Roadmap to the Domestic Production of Mobile Phone and Its Market Feasibility in Nigeria

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Abstract:
The mobile phone system is one of the instrumental devices that has helped shaped our socio-economic ecosystem in many ways, and it has been an integral part of many societies all over the world due to its versatility. Nigeria currently is facing a great deal of economic hardship owing to successive political failures to balance the import-to-export ratio over the years thus affecting the nation's Gross Domestic Product (GDP) and Gross National Income (GNI). Domestic production of mobile phones has been identified as one of the structures if put in place that can help in a national economic revival in terms of a technological revolution that would contribute to the GDP, GNI, and general economic effect. In this paper, we identified some key elements that could help establish the mobile phone production industry in Nigeria which include identifying the existing phone markets and buyers' usage patterns to guide in the kind of phone to be produced that would appeal to Nigerians and their neighbouring countries such that it would scale well and have a competitive advantage over imported phones. With the help of a survey aided by Google Form, an insight into the kind of phones Nigerians uses and preferred was elucidated. Furthermore, a small-scale design of a phone was carried out to test the technical or manpower know-how and feasibility of the venture. Overall, the feasibility of embarking on domestic production shows a green light.

Keywords: D Mobile phone, Global System for Mobile communications (GSM), production, manufacturing

1. Introduction

The mobile phone is one of the technological gadgets that has revolutionised the world and have bridged the space between friends, families, associates, and even accomplices. Africa is one of the most consumers of mobile phones in the world [1] but is the least contributor to the innovation and development of the technology. Most countries in Africa are tagged as developing countries, including South Africa, the country with the most well-established infrastructures in Africa as depicted in [2]. The state of being considered a developing country is based on various factors, most notably technological industrialisation and the state of infrastructural development; many African countries are behind when it comes to these considerations. The inability of developing countries within Africa to significantly contribute to technological innovations and development has made Africa lag behind in many ways. As a result, not only that many developing countries have poor Gross Domestic Product (GDP) [3] and Gross National Income (GNI) per capita, they are also over-reliant on a single or few source(s) of national income, thus making them less competitive in the world market and making them be at the mercies of the technologically advanced countries. The GDP is a direct reflection of the ratio of export to import or in another sense the ratio of national/local consumption to international consumption, or simply put as the volume of a country's production [4]. African countries have today experience declined in economy with reference to their time of independence, with a 14.6% drop in their real income per capita [5]. This situation is considered worrying and must be addressed by all stakeholders, either politicians, academia, or private sector.

The production of mobile phones has been considered an industry that could help revive the economy of a nation and even that of the region around her and thus help to attain relevance within the world market. It is believed that having a local production of mobile phones in the country could induce competition that would make foreign companies bring their factories down to Nigeria, which can bring to fruition some of the five indices of the ninth (9th) Sustainable Development Goals (SDGs) [6] which are manufacturing value addition as a proportion of GDP, manufacturing value addition per capita, and manufacturing employment as a proportion of total employment [7]. So, in alignment with this 9th goal of the SDGs, this paper is poised to identify what it would take to embark on the production of this significant device. Firstly, mobile phone markets and the tastes of the consumers that make them go for a particular brand are discussed. Secondly, taking Nigeria as a case study, the various mobile phone brand the average Nigerian uses is examined. Thirdly, an assessment of

successful and failed attempts and/or efforts that have been observed or executed so far to ensure the production of mobile phones in Nigeria is done. Lastly, a prototype design of a mobile phone functionality is presented to establish the feasibility of a successful domestic production of the technology.

