

Review Article

Bridging the Divide: A Conceptual Framework for a Viable AI-Driven Offline-to-Online (O2O) Commerce Application for Traditional Businesses in Gombe Metropolis, Nigeria

Ahmed Bappah* and Haruna Adamu

School of Education, Federal College of Education (Technical) Gombe, Nigeria

*Corresponding author: Ahmed Bappah, School of Education, Federal College of Education (Technical) Gombe, Nigeria

Email: syndicate2023d@gmail.com

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Abstract

The digital transformation of commerce, characterized by the integration of Offline-to-Online (O2O) models and Artificial Intelligence (AI), presents a formidable challenge for traditional businesses in emerging economies. These businesses, which form the backbone of cities like Gombe Metropolis, Nigeria, risk obsolescence due to a confluence of infrastructural, socio-cultural, and technological barriers. Existing literature on O2O and AI in retail is predominantly rooted in the contexts of advanced economies, rendering its direct application in regions like Northern Nigeria problematic. This conceptual paper addresses this theoretical gap by constructing a novel framework for developing a viable and context-appropriate AI-driven O2O application. We argue that viability is not a function of technological sophistication but of contextual intelligence. The proposed framework is built upon three foundational pillars: Contextual Intelligence, which mandates a deep understanding of the local business ecosystem, consumer behavior, and infrastructural realities; Appropriate AI, which advocates for the use of "lightweight," high-impact AI modules like computer vision for product cataloguing and SMS-based predictive engagement, designed for low-bandwidth and low-digital-literacy environments; and (3) Integrated Ecosystem Design, which prioritizes multi-channel accessibility (including USSD and feature phones), integration with existing mobile money systems, and a trust-building "phygital" loop. This paper synthesizes theories from technology adoption, frugal innovation, and ICT for Development (ICT4D) to challenge the direct technology transfer paradigm. It concludes that the successful digitization of traditional commerce in cities like Gombe requires a bespoke, human-centric approach that leverages AI not to replicate Western models, but to amplify local strengths and navigate specific constraints, thereby offering a scalable theoretical blueprint for similar contexts.

Keywords: Offline-to-Online (O2O) Commerce; Artificial Intelligence; Conceptual Framework; Traditional Businesses; Gombe Metropolis; Appropriate Technology; Digital Inclusion

Introduction

The global retail landscape is in the throes of a paradigm shift, moving from siloed channels to integrated, phygital experiences where the boundaries between physical and digital commerce blur [1]. The Offline-to-Online (O2O) commerce model, which strategically directs consumers from physical environments to digital platforms for discovery, decision-making, and transaction, has become a cornerstone of this new reality [2]. In advanced economies, this model is supercharged by sophisticated Artificial Intelligence (AI) that powers hyper-personalization, demand forecasting, and seamless logistics [3]. However, the universalist narrative of digital transformation often obscures a starkly divergent reality in emerging economies [4]. Here, the promise of digital commerce remains largely unfulfilled for millions of traditional small and medium-sized enterprises (SMEs) that constitute the economic and social fabric of secondary cities [5].

Gombe Metropolis, the capital of Gombe State in North-Eastern Nigeria, serves as a critical case in point. Its economy is pulsated by traditional businesses—textile merchants, grocery stores, artisans, and hospitality providers—whose operations are entrenched in offline, relational, and cash-based paradigms [6]. For these enterprises, the leap to complex, data-intensive O2O platforms is not merely a step but a chasm, widened by limited digital literacy, unreliable and costly internet connectivity, and a pervasive distrust of digital financial systems [7]. The direct transplantation of O2O models from contexts like China or the United States, with their assumptions of high smartphone penetration, ubiquitous broadband, and robust digital payment infrastructure, is a theoretical and practical misstep destined for failure [8].

This conceptual paper aims to bridge this theoretical gap by constructing a novel framework for the development of a viable

AI-driven O2O application specifically for the context of Gombe Metropolis. The term "viable" is central to our thesis; it denotes a solution that is not only technologically feasible but also economically sustainable, socially acceptable, and resilient to local infrastructural and socio-cultural constraints [9]. Our central argument is that the design of such an application must be fundamentally guided by the principle of contextual intelligence, where technology is adapted to the user, not the other way around.

