

A GRAPHIC DESIGN ANALYSIS OF USABILITY AND PUBLIC AWARENESS OF ANTI-COUNTERFEITING FEATURES ON ANTI-MALARIA PACKAGING IN NIGERIA

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Abstract

Every day in Nigeria, patients visit pharmacies to obtain vital anti-malarial drugs. Trusting the packaging, they may unknowingly purchase counterfeit, ineffective, or harmful medicine. This doctoral research examines a key visual communication failure: the "security gap" between anti-counterfeiting graphics on pharmaceutical packaging and their usability. Focusing on anti-malarial medicine, the study explores how design decisions impact public safety. Using a cross-sectional mixed-methods approach with 150 participants—including consumers, healthcare workers, and graphic designers—the study evaluated awareness, recognition, and usability of security features such as holograms, QR codes, and the NAFDAC registration number from a user-centred perspective. Results show a significant gap: 78% voiced concern about counterfeits, but only 34% verified security features. Awareness was not associated with education level (ANOVA, $p = 0.912$), suggesting that design shortcomings outweigh user knowledge. Notably, 61% of informed users found security features difficult to interpret. Tamper-evident seals were most recognised (70%), followed by the NAFDAC number (67%), while QR codes were least used (12%). The study concludes that security graphics fail without a user-friendly design, recommending increased intuitiveness, clarity, and a stronger focus on human-centred packaging.

Keywords: Visual Communication, Human-Centred Design, Security Graphics, Packaging Design, Nigeria.

Introduction

Counterfeit anti-malarial drugs in Nigeria pose a public health crisis, revealing a critical design failure in pharmaceutical packaging. Although anti-counterfeiting technologies, such as holograms and QR codes, are in use, their effectiveness often depends on users' ability to verify authenticity. This study directly addresses whether current graphic solutions on packaging enable Nigerian consumers to authenticate medicines and stay safe.

This creates a 'security gap': an ongoing disconnect between existing anti-counterfeiting packaging solutions and their usability for the public. Driven chiefly by design shortcomings, this gap hinders the effectiveness of security features. This research assesses how these graphics are understood and used by the public, arguing that intuitive, user-centred design is critical, more so than technology alone, in providing pharmaceutical security in Nigeria.

Literature Review: The Designer's Role in Pharmaceutical Security

The effectiveness of anti-counterfeiting graphics is determined by human perception, cognition, and behaviour, which are central concerns within the field of graphic design (Tseng & Chuang, 2024). The effectiveness of anti-counterfeiting graphics—such as holograms, unique color schemes, and security patterns—is closely linked to how consumers perceive, cognitively process, and respond to these visual cues. Bulama et al. (2021) found that, within the Nigerian

fast-moving consumer goods sector, consumers are more likely to identify and trust products featuring visually distinctive anti-counterfeiting features. Their research demonstrated that clarity, uniqueness, and recognisability of security graphics improve consumers' ability to differentiate genuine products from counterfeits. These findings highlight the significance of perceptual factors, specifically the ease and accuracy with which consumers notice and interpret anti-counterfeiting cues

Packaging is a key factor in shaping consumers' buying behavior, and companies are encouraged to innovate and improve their packaging to attract and retain customers. This highlights how cognitive processes play a critical role in how people perceive and respond to graphic security elements (Olagbemiro et al., 2025) . Factors such as cognitive biases and decision-making processes significantly influence how individuals in Nigeria react to security challenges and assess security features. Their study indicates that effective graphic design can educate and motivate consumers to actively seek out these features, thereby strengthening the deterrence of counterfeit goods (Alaku et al., 2025).

In summary, empirical evidence from Nigerian studies demonstrates that the effectiveness of anti-counterfeiting graphics is fundamentally determined by human perception, cognition, and behavior. Consequently, graphic designers play a critical role in protecting brands by developing security features that are visually salient, cognitively accessible, and capable of influencing consumer behavior.

