CHALLENGES OF GLAZED-CERAMIC PRODUCTION IN NIGERIA: FROM MATERIALS TO METHOD

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Abstract
The significance of glaze application in the finishing of traditional ceramics cannot be overstressed. Aside functional and mechanical qualities, a well-finished glaze lend aesthetic values which in turn add to the perceptual value of the clayware. Despite the teeming market available for a wide range of ceramic products, a substantial amount of its products is still being fed by foreign countries. The slow pace in the capacity development of ceramic cottage industries and institutions in Nigeria can be attributed to various factors among which are under-utilization of materials and inadequate techniques to enable effective production. From the perspectives of glaze materials and techniques, this paper examines the clog in the wheel of progress towards maximizing the untapped potentials for glazed ceramic productions with specific case studies drawn from the survey conducted in selected areas in Nigeria. The outcome of the study revealed the gap to be filled in order to boost glazed-ceramic production in Nigeria.

Introduction
From the traditional history to modern-day life, clay-based products have continued to satisfy diverse human needs from utility wares used for culinary, sanitary, and structural purposes to technical ceramics in advanced application. Irabor (2009) remarked that pottery (ceramics), through development in science, technology and engineering, has grown to assume a formidable role in the modern and space age of man. Today, advanced ceramics has become a core material in the field of Nano-technology (Masuo, Kiyoshi, Makio & Toyokazu, 2012). Now it could be hard to imagine a world without ceramics.

The prospect for glazed ceramics in Nigeria is very remarkable as it potentially stands to accelerate socio-economic development. As estimated in 2009, the Nigerian ceramics market was said to be valued at three hundred and twenty seven million dollars (US$327M) as reported by Wray (2009). Despite a teeming market of over 150 million people available for a wide range of consumer products, a substantial amount of ceramic products is still being fed by foreign countries. According to the 2009 report on world production and consumption of ceramic tile between 2005 and 2009, Nigeria ranked the world 12th largest country consumer of ceramic tiles by importation and even more so, she purchases more tiles from overseas than any other African nations (Stock, 2010). Figure 1 shows the imports of the 20 major importing countries which represented 52.4% of total imports and 10.8% of total world consumption in 2009. This unfavorable economic indicator cannot be justified by the vast potential of socio-economic and mineral resources preponderantly available within the border of the country.

The slow pace of ceramic development in Nigeria can be attributed to many factors among which are gross inadequacies towards delivery of quality finished products. It is considered that the development and production of ceramic glazes, a specialized science and technological based process in

the aspect of ceramic product finishing, strongly impact on the successful outcome of ceramic manufacturing and practices in the country (Irabor, 2009). Hence, this paper has attempted to expound on some key challenges impeding an advance development of glazed ceramics production based on a survey study conducted to address this issue. The primary factors identified were problems related to raw materials utilization, glaze method and techniques. While previous studies have acknowledged that most ceramic industries suffer a lot of setbacks due to problems associated with discrepancies in product output and the realization of effective indigenous methods dependable for a sustainable production, there has not been in-depth focus on this particular issue. Considering the backward trend in the development of indigenous glazes in Nigeria, especially in institutions and ceramic cottage industries in Nigeria; this paper concluded by revealing some crucial gaps to be filled in order to boost local glazed-ceramic production in Nigeria.

Fundamentals of Glaze Raw Materials

Ceramic glaze production requires the use of various raw materials. These materials mostly are naturally occurring chemical substances called minerals found on the earth and readily available for use (needed to be refined from their raw sources in order to achieve better results). The composition of glazes requires selections of specific materials which are blended in the right quantities, applied on clay-wares and fired under proper condition in order to have desired outcome. The list of raw materials and quantities required to make a particular glaze for a particular firing temperature is known as the recipe. Each of the materials in a glaze recipe contributes component oxide(s) that will end up to in the fired glaze. The glaze technology is thus based on the fact that a number of oxides supplied by constituent glaze materials interacts as building blocks comprising of glass forming oxides (RO), fluxing oxides (RO/R_2O) and stabilising oxides (R_2O_3). While it is possible to use raw and semi-processed raw materials in the ceramics product body, glazes demand materials with specific quality standards. According to Rogers (1991), of all the oxides contained within the earth's crust, silica (SiO_2) accounts for almost 60% of the total, Alumina (Al_2O_3) accounts for a further 15% and all the others remaining 25%. Rhodes & Hooper (2000), Cooper & Royle (1992), Igbinedion (1987), Rogers (1991), Ima (2000), and Saibu (2000) recorded most of the materials commonly used in ceramic glaze composition.

Nigeria possesses vast ceramic resources which are potentially viable and could be harnessed for the production of glazed pottery including modern ceramics. In recent years, the Nigeria's Raw Material Development Research Council (RMDRC), Ministry of Solid Minerals Development and Federal Institute of Industrial Research Oshodi (FIIRO) have opened up a growing database of basic ceramic raw materials occurring at various geological locations in Nigeria in appreciable millions of tonnage that supports experimental and mass production purposes. Refer to the appendix (Table 1) for a quick reference to basic glaze materials which are available in Nigeria.

