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THE CONSTRUCTION IMPACT OF USING LOW-QUALITY PIT AND RIVER SAND IN BUILDING AND FINISHING OF PROJECTS IN ABUJA CONSTRUCTION INDUSTRY.

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ABSTRACT

The article on the construction impact of using low-quality sharp sand (pit sand) and plaster sand (river sand) in Abuja on the building and finishing of projects explored how the use of low - quality pit and river sand affects the building and finishing of construction projects in Abuja. This research presents the quality of the bad and good sand used for construction projects in Abuja as well as the quality of manufactured as an alternative to natural pit and river sands. This research takes on a conceptual framework of considering the impact of both pit and river sand in their different forms and also manufactured sand on residential projects. One hundred and fifty structured questionnaires were distributed out of which 107 responded representing 71%. Descriptive statistics was used for analysis. Most of the respondents to the questionnaires were civil engineers with an experience level between 16-20 years which help improved and galvanizing the results gotten from the survey. The survey research design method was used and the appropriate same sampling technique – cluster sampling was applied. The methods for the analysis of data were tables, simple percentages and the Relative Importance Index (RII). The findings revealed that sand with high silt content is very unfit for building and finishing of construction projects as it reduces durability whereby the most acceptable quality of sand is the

Introduction:

Building/construction projects are of varying size, scale and magnitude and they different types and styles of construction and are finished with plaster, a composite material made of proportionate amounts of cement, fine aggregate and water. They are also built with mortar, concrete and often sandcrete blocks; all of which have sand (fine aggregate) as a major component. Given the ubiquity of sand used in the construction industry, the inevitable question of its quality must be investigated. Of the three component materials used to make plaster for construction, the fine aggregate is the one with the least quality assurance (Yusuf *et al.,* 2020). The fine aggregates used for plaster, as well as for building/construction projects in the Abuja urban area and its nearby suburbs are obtained via extraction from riverbeds, streams or banks and deep pits dug a few metres beneath the topsoil (Dadu, *et al.,* 2019). These sand extracts are then moved to the construction sites for use with

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sand to produces good and workable mix with appropriate quantity of water. Also, the best source of sand for site works are well blended quarry sand (otherwise known as manufactured sand). By using this sand, one can get the best all-round and expected results desired for any construction project. The research concluded that as much as sand is very important for construction projects, the site managers should not accept low profiling sand in the name of saving cost as the long-term effect of using such sands are devastative and unfit for quality control in the construction industry. Time and professional acumen are necessary for profitable construction projects. The blending of experience, good taste and professional dexterity cannot be jettisoned in achieving the desire results. Manufactured sand has been proven to be the best for the Abuja construction industry followed by sharp river sand. Base on the aforesaid, it is recommended that necessary quality control measures be put in place to crosscheck the check and quality of sand to be used for building and finishing of construction projects. It is also averred that there is the great need to motivate and encourage professionals in the construction industry through good emoluments and support from the clients and owners of construction projects to explore the use of manufactured sand for all construction purposes.

Keywords: Silt, Pit, River and manufactured sands, construction industry and construction projects.

minimal treatment for impurities removal before use. The investigation of the resulting impacts of such are grave and collapsible I the long run. Further analysis of the subsequent influence of low-quality sand from both pit and river sources on building construction in general is always considered. This can be done through multiple choice questionnaires, personal inspections, observations and interviews by a large sample of individuals currently engaged in building construction projects. These individuals include contractors, project managers, engineers, site managers and foremen, bricklayers, block industry personnel, sand suppliers and extractors, as well as building finishing artisans.

Poor choice of sand can lead to cracks (Dianabasi and Timothy, 2018). Cracks on plaster walls are aesthetically unpleasant and can indicate that something is wrong with the material selection or procedure used for application. Good and durable plasters prevent moisture and abrasion from encountering sandcrete blocks or concrete structural elements underneath. In its absence, the underlying building element is weakened progressively over time, which will eventually lead to further complications. Consequently, the detrimental impacts of bad material selection for plaster production and building construction is fully explored and solutions recommended for better industry practices.

Plaster is a versatile and weather-resistant surfacing material for either interior or exterior use. It may be applied to flat or curved bases made from concrete, clay, and concrete masonry (Weyer, *et al.*, 2015). Portland cement plaster has an excellent history of satisfactory performance in diverse environments. The workability of plaster allows a variety of shapes, designs, and textures. When the plaster hardens, these features are preserved in a rigid permanent form. With these versatile properties and ubiquity of use, the use of poor plaster materials due to low-quality fine aggregates being used will inevitably lead to damage in a wide range of construction projects.

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However, the current events in the Abuja urban area and its nearby environs suggest that both the sand procured from excavation pits or riverbeds within the state and neighbouring states have impurities such as silt or clay, which are wrong for construction work and plastering. These impurities in the sand lead to poor-quality plaster, which causes the wall to have cracks, and not hold paint and other wall finishes. These eventually lead to the seepage and retention of water within the building elements, which were supposed to be protected by the plaster. It also leads to progressive structural damage due to dampness in a structure not designed for consistent contact with moisture that is weakened it (Dianabasi and Timothy, 2018). The resulting impact of low-quality sand in plaster and building work having been observed in building practice will be thoroughly investigated in this research.

Statement of the Research Problem

In the absence of poor regulations and in the presence of standardised construction material practices, there should be great care taken to avoid impurities in the sand used for building construction materials. The use of quality construction materials directly leads to not only an improvement in the quality of construction and finishing works but also in a direct increase in worker productivity (as time spent on site removing the impurities from the sand is used for other valuable activities) and reduction in the quantity of cement used. In addition to the direct uptick in productivity, a cascading effect is also in the saved costs and work time required to deal with the resulting finishing defects due to poor sand quality. Many building/constructions works start manifesting cracks, flaking, dampness, dilapidation and decay of the building/constructions, which is to say the projects have not lived up to the expected duration of their life cycle. This is a challenging problem leading up to economic, physical and structural obsolescence setting in on the constructions at an early stage more than what is expected in the construction lifecycle.

The impact of bad sand from either riverbeds or burrow pits within the Abuja urban environment is multifaceted. Such impacts are more likely to be seen far more quickly before realising the economic and physical values derivable from the constructions, this implies that, the typical economic value desired for swift project delivery with simultaneous aims for maximum profit often means quality control is an afterthought. This has negative repercussions that paradoxically hinder swift project delivery and profits derivable from it and leave complications for the project after the completion.

Implementation of an industrial practice of quality control in respect of not only the fine aggregates or construction materials, but also with the workmanship. It should be bond in mind that there is an absence of quality control when good quality sand is compromised and substituted with alternative bad pit and river sands. It can thus be stated that the pivotal challenge of construction of projects that will stand the test of time with the attendant quality and value scale is hampered by the use of impure sands with quality and economic value jettisoned.

Research Objectives – The main objective is to investigate and determine the impact of low-quality sand (i.e., the sand with large presence of impurities) on the construction works and finishing in Abuja. The Supporting Objectives are to examine – a. The construction impacts of using bad sand on construction and finishing of projects in Abuja; b. The construction impacts of using bad pit and river sand on the construction and finishing projects in Abuja; c. The construction impact of using good pit and river sand on construction and finishing of projects in Abuja; d. The construction impact of using manufactured sand in construction and finishing of

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projects in Abuja; e. The acceptable quality of sand for the construction and finishing of construction projects in Abuja.

Research Questions - a. What are the construction impacts of using bad sand on construction and finishing of projects in Abuja? b. what are the construction impacts of using bad pit and river sand on the construction and finishing projects in Abuja? c. What are the construction impact of using good pit and river sand on construction and finishing of projects in Abuja? d. What is the construction impact of using manufactured sand in construction and finishing of projects in Abuja? e. What is the acceptable quality of sand for the construction and finishing of projects in Abuja?

Research Hypothesis -

HO_1 - There is no significant impact on the use of good river sand on the construction and finishing of projects.

HO_2 There is no significant impact on the use of bad river sand on the construction and finishing of projects.

HO_3 There is no significant impact on the use of good pit sand on the building and finishing of projects.

HO_4 There is no significant impact on the use of bad pit sand on the construction and finishing of projects.

HO_5 There is no significant impact on the use of manufactured sand in the construction and finishing of projects.