II. LITERATURE REVIEW

Mobile phones have played a significant role in the lives of people in different capacities. Aside from the primary functions of making calls, over the years the devices have been saddled with additional responsibilities of exchanging text information, firstly in form of Short Messaging Service (SMS), and recently in form of electronic mails and Instant Messaging (IMs) such as in WhatsApp and the likes. There are many other crucial roles that mobile phones have played such as keeping small records, reminders, keeping tasks/work schedules, monitoring health conditions, and keeping up with religious contents such as the Holy Quran and the Holy Bible. Transition into the development of smart mobile phones is believed to be inspired by a drive to achieve more functionality from one generation to the other. On this basis, much more functionality has been made to be exhibited by modern mobile smart mobile devices to the point of almost becoming a general-purpose computing systems like laptops, desktops, or servers. Today, highly sophisticated mobile phones are equipped with a number of specialised sensors such as gyroscope, accelerometer, light sensor, GPS, proximity sensors, and a host of others [8]. These peripheries have made them greatly versatile, thus being found used in various applications and spheres of life.

A study by [9] established the role of mobile phones in improving the health conditions of people in some countries in Asia and Africa. [10] developed an iPhone Operating System (iOS) and Android-based smartphone application called MASK-rhinitis to assess allergic rhinitis symptoms, perform disease control, and its impacts on patients' lives. [11] highlighted how the application of mobile phones in bio-sensing will move societies towards smart cities and allow users to perform quick assays either at home or in the field.

Also, mobile phones have played the role of remote control in having access to and controlling systems far distance away from it, even before the widespread of the Internet of Things (IoT). For example, [12] use a cell phone to remotely control home and office appliances; likewise [13] exploited the GSM phone technology to remotely control an ultrasonic motor. [14] designed a multi-purpose GSM-based interactive embedded data acquisition system in order to offer solutions for accident cases. Also, [15] designed and implemented a GSM-based user-machine remotely interacting with a refrigerator. Of recent [16] developed a lean approach to control a long-distance Unmanned Aerial Vehicle (UAV) using Dual Tone Multi-Frequency (DTMF) signals [17, 18] on GSM. [19] established the effectiveness of mobile technology to moderate destination competitiveness in the tourism industry to improve tourists' experiences. More fascinating is the use of smartphones and it accessories to perform scientific analysis. For example, [20] used a smartphone's camera to perform advanced mechanical analyses which include estimation of instantaneous angular speed from video analyses and estimation of natural frequencies from video analyses. The usefulness of mobile phones is not found wanting in the civil engineering arena, as [21] highlights proves that smartphones can be used as a cost-effective tools for real-time data collection in the monitoring of civil infrastructure. In the same context, [22] experimented a bridge monitoring system using a smartphone through a vehicle-bridge interaction. Also in the civil engineering context, [23] exploited a smartphone's accelerometer alongside other tools to dynamically characterise a vibration based bridge framework. One common mobile phone accessories that has proven to be very important is the camera flash-light which is used as a torch in place of darkness. This accessory is used to obtain quality document scan when smartphones are being used as scanners. Some even take advantage of the adjustable brightness of the screen light radiation to illuminate their immediate surroundings. Study by [24] exploited an Andro-sensor app to measure artificial light at night and noise. In the social sphere, mobile phones have emerged as an arm of electronic banking [25] aided through mobile applications across different mobile operating systems and Unstructured Supplementary Service Data (USSD) [26]. The USSD provides avenue for people that does not have the luxury to acquire a smartphone; in essence, bank and other transactions can still be carried out on a non-smartphone device. The list of the application of mobile phones is unending and more use cases are yet to come. These and many others are the applications that have been utilised from the use of a mobile phone system other than voice and/or data communications.

The mobile phone business is one of the most thriving businesses in West African countries today, with Nigeria being the largest consumer even in Africa [27]; this is due to its versatility and utility value as they comprise of features other than for communication such as calendar, timer, alarm, record keeping, media players, and so on. Out of the various brands that exist in the world, the following are popular in West Africa: Samsung, Tecno, Infinix, Gionee, iTel, iPhone, and Nokia [28]. The choice of a phone being used is dependent on various factors such as cost, sophistication, utility value, quality, and other features that creates benefits that engender specific outcomes and supportive of personal values [29]. In the next section, we would evaluate the various kinds of phones and the motivation behind them based on a survey conducted.