Concept of Glaze Formulation Methods and Design Techniques

Basically, the design and formulation of new glazes have involved two major approaches. These include the trial and error method and more currently the scientific method which now incorporates advanced computer applications. The trial and error method is usually characterized by guesswork and rigour with various uncertainties while the latter is offering a methodical and systematic approach to glaze formulation, which however might help the designer to have a greater level of control on the final result. To design a new glaze successfully as described by Buck (1999) requires no mysterious chants, but just a thorough understanding of the factors involved in the process. According to Buck (1999), two main steps involved can be explained as follows:

1. Choosing suitable raw material and mixing them in various proportions to meet a planned series of glaze tests; or
2. Choosing an appropriate "formula", based on previous practice, and deriving a "mix-batch" recipe for testing, etc. In either case, one needs to have proper underlying knowledge about the raw materials at hand.

One way to enhance a glaze formulation process and evaluate a glaze recipe is through the molecular Unity Formula otherwise called Seger Formula. This approach was developed

by a German ceramist Hermann Seger who in a century ago arranged glaze components into a particular order- the RO/R_2O group for basic oxides, R_2O_3 group for amphoteric oxides and RO_2 for the acidic oxides. Hermann Seger carried out in-depth research into the importance of the ratios of the groups to each other and listed three ratios which are of outstanding importance to the potter when compounding glazes. Unity Formula as noted by Latorre (2009) provides a means of comparing different glaze formulas with each other or a way to show the relative amounts of the oxides in a fired glaze as pictorially described by Ewing (2009) in Figure 2 below. Table 1 shows an example of a computer glaze software generated recipe derived from Nigerian local materials based on Unity Formula.

Cardew (1969) opined that the main use of the Seger Formula is that it provides a simple means for controlling the balance of the three oxide groups (i.e RO, R_2O_3 and RO_2) and the composition within the group. He added that this combination play the chief part in determining the character of a glaze like its fusibility; its maturing range (the length of the temperature over which a glaze can be used without over firing); crazing; viscosity; the colour and stability of in-glaze pigments (especially iron pigment); and the surface quality (whether bright or matt). Adelabu (2011) presented a comprehensive report on computer aided approach to apply the Unity Formula for glaze formulation based on locally available materials in Nigeria.

Research Method

This study examined the challenges facing glazed ceramic production in selected parts of Nigeria. To this end, a survey was conducted through questionnaire and opinion sampling. The target population sample included local ceramic practitioners- students, instructors, studio potters and technologists (n=56). n means the total number of respondent.

Analysis, Results and Discussion

From the field survey conducted by the study, responses were gathered from local ceramic practitioners which included ceramic students, instructors, studio potters and technologists (n=56). The collected data were descriptively analyzed while the results are presented in charts. The demographic information of the respondents for this survey is presented in Figures 4 (male respondents=87% while female respondents=13%) and 5 below. Figure 6 indicates their level of exposure to glaze ceramics practices.

The study findings identified some militating factors against advance development on glaze ceramics production in Nigeria connected to issues on glaze materials, glaze composition and technique.

On the subject of availability of glaze raw materials in Nigeria, about 95% of the respondents agreed that there is a vast presence of glaze raw materials in Nigeria (Figure 7 above). Meanwhile in Figure 8, we observed an equivocal response on the issue of accessibility to local glaze materials by the respondents. Nevertheless, we reasoned that the level of access to various local material sources may not be consistent since there are existing challenges of land ownership and territorial land resource control. In addition, we noted a low presence of industries involved in mining and beneficiation of locally available materials which in turn could have facilitated the distribution and access to these materials for local consumption. While there might seems to be several factors downsizing access to local glaze materials. Figure 9 somewhat indicated low prospects for locally available materials while many still choose to seek for foreign substitutes, hence an under-utilization of local materials. From Figure 10 above, we can infer some key influential factors affecting an advance development of glaze ceramics practices using local materials. These factors could be summed up as under-utilization of glaze materials due to inadequacies of technical knowledge and paucity of efficient glazing facilities.

While traditional ceramic practices seem to have come of age in Nigeria, this study findings indicated that the global advances in ceramic glaze technology in Nigeria is yet to be felt. Generally, many challenges remained unresolved as ineffective traditional approach to glaze formulation and paucity of equipment continues to abound. The trial and error method and use of already-prepared glazes are still common practices in most ceramic institutions and cottage ceramic outfits examined in the study. This do not often deliver as expected due to varying conditions

which cannot be accounted for scientifically in the course of replicating an existing glaze or trying out new ones. Another point worthy of mention is that most of the respondents (practitioners) discontented to the opinion that glazes composed basically with local materials are often problematic (see fig. 9). This indicated that they are confident about the viability of glaze material resources which are locally obtainable. We observed that within the South-western areas of Nigeria, local pottery productions appear to be driven by demand for artistic and decorative purposes especially among the studio potters. In this regards, utility articles such as glazed tableware, dinnerware or sanitary ware are rarely produced as contrary to the studio production culture around the Northern areas.

Irabor (2009) having observed the big opportunity in the ceramics business awaiting the nation, considering that 85 percent (85%) of the raw materials that would be needed could be obtained locally, described the current challenges facing ceramics and its glaze component manufacturing in Nigeria as being enormous. Oyeoku (2003) simply referred to modern Nigeria ceramics as a sick baby as he questioned why the sector was not enterprising enough with the opulent raw materials that abound in the country. Irabor (2009), however noted that there are a number of crucial factors necessary for the development and growth of ceramic and glaze technology and manufacture in Nigeria and such varied factors ranges from government policy frame work, financial structures, politics, expert manpower, technology, to availability of appropriate raw materials. Of significance is the science and engineering nature of the ceramic discipline as obtained in the developed and developing worlds, except in the under-developed worlds where a degree of lack of knowledge exist in the area of pottery, its technology and engineering. All of the foregoing situations can be tracked down on the issue surrounding understanding of glaze raw materials and low level of technical know-how for the emerging glaze technology.