Literature Review

The influence of poor sand quality on construction performance in both the short and long run cannot be underestimated. It creates and cause defects which include failures in finishes; mechanical and electrical malfunctions; and in some instances defects in new houses could cost the new owners considerable financial resources in repairs after purchases (Mastin, 2008). The consequences of these defects are that they affect the quality of the finished buildings and the environment. Defects are a foremost challenge in the Nigerian Building Industry particularly with the mass housing projects in Abuja. Amazingly, Ojo and Ijatuyi (2014) reported that defective housing construction is global and not limited to Nigeria or developing economies alone; and there are proofs of the existence of the problem of defective construction claims on defective construction in the California Housing Market Project in the United State of America.

Concepts of different types of sand in building construction

Formation of Sand

Sand is mainly formed as a result of the chemicalor physical breakdown of rocks known as **weathering**. **Chemical weathering** is most efficient in humid and hot climates (Moore & Braucher, 2008). **Physical weathering** dominates in cold and dry areas. **Dunes** are the significant sources of sand. Dunes are formed using three things (Ronca, 2008) which are a considerable amount of *loose sand in an area with little or no vegetation like a coast, dried up river, lake or seabed; a wind or breeze to transport the grains of sand and an obstacle that will hinder the movement of sand causing it to lose momentum and deposit.*

Where these three variables happen simultaneously, dunes are formed. As the wind picks up the sand, the sand rises above the ground through saltation, creep and suspension processes. Once in motion, it will continue to move until an obstacle obstructs its movement. The heaviest grains settle against the obstacle and small ridges are formed. The lighter grains are deposited on the other side of the obstacle. The wind crests and the light grains cascade down the slip face like an avalanche forming a dune after the grains have collapsed under their weight. The pile stops collapsing when the slip face reaches the right angle of steepness (called angle of repose) which ranges from 30 to 34 degrees (Ronca, 2008).

Another source of sand is through the process **of sedimentation**. Sediments are collections of grains of pre-existing rocks, fragments of dead organisms or minerals precipitated. The term sediment is attributed to loose, unconsolidated material. Sediments can be classified as clastic, biological and chemical (Taylor, 2012). Clastic sediments are composed of particles from pre-existing rocks (igneous, metamorphic or sedimentary). The particles are transported away from the site by water, wind or ice and will ultimately settle out and accumulate in a range of continental or marine environments. Biological sediments are derived from remains of dead organisms such as shells and plants or build-up framework building organisms such as coral reefs. Chemical sediments are formed by chemical processes as a result of precipitation of minerals from the water body (Taylor, 2012). Sand as a clastic sediment is transported by bodies of water, wind or ice. Gravity also plays a role in transport. This mostly occurs on steep slopes and is the first stage of erosion and transport of weathered material. Materials move down slopes through rock falls, landslides, soil creep and slumping. In rock falls, consolidated material falls and breaks up into a jumble of material at the base of a cliff or steep slope. Water is the most common medium for sediment transport. The flow occurs in channels or current generated by wind and tides. If the movement is fast enough, it can transport sediments for hundreds of kilometres before deposition takes place (Loomis, 2018).

Several anthropogenic activities have had negative impacts on sedimentation. Such activities can be direct or indirect. Direct activities include the engineering of water bodies (dams and reservoirs). Indirect include changes in catchment characteristics (mining and urbanisation). Dams and reservoirs have been constructed for regulation of water and hydroelectric energy generation. These have increased tremendously in the last 50 years. They have a marked impact upon water flow and hence sedimentation within the catchment area. The most significant impact is the trapping of sediment behind the dam and the reduction of sediment load of rivers downstream (Moore & Braucher, 2008).

Urbanisation also has some effects on sedimentation in water bodies. Water courses are engineered by channelisation and construction of culverts; land surfaces are paved over. This result in decreasing the amount of sediments supplied to receiving water bodies. Similarly, loss of vegetation reduces the storage capacity of the water. The quality of the deposits is also affected by urbanisation. Deposits can be contaminated by sewage, industrial pollution and vehicular pollution leading to the generation of noxious methane gas (Taylor & Owens, 2009).

Table 1 - Grain size Classification Scheme

Mm	Φ	Class terms Boulder	Sub-classification
256	-8	-8 Cobbles	
128	-7		
64	-6	Pebbles	
32	-5		
16	-4		

8	-3		
4	-2	Granules	
2	-1		
1	0	Sand	Very coarse
0.5	1		Coarse
0.25	2		Medium
0.125	3		Fine
0.0625	4		Very Fine
0.0312	5	Silt	Coarse
0.0156	6		Medium
0.0078	7		Fine
0.0039	8		Very Fine
		Clay	

(Source: Taylor, 2012)

Types of Sand used for construction

Sand used in construction is classified as fine sand, medium sand and coarse sand. Fine sand has a diameter between 0.075 to 425mm. Medium-sized sand has a diameter of 0.425 to 2mm while coarse sand has a diameter of 2mm to 4.75mm. Sand used in construction must be clean, free from waste, stone and impurities (Anime-Edu-Civil, 2017).

Pit sand is procured from deep pits of abundant supply and red-orange, its sharp angular grain makes it convenient for use in concrete. River sand is procured from rivers, streams and banks. It has rounded grains and is generally white-grey and is used for plastering work. Sea sand is taken from seashores and is brown with fine circular grains. It is salty owing to its source, and it absorbs moisture from the atmosphere attracting dampness. It is because of its salty nature that it is only used for local purposes instead of structural construction (Eazyhomes, 2015

Pit Sand - Figure 1 Showing Pit sand being excavated

This sand is procured forming a pit, by excavating normally between 1 metre to 8 metres beneath the earth's surface is termed as pit sand. Pit sand is a natural and coarse type of sand. The pit sand particles are usually angular in shape with a rough surface and sharp edge as compared to the river sand. The pit sand contains coarser grain size particles by percentage, which makes them the most suitable type of sand for concrete work. However, by sieving and grading, you can use them for all the general-purpose in construction work. The pit sand does not contain any marine impurities like seashells, chemical salts, or silt deposits, which are more common in river or sea sand. Sometimes you may find them associated with the clay materials, or some organic impurities, which can be removed effectively by sieving and washing them as said earlier.

Figure 2 – Showing Pit sand in situ

It is in red-orange colour due to the presence of iron oxide around the grains. These sand grains are free from salts; hence it does not react with the moisture content present in the atmosphere. Due to its superior binding properties pit sand is used in construction. As mentioned above, pit sand is a coarse type of sand, and this is not recommended if the sand is coarser than the acceptable limits.

River Sand – Figure 3 showing River sand being excavated.

River sand is a type of fine sand formed by corrosion from water currents and is obtained from river streams and banks. It is generally white and grey. Unlike pit sand, the grains of river sand is smooth, rounded and of fine quality. Due to the weathering action with the water, river sand particles are mostly round. Hence, it is used globally for a broad range of construction purposes such as plastering. River sand is obtained from the bank of rivers and riverbeds. It is usually in white–grey colour and has very fine quality. River sand is well-graded, and it is good for all types of concrete and masonry works. The natural river sand was the cheapest resource of sand. However, the excessive mining of riverbeds to meet the increasing demand for sand in the construction industry has led to an ecological imbalance and adversely affected the environment.

Fig. 4 Showing River sand in situ.

River sand has a silica content. The excessive presence of silica content makes the sand useless for concrete work and responsible for efflorescence on the surface in future. To overcome this, the sand should be tested for silica content before using it. Good sand should have less than 5% of silica in it.

Sea Sand - Sea sand (also known as offshore sand) refers to sand eroded by seawater. It is secured from seashores and has a distinct brown colour. The grains of sea sand is very fine in quality with a circular shape. Sea sand consists of salt and other marine impurities, which tend to absorb atmospheric moistness and bring forth dampness. Therefore, it is avoided for concrete structure and engineering techniques.

Manufactured Sand - This is also referred to as Manufactured Fine Aggregate (MFA). Created by crushing hard granite stones, manufactured sand refers to an artificially created type of sand made as an alternative to river sand for construction. It is prepared with the required gradation of fineness, shape, surface smoothness, texture, and consistency making it the best sand suitable for construction while providing greater strength to the concrete by reducing segregation during placing, bleeding, honeycombing, voids, and capillary. Furthermore, its usage also prevents dredging of riverbeds to obtain river sand, helping to avoid disasters like groundwater depletion, water scarcity, threats to bridge safety thus making it an eco-friendlier alternative to other sands. Due to massive growth in construction, high demand for sand has arisen. To meet the demand and to maintain the ecological balance without affecting the environment. manufactured sand is manufactured. Manufactured Sand is an alternative to River sand. Manufactured sand can also be produced by crushing hard granite stone. The size of manufactured sand is less than 4.75mm. The colour of the sand is greyish blue to red based on the type of rock used in crushing.

Fig. 5 Showing manufactured sand in situ.