III. CURRENT EFFORTS FOR THE LOCAL PRODUCTION OF MOBILE PHONES IN NIGERIA

It is noteworthy to highlight that there have been different attempts at ensuring local production of mobile phones in Nigeria which either failed or are in the pipeline. As opposed to popular believe that mobile phone products such as Tecno, Infinix, Itel, and Gionee, are owned by Nigerians, and that their production is outsourced to Chinese factories, the products aforesaid are owned by a Chinese group called Transsion Holdings (the first three aforementioned brand) and produced in the People's Republic of China (PRC). However, there are indeed phones produced in Nigeria and they include Plirisblazex-64 by Pliris Mobile Limited, Aspire by Solo, and

Ankara K2 by Imose mobile. While this feat to produce these products locally is laudable, they failed to gain wide acceptance, as many people seem to be unaware of the existence of these brands, thus the venture becoming collapsed and discontinued. Other possible explanation for their unpopularity might be that they do not meet up with the minimal taste and expectations of average Nigerians and this might be due to the lack of technical quality involved in the production, as most of the manufacturers went straight into the design and production of a more advance mobile set rather than starting from a less sophisticated featured phones. Perhaps if they had started with the production of featured phones which is less sophisticated, they would have understood the fundamental challenges for which they can build on to produce a more sophisticated phone. Also, they would have been able to build on the successes and quality of the developed featured phone to design a more advanced one that would suit the peculiarity of Nigeria and her neighbouring regions. Other possible factors leading to failure could be lack of strategy formulation and implementation, and a well-thought business plan. With well-planned marketing strategy plus the possibility of lower cost products compared to imported ones, it can well be assured that the locally made phones would gain more acceptance and popularity than the imported ones, and consequently topple them in the market thus paving the way for only Nigerian made phones, and at the same time forcing importation to a halt. In fact, it is possible that the foreign made phone manufacturers can be forced to setup their factory in the country in attempt to compete with local manufacturer and to maintain their customer base of the Nigeria mobile phone market. These events could foster healthy competition leading to a more affordable mobile phone.

On the other hand, [27] believes the failed attempts in the local production of the device are due to bad government policies which are not offering favourable factors to breed such venture. They hinted at some of the notable attempts which include efforts made by AfriOne, RLG a Ghanaian company in partnership with Osun state government, and recently Industrial, Training Fund (ITF); all of which their efforts have failed to materialise or have had nothing to show for it. This article however looks beyond the factor of government policies and look to another direction to determine how the local production can be a successful venture. This is showcased in the methodology where we attempt to study the behavioural landscape of potential users of made in Nigeria phones. Although one thing that is agreeable with [27] is the fact that locally produced phones are or would be more expensive than the imported ones but they attributed to government's policies.

IV. METHODOLOGY

i. Typical Phone Brands Used In Nigeria

For the reason of difficulty in getting trusted articles to obtain data on phone brands used in Nigeria, a survey is conducted using a questionnaire which is made available to the public to get a glimpse of the type of phone they used and the expectations they seek for in them. Table 1 details the content of the questionnaire made available to participants through the use of Google form.

Table 1: Questionnaire for user's phone preference vs. phone in use

Field	Description
Age	Redundant for this purpose but for future work and reference by other works or authors.
State of residence	To know the demographics represented in the survey
Nationality	To filter the participants to a Nationality of interest
Phone type (feature phone, android, iOS, Windows)	To know the population of people using a particular type of phone and to establish the relationship it has with income
Brand of phone	To establish the relationship between user taste, income, and phone in use
Preferred phone	To establish the relationship between user's preference, income, and phone in use. This would help us to know the ratio of people using phone of their taste to those using alternatives to their taste.
Average monthly income	To establish the relationship between user's preference, income, and phone in use. This would allow us to arrive at whether income plays a major role in phones people uses.
Preferred phone features	To establish the relationship between user's taste, income, and phone in use. This would help us to know the ratio of people using phone of their taste to those using alternatives to their taste (such as fairly used or a cheaper brand but have similar features with the preferred one).
Condition of purchase	To establish the relationship between user's preference, income, and alternative to preference (such as fairly used)
SIM cards utility (Single/Double/Multiple SIMs)	This would help to know the SIM utility users would prefer in relation to income.

