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A Historical Background of Some Basic ICT Tools Used in Counterfeit Drug Control

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ABSTRACT

Counterfeit drugs impose risk to human life and properties. Many organizations globally are involved in campaigning for counterfeit drugs control. Almost all these efforts are focused on control at various stages of production and supply chain, while less or rare efforts are invested at terminal intervention by the end users. In this paper, a historical background of some of the existing applications of ICT to counterfeit drug control is presented. These basically revolve round the Global System of Mobile Communication (GSM), mainly voice and text; Internet technology is faintly mentioned. The paper is expected to provide background resource for an efficient and effective information system capable of preventing and/or minimizing the risks resulting from counterfeit drugs. The ultimate goal is to develop products which will assist counterfeit drug control agencies and health information related agencies.

Keywords: *Counterfeit drug control, ICT, Health information agencies, Drug control agencies, Human health.*

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I. INTRODUCTION

The key to preventing disease and promoting health care is to provide timely, well- documented and useful information to the citizenry. Thus, there is need to "Educate before medicate". Information Technology has become essential in our daily life activities, especially the services provided by new generation of mobile communications systems. The cell phone (otherwise sometimes called mobile phone, handset) has become an integral part of the modern world; it provides human connectivity easily in a means that was never possible before. Mobile phones were originally used for making telephone call (voice call) wirelessly, but now other features such as Short Message Service, Downloading, video and image taking are incorporated in it. SMS (Short Message Service) is considered as one of the major milestones in the history of mobile telephony. With this service, users have forged their own dialect to cope with service limitations, composed their own communication groups or communities, and are enjoying new channels of interactions. Any GSM handset has SMS capabilities and if each GSM subscriber sends a message at the same time then more than 1 billion messages would fly over the radio waves of mobile networks worldwide, simultaneously.

Many factors contributed to the importance of SMS such as its rapidness, connectionless, simplicity, cheapness, mobility, and it is easy to operate as it needs no technical background. There are many applications supported and provided by SMS, such as Consumer Application, Corporate Applications and Cell Operator Applications. Counterfeit refers to the act of making a product to look like the original of its nature, usually with respect to making money by dishonest or illegal purposes. A lot of risks occur daily in several forms. While some are officially reported, many are not. The risks resulting from Counterfeit Drug include loss of life massively, loss of business and integrity, health complications, patients' loss of trust in medications etc. The problem of Counterfeit Drug, according to the World Health Assembly, is that information on the scale of the problem is inadequate and there are no adequate global studies conducted [1]. However, it is known to affect both the developed, developing countries, and to great extent the under-developed countries. The problem is more pronounced in countries where manufacture, importation, distribution, supply and sales of drugs are less regulated and enforcement is weak.

Factors responsible for the occurrence of Counterfeit drugs vary from country to other. However, the most common factors are considered to be; lack of legislation prohibiting counterfeiting of drugs, weak penal sanctions, weak or absent national drug regulatory authorities, weak enforcement of drug laws, shortage/erratic supply of drug, lack of control of drugs for export, trade involving several intermediaries and free trade zones; corruption, and conflict of interest and social factors like low income of populations [1]. It has been observed that countermeasures used to control counterfeit drugs is based on controlling counterfeiting from manufacturing to delivery chain and this measure is not applied on end-users when handling their medications. To overcome and minimize the risk of counterfeit drug at user side, there is need for development of an Information System which will enable end-user to check for authenticity of the medication in addition to be able to confirm the product at hand, therapeutic use, dosage form, manufacturer and expiry date. This system will also enable Drug Control Agency to be aware and to track illegal product in the community.

Counterfeit Medicine, as defined by World Health Organization (WHO) [1], is "one which is deliberately and fraudulently mislabeled with respect to identity and/or source. Counterfeiting can apply to both branded and generic products and counterfeit products may include products with the correct ingredients or with the wrong ingredients, without active ingredients, with insufficient active ingredient or with fake packaging.