Researcher's conceptual framework design
The variables to be used for analysis are as follows:

Independent Variable **Mediating Variable** **Dependent Variable**

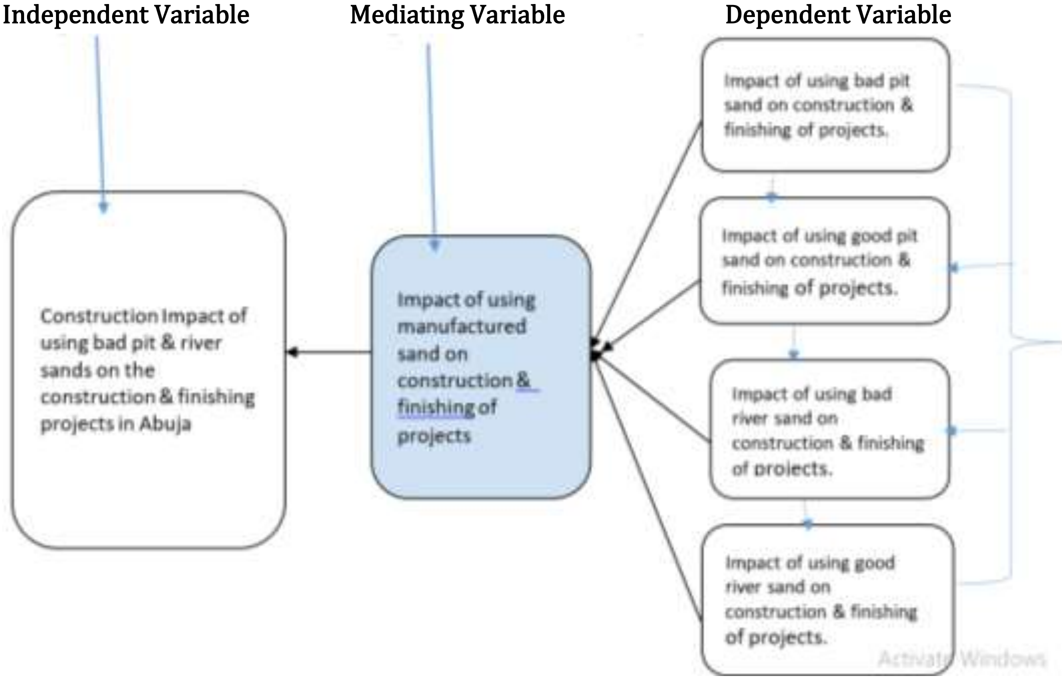

Figure showing Researcher's conceptual framework (2022)

Discussion on the dimensions of the variables

a. Impact of Bad Pit Sand on construction and Finishing of Projects

Pit sand is a naturally coarse type of sand. The pit sand particles are usually angular in shape with a rough surface and sharp edge as compared to the river sand. The pit sand contains coarser grain size particles by percentage, while this makes them the most suitable type of sand for concrete work, they need treatment. By sieving and grading, you can use them for all the general-purpose in construction work. Poor quality pit sand often has clay materials and some organic impurities, which can be removed effectively by sieving and washing them as said earlier. As mentioned above, pit sand is a coarse type of sand, and this is not recommended if the sand is coarser than the acceptable limits. Excessive coarseness from bad pit sand can produce concrete and plaster with poor abrasion resistance while excessive bad pit sand can produce mixtures requiring increased water for effective pumping and finishing. Simultaneously, though, insufficient fine material can produce mixtures that lack cohesion and segregate readily (Harini *et al*., 2018).

Particle size distribution of sand is a measure of variations in grading of the sand. In soil mechanics the coefficient of uniformity (C_u) and coefficient of curvature (C_c) is used to describe the soil grading by giving an indication of the slope of the grading curve (Alexander and Mindess, 2005). The greater the value of Cu, the more continuously or 'well' graded is the soil or aggregate sample. With a greater degree of coarse particles than other sand types, these variations could seriously affect the uniformity of concrete, which subsequently may have a direct effect on the shrinkage property.

b. Impact of Good Pit Sand on Construction and Finishing of Projects

The pit sand contains coarser grain size particles by percentage, and while this makes them the most suitable type of sand for concrete work, they need treatment. By sieving and grading, you can use them for all the general-purpose in construction work.

Good pit sand does not contain any marine impurities like seashells, chemical salts, or silt deposits, which are more common in river or sea sand. Sometimes you may find them associated with the clay materials, or some organic impurities, which in this case have been removed effectively by sieving and washing them as said earlier. These sand grains are free from salts; hence it does not react with the moisture content present in the atmosphere. As a result, it has superior binding properties which are needed in construction and plasterwork.

Particle size distribution of fine aggregate plays a very important role in the workability, and segregation of fresh concrete. Many authors claim that uniformly distributed mixtures produce better workability than gap-graded mixtures, although higher slumps could be achieved with gap-graded mixtures. Some properties of hardened concrete are also affected by grading (Golterman *et al*., 2018). Good quality pit sand, with its well-graded and coarse particles, can conveniently achieve uniformly distributed mixtures.

c. Impact of Bad River Sand on Construction and Finishing of Projects

River sand is a type of fine sand formed by corrosion from water current and is obtained from river streams and banks. Unlike pit sand, the grains of river sand is smooth, rounded and of fine quality. Due to the weathering action with the water, river sand particles are mostly round. Hence, it is used globally for a broad range of construction purposes such as plastering. Bad river sand while being well-graded has a plethora of defects. The presence of organic substances present in bad river sand may not be acceptable for concrete or plaster production as the organic substances present might inhibit the hydration process, and form a film layer between cement paste and aggregate, hindering adequate bonding and subsequently affecting concrete performance.

River sand has a silica content in its raw state. The excessive presence of silica content which is a common feature of bad river sand makes the sand useless for concrete work and responsible for efflorescence on the surface in future. To overcome this, the sand should be tested for silica content before using it. Low-quality river sand also has a significant amount of silt. BS 882 states that the percentage of clay and fine silts must not exceed 4% (Anosike 2011). The silt reduces the strength and durability of the resulting concrete or plasterwork mix.

The porosity, permeability and absorption in sand influence the bond between it and the cement paste, the resistance of concrete to freezing and thawing, as well as chemical stability, resistance to abrasion and specific gravity. Poor quality river sands have high porosity. The porous sand absorbs more moisture, resulting in the loss of workability of concrete at a much faster rate. Absorption and surface moisture affects mix-design, soundness, and strength/abrasion resistance (Cho 2013). The specific gravity and porosity of sand greatly influence the strength and absorption of concrete. The specific gravity of sand generally is indicative of its quality. A low specific gravity may indicate high porosity and therefore poor durability and low strength. Material Passing the No. 200 Sieve (3.0%) and other deleterious substances (Shale, Alkali, Mica, Coated Grains, Soft, and Flaky particles).

d. Impact of Good River Sand on Building and Finishing of a Residential Project

Unlike pit sand, the grains of river sand is smooth, rounded and of fine quality. Due to the weathering action with the water, river sand particles are mostly round. Hence, it is used globally for a broad range of construction purposes such as plastering. River sand has a silica content. The absence of excessive silica content makes the sand excellent for concrete work and can greatly improve the strength of the concrete and plaster in future. Good quality river sand also possesses a higher quantity of fines and organic matter that are responsible for absorbing more water, making the water absorption of the concrete made from it higher than that of bad river sand which has a comparable small quantity of organic matter and fines.

e. Impact of Manufactured Sand on Construction and Finishing of Projects

This is also referred to as Manufactured Fine Aggregate (MFA). Created by crushing hard granite stones, manufactured sand refers to an artificially created type of sand made as an alternative to river sand for construction. It is prepared with the required gradation of fineness, shape, surface smoothness, texture, and consistency making it the best sand suitable for construction while providing greater strength to the concrete by reducing segregation during placing, bleeding, honeycombing, voids, and capillary.

Due to massive growth in construction, high demand for sand arises. To meet the demand and to maintain the ecological balance without affecting the environment. manufactured sand is manufactured. M Sand is an alternative to River sand. Manufactured sand can also be produced by crushing hard granite stone. The size of manufactured sand is less than

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4.75mm. The colour of the sand is greyish blue to red colour based on the type of rock used in crushing.