All of the information obtained through the table would help to guide the decision of the kind of phones to be manufactured within the country. Out of scope for this article is to determine if a phone brand is certified by a standard organisation (original) or counterfeit, but then the reason for having counterfeit phones in the market may be due to their very low cost which attracts low-income earners. However, a consumer or interested reader can find a list of standard approved mobile equipment in [30].

V. PROTOTYPE DESIGN AND FEASIBILITY STUDIES

Following the survey as presented above, a small design for the phone was experimented to see the feasibility of the work. A GSM module, an Arduino Uno board, and a Nextion LCD touchscreen module were acquired. The GSM module and the Nextion touch screen were connected to the Arduino board. A Human to Machine Interface (HMI) software called "Nextion Editor" was used to design the interface as shown in Figure 1; the major part of the interface includes the phone number dial interface and the SMS sending and receiving interface. The outcome of the interface design at runtime is shown in Figure 2. A small operating program was written on the Arduino to perform call dial, call receive, and Short Messaging Services (SMS) sending and receiving. The program was successful in achieving the objectives for which it was written. The operating code utilises the AT commands provided by the SIM900A module to achieve these functions. For example, the ATD command was exploited to achieve call dial, and AT+CMGS and AT+CMGF were exploited to achieve SMS transactions.

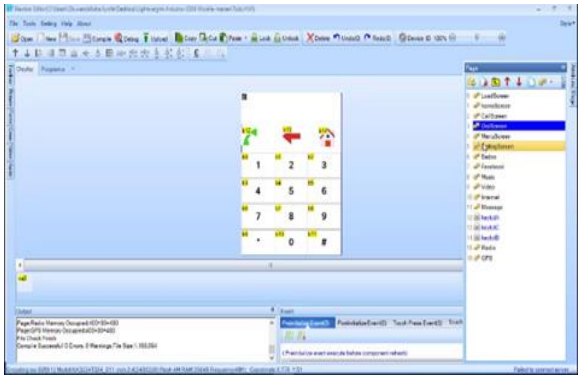

Figure 1: Interface design using the Nextion Human Machine Interface (HMI)

Figure 2: Various phone interface design at runtime

The schematics of the implemented prototype using the GSM module is shown in Figure 3.

While the primary function of a phone was performed, many utility functions of phone functions such as contact storage, clock functions (alarm, stopwatch), were not implemented. The prototype presented in Figure 3 is simply done to experiment the feasibility of the work, and not to implement the full phone functionalities on the small piece of hardware in use. It should be noted that many of these utilities are more of software function and so would be kept as a separate endeavour. The main focus is to implement software that would deal with the operation of the phone as regards signal and communication manipulation. This would take a great deal of technical know-how to implement through the various Digital Signal Processing (DSP) techniques. The evolutionary advancement of System on Chip (SoC) production where all communication electronics are embedded into a single chip has tremendously assisted in overcoming the challenges of DSP methods. One such example is MT6162DA by MediaTek. The SIM900A chip shown in Figure 3 is another typical example of SoC. The various features and periphery the MT6162D SoC [31] comprises can be seen in Figure 4.