The proposed Information System will play important role in minimizing the risks resulting from counterfeit drugs because it will give clear message to end user to the effect that the product at his/her possession is counterfeited. This system will serve as solid and reliable source of information to Drug Regulatory Authorities because it will provide database of forged or fraudulently labeled items in circulation and with recently user mandatory registration of SIM card will help in geo-locating the areas where counterfeit product is being distributed.

The health care system currently experiences fundamental changes with respect to innovative development and application of Information and Communication Technology (ICT). This plays an important role in healthcare services, including the safety of patients. In his paper, Siau [2] described different IT tools and concepts such as internet, intranet, extranet, enterprise resource planning (ERP), decision support system (DSS) and data mining, useful in mobile healthcare system. All these serve as means of providing better patient care, making the job of physicians easier and save consultation time. In [3], the authors analyzed the value and properties of telemedicine and M-health, as well as the status, barriers and potential of these services in African countries. They further compared the status of African countries with other countries of the world, and recommended that there should be improvement in e-learning, especially in medical field, towards gaining and sharing knowledge with others globally.

The role of new 3G or mobile messaging is the focus of [4]. The study called for the development of new interactive wireless services. Although the study is limited to local hospital appointments, the lesson learned will generally lead to improve the healthcare services. In [5], the researchers developed and implemented a portable medical prescription using Information and Communication Technology which helps in patient Safety and reduces medication error. In this system, a patient will have access to his medical prescription through portable devices.

In their work [6], Kumar and Rahman developed a system called "Wireless Health Alert and Monitoring System". The system is useful in many cases, including those relating to the elderly or chronic patients. The scope covers fire fighters and soldiers in the battle field. The system is characterized by its unobtrusive size and weight. It functions by sensing the physiological changes in the body of user and sending a signal to base unit, which in turn sends the signal based on information to the server unit. Similar to this system, Sukanesh et al [7] developed a system named "Cellular Phone Based Biomedical System for Health Care". Furthermore, Dillmon and Znati [8] proposed a system to support a patient under observation beyond the confines of traditional point of care. This tether-patient can be monitored in real time when the caregiver receive a sensory signal generated by device on patient. The system uses smartphone.

II. COUNTERFEIT DRUG

Counterfeit drug act in general has been traced back to human beings' abnormal activity. Warning about this act was found in writings as early as the fourth century BC. The history of counterfeiting was narrated in [9]. In it, counterfeiting was described as the second oldest profession.

The author also related the story of Thomas and Anne Rogers who in 1690 were executed in England for clipping the edges off of forty pieces of silver to make new coins from them. Punishment for counterfeiting was severe. Thomas was hanged while Anne was burned alive. The circulation of substandard drugs is a major policy issue worthy of attention. Many studies focus primarily on counterfeit drugs, that is, drugs deliberately produced and labeled. Despite differences in definition, it is important to note that the distinction between counterfeit drugs and substandard ones can be in practice.

The act of counterfeiting is as old as money itself. Plaguing ancient Rome, empirical China, newborn America, and many other nations over the past 2500 years, the illegal activity came hand in hand with the creation of money. Even prior to the invention of coin and paper currency, counterfeiting was a popular form of trickery. In Pre-Hispanic Mexico, for example, Cacao traders would extract the contents of the bean and substitute the valuables of the plant with soil. The problem became so severe in places like ancient Rome, that "it was considered treasonous and punishable by death if the perpetrator was caught. This was because many believed that anyone who disturbed the market with fake money was putting the nation's economy and its general stability and strength in serious jeopardy." [9]

Throughout history, however, counterfeiting is not restricted to individual criminals. The British government produced bogus French currency in large quantities in order to undermine revolutionary France," and helped the process of devaluing Confederate paper money by printing it themselves and sending it to the South in pre-revolution America, to the point where Confederate banknotes were almost worthless.

