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# Microbiological Evaluation of Point-of-Sale Machines in Nkwerre, Imo State, Nigeria

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## *Abstract*

**Point-of-sale (POS) machines have evolved into some of the most frequently touched devices in Nigeria today. This study aimed to assess the microbial proxies on the surfaces of point-of-sale (POS) machines utilized in Nkwerre Local Government Area, Imo State, Nigeria. Ten samples were collected from the primary operators at easily accessible locations. Surface swabs of the POS devices were obtained using a manually constructed square quadrant and a saline-moistened swab. The samples were transported to the laboratory and analysed for qualitative and quantitative microbial indices using analytical grade reagents and standard procedures. The total heterotrophic bacterial count for sample Bi2 was 4.95 Log10 CFU/cm², accompanied by a total coliform count of 4.86 Log10 CFU/cm². The total fungal count was 3.07 Log10 CFU/cm², and the total Staphylococcal count reached 4.69 Log10 CFU/cm². During the study, twenty-nine (29) isolates were observed, which were then reduced to five (5) based on their biochemical and morphological features. The tentatively identified bacterial isolates included *Citrobacter* sp., *Proteus* sp., *Klebsiella* sp., *Staphylococcus* sp., and *Aeromonas* sp. *Staphylococcus* sp. was found to have a frequency of occurrence of 57.50%, *Klebsiella* sp. 21.88%, *Proteus* sp. 18.75%, while *Aeromonas* sp. and *Citrobacter* sp. recorded 9.38% and 12.50%, respectively. These flora are known to cause several clinically significant diseases, as corroborated by previous studies. Manufacturers of these devices must be alerted to the necessity of developing a decontamination protocol to ensure the safety of usage for the numerous patrons in urban and rural communities.**

***Keywords*:** *Point-Of-Sale, Microbial Proxies, Frequently Touched Devices, Quadrant, Decontamination*
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## I. INTRODUCTION

The online banking is a lifeline of seamless banking; it holds the pinnacle of modern electronic banking; a wide population of patrons worldwide has appreciated this, as it has revolutionized banking activities in Nigeria, especially as it concerns access to cash for a wide population of society. It is rather becoming 'an essential to have' than a pleasure to have the service. Some of the e-banking systems that have improved over the years have been ascribed to be the most popular technologies (Folorunso *et al*., 2010). These services are provided in specific locations where transactional activity may occur or in areas with high population density (Okafor and Ezeani, 2012). Therefore, the development of e-banking services has not only affected the economic status of countries but has also had several deep social and cultural effects on the quality of individual lives. Studies indicate that patrons of online banking platforms have geometrically peaked in the last two years, other than queuing at banking halls for financial transactions, especially as most countries gravitate towards a cashless economy (Abban and Tano-Derah, 2011). While enormous investment has been made in the acquisition, installation, maintenance and even the security of these e-banking facilities, little has been done to ensure their sound environmental quality health-wise.

The wide acceptance and extended usage of point-of-sale machines across Nigeria, the e-banking interface has been identified as a modern-day fomite that has been implicated in the cross-infection and infection challenges (Nworie and Okafor 2023). Cross-infection of surfaces by multi-drug-resistant pathogens and their versatility to resist harsh conditions and adapt has been identified as a major number of bacterial strains that acquire resistance against disinfectants and particularly antibiotics, are on the increase and faster than expected. This is due to the intermittent threat to human life; regulating the development of pathogenic microorganisms, specifically bacteria, fungi and viruses on non-living surfaces, remains a fundamental interest globally



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(Hamouda and Baker, 2000). Microorganisms are ubiquitous and often found on surfaces of animate and inanimate objects, including human beings, and are, severally, a part of their host (Iquo *et al*., 2015).

Decontamination and extermination may not achieve proper removal, while sterilization may imply the removal of the pathogens. Cross-contamination and infections may heighten from direct contact to passive, especially from the reservoirs or infected persons (Thomas *et al*., 2024; Gerba, 2015). Microbial colonization of inanimate surfaces of frequently touched object surfaces has increasingly bothered a wide array of research enthusiasts who have been adjudged to worsen the transmission of idiopathic diseases (Iquo *et al*., 2015).

Electronic devices have been recognized as the most frequently touched surfaces globally (Effiong *et al*., 2024). Keypads of laptops and screens of data capture machines and point-of-sale machines have been implicated in disease epidemiology in most outbreaks (Odoemelam *et al*., 2020); the likelihood of transmission of diseases through the popular portals of entry may be exponential due to usage and inefficient decontamination of surfaces from time to time (Williams *et al*., 2018).