Negative Consequences of Sand Mining

According to Sanda Aguila Foundation (2016) negative consequences of sand mining include:

i. Destruction of beaches and the ecosystems they protect,
ii. Loss of habitat for marine species offshore and onshore
iii. Change in water flow, flood regulation and marine currents
iv. Increased erosion of the shoreline, changes in delta structures, lowering of the water table,
v. Salinisation of groundwater and arable soils and pollution of rivers;
vi. Impacts on coastal infrastructure and embankments;
vii. Effects on climate directly through transport emission and indirectly through cement production;
viii. Social and political turmoil due to illegal sand mining leading to corrupt practices;
ix. Economic losses through tourist abandonment.

Alternatives for Sand

Demand for sand is very high in developing countries to satisfy infrastructure growth. Research has been conducted into finding alternatives to river sand and these are presented thus –

Copper Slag

A study carried out by the Central Road Research Institute of India showed that copper slag may be used as an alternative to river sand as fine aggregate in concrete without any loss in compressive and flexural strength (Sankh, Biradar, Nagathan, & Ishwargol, 2014). Such concrete has exhibited 20% higher strength than that of conventional cement concrete of the same grade.

Granulated Blast Furnace Slag

As a by-product during the production of steel, granulated blast furnace slag can be used as an alternative for sand (Sharma, 2017). As the replacement level of GBFS increases the compressive strength of cement mortar increases.

Quarry Dust

On a construction site, about 20 to 25% of total materials produced in crushers are left out as waste material quarry dust. Quarry dust, when mixed with fly-ash, is an excellent replacement for sand. It has the additional benefit of increased workability, reduction of cement consumption, increased sulfate resistance, increased resistance to the alkali-silica reaction and decreased permeability (Chandana, Katakam, P.Sri Lakshmi, & Rao, 2013).

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Construction and Demolition Waste

Construction and demolition waste generated can pose an environmental challenge. Recycled sand and aggregate from construction and demolition waste have 10-15% less strength than concrete. It can, therefore be used in non-structural applications like flooring and filling (Akaninyene, 2012).

Manufactured Sand

Artificial sand is fast emerging as an alternative for river sand. It is manufactured by crushing granite or basalt rock through a three-stage crushing process. The end-product is sand that is free from impurities. Having been produced under controlled conditions, it is free from silt and organic impurities that hinder the setting time and compressive strength of concrete (Govind, 2016).

Washed Bottom Ash

Washed Bottom Ash is gotten as waste material from coal in thermal power plants. The mechanical properties of concrete made with 30% replacement of river sand with washed bottom ash by weight have an optimum usage in concrete to get required strength needed (Syarhu, Sani, Muftah, & Muda, 2010).

Foundry Sand

Foundry sand is gotten from discarded material from the metal industry. Currently, there are no disposal mechanisms, but research has shown that up to 50% foundry sand can serve as for economical and sustainable development of concrete (Vijul, Nilay, & Jayeshkumar, 2013)

Spent Fire Bricks

Firebricks are waste material gotten from foundry beds and walls and lining of chimneys adopted in industries. These can replace sand as fine aggregate in concrete (Keerthinarayana & Srinavasan, 2010)

Sheet Glass Powder

Attempts have been made to replace sand with waste glass. However, these have been found to crack, thus limiting its usage in concrete (Mageswari & Vidivelli, 2010)

Theoretical Review

Quality is defined as "fitness for purpose" or compliance with specification (Anosike, 2011) the totality of features required by a product or service to satisfy stipulated and implied needs (Eze et al, 2005). ISO 8402-1986 standard defines quality as "the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs". Similarly, the Manufacturing Business dictionary, defined quality as a measure of excellence or a state of being free from defects, deficiencies, and significant variations, brought about by the strict and consistent adherence to measurable and verifiable standards to achieve uniformity of output that satisfies specific customer or user requirements. In a similar development (Ogunsanmi et al, 2011) identified quality as one of the three key elements for developing risk classification models for design and build projects. This, therefore, follows that quality is a significant factor that cannot be undermined in the construction of projects. Quality management and quality assurance on the other hand have been adopted to include all aspects of producing and accepting a construction project which meets all required quality standards (Nunnally, 2007). He further asserts that quality management includes such activities as specification development, process control, product acceptance, laboratory and technician certification, training and communication. Consequently, (Nunnally, 2007) concluded that quality control, which is a part of the quality management process, is primarily concerned with the process control function.

Component Materials in Plaster

The component materials in Portland cement plaster are cement, water and fine aggregate (sand).

Cement

Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and non-speciality grout. It was developed from other types of hydraulic lime in England in the early 19th century by Joseph Aspdin and is usually made from limestone. It is a fine powder, produced by heating limestone and clay minerals in a kiln to form a clinker, grinding the clinker, and adding 2 to 3 per cent of gypsum.

Figure 6 showing Portland cement powder.

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Several types of Portland cement are available. The most common, called ordinary Portland cement (OPC), is grey, but white Portland cement is also available. Its name is derived from its resemblance to Portland stone, which was quarried on the Isle of Portland in Dorset, England. Joseph Aspdin who obtained a patent for it in 1824 named it. However, his son William Aspdin is regarded as the inventor of "modern" Portland cement due to his developments in the 1840s (Courland, 2011). The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement, and water. Concrete produced from Portland cement is one of the world's most versatile construction materials and has changed the world in almost every observable aspect. It is one of the most widely used substances on Earth, and as such, Portland cement manufacturing is currently vital to the world's economy.

Water

Water is necessary to develop the plasticity of the cementitious material and to assist in the chemical reactions involved in the hardening process. Potable water is generally acceptable. The water used in mixing and curing Portland cement plaster should be clean and free from injurious amounts of oil, acid, alkali, organic matter, salts, or other deleterious substances. Such substances may impair the setting and hardening characteristics of the plaster, or stain or discoloured the surface.

Sand

Sand is used to increase capacity and reduce shrinkage. Care should be exercised in the selection of sand, the principal aggregate in plaster. Both the angular and globular types are satisfactory and may be either natural sand or ground rock. It should be composed of clean, hard, durable stone particles, free from objectionable matter, with an allowance of not more than 5 per cent of loam, silt and clay (Shetty, 2009). Sand for plaster should be graded to pass a No, 3 or No. 4 sieve and at least 85 per cent should be retained on a No.100 sieve. According to Singh and Singh (2006). An important requirement is that sand to be used for producing plastering mortar should be free of organic matter such as roots, seeds, twigs, and hummus.

It is not surprising that the properties of concrete will be largely affected by the properties of its individual components. The specific gravity of the sand is indicative of the strength of the resulting concrete. With quality sand, the critical factor turns to the cement paste – the strength of which is primarily a function of the water-cement ratio. In conjunction with these, the particle size distribution of the constituent-sand can be either an enabler or a mitigating factor in the achievement of the strength of the concrete.

Properties of Fresh Plaster

Adhesion

The capability to adhere or stick to a substrate is developed in the plaster by the combination of materials and application techniques. Adhesion is influenced by the aggregate, water-cement ratio, and absorptive characteristics of the base.

Cohesion

The ability of plaster to cohere or stick to itself is affected by the Portland cement paste; particle size, shape, and gradation; and quantity of aggregate and water. A cohesive plaster will remain in place without sagging, sloughing, or delaminating.

Workability
is the ease with which the plaster is placed, shaped, floated, and toiled. Workability involves adhesion, cohesion, weight, and spread ability. To give the best workability, all materials should be proportioned properly and combined during mixing. Plaster with poor workability requires greater effort to apply, increases costs, and may result in an appreciable impairment in the desired hardened properties of hardened material.

Characteristics of finished hardened plaster
Weather resistance
The ability of plaster to withstand weathering includes resistance to wind and rain penetration, resistance to freezing and thawing, and resistance to thermal and moisture changes. Resistance to aggressive chemicals in the atmosphere, such as acid rain, is also of concern. Freezing and thawing resistance-The use of air-entrained plaster is beneficial, especially where snow or de-icing chemicals may encounter a plastered surface.

Sulphate resistance
In aggressive sulphate environments, additional resistance to sulphate may be obtained with the use of Type II or Type V Portland cement, or masonry cement. A suitable mineral admixture, as defined in ACI 201, "Guide to Durable Concrete," may also be used in combination with Type I or Type II Portland cement. Additional precautions may include the application of a water-resistant surface coating or penetrating sealer applied to plaster below grade, or plaster should be terminated 6 in. above grade.

Bond
Bond is the adhesion between similar or dissimilar materials. Bonding between one plaster coat and another is the result of chemical bonding, mechanical keying, or a combination.

Defects in Plaster
Defects in plasterwork include but are not limited to the following:

Blistering of Plastered Surface
Blistering of the plastered surface occurs when small patches swell out beyond the plane of the plastered surface. Blistering is seen in the case of plastered surfaces inside the building.