Conclusion

From issues bothering on glaze materials to composition methods, this paper has considered investigating more deeply into some of the main clog in the wheel of progress towards maximizing the untapped potentials for glazed ceramic productions with survey findings drawn from selected areas in Nigeria. Many a reason has been attributed to this abysmal performance of the productive sector, with over-dependence on the country's vast and non-renewable oil resources as the most convincing reason. Akinbogun (2008) decried the downtrend of the small- and medium-scale businesses which are supposed to be the economic nerve center of a developing country like Nigeria. For the educational sector, Akinbogun (1997, 2006) identified one of the major factors responsible for students' skepticism on specializing in the area of ceramics being the fact that prospective students without science background tends to avoid anything that has to do with chemistry of ceramic materials and glaze calculation. As observed, the retarded growth of local glazed ceramics practices can be justified against the fact that the trial and error methods of glaze formulations are still being used which proves unpredictable. Therefore, the importance of gaining the underlying knowledge of the glaze materials and chemistry of composition cannot be overstressed. This enables the ceramists to have better control over glaze preparation and innovate instead of dependency on pre-mixed glaze bodies.

Despite the previous achievement following the pioneering works of Michael Cardew in the *Anglo-Nigeria* pottery experiment (Akinbogun, 2009), there is a need to constantly review local ceramic production process on the background of current technological possibilities as supported by Kashim and Akinbogun (2007). An appraisal of the traditional method vis-à-vis the scientific approach somewhat shows that the former is liable to suffer much setback in terms of time efficiency, quick modification, creativity, accuracy and analytical approach to glaze formulation.

There is a large potential growth prediction for Nigeria as a world emerging economy. Interestingly, Nigeria is rated first among top 11 nations (referred to as 3G countries) that will experience an unprecedented economic growth between 2010 and 2050 (Citi Investment Research and Analysis, 2011). One of the stated reasons is that Nigeria has large natural resource endowments that is hoped will be more beneficial than often have been in the past. Adelabu and Kashim (2010)

rightly affirmed that when local materials are effectively utilized, it create impetus for industrial development, thus minimizing over-dependence on imported materials with its derailing effect on the economy.

Despite the current abysmal performance of Nigerian ceramic industries, there is a ray of hope. Glazing process expedited through technological inventions of new methods, tools and techniques; will greatly facilitate cost, time and energy management. Hence, the best of ceramic practices in Nigeria could be achieved if technological inventions on glaze processing and composition are explored.

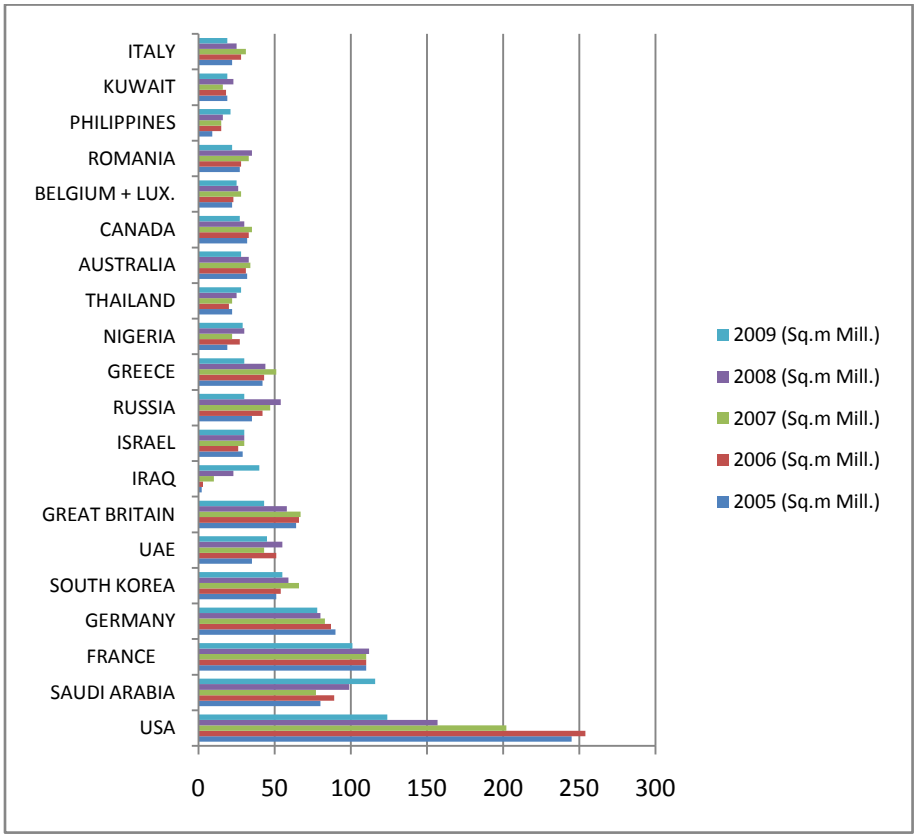

Figure 1: Ceramic tile imports of the 20 top importing countries between 2005 and 2009 (in Million square metres). *(Stock, 2010)*