The prevalence and rate of transmission peak with the increase in the population of patrons and usage; from the rural to peri-urban and urban communities, the propensity to transmissibility of infectious agents increases rapidly. Point-of-sale machines have been identified to improve the pace of cash transactions, hence the need to assess the microbiological indices of these devices used in Nkwerre. Imo State (Effiong *et al*., 2024; Odoemelam, 2020). The study was designed to ascertain the microbiological quality of point-of-sale machines in Nkwerre, Imo State, Nigeria.

## II. Materials And Methods

### A. The Study Area

Nkwerre is in the Nkwerre Local Government Area of Imo State, Nigeria (Figure 1). The geo-coordinates of Nkwerre by its latitude is 7º02'N to 7º 10N and Longitude of 5º 44E to 5º47E having an area of about 38 Km$^2$ (Onunkwo *et al*., 2013). In 2006, the National Population Census estimated the population of Nkwerre people was 2,35273, the area is tropical in its climate, experiencing both rainy and harmattan or dry winds. The soil in Nkwerre is loamy, and the presence of perennial crops such as iroko, palm trees, cocoa, rubber and obeche can be easily seen in Nkwerre. The soil is replete with scattered pebbles (Ofomata, 1985). The physiography is dominated by a segment of northern, southeastern trending Okigwe regional rich tropical rainforest vegetation, which is typical of a state in the Southeastern part of the country (Oguntoyinbo, 1986). The unique challenges plaguing the area are soil erosion and several other issues, such as logging trees and forest fires etc.

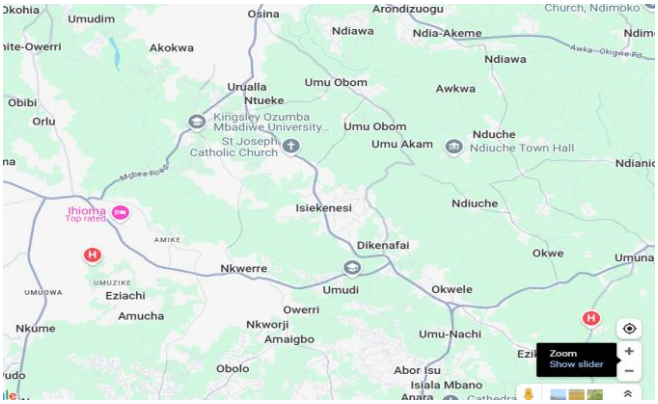


Figure 1. Geomap of Nkwerre, showing the communities sampled during the study (Source: Google Map)

### B. Study population

The collection of samples from the point-of-sale machines used in Nkwerre L.G.A in Imo State followed a simple randomized sampling of the surface of the machines operated in highly densely populated areas within the local government area.

### C. Sample collection

The POS swab was obtained using a box square made from sanitized wooden material and saline water-impregnated swabs (Odoemelam *et al*., 2020). The surfaces were swabbed twice on the touchscreen surface of the POS before they were transported to the microbiology laboratory. Ten samples were obtained from the different operators in Nkwerre, L.G.A, in Imo State, Nigeria. The machines with keypads were excluded to avoid damage.

### D. Sample handling

The swabs were dislodged in peptone, and 1.0 ml were made to go through a 10-fold serial dilution using 9.0 ml physiological saline. The swabs were placed in a cold container and then transported to the laboratory, where they were placed in the refrigerator before the commencement of the work.

### E. Determination of microbiological proxies

Microbiological indices of the point-of-sale machines were determined using the modified method of Effiong *et al*. (2024), whereas total heterotrophic count, total fungal count using potatoes dextrose agar (PDA), coliform count was determined using Eosin Methylene Blue Agar (EMB), total Staphylococcal count using Mannitol Salt Agar using spread plate technique, and coliform count. The plates were counted and presented in CFU/cm$^2$

### F. Biochemical identification of bacterial isolates

An 18-hr- old pure culture was obtained from the plates and used for the biochemical identification of the bacterial isolates. The modified method of Effiong *et al*. (2024) was employed in the identification of the bacterial isolates obtained from the point-of-sale machines sampled in Nkwerre, Imo State, Nigeria. The following biochemical tests

were carried out, namely Gram reaction, oxidase, catalase, triple sugar ion, Indole, methyl red, Voges-Proskauer, citrate, motility and sugars like glucose, lactose, mannitol and sucrose. A dichotomous key of responses was used for the interpretation of the results.

### G. *Identification of fungal isolates from the study*

Fungal isolates from the study were identified using the dichotomous keys for identification of fungi by Magan, (1993). Cotton blue stain was used to improve the resolution of the fungi under the low-power optical microscopes.

