, the cost consultants calculated the quantities and cost of the required building deliverables. The architects participated in developing the budget estimates of erecting the building carried out by the quantity surveyor on 3rd January, 2016. The architects adopted value engineering strategy in order to realize the project at the best cost effective price and also scrutinized the different bills contained in the estimates prior approval. The proposed Estimated Total Cost (E.T.C) was based on the developed design and required specifications as well as captures all components of the proposed building which inspired our further planning and decisions of which the client was pleased to put up approval for the next stage.

Construction documentation: Prior to this stage, all the modification in the design development stage as well as the specifications has been concluded. The architects also notified the client that any alteration at this stage will affect the design, thus, should be guarded against. After the developed design and specifications were completed the client approved the commencement of the construction documentation on 6th of January, 2016. In this stage, all the project consultants produced the working drawing of the architectural, structural, mechanical, and electrical designs. After compiling the drawings, the first draft was delivered to Owerri - North L.G.A Physical Planning and Development Board for pre-assessment of the project deliverables and to acquire the checklist for final submission. On incorporating the details noted by the Board, complete construction documents were developed, sealed and duplicated in 7 copies. 3 copies were presented to Owerri - North L.G.A office for approval and payment of necessary charges. The building approval process was completed and a copy of the completed approval documents / drawings delivered to the client.

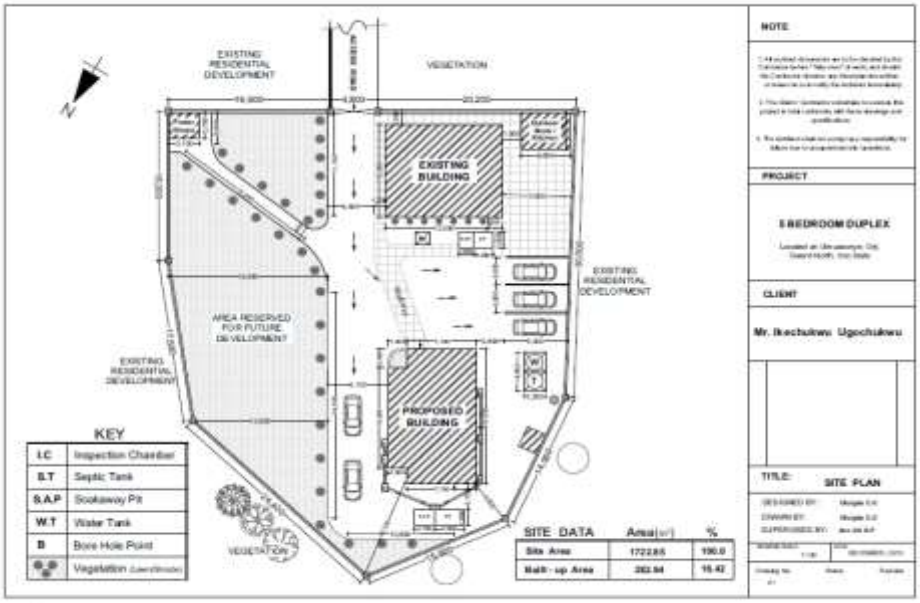

Fig 10: Site plan of Case Study

Tender process: This residential building project was contracted for construction via negotiation with the selected tender. Having completed construction documents on the 30th January, 2016, the tendering process commenced on the 1st February, 2016 with the tender documents delivered to the selected tender. In

lieu of inviting tender, the architects negotiated tender with a selected contractor recommended by the client in a meeting with the design team present, contract sum was agreed and the contract was awarded to contractor. Stipulated in the terms of contract was that the execution of the project will be in stages: from the foundation to the ground floor level, from the ground floor level to the suspended floor level, from the suspended floor level to the roof level, and to be completed with required finishing and installations.