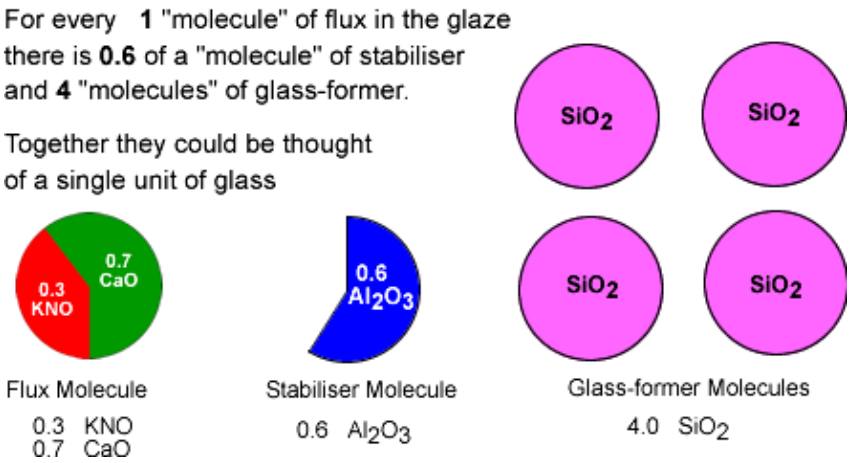

Figure 2: Graphical representation of glaze based on Unity Formula
Ewing (2009)

Table 1: A glaze software formulated recipe in Unity format using Nigerian local materials

Flux	**Stabilizer (Amphoteric)**	**Glass former (Acid)**	**Oxides % composition value**	**Recipe in %**
KNO 0.363 CaO 0.637	Al_2O_3 0.407	SiO_2 2.309	Flux – 26.81 Ampho. – 10.92 Acid – 62.27	Auchi Feldspar – 78.69 Auchi Kaolin – 7.08 Auchi Whiting – 14.23
1.000			100.00	100.00
				Si:Al 5.67

Source: Adelabu (2011)

Table 2: Target population for the study

Population	Location	Condition
Pottery enterprises (SMEs)	Kaduna, Abuja, Osun, Lagos	Active involvement in glaze pottery production based on indigenous recipes using local techniques and raw materials A contemporary studio outfit highly resourceful in glaze materials and facilities
Institutions of learning	Ondo, Ekiti, Kaduna, Lagos, Oyo	Includes universities, polytechnics and colleges of education where ceramic courses are offered

Adelabu (2011)

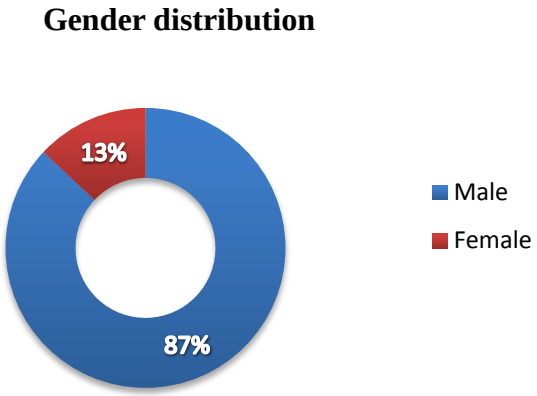

Figure 4: Gender distribution of the respondents (n=56)

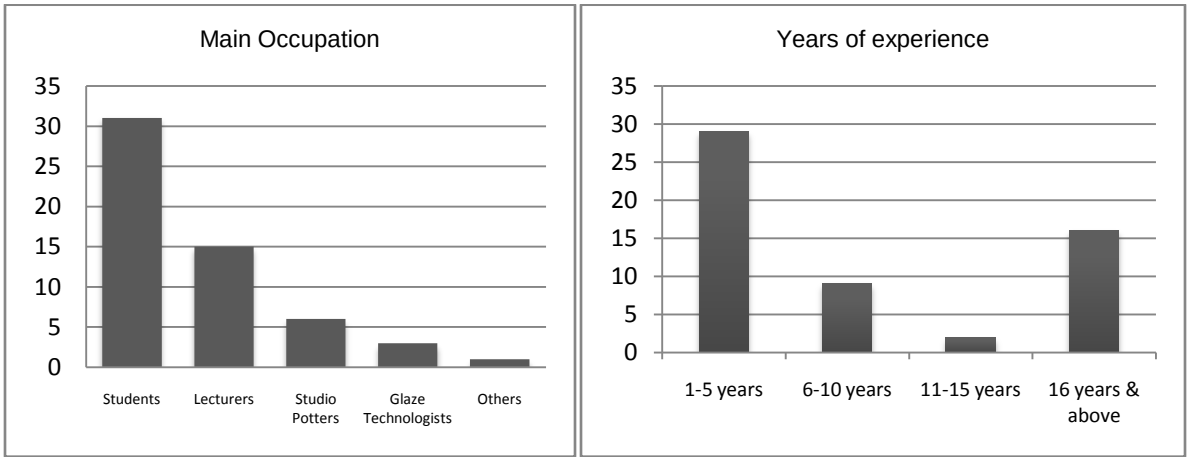

Figure 5: Chart showing the occupational pattern and years of experience in ceramic practices