The act of creating a counterfeit is called counterfeiting. The word "counterfeit" most frequently describes forged currency or documents, but can also describes clothing, software, pharmaceuticals, watches, or any other manufactured item, especially when this results in patent or trademark infringement. Concern regarding the quality of drugs in International Commerce took on a global dimension following the establishment of World Health Organization (WHO) in 1948. The problem of counterfeit drugs was first addressed at the International level in 1985 at the Conference of Experts on the Rational Use of Drugs in Nairobi. The World Health Organization (WHO) created IMPACT (International Medical Products Anti-Counterfeiting Taskforce) in 2006. The taskforce has been active in building international collaboration that (1) seeks global solutions to this worldwide challenge and that (2) raises awareness of the dangers of counterfeit medical products. IMPACT also emphasizes priority action countries should take to combat the counterfeiting, such as strengthen legislation.

United States of America initiated a working group named, Counterfeit Pharmaceutical Inter- Agency Working Group and this group reports to the Vice President of the US and Congress. Victoria Espinel, the White House Intellectual Property Enforcement Coordinator, led a comprehensive study of the issue of counterfeit drug and revealed the comprehensive approach to address the handling of counterfeit products. Some countermeasures suggested in the report work perfectly in that region of the world where they have all necessary infrastructure and systems are integrated [10].

Nigeria recently threatened to ban the import of all drugs from India, a major supplier, because of the high prevalence of counterfeits amongst the imports. In Haiti, Nigeria, Bangladesh, India, and Argentina, more than 500 patients, predominantly children, are known to have died from the use of the toxin diethylene glycol in the manufacture of fake paracetamol syrup. During the 1995 meningitis epidemic in Niger, the authorities received a donation of 88,000 Pasteur Merieux and SmithKline Beecham vaccines from neighboring Nigeria. The drugs were found to be counterfeit, with no traces of active product. Some 60,000 people were innoculated with the fake vaccines. The global distribution and the scale of the racket in fake adult Halfan capsules was clear in December 2000, when Belgian customs seized 57,600 packs of fake GSK Halfan capsules (and 4,400 packs of fake GSK Ampiclox and 11,000 packs of fake GSK Amoxil (amoxicillin] en route from China to Nigeria. The counterfeiters in China were found to be preparing to export 43 tons of 17 brands of drugs from seven international pharmaceutical companies [11].

The pharmaceutical industry, which is a source of benefit to our health, is harming both patients and itself by not vigorously warning the public of fake products when they arise. Apart from the moral imperative, there is the prospect of growing legal pressure on drug companies to take responsibility for fakes of their products. In Britain, there are proposals to introduce a charge of "corporate killing" for companies who have contributed to the deaths of customers; this could also apply to drug companies if they do not take reasonable steps to warn the public of a fake product. In addition, in a survey conducted by a team of Nigerian researchers [12], it was discovered that storage practices by patent medicine stores and homes were poor when compared to hospitals; furthermore, it was stated that National Food and Drug Administration and Control (NAFDAC) in recent times achieved a great feat by at least closing down Onitsha drug centre for charges relating to stocking of fake and adulterated drugs. The centre is a major illegal regional drug market in Africa.

The industry, along with pharmacists, health workers, and governments, need to extend the "behind the scenes" fight against fakes to a public collaborative approach with a legal responsibility to report suspected counterfeits to drug regulatory authorities, in a similar way to the reporting of "notifiable" infectious diseases. The drug regulatory authorities, accountable to the consumers of drugs, should have a statutory duty to investigate and disseminate the information, with the interests of patients as the prime concern.

A research [13] established that the pharmaceutical system, including the registration, procurement, inspection of ports, inspection of establishment and distribution, in Nigeria reflects a moderate vulnerability to corruption. The study suggests that facets of the pharmaceutical systems in Nigeria remain fairly vulnerable to corruption. The most glaring deficiency seems to be the absence of conflict of interest guidelines which, if present and consistently administered, limit the promulgation of corrupt practices. Other major contributing factors are the inconsistency in documentation of procedures, lack of public availability of such documentation, and inadequacies in monitoring and evaluation.