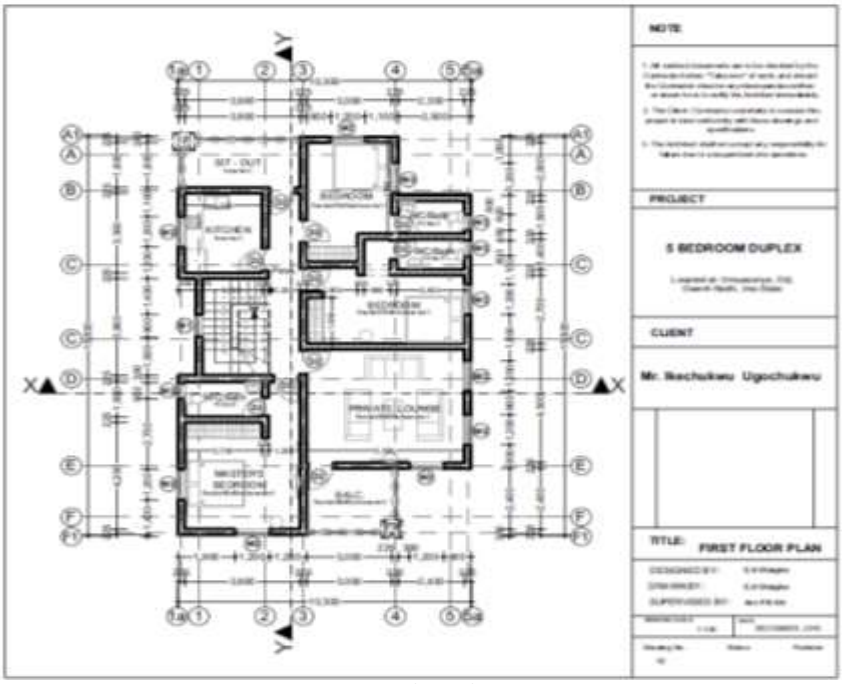

Fig 11: Ground floor of Case study

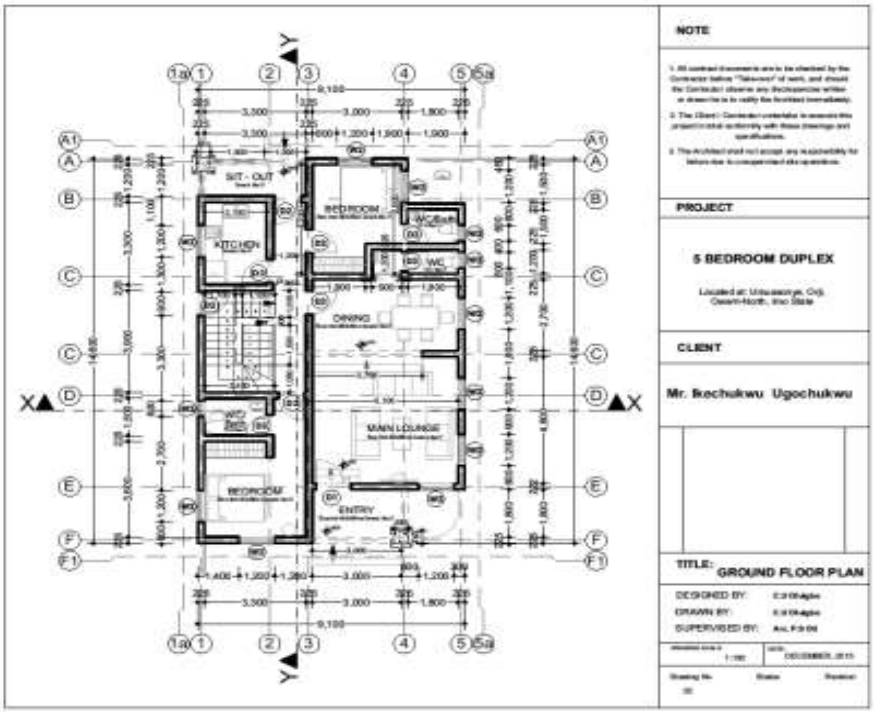

Fig 12: First floor of Case study

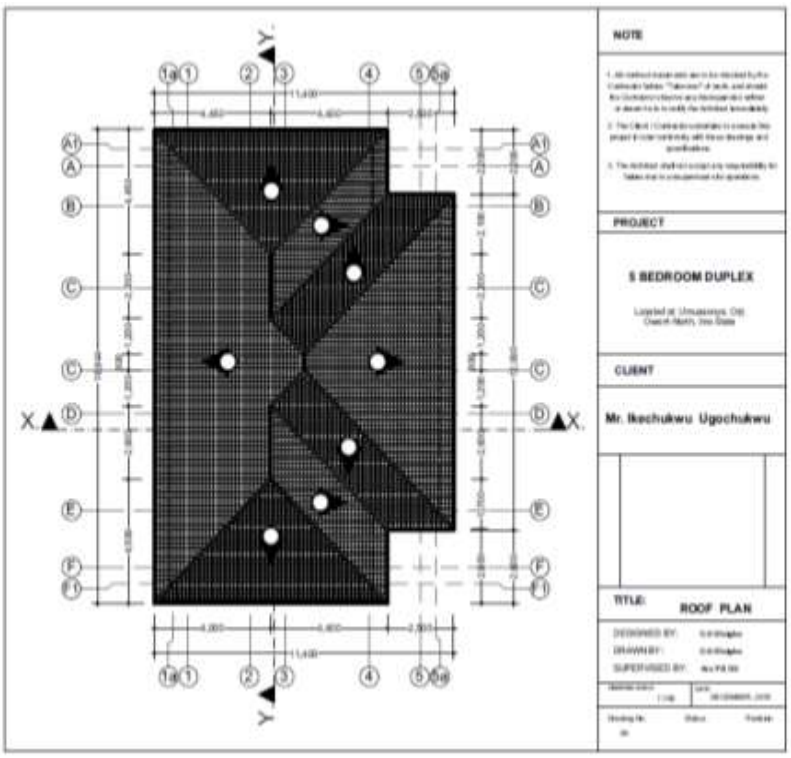

Fig 13: Roof plan of Case study

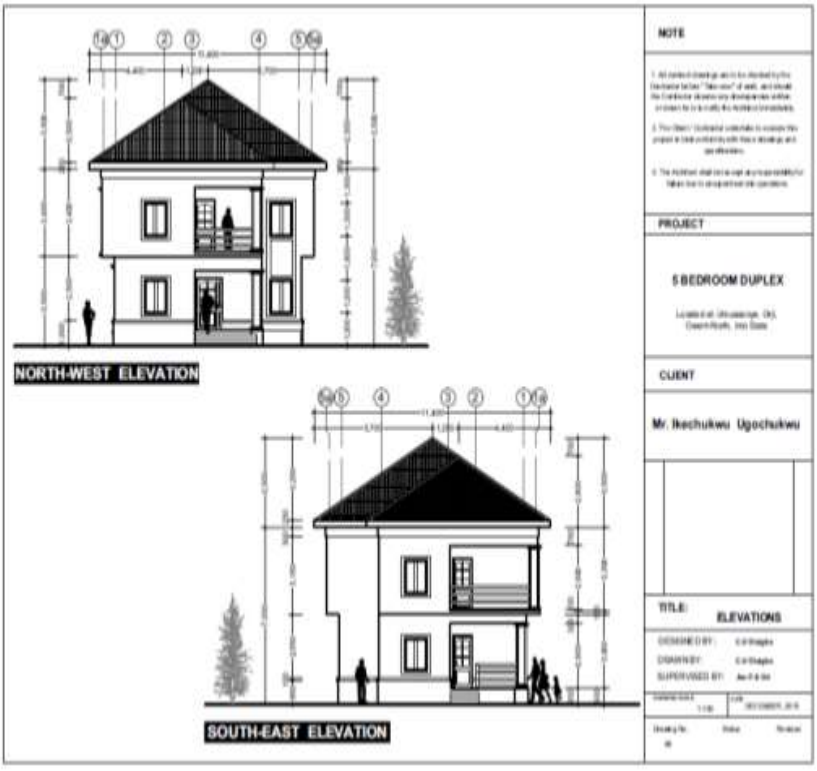

Fig 14: Elevations of Case study

Contract management: The type of contract adopted to run this project is the Lump sum and scheduled contract. This contract is suitable when the number of items is limited or when it is possible to work out exact quantities of work to be executed. On the 1st February, 2016 the contract was awarded to the contractor while

on the 3rd February, 2016 the architects handed over the site to him with the client making all the required materials and consumables readily available for construction. The