User-Centred Design and Visual Usability

Principles of user-centred design (UCD) are fundamental to pharmaceutical packaging. Security features must be prominent, easily interpretable, and straightforward in application (Dégardin et al., 2018; Dégardin et al., 2014). For example, a clearly visible seal indicating product authenticity directly supports core responsibilities in graphic design:

- **Visual Hierarchy:** Security features must be integrated into the packaging's layout with appropriate prominence to guide the user's eye. Visual hierarchy refers to the arrangement of design elements to convey their relative importance, making key features stand out (Elwany, 2025).
- **Affordances and Signifiers:** QR codes should clearly indicate that they are scannable, and holograms should encourage tactile inspection. In design, an "affordance" is a property that suggests how an object should be used, while a "signifier" is a visual cue that conveys the object's intended use. The design must communicate its intended function (Liao et al., 2025).
- **Legibility and Iconography:** Instructions should employ clear typography, such as large fonts and high contrast, and utilise universal pictograms to address literacy barriers, thereby making verification accessible to all user groups. "Legibility" is the ease with which text can be read, while "iconography" refers to the use of images or icons to convey meaning (Onwujekwe et al., 2009).

The Nigerian Context: A Design Brief

In Nigeria, the proliferation of counterfeit medicines is shaped by systemic factors such as corruption, conflicts of interest, weak regulatory enforcement, and poor health-seeking behaviour (Ubajaka et al., 2016). These challenges intersect with design-related issues, including the digital divide, varying literacy levels, and inconsistent mobile network access.

The National Agency for Food and Drug Administration and Control (NAFDAC) pioneered the Mobile Authentication Service (MAS) to support product verification (Adigwe & Onavbavba, 2024; NAFDAC, 2024a), yet its effectiveness has been limited by network connectivity issues, low digital literacy, and limited public awareness. In contrast, the high recognition and trust associated with simpler, text-based features, such as the NAFDAC registration number, demonstrate that straightforward and familiar cues can be highly effective in this context (HC3, 2016).

In summary, the Nigerian context presents a critical design challenge: security solutions must be robust, intuitive, and accessible to a diverse population. Achieving this goal requires understanding user capabilities and constraints, as well as critically analysing the usability and public awareness of existing authentication features to inform a more inclusive, context-appropriate security design (Onwujekwe et al., 2009). To bridge this gap, design recommendations must clearly distinguish between regulatory support and industry-initiated measures. For instance, implementing a 'NAFDAC mandate' could be essential for ensuring standardisation across security features, while an 'Industry-led quick win' might include adopting user-friendly icons on packaging. By outlining these distinctions, policymakers can better recognise their role in facilitating effective solutions, while the industry can focus on swift, impactful changes (Adigwe, 2023).

Methodology

A cross-sectional, mixed-methods study was conducted using a practice-based research approach, a design inquiry approach common in mixed-methods research (Yeo, 2014). This methodology bridges theory and practice, facilitating the development of more effective security design prototypes.

The research integrated:

- **Ethnographic Research:** Observing how consumers and pharmacists physically interact with packaging in real-world settings like pharmacies and markets in Kaduna and Zaria.
- **Narrative Research:** Capturing lived experiences with counterfeit detection to understand the user's emotional and cognitive journey.

Data collection

Structured questionnaires were administered to a purposive, stratified sample of 150 participants, including general consumers, healthcare personnel, and professional graphic designers. Participants were recruited from ABU Samaru campus, ABUTH Shika, Zaria Town, and Kaduna. This multi-stakeholder approach ensured that insights reflected both end-user and creator perspectives. The sample size and procedures adhered to established doctoral-level methodological standards (Mocanasu, 2020). The instrument assessed awareness, usability, and interpretation of common security features. This mixed-methods approach enabled a comprehensive evaluation of usability and contextual factors influencing interaction with security features, supporting the study's human-Centred, practice-based design objectives. Quantitative data analysis was conducted using SPSS to ensure academic rigour. Ethical approval was granted by the departmental research ethics committee, and informed consent was obtained from all participants.



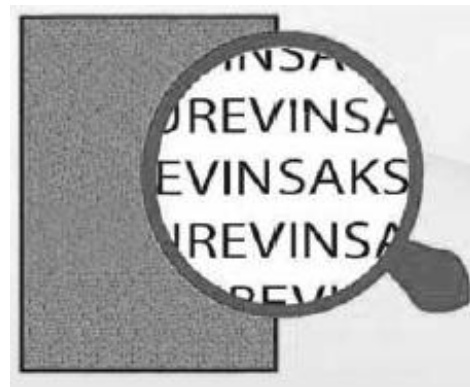
Temper-Evident seal (Labels, 2020)



Holographic seal (Artyway, 2025)



QR Code (Deineko et al., 2022)



Microtext (Vinsak, 2022)

Figure 1: Common Anti-Counterfeiting Security Features on Pharmaceutical Packaging