## III. RESULTS

### A. *Microbial population of point-of-sale machines in Nkwerre, Imo State*

The result presented in Figure 2 shows the microbial population obtained from the study. The total heterotrophic bacterial count for sample Bi2 was 4.95 $Log_{10}CFU/cm^2$, the total *Staphylococcal* count was 4.69 $Log_{10}CFU/cm^2$, the total coliform count was 4.86 $Log_{10}CFU/cm^2$ and and total fungal count of 3.07 $Log_{10}CFU/cm^2$. The microbial population obtained for sample D5 had a totalS heterotrophic count of 3.88 $Log_{10}CFU/cm^2$ and a total coliform count of 2.62 $Log_{10}CFU/cm^2$. The total *Staphylococcal* count for Bi1 was 3.69 $Log_{10}CFU/cm^2$ and a total fungal count of 3.3 $Log_{10}$ $CFU/cm^2$.

### B. *Colonial morphology of bacterial isolates obtained from the point-of-sale machines used in Nkwerre, Imo State*

The result presented in Table 1 shows the colonial morphology of the bacterial isolates obtained from the point-of-sale machine used in Nkwerre, L.G.A of Imo State. Isolate B1 was observed to have a flat elevation, irregular edges, a mucoid texture and a moderate description. Isolate A4 had a raised elevation, regular edges around the colony, and had creamy pigmentation and a large size. The isolate A2 had a flat elevation, regular edges, smooth surfaces with a milky pigmentation and a punctiform size description.

Table 1. Colonial morphology of bacterial isolates obtained from samples from POS machines at Nkwerre LGA, Imo State.

| Isolates | Elevation | Edge | Texture | Pigment | Size |
|---|---|---|---|---|---|
| B1 | Flat | Irregular | Mucoid | Creamy | Moderate |
| A4 | Raised | Regular | Dry | Creamy | Large |
| D5 | Raised | Irregular | Smooth | Milky | Punctiform |
| B2 | Flat | Regular | Dry | Creamy | Moderate |
| B3 | Flat | Regular | Dry | Creamy | Punctiform |
| A2 | Flat | Regular | Smooth | Milky | Punctiform |

### C. *Biochemical identification of the bacterial isolates obtained from the POS, in Nkwerre, Imo State, Nigeria*

The result presented in Table 2 shows the biochemical reactions and identification of the bacterial isolates. Isolates Bi1, Bi3, Ai4 and D5 were observed to be Gram-negative, while Bi2 was observed to be Gram-positive. The isolate identified as *Staphylococcus* sp. was observed to be negative for citrate, while *Proteus* sp. was identified as a slow utilizer of Simmon's citrate, and *Klebsiella* sp. was observed to have significant utilization of Simmon's citrate. The entire isolates were observed to be catalase and oxidase-positive. The isolates obtained from the study were *Citrobacter* sp., *Proteus* sp., *Klebsiella* sp., *Staphylococcus* sp., and *Aeromonas* sp.

### D. *Frequency of occurrence of bacterial isolates obtained from the POS machines in Nkwerre, Imo State, Nigeria*

The result presented in Figure 3 shows the frequency of occurrence of the bacterial isolates associated with the point-of-sale machines. The most common isolate, *Staphylococcus* sp, was identified to have a frequency of occurrence of 57.50%, *Klebsiella sp.* had a frequency of occurrence of 21.88%, *Proteus sp*. had a frequency of occurrence of 18.75% while *Aeromonas sp*. and *Citrobacter sp*. had a frequency of occurrence of 9.38% and 12.50%, respectively.

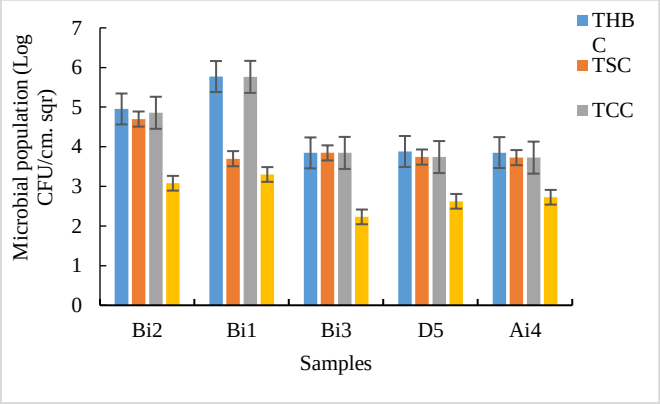


Figure 2. Microbial population of Point-of-Sale (POS) machines, used in Nkwerre, L.G.A, Imo State, Nigeria. THBC - Total heterotrophic bacterial count; TSC- Total Staphylococcal count; TCC- Total coliform count; TFC - Total fungal count.