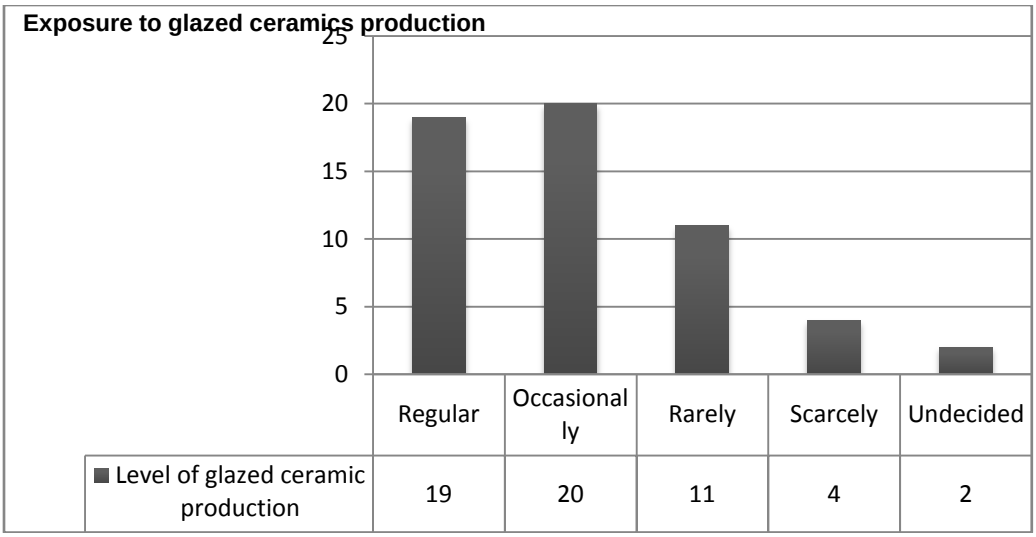

Figure 6: Chart showing the frequency of glaze practices by the respondents

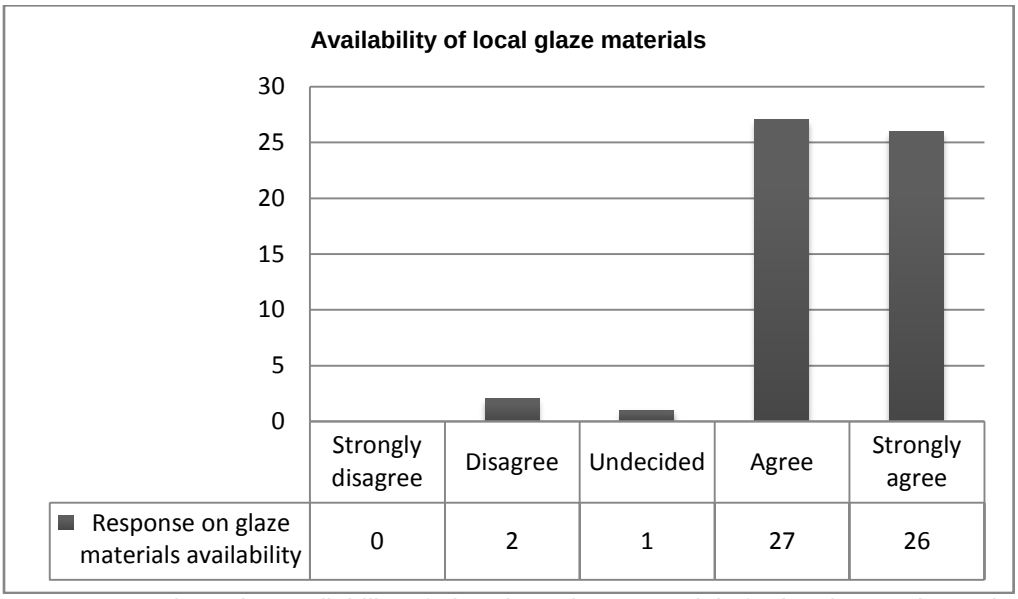

Figure 7: Response about the availability of abundant glaze materials for local ceramic production in Nigeria