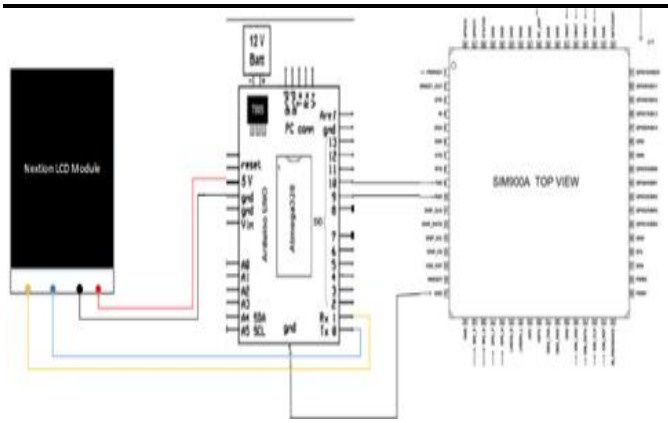

Figure 3: Schematics of the developed prototype

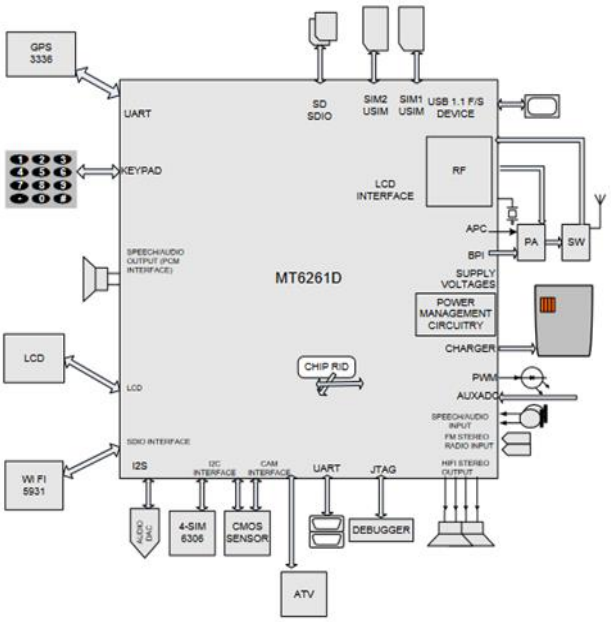

Figure 4: The MT6162 SoC Architecture [31]

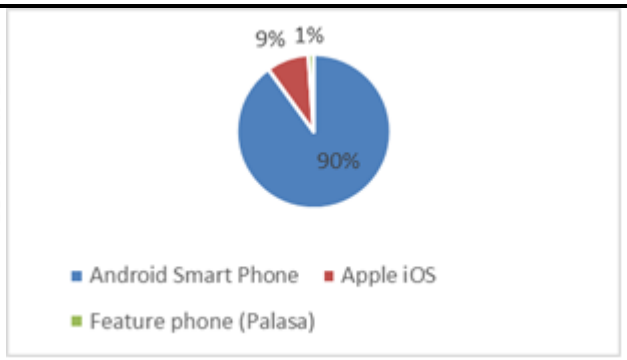

Figure 5: Pie chart depicting the phone type/platform used by Nigerians

Of the 13 different phone brands obtained from the questionnaire, Infinix is recorded to be largely used, followed by Tecno, Samsung, and iPhone making up 32.22%, 17.78%, 14.44%, and 8.89% respectively. The phone brand Vivo carries the least Nigerian utilised phone making up about 1.12%.

The percentage distribution is shown in Figure 6., In another aspect of the questionnaire, about 44% of people would have preferred to use Samsung compared to about 14% of people who are using Samsung, about 6% prefer to use Infinix compared to about 32% using Infinix, about 40% would have loved to use iPhone compared to about 9% people who are able to use it, about 3% people indicated Tecno to be their preferred choice of phone compared to about 18% people currently using the phone. About 2% and 3% of people indicated Nokia and Xiaomi/Redmi, respectively as their preferred choice of phone. The list of features the survey participants indicated they want in a phone which includes camera resolution, processor speed, memory and secondary storage space, indicates these phones meet all these features. The bar chart in Figure 7 below depicts the preferred phone choice of Nigerians.