Some researchers go further and consider counterfeit drug action as a form of organized crime [14]. 40-50% of the income of organized crime comes from drug traffic, in opiates, cocaine, cannabis, or synthetics. The last two are produced in many places, while opiates originate mainly in Asia's Golden Crescent (Afghanistan, Iran, Pakistan) and Golden Triangle (Burma, Laos, Vietnam and, formerly, Thailand). Widespread demand for psychoactive drugs is mainly serviced through illegal supply in which organized crime is a major player: this is the main source of funds for many criminal groups, such as Albanian, Turkish and Russian mafia, Chinese Triads and the Japanese Yakusa. New players continue to enter the game: West Africa has now become a significant drug trafficking nexus. In addition to any direct involvement, organized criminals may exact "taxes" from those involved in the drug trade (sometimes in exchange for protection against other actors).

Pharmaceuticals are subject to stringent intellectual properties protection, thus counterfeiters gain a substantial economic benefit as they are spared the major cost of development and licensing of the products. Producers of counterfeits also benefit by substituting high-cost ingredients and ignoring quality processes, environmental and employee protection, and taxation. These processes have become extremely sophisticated. One fake medication network involves imports from China to Europe, through the port of Naples, where the local Camorra mafia duplicate the legitimate barcodes on merchandise legally imported into Italy [15]. In their own contribution to ongoing battle of counterfeit drug, Gogo and Garmire [16] developed a prototype system tested on 8 different pharmacies in Ghana. The authors used the engineering approach and the system serves only as a means of authentication.

In two recent papers by same authors [17, 18], the opinion of Nigerians were sampled at random on the use of information technology to manage counterfeit drugs. While [17] focused on the prevention of counterfeiting, [18] is on its detection. Essentially, the opinions of a total 1391 persons were sampled in all the six geopolitical zones of Nigeria, namely Southwest, Southeast, Southsouth, Northeast, Northwest and Northcentral zones. It was observed, among others, that fake drugs are not easily identified by Nigerians, even though there is a high level of awareness in the prevention and detection of these drugs.

III. MOBILE TELEPHONE TECHNOLOGY

In this section, a general review of mobile telephone technology, including voice and text technology, is presented. Short Message Service (SMS) is one of the applications of mobile telephone technology. Only brief information about how mobile phone works is sufficient to understand the SMS function. In particular, text messaging eliminates any ambiguities and misunderstandings in voice communications.

3.1 History of Mobile Phone

In 1973, Martin Cooper invented the first personal handset while working for Motorola. He took his new invention, the Motorola Dyna-Tac., to New York City and showed it to the public. He is credited as the first person to make a call on a portable mobile-phone. Although the history of cell phone can be traced back to 1843 when Micheal Faraday, a talented chemist, began to do research on the possibility that space can conduct electricity, Cooper's research kick-started the wheels for many other 19th century scientists. In 1865 A Virginia, USA Dentist/Scientist, Mahlon Loomis, developed a method of communicating through the earth's atmosphere by using an electrical conductor. He did this by flying two kites, that are rigged with copper screens and wires, which are connected to the ground on two separate mountains about 18 miles apart. He later received a grant from the U.S. Congress for $50,000 [19].

3.2 Cellular Communications from 0G to 5G

In this sub-section, the evolution of cellular communication from the period of 0G to 5G is presented [26].

0G = Zero Generation

The story of the modern mobile phone really began in the 1940s when engineers working at AT&T developed cells for mobile phone base stations. The very first mobile phones were not really portable at all. They were two-way radios – means using half duplex technique (the caller would have to release the button to hear the other person; it was initially used mainly in military or other emergency services. This generation refers to pre-cell phone mobile telephony technology, such as radio telephones that some people had in cars before the advent of cell phones i.e. mobile radio telephone systems preceded modern cellular mobile telephony technology. Technologies used in 0G systems included PTT (Push to Talk), MTS (Mobile Telephone System), IMTS (Improved Mobile Telephone Service), and AMTS (Advanced Mobile Telephone System) [20].