handover process was also characterized by a meeting, inspection, and site preparation. On 6th February, 2016, the architects inspected the setting-out of the building to ensure adherence with the construction documents. The supervision of works throughout the building construction process continued. During construction, a variation was noted and executed on the stair case of the building. As agreed, interim payments were made at the completion of each of contract stages based on the conformity of the executed works with acceptable standards. The construction process was characterized by weekly site meetings and quarterly reports until the completion of the building project.

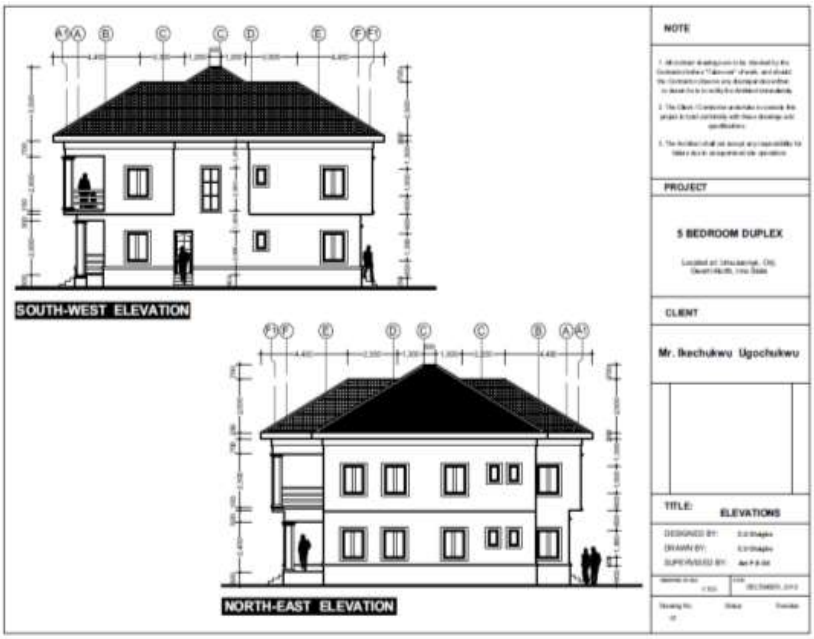

Fig 15: Elevations of Case study

Tender process: This residential building project was contracted for construction via negotiation with the selected tender. Having completed construction documents on the 30th January, 2016, the tendering process commenced on the 1st February, 2016 with the tender documents delivered to the selected tender. In lieu of inviting tender, the architects negotiated tender with a selected contractor recommended by the client in a meeting with the design team present, contract sum was agreed and the contract was awarded to contractor. Stipulated in the terms of contract was that the execution of the project will be in stages: from the foundation to the ground floor level, from the ground floor level to the suspended floor level, from the suspended floor level to the roof level, and to be completed with required finishing and installations.