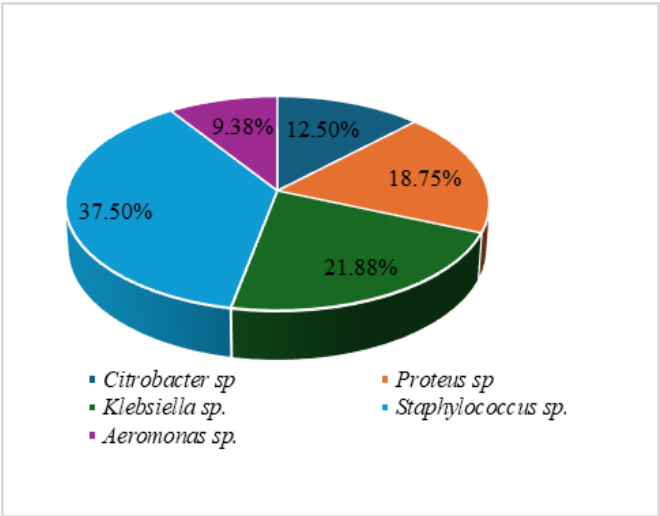


Figure 3. Frequency of occurrence of bacterial isolates obtained from POS in Nkwerre, Imo State, Nigeria.

Table 2. Biochemical identification of bacterial isolates associated with samples obtained from POS machines at Nkwerre LGA, Imo State.

| Biochemical | Bi1 | Ai4 | D5 | Bi2 | Bi3 |
|---|---|---|---|---|---|
| Gram Reaction | -/rod | -/rod | -/rod | +/cocci | -/rod |
| Oxidase | + | + | + | + | + |
| Catalase | + | + | + | + | + |
| TSI Slant | A | K | K | K | K |
| Butt | A | A | A | A | A |
| Gas | - | - | - | - | - |
| H2S | + | + | - | + | + |
| MR | + | + | - | + | + |
| VP | - | - | + | - | - |
| Citrate | + | + | + | | + |
| Motility | - | + | + | + | + |
| Glucose | A/- | A/+ | A/+ | A/+ | A/+ |
| Lactose | A/+ | A/+ | A/+ | A/+ | A/+ |
| Mannitol | A/- | A/+ | A/- | A/- | A/- |
| Indole | A/+ | A/+ | A/+ | K/- | A/+ |
| Sucrose | A/+ | A/+ | A/+ | A/+ | A/+ |
| Tentative Identity | *Citrobacter sp.* | *Proteus sp.* | *Kleb. sp.* | *Staph. sp.* | *Aeromonas sp.* |

Table 3. Morphology and Microscopy of the fungal

| S/N | Morphology | Microscopy | Isolate |
|---|---|---|---|
| 1 | Creamy, raised, and wide colony | Oval Buds with occasional pseudohyphae | *Candida sp.* |
| 2 | Sueded black with the venations | Conidiophore with its condiospores | *Aspergillus sp.* |
| 3 | Whitish and fluffy growth | Aseptate hyphae with a ball-like sporangiospore | *Mucor sp.* |
| 4 | Dense white colony with a centralized colony | Septate hyphae with a protruded collumella. | *Phoma sp.* |

## IV. DISCUSSION

Point-of-sale machines in Nigeria have gained relevance in our day-to-day activities in Nigeria; this is because they have become an indispensable tool for financial transactions for all and sundry. These frequently used devices have been characterised by their personalised usage because of the secrecy of the password access. This study identified the microbial load of the POS devices used in Nkwerre L.G.A, in Imo State; the total heterotrophic count for Bi2 was 4.95 LogCFU/cm$^2$, total *Staphylococcal* count was 4.69 LogCFU/cm$^2$, total coliform count was 4.86 LogCFU/cm$^2$ and and total fungal count of 3.07 $Log_{10}$ CFU/cm$^2$. These findings agree with the report of Ya'aba *et al*. (2021), although compared to the microbial load of keypads during the day and night, the microbial load of the keyboards was less than 200 CFU/sq.cm. These also agreed with the report of John *et al*. (2021), who identified a bacterial load of the assessed ATM and POS user interface from the different locations in both seasons, showing a bacterial load range of 4.1 to 7.8 ± (0.6) $Log_{10}$CFU/cm$^2$.