1G = First Generation

The period covers 1970s to1980s; the mobile device was large in size, and would only fit in the trunk of a car. All

analog components such as the power amplifier, synthesizer, and shared antenna equipment were bulky. 1G systems were intended to provide voice service (call only) and low rate. The first-generation handsets provided poor voice quality, low talk- time, and low standby time. The 1G systems used Frequency Division Multiple Access (FDMA) technology and analog frequency modulation [21]. The system in this generation system was analog in nature and used Frequency Division Multiple Access (FDMA). Martin Cooper, a researcher and executive at Motorola, is credited with being the first person to make a call on a portable mobile-phone in 1973. The prototype handheld phone used by him weighed 1.1 kg and measured 23 cm long, 13 cm deep and 4.45 cm wide. The prototype offered a talk time of just 30 minutes and took 10 hours to re-charge.

2G = Second Generation
This period of 1980 to 2000 is characterized by fully digitalized technology. The period also led to the evolution of 2.5 G which was characterized by EDGE technique. 2G phones [22] using global system for mobile communications (GSM) were first used in the early 1990s in Europe. GSM provided voice and limited data services, and used digital modulation for improved audio quality. The development of 2G cellular systems was driven by the need to improve transmission quality, system capacity, and coverage. Further advances in semiconductor technology and microwave devices brought digital transmission to mobile communications. Speech transmission still dominated the airways, but the demand for fax, short message, and data transmission is growing rapidly. Supplementary services such as fraud prevention and encryption of user data have become standard features, comparable to those in fixed networks. The mobile technology using general packet radio service (GPRS) standard has been termed as 2.5G. 2.5G systems enhance the data capacity of GSM and mitigate some of its limitations.

3G = Third Generation
This period is mainly on broadband technique and the communication is faster than ever before, and this period saw the birth of WCDMA (Wideband Code Division Multiple Access) and HSPA (High Speed Packet Access) technologies. The third generation mobile technology [23] is based on wide band wireless network and complied with the International Mobile Telecommunications-2000 (IMT-2000) specifications by the International Telecommunication Union. The communication provides enhanced clarity and perfection like the real conversation. Recent 3G releases provide mobile broadband access of several M bit/s to smart phones and mobile modems in laptop computers. 3G offers a vertically- integrated, top-down, service-provider approach to delivering wireless Internet access. 3G is a technology for mobile service providers. Mobile services are provided by service providers that own and operate their own wireless networks and sell mobile services to end users, usually on a monthly subscription basis. Mobile service providers use licensed spectrum to provide wireless telephone coverage over some relatively large contiguous geographic serving area. The IMT-2000 framework sets the following goals for the so called 3G wireless systems:
Global standards to allow for low cost and worldwide roaming. High Quality of Service (QoS) especially for voice.
Support for advanced services: Multimedia, Bandwidth on Demand, High speed data.

4G = Fourth Generation
The 4G (fourth generation) of mobile phone mobile communications is a successor of the third generation (3G) standards. A 4G system provides mobile ultra-broadband Internet access, for example to laptops with USB wireless modems, to Smart-phones, and to other mobile devices. Conceivable applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing and 3D television. Recently, Android and Windows-enabled cellular devices have fallen in the 4G category. One base advantage of 4G is that it can at any point of travelling time provide an internet data transfer rate higher than any existing cellular services (excluding broadband and Wi-Fi connections). Two 4G candidate systems have been commercially deployed: the Mobile WiMAX+ standard (at first in South Korea in 2006), and the first release Long Term Evolution (LTE) standard (in Scandinavia since 2009) [24].