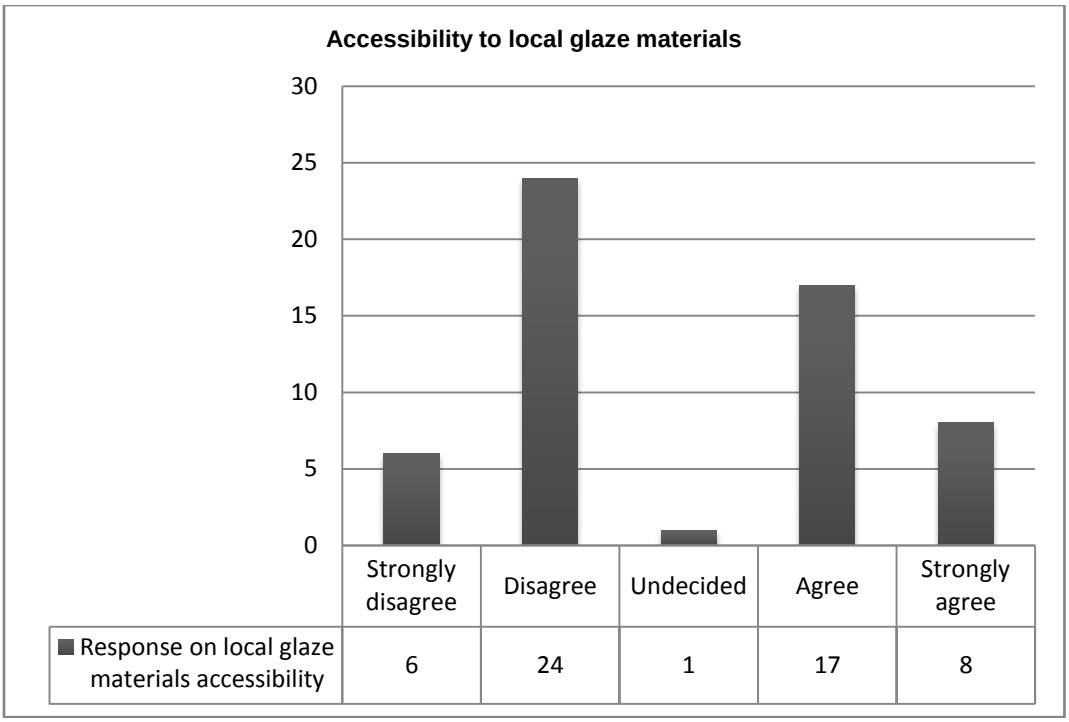

Figure 8: Response about the non-accessibility to glaze materials for local ceramic production in Nigeria

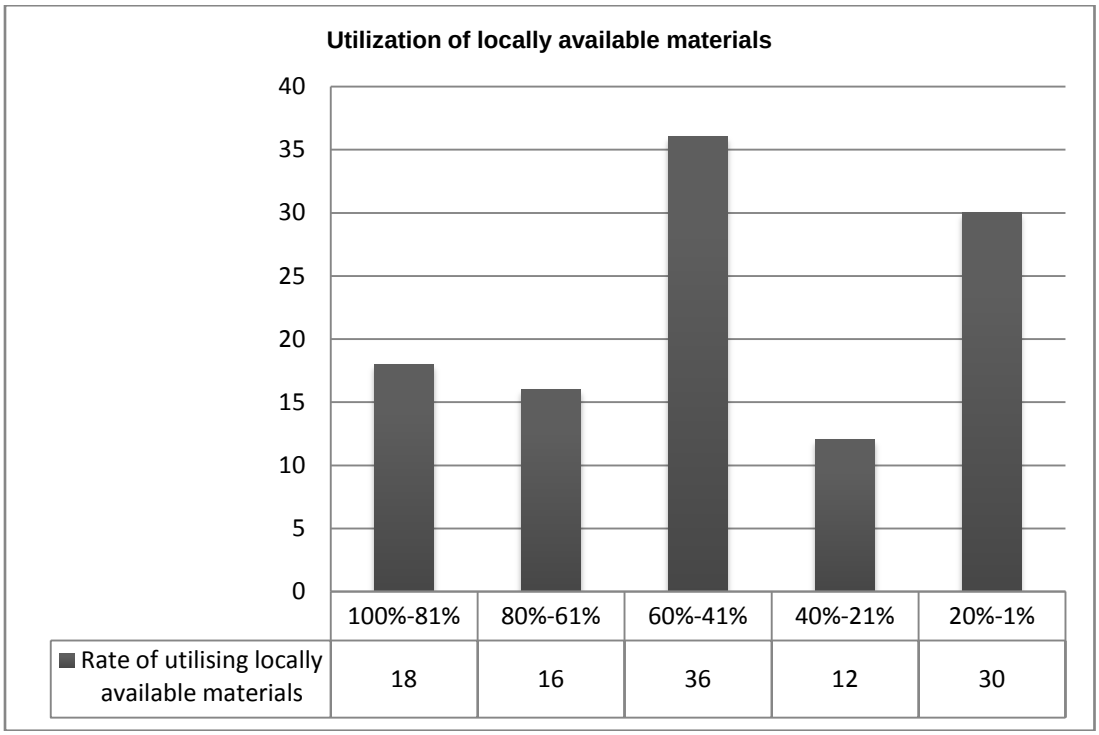

Figure 9: Utilization of locally available glaze materials for composition of glaze recipes

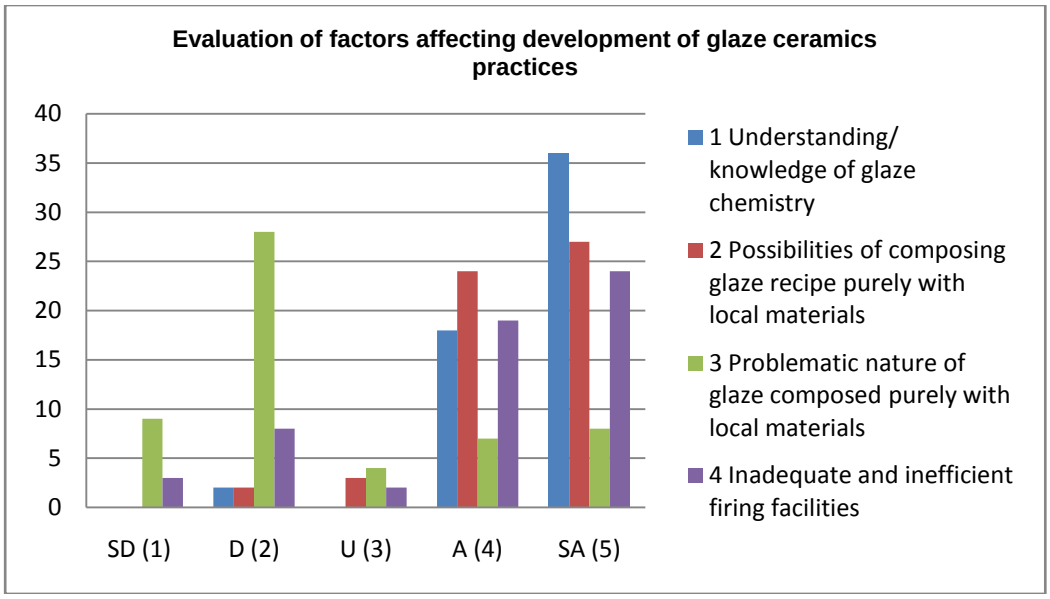

Figure 10: Responses to factors affecting development on glaze ceramics practices
Keys: SD-Strongly disagree, D-Disagree, U-Undecided, A-Agree, A-Strongly agree