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Close out: On 18th November, 2016 prior to the hand-over of project to the client, the construction team had to run a thorough check (snagging) on all the building components and facilities of which in the process some defects were corrected. Furthermore, 2nd December, 2016 was fixed for the hand-over of project to the client, and on that day, the team toured round

the building led by the contractor. In the course of this activity, the architects prepared a snag list of the project. At the confirmation of the practical completion of the project, a certificate of practical completion was issued to the contractor with the corresponding payment made to him by the client and 2.5% of the retention fund released to him to make good all defects listed out in the snag list for about a period of 6 months (3rd December, 2016 – 6th June, 2017). After the expiration of the defects liability period, the architects also inspected the building to ensure strict response to 'making good all defects' on 7th June, 2017 (final inspection). Having confirmed the making good of all defects, the client was invited to see the final completion of the project on the 24thJune, 2017. The client was pleased with the completed building project in a tour round the building. Thus, my supervisor ordered the quantity surveyor to prepare the final account and the remaining 2.5% moiety was released to the contractor. The project was completed at the cost of Ten Million, Five Hundred and Thirty – Two Thousand, Six Hundred and Twenty Naira (₦10, 532,620) and closed-out on 28th June, 2017. Hitherto, the client and his nuclear family are occupying their five (5) bedroom duplex.

RESULTS AND DISCUSSIONS

Drawn from the stages of the architectural services reviewed, the vitality of the brief and need to interact with all the involved stakeholders (particularly the client and users) in the design process to evolve an all-inclusive design brief is not negotiable. In addition, this approach was replicated in the concept design stage to inspire an integrated design. More so, from the inception, the stages for delivering architectural services was made known to the client and strictly followed. Intervals for formal sign-offs was adhered to. More so, the client was equipped with necessary deliverables to assist him in understanding and appreciating every stage of the architectural services delivered to him. Observation of the design stages also shows that simple means and tools such as visuals, models, mock-ups, photographs, and demonstrations was used to communicate to the client the various deliverables and concepts projected for his project. This led to the seamless approval of most of the proposals communicated to the client. In addition, there was good level of collaboration with all the players involved in the building project. This teamwork led to the promotion of an integrated design.

Experience with the use of Reinforced Concrete: From this project, experience with reinforced concrete spans through false-work, formwork, reinforcement, transporting, placement, mixing, and curing of concrete. More so, it was deduced that stable false-work is vital for the concrete formwork. Furthermore, the workability and affordability of timber makes it a key and common material in setting up the false work. The formwork for concrete should also be well positioned using spirit level and plumb. Lastly, the construction team also took cognizance of the placement of concrete to ensure it takes exact form and gradually cures to attain sufficient strength.

Construction stage of the building project: The success of the Construction industry in Nigeria can be aligned with the use of construction project management systems, although, the industry has been maligned by issues such a building collapse, incessant delays, abandonment and cost overrun. It is therefore crucial to assess the challenges confronting construction project management system in Nigeria. The figures below show the construction stages of the selected building project

Fig. 16: The casting of the foundation footing

Fig. 17: Construction of the Septic tank / Soak-away pit

Fig. 18: Completion of Stage IV

Fig. 19: Construction of the Stair case

Fig. 20: Finishing of the interior spaces

Fig. 21: Project under defects liability period

Post Construction stage of the building project: Many developers and stakeholders in the built environment do not give much attention to post construction stages. However, this should be in considered in order to meet the sustainability goals of a building project, and thus should be approached by applying project management concepts on sustainable construction projects using 'Life Cycle Method Approach' in the post construction stages (Salem, 2018).

Fig. 22: Post construction stage capturing the interiors of the bedroom, lounge, and lobby

Conclusion: This paper highlights real life experiences drawn out from the design and construction of the project. The study was able to unravel some challenges laden with the delivery of architectural services from inception to close out as well as provided solutions to address those identified issues that were attributed to each architectural design stage. This paper recommends that players in the built environment should always educate and enlighten the general

public on the need to the engage professionals to foster contract administration and project delivery.

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