Table 2: Percentage figure of people that uses their preferred phone

Phone brand	Phone used to phone preferred ratio (%)
Samsung	6.67
Infinix	1.11
Iphone	4.44
Tecno	1.11
Nokia	0
Huawei	0
Umidigi	0
Itel	0
Xiaomi/Redmi	2.22
Gionee	0
Vivo	0
Motorola	0
Oppo	0
Percentage Total	**15.55**

VI RESULTS

i. Typical Phone Brands Used in Nigeria

From the information obtained from the questionnaire answered, various people from 23 states plus the Federal Capital Territory (FCT) out of 36 states of Nigeria participated; basically, all regions of Nigeria were represented in the survey. The age of people represented is between 17 and 56 years. The survey showed that about 90% use Android phones, about 9% use iPhone's Apple iOS, and about 1% use featured phones. Other smartphones type like Windows and Samsung's Tizen got no score. The pie chart in **Error! Reference source not found.** depicts these statistics.

The questionnaire result further shows that about 16% of the total participants use their preferred phone while the remaining settled for an alternative, as depicted in **Error! Reference source not found.**. Finally, as shown in the pie chart in **Error! Reference source not found.**, most Nigerians prefer the use of single phones with two or more SIM card slots to phones with a single SIM card slot. About 92% opted for using a single phone with multiple SIM cards while 8% prefers a single phone with a single SIM card.

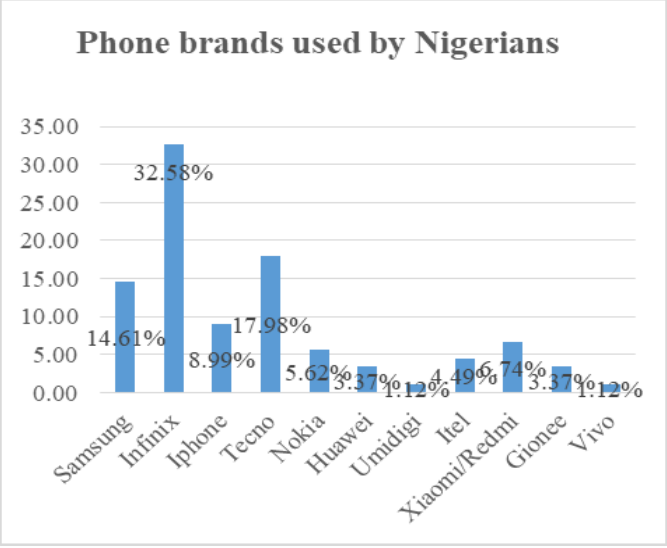

Figure 1 : Bar chart depicting the common phone brand used by Nigerians.