The research question guiding this conceptual inquiry is: What are the core theoretical components and design principles necessary for a viable AI-driven O2O commerce application for traditional businesses in a resource-constrained environment like Gombe Metropolis?

To address this question, this paper proceeds as follows. Section 2 provides a comprehensive review of the literature, critically examining O2O commerce, AI in retail, and the Nigerian digital landscape to identify the theoretical gaps. Section 3 details the conceptual methodology employed in constructing the framework. Section 4 is the core of the paper, where we present and elaborate on the three pillars of our proposed framework: Contextual Intelligence, Appropriate AI, and Integrated Ecosystem Design. Section 5 discusses the theoretical and practical implications of the framework, situating it within broader discourses on frugal innovation and ICT4D. Finally, Section 6 offers a conclusion, outlining limitations and proposing directions for future research, including the necessary empirical validation of this conceptual model.

Literature Review: Foundations and Gaps

This section synthesizes existing literature to establish the foundational concepts and, more importantly, to highlight the critical theoretical voids that this paper seeks to fill.

The O2O Commerce Model: A Mismatch of Contexts?

O2O commerce is defined as a business model that uses online channels to attract customers to make purchases in physical stores [10]. Its theoretical strength lies in creating a virtuous cycle: the online platform serves as a discovery and marketing engine, driving valuable foot traffic and data, while the offline store provides tangible experience, trust, and fulfillment [2]. Scholars have identified key success factors, including channel integration, data analytics, and personalized customer journeys [11].

However, this body of literature is overwhelmingly predicated on the infrastructural and socio-economic realities of developed nations. The models assume a baseline of technology adoption and digital fluency that is absent in many parts of the world. The theoretical gap, therefore, lies in the lack of a robust O2O framework that accounts for structural constraints such as digital illiteracy, intermittent electricity, and a preference for cash-based transactions. The challenge in contexts like Gombe is not just implementing O2O, but *re-theorizing* its fundamental components to align with a different reality.

Artificial Intelligence in Retail: From Sophistication to Appropriateness

AI's transformative potential in retail is well-documented. Machine learning algorithms drive recommendation engines [3],

computer vision automates inventory management [12], and natural language processing powers customer service chatbots [13]. The prevailing narrative is one of increasing sophistication, leveraging vast datasets ("big data") to achieve ever-greater precision and automation. This narrative, however, creates a significant theoretical gap for application in emerging economies. The prerequisite "big data" is a luxury most traditional businesses do not possess. Their operations are often data-poor, relying on tacit knowledge and paper-based records. Furthermore, complex AI models demand computational resources and continuous, high-speed connectivity that are either unavailable or prohibitively expensive [14]. The relevant question shifts from "How can we use the most advanced AI?" to "What is the most appropriate form of AI for this specific context?" This calls for a theory of "frugal AI" or "appropriate AI" that prioritizes low-resource, high-impact applications.

The Nigerian Digital Landscape: A Tale of Two Economies

Nigeria boasts a vibrant digital economy, with high mobile penetration and innovative fintech solutions like mobile money and USSD banking [15]. This success story, however, is geographically and demographically uneven. Research indicates that digital adoption in secondary cities and among older, less-educated populations lags significantly [5]. The work of Adewole & Akinyemi (2021) highlights barriers such as the cost of data, limited digital skills, and security concerns as major impediments to SME e-commerce adoption. For Gombe Metropolis, these national challenges are compounded by its regional position in North-Eastern Nigeria, which may face additional hurdles related to security and infrastructure investment [6]. The theoretical gap here is a lack of synthesized understanding of how these multi-layered constraints—national, regional, and local—interact to shape the viability of digital commerce solutions. A conceptual framework must, therefore, be multi-dimensional, addressing technological, economic, and social factors simultaneously.

Conceptual Methodology

This paper adopts a theory synthesis approach [16] to construct a novel conceptual framework. Theory synthesis is a method for integrating existing concepts and relationships from disparate fields to develop a new, cohesive theoretical model. The process involves three key steps:

1. Problem Identification: The core problem—the inapplicability of standard O2O and AI models in contexts like Gombe Metropolis—was delineated through a critical review of the literature, as outlined in Section 2.