5G = Fifth Generation
The Consumer expectations for mobile broadband service quality are growing in parallel with traffic complexity and increase usage [25]. There is expectation that this generation will be given birth by the year 2020. Complex and constantly evolving multi-vendor networks and services are placing considerable demands on service management. The next wave of the Digital Society will be characterized by an ICT network's capability for immediate service availability and on-demand adaptability. The technologies behind 5G architecture are :- a) NanoEquipment b). Cloud computing. c). IP platform.

Figure 1 depicts the evolution of IG up to 5G from the 1980s to the present 2000s. Table 1, Table 2 and Table 3 show the mobile cellular telephone subscription in Nigeria between 2000 and 2018.

3.3 History of SMS
Although it is difficult to ascribe credit for the development of the SMS idea to any particular person, sources indicate that Neil Papworth [28] sent the first commercial text message on December 3rd 1992 to Richard Jarvis and the content of his message was "Merry Christmas". Though, wireless messages were in existence before 1992, Tero Isotalo, referred to this in his PhD thesis at Tampere University of Technology where he quoted the following:" SOS SOS CQD CQD Titanic, We are sinking fast, passengers are being put into boats, Titanic ". According to Isotalo [29], that was the last wireless messages from RMS Titanic and was received by RMS Carpathia on 15th of April 1912, between 2:15 am and 2:25 am. The rescue of 705 passengers from RMS Titanic was made possible, thanks to a

message sent by wireless telegraph, which was developed by Guglielmo Marconi a decade before.

It is tempting to seek a single idea and a single person who created, nurtured and delivered today's SMS texting experience. But the reality is that there were many contributors who did this work. In addition, the community of users was instrumental in converting "SMS" as created by the standards developers and implemented by various vendors and network operators, into the "texting" phenomenon. This was the overall conclusion on an investigation done by a Team from The European Telecommunications Standards Institute (ETSI) that offer information about the fact to clear the air that Matti Makkonen is not the father of SMS, as claimed by him in his interview with BBC as published on their website on 3rd December 2012 [30].

As stated by European Telecommunications Standards Institute [31], the origin of the text messaging services in GSM lies in the historical development of telecommunication services, and SMS was created by a small group of persons. The work on the standardization of services and the technical realization was approved by the CEPT Groupe Spécial Mobile. Text messaging was a known telecommunications service years before the development of GSM started in 1982. Proposals for text messaging as a service in GSM were made by Nordic, German and French operators, who were all co-operating in the task. The Nordic operators focused their work on text messaging by using an access to a message handling system, a service similar to e-mail. This service was standardized by the GSM committee and led to a technical report on the technical realization of the access to Message Handling Systems.

The German and French operators focused their work on 'Short Message Transmission'. This service used a dedicated service centre and transmits the text messages over existing signaling paths of the GSM telephony system on a lower priority basis. This transmission method obviously constrains the message to be short: the maximum length, initially estimated as 128 octets, later optimized to 160 characters, is still sufficiently long for most personal or professional purposes.

The first ideas for text messaging services came about in the 1980s when experts from communities of mobile communication services were discussing which services should be included in the GSM standard. Many of these experts thought that SMS would be a way to alert an individual mobile user, perhaps about an incoming voicemail. By the time that the GSM standards came as a package in 1985, there was discussion about creating standards for messaging that could be both sent and received by mobile users. In 1987 a new GSM body was created, called the Implementation of Data and Telematic Services Experts Group, or IDEG, which was tasked with creating the standards for a short messaging system for GSM.