According to John *et al*. (2021), seasonal fluctuations of surface-colonising bacterial flora were more likely to be Gram-negative bacteria with fewer Gram-positive bacteria. These included Staphylococcus epidermidis, *Staphylococcus aureus*, *Escherichia coli*, and species of *Bacillus*, *Pseudomonas*, *Proteus*, *Streptococcus*, *Salmonella*, *Shigella*, *Micrococcus*, *Vibrio*, and *Klebsiella*. These results corroborate the reports on the colonisation of fomites by microbes via hand contact surfaces. However, the variations in the population of bacterial isolates and their frequency in a densely populated country like India were due to microbial adaptation and surface chemistry (Nagajothi *et al*., 2015). The predominance of Micrococcus (17.2%) in the dry season was probably due to an abundance in the air, thus easily contaminating the ATM/POS machines, as they are located in open places and exposed to dust See Figure 3.

It was observed as the fifth (9%) in the order of occurrence among isolates in the wet season. Micrococcus sp. is an opportunistic pathogen in the air, often present in fine dust particles and may colonise the skin or mucous membrane of humans, as well as the flora of human skin and hands, which often make contact with objects in the environment (Kao *et al*., 2014). Species of Vibrio (1.4%) were the least isolated bacteria in the dry season and were attributed to the microbial pattern among users of the ATM and POS, as well as the environmental conditions hosting the facilities.

The present study identified the following isolates, viz. *Citrobacter sp*., *Proteus sp*., *Klebsiella sp*., *Staphylococcus sp*. and *Aeromonas sp*. This agrees with the report of Abban and Tano-Derah (2011) reported *Staphylococcus sp*. and coliforms like *E. coli* from ATM machines. Our findings from the point-of-sale machines were in tandem with the study compared in the United Kingdom, where the bacterial isolates obtained from ATM keypads were in strong alignment with the current study, identifying nosocomial pathogens and soil microbes on the surface of the metallic keypads (Odebisi-Omokanye *et al*., 2014). The role of proper hand hygiene was identified as a major reason for contamination of frequently touched surfaces (Effiong *et al*., 2024). Ya'aba *et al*. (2021) identified a series of pathogenic *Staphylococcus aureus* and gastroenteritis-causing pathogens compared with the study of Osarenmwinda and Blessing (2020), who gave a wider range of pathogens associated with the surface of electronic devices. In a related study, Oluduro *et al*. (2011) obtained *Klebsiella pneumoniae*, *Proteus sp*., *Aeromonas viridians*, and *Bacillus sp*., from ATM keypads and mobile phones in Ile-Ife, Oyo State, Nigeria. Their study accounted for a higher titre of microbes on keypads and keyboards of devices than on point-of-sale machines. Tekerekoglu *et al*. (2011) reported the presence of multiple drug-resistant bacterial flora in the mobile phones of hospital attendees. Their visitors and health care providers are one of the cases in which the presence of Extended Spectrum Beta-lactamase in Gram-Positive isolates.

It was documented by some researchers that *Staphylococcus aureus* was more prevalent on computer keypads and mice (Anderson and Palombo, 2009). This present study identified and reported several normal flora and pathogenic organisms on surfaces, although the most prevalent was *Staphylococcus aureus*, although the presence of resistant species was underscored, the study further implicated the picking of the nose, sneezing, talking and skin flora as a major source of these microorganisms (Itah and Ben, 2004). The presence of microorganisms like coliforms and flora implicated in gastroenteritis is indicative of poor sanitary hygiene as *Enterobacter fecalis* and *Escherichia coli*.

## V. Conclusion

Frequently touched surfaces are recognized as a means of spreading life-threatening diseases worldwide. This research examined the microbial properties of point-of-sale (POS) machines in Nkwerre, Imo State. The microbial load found on these devices indicates inadequate decontamination methods and procedures during their use. Certain bacteria may signal contamination and the presence of pollutants. The study detected nosocomial pathogens and bacterial strains linked to serious systemic infections and respiratory illnesses. It emphasizes the necessity for developing efficient decontamination strategies, including the creation of alcohol swabs and disinfectant solutions capable of significantly reducing vegetative pathogens. In Nigeria, POS machines have become some of the most commonly touched surfaces, highlighting the urgent need for manufacturers to create user-friendly surface swabs that should be mandatory for each transaction. The identification of bacterial flora associated with systemic and localized infections suggests that the surfaces of POS machines can act as vectors for life-threatening diseases. Therefore, it is essential to educate machine operators on hygienic practices, as it strongly suggests possible cross-contamination, inadequate sanitary habits among operators, and poor storage conditions.

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