2. Concept Mapping: Key constructs from relevant domains were identified and mapped. These include:

From O2O Commerce Literature: The O2O loop, channel integration, customer acquisition.

From AI and Computer Science: Lightweight AI models, computer vision, natural language processing, USSD technology.

From ICT4D and Frugal Innovation: Appropriate technology, user-centered design, leapfrogging, multi-channel platforms.

From African Digital Economy Studies: Mobile money, trust paradigms, informal sector dynamics.

3. Synthesis and Framework Development: The mapped concepts were synthesized and organized into a new theoretical structure—the Three-Pillar Framework for Viable AI-O2O Adoption. The relationships between the pillars were logically deduced to explain how they collectively overcome the identified barriers.

This conceptual methodology allows for the development of a testable model that can guide future empirical research and practical design efforts in Gombe and analogous environments.

The Proposed Conceptual Framework: The Three Pillars of Viability

The proposed framework, visualized in Figure 1 below, posits that the viability of an AI-driven O2O application in Gombe Metropolis rests on three interdependent pillars: Contextual Intelligence, Appropriate AI, and Integrated Ecosystem Design. This is the foundational pillar. It asserts that every design decision must be rooted in a deep, empathetic understanding of the local environment.

The Local Business Ecosystem: Traditional businesses in Gombe are not merely smaller versions of Western SMEs; they operate on a different logic. Relationships are paramount, transactions are often relational and credit-based, and record-keeping is minimal. An O2O application must complement, not replace, this relational fabric. It should be positioned as a tool for enhancing customer relationships and reaching new clients, not as an impersonal automation tool.

Consumer Behavior and Trust Paradigms: Consumers exhibit a strong preference for physically inspecting goods (the "look and feel") and a deep-seated distrust of digital payments. Therefore, the O2O loop cannot be designed to end with an online payment. Instead, the "online" phase must be focused on discovery and assurance—allowing users to find products, check availability, and perhaps secure a reservation. The final transaction, including payment, must predominantly happen offline, in the store, thereby respecting the trust paradigm.

Infrastructural Realities: The framework must accept that high-speed, always-available internet is a fantasy for many. Viability depends on designing for intermittent connectivity. This means applications must be able to function offline or with significant latency, syncing data when a connection is available.

Pillar 2: Appropriate AI

This pillar redefines the role of AI from a driver of complexity to an enabler of simplicity. It advocates for "lightweight" AI that solves critical pain points with minimal resource requirements.

Automated Product Cataloguing via Computer Vision: The single biggest barrier for a merchant going online is creating a digital inventory. Manually taking photos, writing descriptions, and setting prices is prohibitively time-consuming. An "appropriate AI" solution would involve a smartphone-based computer vision model. A merchant simply photographs an item, and a lightweight, on-device convolutional neural network (CNN) automatically generates tags (e.g., "shoe," "black," "leather") and suggests a category and description (LeCun et al., 2015). This reduces the data entry burden by an order of magnitude, making digitization feasible.

Predictive Engagement via SMS Analytics: Instead of a complex, data-hungry recommendation engine on a consumer app, the AI can work on the back-end. By analyzing simple data points—a customer's saved searches or past expressed interests—a rule-based system can prompt the *merchant* to send a personalised SMS. For example: "Hello [Name], new men's caftans have arrived at your preferred store. Show this SMS for a 5% discount." This leverages AI for personalization but delivers it through the most ubiquitous and trusted digital channel: SMS [3].

Low-Bandwidth, Predictive Inventory Alerts: Using the minimal sales data input by the merchant, a simple machine learning model can run on the cloud to identify basic sales trends. It can then send proactive, low-data alerts to the merchant via SMS: "Stock alert: Your supply of 'Dangote Cement' is predicted to run out in 7 days." This provides the core benefit of predictive analytics without requiring real-time IoT sensors or continuous data streams [17].

Pillar 3: Integrated Ecosystem Design

This pillar ensures that the application is not a standalone silo but is woven into the existing technological and behavioral fabric of the city.