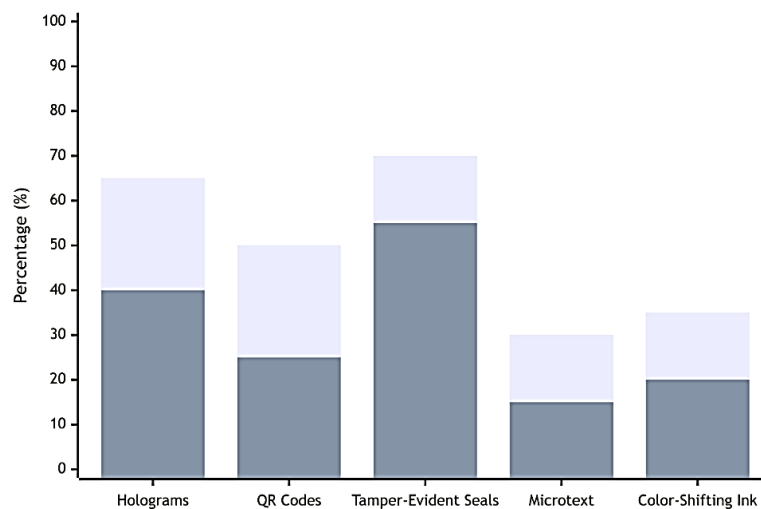


Figure 2: Bar Chart Showing the Verification Gap: Consumer Awareness vs. Active Verification of Security Features

Table 1. Awareness of Risks Posed by Counterfeit Anti-Malarial Medicines (n = 41)

Response Category	Frequency	Percentage
Strongly Agree	21	51.2
Agree	13	31.7
Neutral	4	9.8
Disagree	1	2.4
Strongly Disagree	2	4.9
Total Concern (Agree + Strongly Agree)	34	82.9%

Interpretation:

The majority of respondents demonstrate high concern about counterfeit medicines, indicating that awareness alone is unlikely to be the primary barrier to authentication behaviour.

Table 2: Showing the Awareness and Verification Rates of Security Features

Security Feature	Awareness (%)	Active Verification (%)	Verification Gap (Percentage Points)
Tamper-Evident Seals	70	55	15
Holograms	65	40	25
QR Codes	50	25	25
Color-Shifting Ink	35	20	15
Microtext	30	15	15
Average	50%	31%	20pp

Interpretation:

Although awareness of security features is moderate, verification behaviour remains significantly lower, producing an average verification gap of approximately 20 percentage points.

Results & Visual Analysis

The data reveal a critical disconnect: while approximately 83% of respondents report concern about counterfeit medicines (Table 1), the average rate of feature verification is only 31% (Table 2). This disparity demonstrates a substantial gap between risk awareness and protective action. Analysis at the feature level reveals an average verification gap of about 20 percentage points between awareness and active verification, suggesting that recognised security features are not consistently utilised. These findings collectively imply that the primary limitation of current anti-counterfeiting strategies is not public awareness, but rather the usability of security features, which lack sufficiently intuitive cues to encourage routine verification. Facilitating easier verification for even a portion of concerned individuals could meaningfully increase verification rates and thereby reduce the prevalence of counterfeit medicines and their associated health risks. Furthermore, awareness did not differ by formal education (ANOVA, $p = 0.912$), suggesting that intuitive design was the primary challenge rather than user knowledge.

Analysis of individual security features reveals a distinct verification gap (see Figure 2, Table 2). Tamper-evident seals achieved the highest awareness (70%) and verification rate (55%), yet the 15-point gap demonstrates that even intuitive physical affordances do not ensure universal use. For example, pharmacists may overlook checking seals during busy periods, which underscores the need for stronger design cues. Holograms (65% awareness) showed a 25-point gap, indicating that the existing design does not sufficiently prompt users to act. For

instance, end-users may quickly purchase medicines without noticing the hologram feature. QR codes revealed the greatest shortcoming: despite 50% awareness, only 25% of respondents used them, demonstrating a gap between digital and physical usability. In such cases, users may perceive QR code scanning as inconvenient or time-consuming. Colour-shifting ink and Microtext also displayed 15-point gaps, further emphasising the prevalence of usability deficits.