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Appendix

Table 1: Basic Glaze Raw Materials Used Locally in Nigeria

Glaze material and their Chemical nomenclature	**Basic function**	**Local areas of deposit**
Ball Clay $Al_2O_32SiO_22H_2O$	Main sources of alumina (Al_2O_3) and silica (SiO_2)	Cross-River (Appiapumet and Ofumbonghaone, Ogurude, Ovonum); Akwa Ibom (Nkari, Nlung, Ukim, Ikot-Etim, Eket-Uyo, Ekpere-Obom, Ikot-okoro, Ikwa); Benue (Katsina Ala, Otukpo, Buruku, Gwer West,Gwer, Makurdi); Ebonyi (Ohaukwu, Ezza North, Abakaliki, Ezzi, Afikpo South, Ohaozara); Abia (Isikwuato, Ikwuano, Umuahia Bende, Arochukwu); Enugu (Enugu, Isi-Uzo, Uzo-Uwani, Oji River, Udi) Ekiti (Ara-Ijero, Igbara, Ado, Orin); Ondo (Erusu Akoko, Ikale, Ode-Aye, Ute Arimogija, Ifon); Ogun (Bamajo, Onibode); Plateau (Bassa, Barinkin-Ladi, Mangu, Kanam, Langtang North); Niger (Lavun, Gbako Suleja, Minna, Agaie, Paikoro); Kaduna Kachia, Maraba-Rido, Farin-Kassa); Kogi (predominant); Rivers (Etche Ikwere); Kano (predominant); Delta (Ethiope East, Isoko South, Ndokwa, South/East/West Okpe, Sapele, Ughelli South, Warri North/South); Niger (Agaie, Bida, Lavun, Mashegu, Murya)
Borax $NaO_2B_2O_310H_2O$	Source of both sodium and boric oxide.	Natural occurrence of this material has not been uncovered yet in Nigeria
Bone ash $4Ca_3(PO_4).2CaCO_3$	Functions as an opacifier and a source of calcium in glazes	Local Abattoirs
Dolomite $CaMg(CO_3)_2$	Single source of calcium and magnesium oxides as fluxes in glazes	Edo, Lagos, Kogi, Cross River
Feldspars $XAl_2O_36SiO_2$ (X could be Na_2O, K_2O, CaO or Li_2O)	Introduce principal glaze flux (sodium, potassium, calcium)	Ogun (Abeokuta); Ekiti (Ijero-Ekiti); Osun (Oshogbo, Ilesha, Ede, Ipole, Iwo); Plateau (Bassa, Mangu, Pan shin, Langtan North, Jos North/South); Niger (Shiroro, Kontagora, Borgu); Kogi (Osara, Lokoja, Egbe, Okene); Nasarawa (Akwanga, Kokona, Nasarawa); Borno (Gwaza, Shani, Kwajaffa, Bakin Kasuwa); Adamawa (Maiba Guyuk); Edo (Etsako East, Etsako central); Kebbi (Zuru, Yawuri, Kaoye); Katsina (Faskari, Batsari, Kurfi); (Taraba Jalingo, Yorro, Baissa, Ussa)
Granite Compound mineral (predominantly contains Quartz, Mica, and Feldspar)	Serve as glaze core materials with glass forming and fluxing oxides	Abia; Adamawa; Akwa Ibom; Borno; Cross-river; Delta; Ebonyi; Edo; Ekiti; Jigawa; Kaduna; Kano; Katsina; Kogi; Kwara; Niger; Ogun; Osun; Oyo; Sokoto; Gombe; FCT-Abuja; Yobe; Zamfara.
Iron Oxide Fe_2O_3	Acts as flux and colourant in glazes	Lagos Other locations of vast deposit still unexplored
Kaolin $Al_2O_32SiO_22H_2O$	Main source of alumina (Al_2O_3) and silica (SiO_2) in glazes	Cross River (Alige, Betukwe, Mba, Behuabon); Akwa-Ibom (Ibiaku, Ntok Opko, Mbiafum, Ikot Ekwere); Abia (Umuahia South, Ikwuano, Isiukwato, Nnochi); Enugu (Uzo Uwani, Nsukka South, Udi, River-Oji, Enugu North); Imo (Ehime, Mbano, Ahiazu, Mbaise, Orlu, Ngor Okpalla, Okigwe, Oru); Benue (Apa, Ogbadibo, Okpokwu, Vandikya); Anambra (Ozubulu, Ukpor, Anyamelum, Ekwusigo, Nnewi South, Ihiala, Njikoka, Aguata); Ondo (Abusoro, Ewi, Odo-Aye, Omifun); Ekiti (Isan-Ekiti, Ikere-Ekiti); Nasarawa (Awe, Keffi); Ogun (Ibeshe, Onibode); Kogi (Agbaja); Niger (Lavum Gbako, Bida, Patigi, Kpaki) Kaduna (Kachia); Plateau (Barkin-Ladi, Mangu, Kanam); Bauchi (Ackaleri, Genjuwa, Darazo, Misau, Kirfi, Dambam); Yobe (Fika(Turmi)); Borno (Maiduguri, Biu, Dembua); Edo