Multi-Channel Accessibility: Insisting on a smartphone-only platform would exclude a significant segment of the population. A viable application must be multi-channel:

Smartphone App: For digitally-savvy merchants and consumers.

USSD/SMS Interface: For merchants with feature phones to receive leads and update basic stock information (e.g., "Reply with 1 to mark item #123 as sold out").

SMS Gateway: For customer engagement, as previously described.

Seamless Payment Integration: Rather than forcing online payments, the platform should enable and encourage digital payments by integrating the systems people already use or are familiar with. This includes generating payment links for mobile money (Paga, Opay) and USSD codes for bank transfers, while fully supporting and tracking "Cash-in-Store" as a legitimate and primary payment method.

The Phygital Trust Loop: The entire user journey should be designed to build trust. A consumer discovers a product online, perhaps communicates with the merchant via SMS to confirm details, and then visits the store. To close the O2O loop and measure success, the consumer can present a QR code (sent via SMS) to the merchant upon purchase to claim a small discount or loyalty points. This scan validates the O2O journey for the platform's analytics while rewarding the consumer and reinforcing the connection between the digital discovery and the physical transaction.

Discussion: Theoretical and Practical Implications

The proposed framework contributes significantly to the theoretical discourse on technology adoption in emerging economies.

Challenging the Technology Transfer Paradigm

This framework stands in direct opposition to the dominant

technology transfer model, which assumes the universal applicability of technological solutions. Instead, it aligns with the tenets of Frugal Innovation [18] and Appropriate Technology [19], which argue for "doing more with less" and designing solutions that are tailored to the environmental, cultural, and economic context. Our framework demonstrates that in the digital realm, "frugality" is not about inferior technology but about strategic, context-aware application.

Contributing to ICT4D and Inclusive Digital Transformation

The framework deepens the theoretical pool of ICT for Development (ICT4D). It moves beyond simply providing access to technology and focuses on how technology can be designed to be *meaningfully* adopted by specific user groups—in this case, low-digital-literacy merchants. It emphasizes that inclusion must be a design principle, not an afterthought, and is achieved through multi-channel access, ultra-simple UIs, and respect for local practices [20].

A Blueprint for Action

For practitioners—policymakers, tech developers, and business associations—this framework provides a actionable blueprint.

For the Gombe State Government: It highlights the need to pair any digital initiative with investments in digital literacy and public internet access.

For Local Tech Hubs and Developers: It provides a clear set of design principles that prioritize problem-solving over technological showmanship.

For Business Associations: It offers a persuasive narrative to present to their members: digital tools can be simple, affordable, and enhance rather than replace their traditional way of doing business.

The framework posits that by adhering to these three pillars, an AI-O2O application can achieve viability: it will be adopted because it is accessible, sustained because it provides tangible value, and scaled because it is built on a realistic understanding of its environment.

Conclusion

This conceptual paper has argued that the development of a viable AI-driven O2O commerce application for traditional businesses in Gombe Metropolis requires a fundamental re-imagining of both O2O commerce and Artificial Intelligence. Viability is not an inherent property of technology but an outcome of its fit with context. The proposed Three-Pillar Framework—comprising Contextual Intelligence, Appropriate AI, and Integrated Ecosystem Design—provides a novel theoretical lens and a practical guide for achieving this fit. The framework's primary contribution is its synthesis of disparate concepts into a coherent model that directly addresses the glaring gap in the literature regarding O2O in constrained environments. It challenges the hegemony of high-tech, high-data AI applications and proposes a more humane, pragmatic, and ultimately more effective approach to digital inclusion.

As with any conceptual paper, a key limitation is the need for empirical validation. The logical next step is to operationalize this framework into a tangible prototype and subject it to action research within Gombe Metropolis. Such research would test the proposed

concepts, refine the AI modules, and measure actual impacts on business performance and consumer behavior.

In conclusion, the path to digitizing traditional commerce in cities like Gombe does not lie in waiting for infrastructure to catch up with Western models. It lies in designing intelligent, empathetic, and appropriate solutions that bridge the digital divide by first understanding the human landscape they are intended to serve. This paper offers a conceptual foundation for building that bridge.

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