Figure 7 showing Wall with Blistering of Plastered surface

Cracks in Plastering

Cracks are formed on the plastered surface. These cracks can be hairline cracks which are difficult to notice, or they can be wider cracks which are easily seen. The development of fine cracks is known as crazing. Cracks on a plastered surface can be due to thermal movements, discontinuity of surface, structural defects in the building, faulty workmanship, excessive shrinkage etc.

Figure 8 Showing Wall with cracks

Efflorescence on Plastered Surface

Efflorescence is formed on plasters when soluble salts are present in plaster-making materials as well as building materials such as bricks, sand, cement etc. Even water used in construction work may contain soluble salts. When a newly constructed wall dries out, the soluble salts are brought to the surface, and they appear in the form of a whitish crystalline substance. Such growth is referred to as efflorescence and it seriously affects the adhesion of paint with the wall surface. Efflorescence gives a very bad appearance and can be removed to some extent by dry-brushing and washing the surface repeatedly.

Flaking

The formation of a very small loose mass on the plastered surface is known as flacking and it is mainly due to bond failure between successive coats of plaster. While the plaster from some portion of the surface comes off and a patch is formed. Such formation is termed peeling, and it is mainly due to bond failure between successive coats of plaster.

Figure 9 -Showing A wall manifesting Flaking and Peeling

Popping

Sometimes the plaster mix contains particles which expand on being set. A conical hole in the plastered surface is formed in front of the particle. This conical hole is called a blow or pop.

Plaster Debonding

Debonding occurs when plaster is separated from the wall. It can be caused by an excessively thick plaster layer, inadequate substrate preparation or may be due to a dusty, oily or dry substrate.

Figure 2. 10 Showing walls manifesting debonding of plaster

Defects in Construction

There are a variety of causes leading to defects in construction. Dorcas *et al.*, (2019) asserted that severe factors affecting project quality in Nigeria's construction industry are: construction mistakes, use of inexperienced labour; poor inspection, and management commitments and leadership styles. Buys & LeRoux (2013) stated that other factors leading to defects in newly completed housing include inadequate artisan skills, project management failures and defects dominated by over design-related origins. Richardson (2001) added that negligence on the part of workmen, use of substandard building materials; absence of professionals in the project building team; and use of unqualified contractors are some of the causes of common defects in recently built houses. Other researchers asserted further that major causes of defects in fresh buildings include noncompliance with Building Code and Building Regulations Standards; deficiencies in designs, planning and supervision of construction of new buildings (Bakri and Mydin, 2013; San-Jose *et al.,* 2011). The consequences these causes of common defects associated with mass housing construction and newly completed housing, Richardson (2001) asserted that these defects include cracks; water seepages; electrical malfunctions; faulty drainages; plumbing defects; peeling and fading of paints. Bakri and Mydin (2013) added that other common type's defects include faulty ventilation, cooling or heating systems and insufficient insulation or soundproofing.

Literature Gap

This section presents a review of past studies that empirically shows the impact of using low-quality sand. Few studies have been conducted on how low-quality sand generally affect the building and finishing of construction projects. An effort was also made to explore the concept of sand sources, impurities and alternative replacements in the production of plaster. The relationship between previous literature on the research problem is examined in the following submissions below.

The study of Dianabasi. R & Timothy. E (2018) states that cracks on plaster walls are not just unpleasant, but they are indications that something is wrong with the material selection or procedure used for application. Vertical and horizontal cracks in drywall or plaster walls typically indicate drying and shrinkage, which is normal after construction. Jagged cracks, stair step cracks and 45-degree angle crack generally signify structural movement or settling issues that are occasionally serious but usually harmless. Plastic shrinkage cracks could be found when an excessive amount of water is lost from the plaster in the first few hours after its application. These cracks are hairy in nature and if proper care is not put in place to solve the problem, there is the possibility of future occurrence. This paper investigated the causes and possible ways of solving plaster cracks in buildings.

Secondly, Dadu, D. et al (2019) addressed the issue of quality control in the paper titled: "Quality Control in Abuja Mass Housing". Houses constructed under the Abuja Mass Housing Scheme are faced with challenges of non-adherence to quality, which result in the defects of houses built under the programme. The study evaluated the common defects in 108 housing units by the administration of structured questionnaires and semi-structured interviews. The questionnaires and interviews set up were based on the categorisations of defects adopted from Project Management Tool Kits 2008 for measurement of defects in buildings. The data obtained from the semi-structured interviews were transcribed and content analysis was used to determine the themes and constructs leading to the identification of various types of defects. Furthermore, the data obtained from the structured questionnaires were analysed using a mean ranking analysis of factors associated with the causes of the various defects in the estates. The analysis and key findings indicated that the common defects in the housing included cracks and plaster failures occurring in all the houses studied. Further defects were observed were electrical fittings malfunctions; irregular water supply and leakages of connecting pipes in over 50% of the facilities. The study also indicated that there were no quality control supervisions on the project. The contractors who were engaged in the projects lacked experience in construction work. The study thus concluded that the defective works of the mass housing projects were a result of a lack of Quality Management (QM) in the project. It is recommended that quality control operational techniques should be adopted for use in the control and measurement of the quality of materials and workmanship for quality mass housing production.

Anosike M. N. & Oyebade, A. A. (2012) state over 90% of physical infrastructures in Nigeria are being constructed using sandcrete blocks. This makes it a very important material in building construction. It is widely used in Nigeria, Ghana, and other African countries as load-bearing and non-load-bearing wall units. For a long time in Nigeria, sandcrete blocks were manufactured in many parts of the country without any reference to suit local building requirements or good quality work. The Standard Organization of Nigeria (SON) developed a reference document, which prescribed the compressive strength and water absorption properties standard requirements for different kinds of sandcrete blocks. The objective of this research was to ensure that all block manufacturers meet a minimum specified standard. The study appraised this objective using field study, sampling and laboratory experimentation and the results obtained revealed very low compliance with as low as 0.66N/mm^2 compressive strength value and as much as 16.95% water absorption capacity. The study revealed that poor quality control, poor selection of constituent materials and inadequate curing period by the manufacturers contributed to the negative results obtained.

Methodology

The study proceeded to gather primary data through a survey of contractors, subcontractors, engineers, project managers consultants and suppliers of construction materials in Nigeria. A structured questionnaire was formulated and administered to the respondents. This was done for fast administration, achieving cost savings, considering the convenience of respondents and for easy generalization of findings. Random sampling was adopted. The first part of the questionnaire elicited the bio-data of the respondents which include educational qualification, the profession of respondent, years of experience, nature of projects worked upon and location of respondent.

The questionnaire also sought to ascertain the sources of sand used by the respondents. It went further to ascertain the negative consequences of sand mining being experienced in their respective localities and the impact of such consequences on project performance. Suggestions as to preventive measures against the negative consequences were also elicited, likelihood of adoption of alternatives to river sand. It then concluded by ascertaining the effectiveness of the alternatives to river sand that are currently in use and their availability within the study area.

For analysis, Percentages were used for presenting the demographics of the respondents. For questions adopting the Likert scale format; weighting was used for analysis with the highest having 5 points and lowest having 1 point. The mean of points for each response was calculated using ∑fx/∑f. where ∑fx is the sum of the points and ∑f number of respondents, after which the Relative Importance Index (RII) was adopted by applying the different variables to the General Model.

Model Specification

Relative Importance Index Technique: is the mean for a factor which gives it weight in the perceptions of respondents. It is used to determine the relative importance of the various impact of the bad pit and river sand. The same method is going to adopt in this study within various groups of variables. The five-point scale ranged from 5 (strongly agree); 4 (agree); 3(moderately agree); 2 (disagree); 1(strongly disagree). Based on the above,
The following model is used and adapted for the analysis. **RII = ΣW / (A*N)**

$$RII = \Sigma W \ / \ (A*N)$$
$$RII = \Sigma W_1 + W_2 + W_3 + W_4 + \ldots\ldots\ldots W_n \ / \ (A*N) \quad \text{-----------------------.1}$$

Where,
W is the weight or height/value given to each variable factor by the respondents (ranging from 1 to 5),
RII = Relative Importance Index;
A = The highest weight (i.e., 5), and
N = Total number of respondents.
Therefore, when the above formula is adapted to equation (1) above, we arrive at the following:

RII_{CBS} - $CBS_1+CBS_2+CBS_3+CBS_4+CBSS_5$ 2
RII_{AQUS} - $AQUS_1+AQUS_2+AQUS_3+AQUS_4+AQUS_5$ 3
RII_{CGS} - $CGS_1+CGS_2+CGS_3+CGS_4+CGS_5$ 4
RII_{SGS} - $SGS_1+SGS_2+SGS_3+SGS_4+SGS_5$ 5
RII_{CMS} - $CMS_1+CMS_2+CMS_3+CMS_4+CMS_5+CMS_6$ 6
$RII_{IULQPRS} = RII_{CBS} + RII_{AQUS} + RII_{CGS} + RII_{SGS} + RII_{CMS}$ - Researcher's Model
Where
IULQPRS - Impact of Using Low- quality Pit and River Sand
CBS - Characteristics of Using Bad Pit Sand
AQUS - Acceptable Quality for the use of Sand
CGS - Characteristics of Using Good Sand
SGS - Source of Good Sand
CMS - Characteristics of Using Manufactured Sand

Frequency Index (FI) = (Σ (a n) ÷ N) × (100 ÷ 4))

Where, a is the constant expressing weighting given to each response (ranges From 1 for rarely up to 5 for always), n is the frequency of the responses, and N is the total number of responses.