Thematic analysis of open-ended responses identified two primary design failures: inadequate signifiers ("I don't know what I'm supposed to be looking for") and low perceived usability ("It takes too much time; I don't know how to use the QR code"). The results indicate that concern about counterfeit medicines is high among respondents, with approximately 83% reporting awareness of the risks posed by counterfeit anti-malarial drugs. However, this concern does not translate into consistent verification behaviour. Analysis of security features shows that while awareness levels are moderate across features, active verification remains substantially lower. Across the five evaluated features, the average verification rate is approximately 31%, despite considerably higher awareness levels. This disparity produces an average verification gap of roughly 20 percentage points, highlighting a consistent difference between recognising security features and actively using them to authenticate medicines. The findings therefore suggest that the limitation of current anti-counterfeiting measures lies not in public awareness but in the usability of the security features themselves, which may lack sufficiently clear visual cues or intuitive interaction prompts to encourage routine verification.

Discussion

This study identifies a systemic verification gap in pharmaceutical anti-counterfeiting graphics, primarily due to usability limitations rather than technological shortcomings. For instance, QR codes exemplify this gap: while approximately 50% of respondents reported awareness of QR codes as a security feature, only 25% actively used them for verification (PQM+, 2023). Holograms demonstrate a similar trend, with 65% awareness but only 40% verification, indicating that even widely recognized physical security features do not consistently prompt authentication behavior (Olaniran et al., 2023). These results demonstrate that awareness of security features does not necessarily lead to their practical use, reinforcing a significant verification gap between recognition and action. This phenomenon aligns with Norman's concept of affordances, which posits that effective design should visually communicate how an object is intended to be used (Norman, 2013). When security features do not clearly indicate their intended interaction, users may recognize them but remain uncertain about the appropriate actions.

Many pharmaceutical security features are designed primarily for regulatory compliance or technical sophistication rather than intuitive use. When users are unsure how to interpret or use these features, they often remain unchecked. Cognitive load theory suggests that designs requiring excessive mental effort to interpret visual cues are unlikely to be used consistently (Sweller, 2011). Simplifying security features can reduce cognitive effort and encourage verification behavior. Counterfeiters may exploit this gap, as unchecked security elements provide minimal protection against counterfeit products (Beargie et al., 2019). Enhancing the usability of these features could strengthen anti-counterfeiting measures. From an economic perspective, simpler, user-focused verification supports supply chain integrity. When consumers can easily verify authenticity, demand for counterfeit products decreases, thereby incentivizing pharmaceutical companies to prioritize clear, user-friendly security features (Aniello et al., 2019).

In contrast, tamper-evident seals achieved the highest verification rate (55%) and the smallest awareness–verification gap, likely because they provide clear, physical evidence when a product has been opened or altered (Peterson, 2025). Recognition of the NAFDAC registration number further indicates that users rely on familiar and trusted institutional markers. These results suggest that clear visual cues and established regulatory signals are more effective in prompting verification than complex or digital security features. To address the identified gap, this study proposes a human-Centred design framework. Specifically, it recommends developing and testing a Minimal Viable Authentication Zone (MVAZ) for pharmaceutical packaging. This concept entails creating a one-look verification area that enables users to quickly identify and check key authentication elements. The zone could incorporate a high-contrast header, a standardized NAFDAC-approved badge, and straightforward pictorial instructions for scanning QR codes. Security elements such as holograms and tamper seals should be strategically positioned alongside visual prompts that encourage verification. Future prototyping and usability testing should assess effectiveness by measuring the time required for users to confirm product authenticity. Additionally, graphics-led public education initiatives may reinforce these cues by demonstrating how consumers can recognize and verify pharmaceutical security features. By integrating intuitive design principles, trusted institutional markers, and user-focused communication strategies, the pharmaceutical sector can enhance the effectiveness of anti-counterfeiting measures and strengthen public trust in the safety of medicines (IGB, 2025; Packaging, 2025).

Conclusion

This doctoral research demonstrates that the "security gap" in Nigeria's pharmaceutical market is fundamentally a design issue. Even the most advanced security graphics are ineffective if the public cannot or does not use them. The findings highlight the need for the Nigerian design community to take action. Graphic and packaging designers should be recognised as essential stakeholders in combating counterfeit drugs. By applying user-centred design principles that emphasise intuitiveness, accessibility, and visual clarity, it is possible to transform passive consumers into empowered verifiers. Closing this gap requires collaboration among designers, regulators, and industry partners to prioritise human factors, positioning design as a critical instrument for public safety and trust. This framework, however, also possesses the potential to be adapted to other low-resource markets, thus positioning this research for wider global impact. By demonstrating its scalability beyond Nigeria, it could attract international collaborations and funding to address the anti-counterfeiting challenge on a broader scale (Sikaria et al., 2025).

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