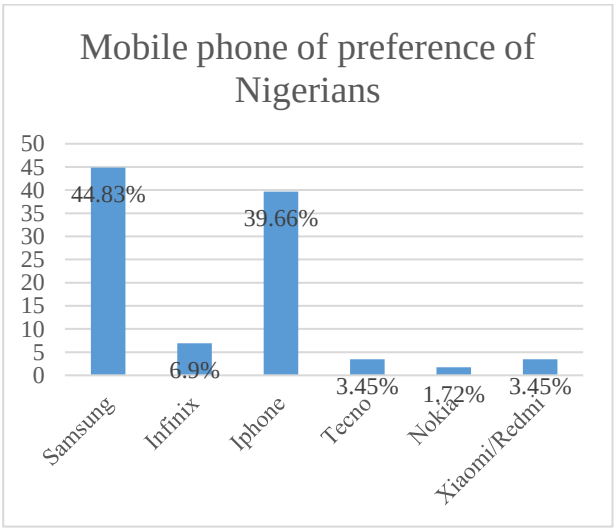

Figure 7: Bar chart of mobile phone preference of Nigerians

VII INTERPRETATION OF RESULTS

From further examination of the questionnaire, it was observed that there is no correlation between the income of people and mobile phone used versus mobile phone of preference, and also the condition for which a mobile phone is purchased (i.e. new or used). It was envisaged that people go for phones of inferior brands to their preferred one because they cannot afford to as the latter is usually more expensive than what their monthly income could cope with. To further understand these discrepancies, a one-on-one verbal interactive investigation was done at random with about 30 people. From this, it was understood that people of low income used a mobile phone of preferred choice, usually more expensive than what their income could afford, due to either committed act of saving over a period of time or obtaining a formal or informal loan; an observation similarly to this was made by [32] where no correlation between income and the ability of a person to use a particular kind of phone cannot be established. Furthermore, the analysis showed that people prefer to buy a new phone over a used especially when they have a means to do so. Also, based on one on one verbal interactive investigation involving 20 people, it was noted that people prefer a single phone with multiple SIM cards over having more than one single phone single SIM card for simple reason of portability. However, some do state some obvious reasons for preferring a single phone equipped with a single SIM card simply because in the event of loss or theft, all contacts and vital information are not lost and they have something to fall back on to continue with their daily business activities.

In view of the above, the following was observed:

i. Features most Nigerians want in a phone include good camera resolution, considerable memory and storage space, and a lasting battery.

ii. Most Nigerians appreciate quality brands of phones but due to cost limitations go for alternatives that have close features to their preferred phones.

iii. Most Nigerians prefer to possess a single phone with two or more SIM cards than phones with one SIM card.

All these observations would be used as a guide in manufacturing a phone that would appeal to the Nigerian populace.

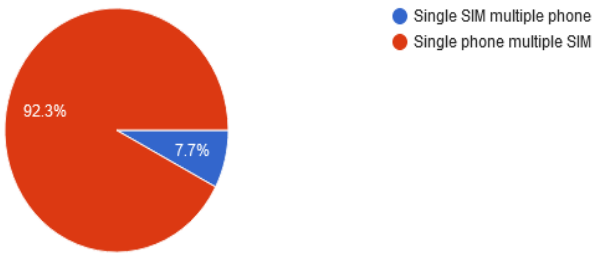

Figure 2: Pie chart depicting Single SIM vs. Multiple SIM mobile phone preference

VIII OBSERVATION AND CONCLUSION

In this study, what it takes to embark on the production of mobile phones domestically in Nigeria was examined. Majorly, the phone brands used by Nigerians and their choice of brands were investigated with the aid of an online form/questionnaire provided by Google. This is a surface-level market analysis that could guide in producing a mobile phone product that can be found appealing by Nigerians in terms of cost and utility functions. Lastly, a prototype design was made to test the feasibility of the production venture. In the advent of a prototype design at a small scale, this work has given a great deal of motivation to the feasibility of a full fledge production of the mobile phone, especially through local design and outsourced production, or with support and funding of both private and public sector, full cycle domestic production is a possibility.

Future work would consider the costs, logistics, machinery, resource materials, and other things to put in place in order to achieve a full cycle domestic production of the device.