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Severity index: A formula is used to rank the impact of bad fine aggregates on severity as indicated by the participants.

Severity Index (S.I.) (%) = A formula is used to rank the impact of bad fine aggregates based on the severity of occurrence as identified by the participants.

Severity Index= (Σ (a n) ÷ N) × (100 ÷ 4))

Where a is the constant expressing weighting given to each response (ranges from 1 for little up to 4 for severe), n is the frequency of the responses, and N is the total number of responses. Importance index: The importance index of each cause is calculated as a function of both frequency and severity.

Importance Index (IMPI) (%) It is a function of both frequency and severity indices, as follows:

Importance Index (I.I %)=(F.I % × S.I %) ÷100

Test of Hypothesis - Using the Pearson coefficient correlation (r) to analyse the hypothesis

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

where:

- n is sample size
- x_i, y_i are the individual sample points indexed with *i*
- $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$ (the sample mean); and analogously for

Rearranging gives us this formula for :

$$r_{xy} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - \left(\sum x_i\right)^2}\ \sqrt{n\sum y_i^2 - \left(\sum y_i\right)^2}}.$$

where n, x_i, y_i e defined as above.

df (degree of freedom) = (n - 2)

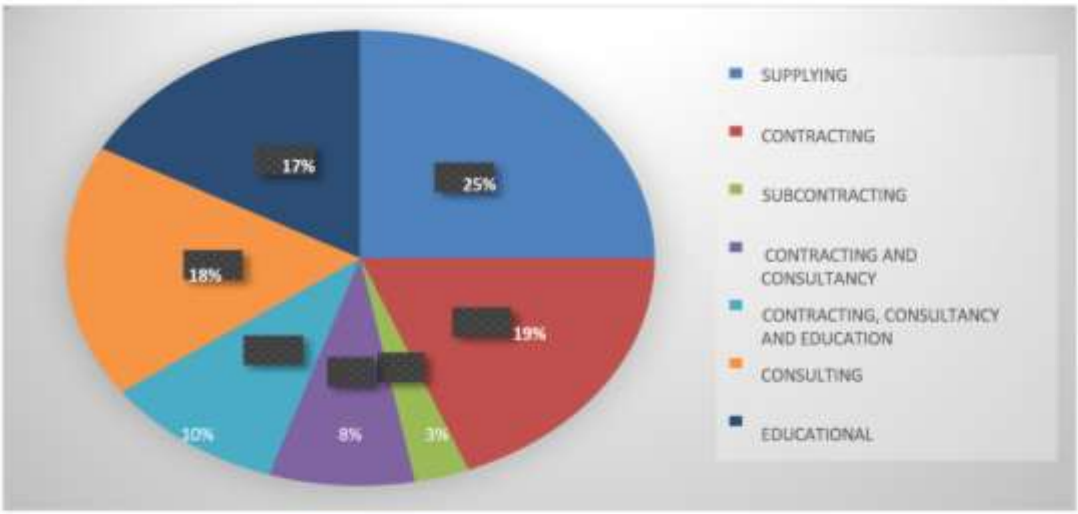
Significance level = 0.05

Presentation of Results

150 questionnaires were administered with 107 returned corresponding to 71% response rate. 28% having a PhD, 23% having a Master of Science, 21% having a Higher National Diploma and Bachelor of Science and finally, 8% having a Post Graduate Diploma. 35% are quantity surveyors, 26% builders, 21% architects and 19% civil engineers. 26% have 11 to 15 years working experience, 22% 21-25 years, 20% 16-25 years, 12% 6-10 years, 11% over 25 years and 8% 0-5 years of experience. 55% of respondents have worked on building construction projects, 18% have worked on Civil Engineering projects, another 18% have worked on both civil engineering

and building construction projects, 8% have worked on building construction as well as mechanical and electrical projects. The location of respondents have spanned across the 6 geo-political regions of Nigeria.

Figure 10: Services Rendered by Respondents



25% are suppliers of construction materials, 19% are contractors, 18% offer consultancy services, 17% are in education, 10% provide contracting, consultancy and educational services, 8% offer contracting and consultancy services and 3% are into subcontracting. Hence, majority of the respondent are into supplying and contracting.

<u>Negative Consequences of Sand Mining</u>

Table 2: Negative Consequences of Sand Mining

Q8: The following are negative consequences being experienced as a result of sand mining in your locality

	SUGGESTION	SA	A	UD	D	SD	Σfx	Σf	Mean	Remark	Rank
		5	4	3	2	1					
i	Depletion of sand	76	31	0	0	0	504	107	4.71	Agreed	1
ii	Soil erosion	77	21	0	0	9	478	107	4.47	Agreed	2
iii	Increasing the cost of construction	37	61	1	3	5	443	107	4.17	Agreed	3
iv	Change in water flow and marine currents	20	61	18	8	0	414	107	3.87	Agreed	4
v	Loss of aquatic life	21	53	21	3	9	395	107	3.69	Agreed	5
vi	Destruction they protect of beaches	27	48	4	26	2	393	107	3.67	Agreed	6

	and the ecosystems										
v	**Formation of sinkholes**	4	1	6	2	9	3	1	3.		7
vii	Coastal erosion	2	4	20	1	9	3	1	3.		8
i	Spreading of vector-borne	2	4	0	3	9	3	1	3.		9
x	Lowering of the water table	1	1	51	1	0	3	1	3.		1
xi	Econo loss throu tour abandonment	11	29	42	16	9	338	107	3.16	Disagreed	11
x	Deforestation	3	1	10	2	19	3	1	3.		1
xii	Loss of biodiversity	1	2	36	2	10	3	1	3.		1
xi	Soil contamination	9	2	31	3	16	2	1	2.		1
xv	Corrupt practices resulting political turmoil	9	11	31	33	23	271	107	2.53	Disagreed	15
	Grand Mean						3.5				

Key: SA: Strongly Agree; A: Agree; UD: Undecided; D: Disagree; SD: Strongly Disagree.

The most experienced negative consequences of sand mining is depletion of sand, followed by soil erosion, while the least experienced are soil contamination and corrupt practices resulting from political and social turmoil. This slightly differs from the report of Beisier (2017) and Stonberg (2017) that opined corrupt practices involved in sand mining as the most experienced negative consequence.

<u>Degree of Impact of Negative Consequences</u>

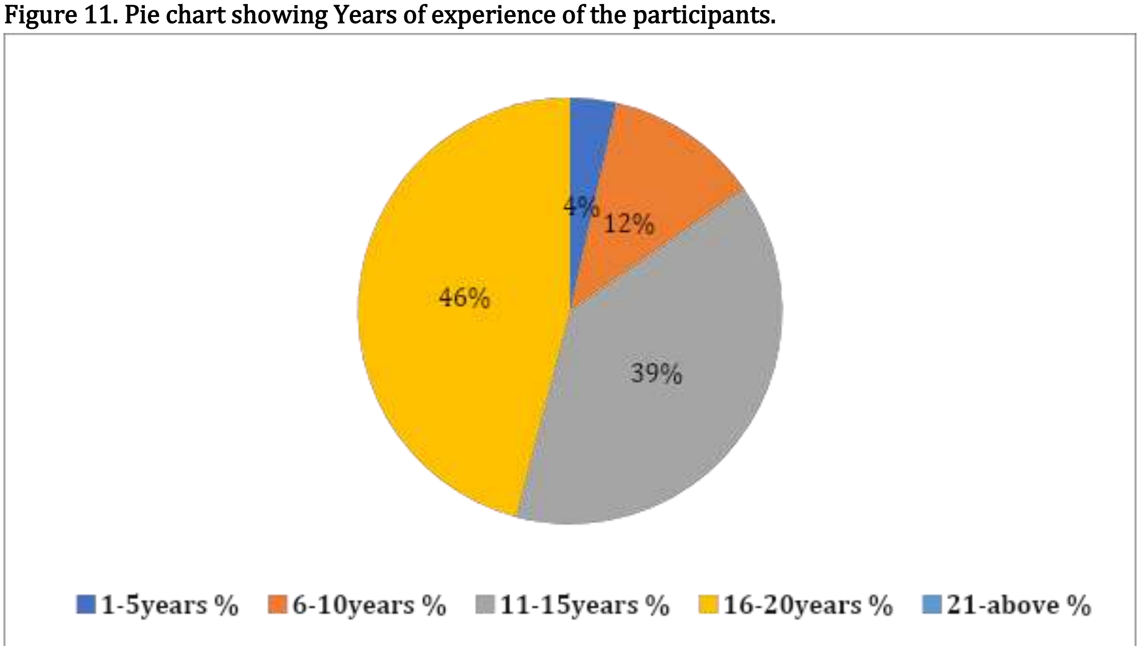
Table 3: Degree of impact of negative consequences