Short message service (SMS) [32] is a mechanism of delivery of short messages over the mobile networks. It is a store and forward way of transmitting messages to and from mobiles. The message (text only) from the sending mobile is stored in a central short message centre (SMS) which then forwards it to the destination mobile. This means that in the case that the recipient is not available, the short message is stored and can be sent later. Each short message can be no longer than 160 characters if Latin alphabets are used. If non-Latin alphabets like Chinese or Arabic are used, the limit is 70 characters. These characters can be text (alphanumeric) or binary Non-Text Short messages. An interesting feature of SMS is return receipts. This means that the sender, if he so wishes, can get a small message notifying if the short message was delivered to the intended recipient. Since SMS used signaling channel as opposed to dedicated channels, these messages can be sent/received simultaneously with the voice/data/fax service over a GSM network. SMS supports national and international roaming. This means that you can send short messages to any other GSM mobile user around the world. With the PCS networks based on all the three technologies, GSM, CDMA (Code Division Multiple Access) and TDMA (Time Division Multiple Access) which support SMS, SMS is more or less a universal mobile data service.

Mobile phone services (SMS) are important because the growth of cell phones in Nigeria, and Africa in general exceeds 65% and is considered one of the fastest in the world [33]. Research shows that in typical rural district of Africa, about 80% of households make regular use of phones. One of the key features driving growth in mobile phones (also known as handsets) is that they are mobile (also as know as handset) and inherently suited to remote area with poor infrastructure. In addition, the prepaid system of low denomination scratch cards is perfectly matched to economic situation of many people. It is recognized that mobiles offer potentially cheap means of communicating, especially through the use of SMS and beeping.

[34] described various positioning services which ease the work of task force agencies. Al Nabhan additionally explained that several positioning technologies are available and being utilized for different navigation and localization areas such as London Business School. A general classification of the positioning methods can be divided into two major groups. The first one is described as network-based positioning, where the computation of user's position is performed using the network infrastructure. Accordingly, based on the network coverage, position determination can be performed either in short or wide ranges. The second positioning category is described as hand held-based methods, in which the mobile device is responsible for user's position calculation after the reception of required measurement data. He explained that Global Positioning System (GPS) is the only fully operational Global Navigation Satellite System (GNSS) and has been widely adopted worldwide for a variety of air, land and sea applications. GPS is considered the cornerstone of positioning in LBS

applications because of its simplicity of use, successful implementation, and global availability.

IV. DISCUSSION

Current statistics indicate that as at 2018, the number of mobile subscription in the particular case of Nigeria was 172.73 million, as released in September 2019 [36]. It need be noted that the statistics on the number of mobile cellular subscriptions (in Nigeria) is not the same as the number of people (Nigerians) using cell phones. This is due to the simple logical fact that a subscriber may have more than one cell phone. Also, subscribers who are corporate organizations are not counted as human beings.

At the end of 2019, 53.6% of the world population are using the internet. This translates to 4.1 billion people, using an estimated global population of 7.6 billion [35]. Apart from number of mobile cellular subscription per country per year, [35] also provides, among others, yearly statistics on number of fixed telephone subscription and number of individuals using the internet.

A key global forum for the discussion of issues relating to telecommunication and ICT measurement is the World Telecommunication/ICT Indicators Symposium (WTIS). This is an annual gathering of experts in information society measurement, and also of policy makers and implementers.

V. CONCLUSION

In this paper, a historical review of the information system of counterfeit drug control is presented. This includes the use of different approaches of controlling counterfeit drugs, from documentation, manufacturing, distribution, and then to administration. The focus is on voice and text technology via the Global System of Mobile Communication (GSM).