		(most parts of the State); Delta (Aniochia South, Ndo Kwu East); Osun (Irewole, Ile-Ife, Ede, Odo-Otin, Ilesha); Katsina Kankara, Dutsema, Safana, Batsari, Ingawa, Musawa, Malumfashi); Kano (Rano, Bichi, Tsanyawa, Dawakin-Tofa, Gwarzo); Kebbi (Danko, Zuru, Giro, Dakin-Gari); Oyo (Iwo, Alakia)
Quartz and Flint (Silica sand) SiO_2	Principal sources of silica the major glass former in glazes	Ebonyi (Ohaozara, Abakaliki); Ekiti (Idao, Iroko, Aiyegunle, Efon-Alaaye, Okemesi); Plateau (Mangu, Pankshin, Kanam, Langtang North); Niger (Duku-Rijau, Gurara); Kogi (Okehi, Okene, Egbe); Katsina (Faskari, Bakori, Kurfi, Funtua); Kebbi (Danko, Washgu); Cross River (Ikom, Ibine Oban, Mfamosing, Okorotong Hills, Akamkpa, Obudu); Akwa-Ibom: Iwuo Ukem, Ibeno beach, Mbo); Benue (Buruku, Gboko, Guma, Katsina Ala, Vandeikya, Agato, Logo); Abia (Ukwa East, Aba North, Isiala-Ngwa North, Isiala-Ngwa South, Ukwa East, Ukwa West); Imo (Ihiagwa, Obinze, Isu, Njaba, Obowo); Enugu (Enugu-Ekulu, Igbo Eze North and South, Isi-Uzo, Nkanu East, Uzo-Uwani); Lagos (Apapa, Badagry, Epe, Eti-Osa, Ibeju-Lekki, Ikeja, Ikorodu, Lagos Island, Ojo); Ondo (Igbokoda, Atijere, Akata-Agbala, Zion Pepe, Aboto Agerige, Ese-Odo Ikare, Ilaje); Niger (Gbako, Gurara, Lavun, Mokwa, Katcha, Muya, Wushishi, Bida); Nassarawa (Lafia, Doma, Nassarawa); Kaduna (Kaduna); Gombe (Yamaltu-Deba, Akko, Dukku); Yobe (Ngeji (Fika), Damaturu, Jakusko, Karasuwa, Nguru, Tarmuwa, Geidam); Borno (Dikwa, Gwoza, Maiduguri, Jere, Monguno, Kaga, Nganzai, Mobbar, Magumberi, Mafa, Kaga, Kukawa, Kala/Balge, Guzamala, Gubio); Delta (Ughelli North, Ughelli South, Aniocha-North, Aniocha South, Bomadi, Burutu, Ethiope-East & West, Ika-North-East, Ika South, Isoko North, Isoko South, Ndokwa-East); Bayelsa (Sagbama, Southern Ijaw, Yenagoa); Katsina (Zango, Baure); Kano (Danbatta, Makoda)
Talc (Steatite) $3MgO4SiO_2H_2O$	Used in glaze where both magnesium oxide and silicate are called for.	Cross-River (Obudu); Osun (Ile-Ife, Ila, Ilesha); Ekiti (Ijero-Ekiti); Niger (Rafi, Shiroro); Kaduna (Zonkwa); Kogi (Isanlu); Oyo (Iseyin)
Tin Oxide SnO_2	Most effective opacifier in glazes	Appreciable deposit in Jos, Plateau state.
Whiting and Limestone $CaCO_3$	Main source of calcium oxide (CaO) as major flux in high-fire glazes	Cross River (Mfamosing, Odukpani, Uwet, Akpa, Okranibang); Akwa Ibom (Obotime); Imo (Okigwe); Abia (Arochukwu, Ohafia, Bende); Anambra (Njikoka); Ebonyi (Abakaliki, Ikwo, Ishielu, Afikpo North, Ohaozara, Ohaukwu); Enugu (Nkanu East, Agwu, Aninri); Benue (Ado, Apa, Gboko, Guma, Gwer West, Katsina-Ala, Konshisha); Makurdi (Oju,Okpokwu, Ushongo); Ogun (Ewekoro, Shagamu); Kogi (Ajaokuta, Osara, Ekinrin-Adde, Itobe, Jakura Nassarawa Awe); Gombe (Gombe, Yamaltu-Deba, Funa-Kaye, Nafada); Yobe (Garin Ari, Turmi(Fika) Deda, Kwayaya (Fune)); Adamawa (Guyuk, Shelleng, Ngurore, Numan); Borno (Yadi-Gilan (Danboa)); Edo (Akoko-Edo, Owan East, Owan West, Etsako East, Etsako Central, Etsako West); Kebbi (Jega)
Zinc oxide ZnO	Main source of zinc as flux and sometimes opacifier for glazes	Ogun Other locations of vast deposit still unexplored

Adapted from Irabor (2009) & Kashim (2011a&b)