NO	SUGGESTION	VH	H	UD	L	VL	Σfx	Σf	Mean	Remark	Rank
		5	**4**	**3**	**2**	**1**					
i	Soil erosion	72	24	4	7	0	470	107	4.39	High	1
ii	Depletion of sand	52	24	2	29	0	414	107	3.87	High	2
iii	Increasing the cost of construction	31	51	0	24	1	408	107	3.81	High	3
iv	Change in water flow, flood regulation	53	22	2	10	20	393	107	3.67	High	4
v	and marine currents Formation of sinkholes	31	33	3	31	9	358	107	3.35	High	5

vi	Lowering of the water table	21	42	4	21	19	334	107	3.12	High	6
vii	Coastal erosion	11	40	2	36	18	305	107	2.85	Low	7
viii	Destruction of beaches and the	15	31	2	34	25	292	107	2.73	Low	8
ix	ecosystems they protect Deforestation	11	42	2	18	34	293	107	2.74	Low	9
x	Loss of aquatic life	10	32	1	32	32	274	107	2.56	Low	10
xi	Economic losses through tourist	10	33	2	32	30	276	107	2.58	Low	11
xii	abandonment Loss of biodiversity	2	31	0	41	33	249	107	2.33	Low	12
xiii	Soil contamination	10	13	0	44	40	230	107	2.15	Low	13
xiv	Corrupt practices resulting from social and political turmoil	0	17	0	55	35	213	107	1.99	Low	14
xv	Spreading of vector-borne diseases	1	24	6	28	48	205	107	1.92	Low	15
	Grand Mean								**2.93**		

Key: VH: Very High; H: High; UD: Undecided; L: Low; VL: Very Low.

Figure 11. Pie chart showing Years of experience of the participants.



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The years of experience of the respondents is very key to this thesis. Most of the respondents used experienced hands that span between 11-20 years of experience. The classification based on the number of years is shown in Table 4.4. 1-5 years are represented by 4%, 6-10 years have 12%, 11-15years are represented by 39% while 16-20 years are represented by 46%, while none above 20 years. The experience gap used in this study form the "cream vitality" of the construction industry.

Table 1 shows the good fine aggregate relative index & rank based on the respondent's results.

Quality of good aggregates	SA(5)	A(4)	N(3)	SD(2)	D(1)	(N)	A*N	Mean	RII	R
Possession of sufficient toughness to bear impact in vibratory loads	80	168	81	0	0	85	425	3.9	0.77	4
Freedom from impurities, inorganic or organic in nature	160	172	18	0	1	85	425	3.9	0.83	1
Capacity of producing a workable plaster mixture	115	144	72	0	2	85	425	3.9	0.78	3
Capacity to pass through the 4.75mm & 0.075mm sieves	145	164	24	0	7	85	425	4.0	0.80	2

Source (Researcher's survey data, 2022)

From the table above, the sand without impurities is rank 1st with RII of 0.83. The 2nd ranking goes for sand that can be properly sieved. The 3rd rank is sand that can be used to work with effectively while the 4th rank is sand with rough and bigger sizes with RII 0.77.

Table 2 shows respondent's knowledge of the characteristics of bad sand

Quality of bad sand	SA(5)	A(4)	N(3)	SD(2)	D(1)	(N)	A*N	Mean	RII	R
Poorly graded	180	172	18	0	0	85	425	4.4	0.87	2
High silt content which decreases durability	225	148	9	0	0	85	425	4.5	0.90	1
Contains organic and soluble compound that affects setting time	165	180	21	0	2	85	425	4.3	0.86	3

Source (Researcher's survey data, 2022)

The table above showing the knowledge of respondents on the bad quality of fine aggregates shows that High silt content with a mean score of 4.5 is strongly agreed and ranked 1st and has an RI of 0.90 while ranking second is fine aggregates being poorly graded with an RII of 0.87 carrying a mean score of 4.4 and ranked 3rd contains an organic and soluble compound that affects setting time with RII of 0.86 and mean score of 4.3. From the RII and mean score we can tell that respondents strongly agree that three options are bad qualities of fine aggregates.

Table 3 Showing the different sand for fine aggregate

Uses of fine aggregates	SA(5)	A(4)	N(3)	SD(2)	D(1)	(N)	A*N	Mean	RII	R
Bad river sand	165	204	3	0	0	85	425	4.4	0.87	3
Bad pit sand	165	200	6	0	0	85	425	4.4	0.87	4
Good river sand	220	164	0	0	0	85	425	4.5	0.90	2
Manufactured sand	235	152	0	0	0	85	425	4.6	0.91	1

Source (Researcher's survey data, 2022)

The results from the table above show that fine aggregates are ranked based on the type of sand used. Manufactured sand gives the best aggregate with 0.91 RII. This is followed by good river sand with 0.90 RII. Bad river sand and good pit sand are ranked 3rd and 4th respectively with RII of 0.87 and 0.87. Bad pit sand consumes more cement and is thus more expensive, this made it not to be used for aggregates in buildings except where there is no alternative.

Table 4. 4 shows the acceptable quality for use of sand both for aggregate and plaster.

Acceptable quality	SA(5)	A(4)	N(3)	SD(2)	D(1)	(N)	A*N	Mean	RII	R
Gives good texture and beautiful finishing.	285	56	30	0	4	85	425	4.4	0.88	2
Versatility of use on site.	250	68	42	0	4	85	425	4.3	0.86	3
Reduction in void content	195	48	12	0	4	85	425	3.0	0.61	5
Good & easy to work with less water.	325	24	33	0	3	85	425	4.5	0.91	1
Has cost-saving attribute in good economy	110	184	51	0	0	85	425	4.1	0.81	4

Source (Researcher's survey data, 2022)

From the table above, the stated qualities, the number 1 ranked qualities are the sand ability to make a workable plaster when mixed with cement and water in the right proportion. Number 2 ranked quality as the ability of the sand to have a good-looking and smooth finish without finishing being applied to it. The ability of the sand to be used for different purposes on the construction site is ranked number 3 with an RII of 0.86. Number 4 ranked quality is the sand has cost savings attribute in the economy making it relatively affordable. The number 5 ranked quality with an RII of 0.61 is the ability of the sand to reduce the chance of reducing void content means the sand can easily be compacted.

Table 4. 5 Showing characteristics of good sand for building works.

Characteristics of good sand	SA(5)	A(4)	N(3)	SD(2)	D(1)	(N)	A*N	Mean	RII	R
Has good looking face and surface area.	40	180	87	0	3	85	425	3.6	0.73	3
Negligible or no flaking after use.	75	132	90	0	7	85	425	3.6	0.72	4
Easily stick to blockwork.	230	104	24	4	3	85	425	4.3	0.86	2
Good plaster surface for painting & other finishes	115	152	48	0	8	85	425	3.8	0.76	5
Prevention of cracking and flaking	310	40	24	0	5	85	425	4.5	0.89	1
It has stability to repel water even without painting the surface immediately.	45	148	84	0	11			3.4	0.68	6

Source (Researcher's survey data, 2022)

The table above represents the perspective of respondents on the characteristics of sand for building works;1st ranked characteristics show that the sand has the ability to prevent flaking or cracking with used for finishing of building works, ranked 2nd with an RII of 0.86 is the ability of the sand to be able to stick to brickwork when used to make plaster for finishing. The ability of the sand to be physically acceptable is ranked 3rd with an RII of 0.73. the ability of no flaking is ranked 4th with an RII of 0.72. Ranked 5th and 6th are the ability of the sand used in making plaster for finishing work to give a good surface for painting or any form of finishing and the plaster to be water resistant without painting respectively.