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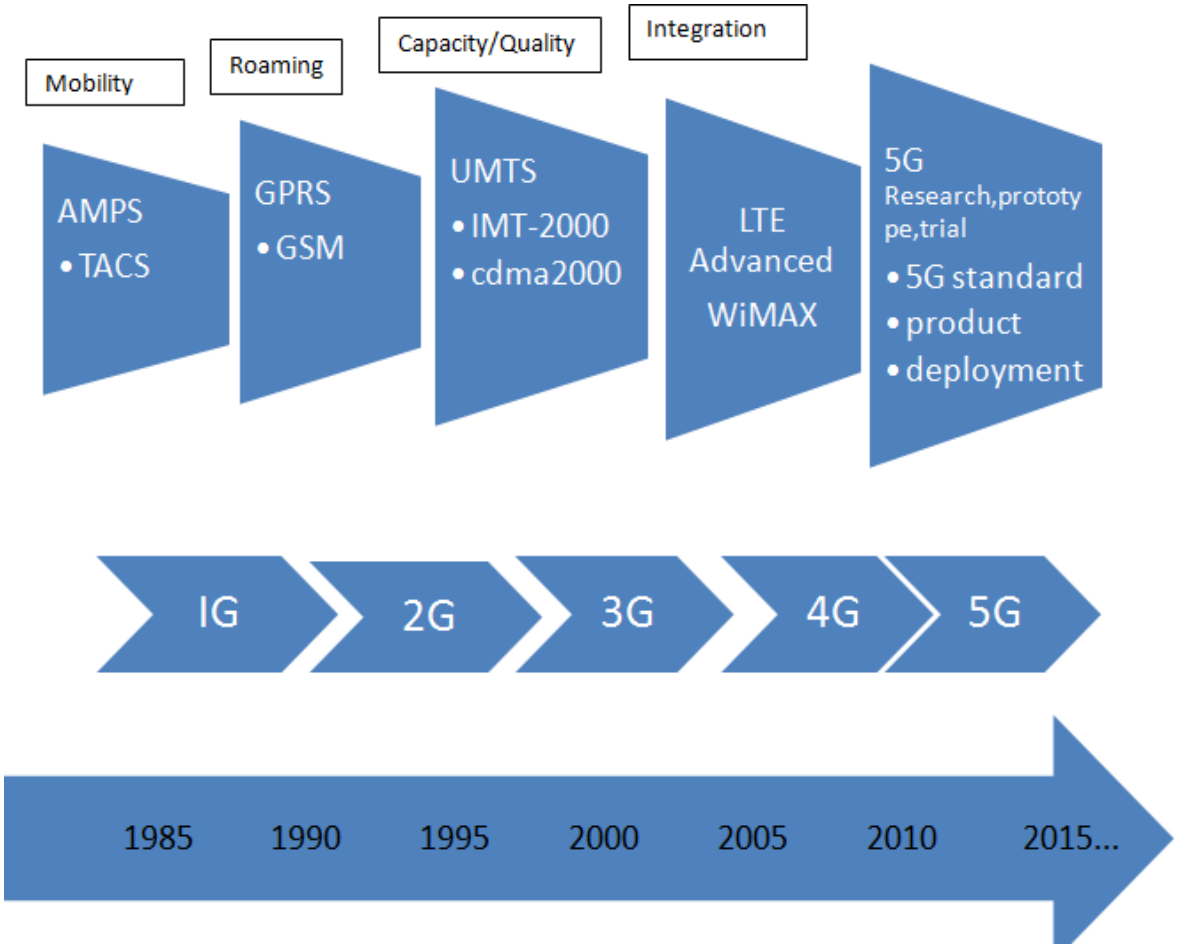

Figure 1: Mobile Cellular Network Evolution Timeline [26]

Year	2000	2001	2002
Number (million)	0.03	0.27	1.57

Table 1: Mobile Cellular Telephone Subscription in Nigeria between 2000 and 2002 [36]

	Mobile-Cellular Telephone Subscription in Nigeria										
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number	3,149,473	9,147,209	18,587,000	32,322,202	40,395,611	62,988,492	74,518,264	87,297789	95,167308	112,777785	127,246092

Table 2: Mobile Cellular Telephone Subscription in Nigeria between 2003 and 2013 [27]

Year	2014	2015	2016	2017	2018
Number (million)	138.96	150.83	154.34	144.92	172.73

Table 3: Mobile Cellular Telephone Subscription in Nigeria between 2014 and 2018 [36]