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CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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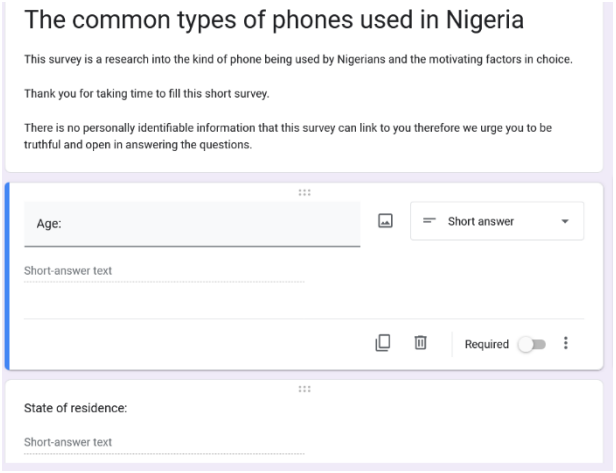
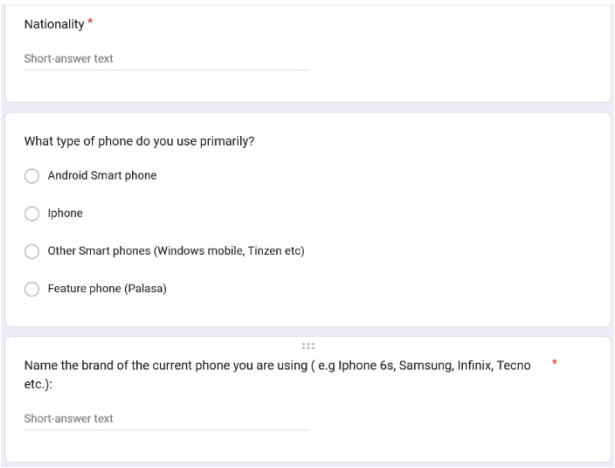
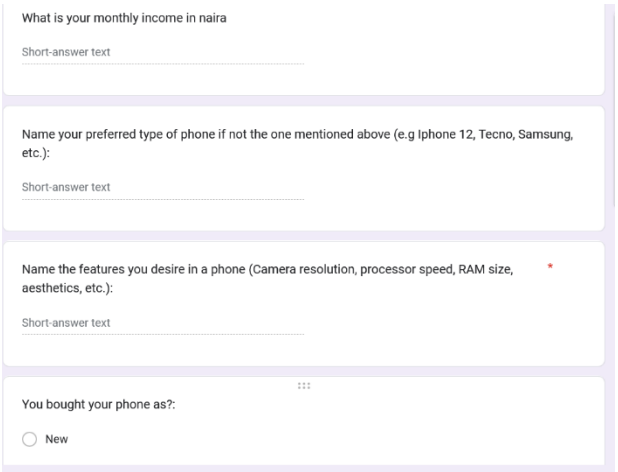
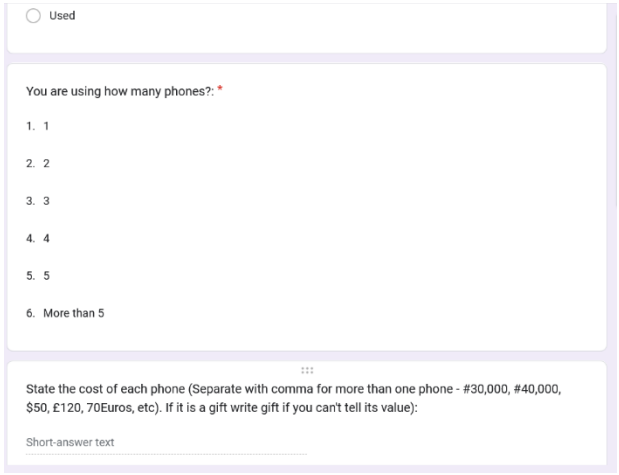
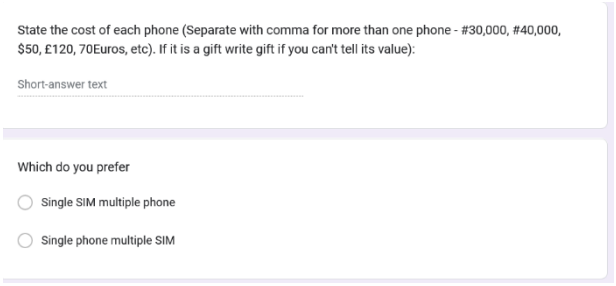
Appendix
1. GoogleForm/questionnaire for the survey studies








Used
You are using how many phones?: *
1. 1
2. 2
3. 3
4. 4
5. 5
6. More than 5
State the cost of each phone (Separate with comma for more than one phone - #30,000, #40,000, $50, £120, 70Euros, etc). If it is a gift write gift if you can't tell its value):
Short-answer text


State the cost of each phone (Separate with comma for more than one phone - #30,000, #40,000, $50, £120, 70Euros, etc). If it is a gift write gift if you can't tell its value):
Short-answer text
Which do you prefer
Single SIM multiple phone
Single phone multiple SIM