Table 6 Showing the sources of good sand for site works

Source of sand	SA(5)	A(4)	N(3)	SD(2)	D(1)	(N)	A*N	Mean	RII	R
Sieved river sand	250	96	3	0	10	85	425	4.2	0.84	2
Fine dry river sand	100	144	51	4	10	85	425	3.6	0.73	3
Fine pit sand	55	140	78	2	12	85	425	3.4	0.68	5
Quarry & purposely blending sand	240	80	45	0	2	85	425	4.3	0.86	1
Fine river sand	55	156	75	4	8	85	425	3.5	0.70	4

Source (Researcher's survey data, 2022)

The table above shows the best source of sand for site works, Quarry and purposely blending sand; sand which are obtained by blasting and crushing of quarry stones then washed and sieved in a plant to remove impurities is ranked 1st with an RII of 0.86, sieved river sand which has sand that has been sieved into the finest grain size making is fine and smooth for finishing work is ranked 2nd with an RII of 0.84,sand with smooth, rounded and sand from the river which has been dried before usage is ranked 3rd with an RII of 0.73,fine river sand which did not undergo any process is ranked 4th with an RII of 0.70 and ranked 5th is a more coarse and angular sand gotten from digging 2-3m below the ground, they are naturally free from impurities.

Table 7 showing the characteristics of manufactured sand

Role of using Manufactured sand	SA(5)	A(4)	N(3)	SD(2)	D(1)	(N)	A*N	Mean	RII	R
Durability	150	116	69	2	3	85	425	4.0	0.80	3
Higher Strength	125	132	66	4	3	85	425	3.9	0.78	4
Greater workability	85	116	93	6	5	85	425	3.6	0.72	6
Offsets construction defects	200	152	9	0	4	85	425	4.3	0.86	1
Economy	65	140	111	0	0	85	425	3.7	0.74	5
Eco-friendly	180	144	30	0	3	85	425	4.2	0.84	2

Source (Researcher's survey data, 2022)

From the table above, the results show that manufactured sand has a wide range of characteristics when it is being used in the finishing and building of construction projects in Abuja as to using natural sands. The majority of the respondents strongly agreed that using manufactured sand in place of natural sand will help to offset construction defects not only, but they are also eco-friendly to the environment, the results from using manufactured sand for finishing gives more durability likewise higher strength while having greater workability making it easy to handle and lastly it is economical.

$RII_{IULQPRS} = RII_{CBS} + RII_{AQS} + RII_{CGS} + RII_{CMS}$ - Researcher's Model

$RII_{IULQPRS}$ - Relative Importance Index of the impact of using low-quality pit and river sand

RII_{CBS} - Relative Importance Index of Bad sand.

RII_{AQUS} - Relative Importance Index of Acceptable quality of Sand.

RII_{CGS} - Relative Importance Index of Good Sand.

RII_{SGS} - Relative Importance Index of Sourced Good Sand.

RII_{CMS} - Relative Importance Index of Manufactured Sand.

$RII_{CBS} = 0.87 + 0.90 + 0.86 = 2.63$

$RII_{AQUS} = 0.88 + 0.86 + 0.61 + 0.91 + 0.81 = 4.07$

$RII_{CGS} = 0.73 + 0.72 + 0.86 + 0.76 + 0.89 + 0.68 = 4.64$

$RII_{SGS} = 0.84 + 0.73 + 0.68 + 0.86 + 0.70 = 3.81$

$RII_{CMS} = 0.80 + 0.78 + 0.72 + 0.86 + 0.74 + 0.84 = 4.74$

$RII_{IULQPRS} = 2.63 + 4.07 + 4.64 + 3.81 + 4.74 = 19.89$

P value for nearness of sand for effective use = **$RII_{IULQPRS}/100 = 0.20$**

Since the P-value is 0.20, it shows that bad pit sand has a great and negative impact on the construction of projects. The relevancy of the study is shown by the average of the RII which is 0.20.

Findings & its implication

The researcher found out that the impact of bad sand selection on building and finishing of projects in Abuja to be the following among others based on the research objectives to include

Objective 1 – the findings are - Improper bonding of the sand with cement for blinding, mortar and aggregates; In the short term, it leads to peeling of paint on the finished walls. It causes a lot of cracks on the internal and external rendered walls; In the long run, leads to sagging or deformation of the foundation leading to lateral irredeemable cracks on the building; Because of the improper bonding with cement, it allows high capillary up such of water resulting to flaking, total peeling of the paintings and defects on finishing; Because of the improper bonding it produces weak oversite concrete leading to weak foundations; Results to bad structural and decorative repairs i.e. it produces a lull, dull and unattractive building.

OBJECTIVE - 2 shows that – the high consumption of cement; Bad and incoherent mix and bonding; Inability to retain water in terms of seasoning; Unreliability of the sand in construction and finishing of projects in Abuja; It leads to deformed and weak structures; It causes quick rusting and weakening of reinforcements used in the buildings.

OBJECTIVE 3 – The findings based on this objective are **-** It gives good plaster surface for paints and other finishes; It enables plaster to stick easily on blockwork; It prevents cracks and flaking thereby making the building durable; It provides strength and stability to other materials mortar for plaster, concrete and cement; It resumes the high consumption of cement.

OBJECTIVE 4 - The findings based on this objective are **-** It is reliable and it is based on the owner of the building taste and finance; Produces good mix for aggregate, mortar, building, plastering and other concrete works; Because of its high-capacity bonding with cement, it rebuffs and stops the capillary up such plus the damp proof course, thereby stopping flaking, peeling and unexpected cracks; Manufactured sand use with high quality cement (i.e. Berger cement) gives the most beautiful, attractive and reliable residential building with very good structural and decorative repairs; It has very high pre-cast bonding capacity and therefore it is often used for pile bases and pillars in water and swampy areas as well as bridges; It also gives a good balance foundation reducing the shearing/shaking forces in loose soils used for building; It is good sand for good quality; it is greater sand for great buildings and it is the gorgeous sand for generational change in construction.

OBJECTIVE 5 - The findings based on this objective are **-** The sand must be good looking and appealing with quick absorbing and drying of water for all purposes; It should be able to give good and strong bonding with sand and gravel thereby giving the building a reliably quality; It must have the ability to reduce rusting and weakening of every form of reinforcement; It must have the ability of becoming stronger when exposed to water for all purposes of seasoning; It must have the ability to optimize the use of cement with the best and attractive completed surface; It must have adaptive capability so as to be used for all purposes because it is relatively expensive; It must have a minimal wear and tear effect on the completed building when exposed to normal uses.

Conclusion

The impact of the applicability for sand findings is that for a good and enduring residential building, the sand that should be used must be endearing, evasive in terms of wear and tear, elastic in terms of elongating the life span of the buildings and sound in the terms of retaining structural and decorative repair without fear for a long time. It also must be cost effective, labour effective and final product encouraging.

Recommendation

Poor plasterwork is epidemic within the Abuja region as many plaster defects are a common sight across the city. Issues such as poor workmanship and materials appear to be the main culprit behind such circumstances. Given that the finishing in discussion is cement plaster, the quality of its component materials can be brought to question. Cement plaster is made of water sand and cement. Of these three components, the quality of the sand is most suspect as the cement is produced and packaged under factory conditions, and most of the water used in construction comes from borehole pumps. The two most common sources of sand for plaster production in Abuja are pit sand and river sand, both of which are often used in the exact state as they were upon extraction with no attention brought to their quality. However, it was discovered that upon using manufactured sand, there were also improvements in the quality of the building and finishing of residential projects. I recommend contractors and client should look into exploring the use of manufactured sand for all construction thereby getting the quality and preserving natural occurring sand.

It is recommended that Preventive measures against negative consequences in sand mining include enacting government policy against sand mining, issuing legislation requiring the use of alternatives to sand. Corrective measures that can be taken include encouraging the use of quarry dust and construction and demolition waste as a replacement to river sand for construction. Setting up factories where sand can be manufactured in order to improve availability. Minimizing waste of construction and demolition waste and other alternatives. Providing adequate sensitization on the benefits of alternatives to sand for construction to improve awareness.

Further studies should investigate strategies for motivating construction practitioners towards the utilization of the identified alternatives. This study is also limited to data collection and analysis; therefore, further studies should test and validate the outcomes of the work in coming years.

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