ISSN 2709-4529
Volume 6, Number 2
December 2025

Journal of Digital Food, Energy & Water Systems [JD-FEWS]

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About the Journal

The Journal of Digital Food, Energy & Water Systems (JD-FEWS) is a peer-reviewed bi-annual publication that publishes recent and innovative deployment of emerging digital technologies in Food, Energy, and Water Systems. Food, energy, and water resources are interconnected scarce resources that require systems and technologies to foster sustainable management and effective utilization. The journal is also interested in articles that explore the nexus between at least two of these resources. The journal considers the following topics as long as they are deployed in the Food, Energy & Water space:

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- Algorithm development
- Artificial Intelligence
- Blockchain and distributed ledger technology
- Case studies
- Cybersecurity
- Data mining & Big data
- Human-Computer Interaction
- Intelligent Forecasting
- Internet of Things
- Machine Learning
- Mathematical Optimization
- Robotics
- System architectures
- Wireless Sensor Networks

Editorial Team

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Design and Implementation of a Web-Based Food Ordering Platform for Academic Environments

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Received: 14 November 2025
Review: 8 December 2025
Accepted: 24 December 2025
Published: 30 December 2025

Abstract – This study presents the design and implementation of a web-based food ordering system developed to address persistent inefficiencies in university food service operations. Conducted at Ebonyi State University, Abakaliki, Nigeria, the research engaged students, food vendors, and administrative staff to assess existing challenges and user needs. Guided by the Rapid Application Development (RAD) methodology, the system was built through iterative prototyping and continuous user feedback to ensure functionality, usability, and relevance. System performance was evaluated by comparing the speed and accuracy of digital order processing with traditional manual methods. Findings revealed that the digital platform significantly reduced processing time and minimized errors associated with handwritten or verbal orders. Usability testing, conducted using a standardized evaluation instrument, further demonstrated high user acceptance and an overall positive interaction with the system. The study concludes that the developed platform enhances operational efficiency, reliability, and user satisfaction in campus food services, while also contributing to ongoing efforts toward digital transformation within higher education institutions.

***Keywords* –** Food ordering System; University Food Service; Digital food; Order accuracy; Service efficiency; OFOS.

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1.0 Introduction

The current pace of digital innovation has led to the redesign of service delivery in various industries, including retail, logistics, and food services. Online food ordering systems (OFOS) have received widespread attention across the world due to their effectiveness in improving food ordering services by minimizing inefficiencies [1], [2]. Recent studies suggest that digital platforms are effective in improving service delivery by ensuring faster service delivery, minimizing human errors, and yielding data-informed decisions in food service delivery [3]. Various colleges and educational organizations worldwide are utilizing digital platforms in food services, not only in advanced technological regions but also in regions with relatively limited technological advancements [4].

On the other hand, in developing countries like Pakistan, there's little use of digital food service solutions [5]. The factors of unavailability of digital infrastructure in food services and minimal automation levels in food system-related computerized systems are responsible for the inefficiency of campus food services [6]. Hence, on many university campuses across the globe, there are still long queues in food services, incorrect food ordering services, and inefficient food service coordination. Moreover, unorganized digital data minimizes vendors' analysis regarding sales data and food service optimization.

At Ebonyi State University in Nigeria, food ordering systems are mostly manual. This entails the use of communication and manual recording by vendors. This makes the system prone to errors and slows the process, considering the traffic the system experiences during peak periods [7]. This is especially true when educational institutions are embracing technological evolution in various parts of the world. The existence of such manual systems in food ordering in educational institutions is seen as a significant service gap.

This research fills the gap by conceptualizing and implementing a web-based food ordering system tailored for academic settings in resource-limited areas. By following a user-centric and iterative software design process, this system aims to increase efficiency, accuracy, and traceability in food ordering services. This research not only fills the current gap in the technical literature but also provides concrete evidence of the effectiveness of food ordering systems in academic settings and highlights the significance of such systems in helping academic institutions undergo digital transformations.

1.1 Problem Statement

Although digital service delivery has made significant strides in delivering food services, food ordering and distribution in most institutions of higher learning, especially in developing nations such as Nigeria, are largely manual. These traditional systems are based on the high usability of face-to-face communication, paper records of orders, and cash payments, which usually lead to long queues, slow service, and poor accuracy of orders, as well as a limited ability to meet demand during peak hours. A lack of automation also limits the monitoring of operations and data-driven decision-making, which in turn reduces the efficiency of services and the level of user satisfaction.

Ebonyi State University (EBSU), Abakaliki, Nigeria, operates a manual food service delivery system in which food vendors take orders manually and wait in line, serving the orders sequentially. The result of this strategy is a long processing time, errors in orders, and overcrowding of services during peak seasons. Additionally, the absence of digital recordings prevents vendors and administrators from measuring their service performance or introducing specific improvements to enhance the customer experience. Such restrictions have a negative impact not only on the productivity of vendors but also on the convenience of users.

Current solutions are typically designed to be scalable commercially, rather than operationally limited. The diversity of users and infrastructural realities of university campuses is often considered first. Thus, it is instructive to note that a context-specific, user-centered digital food-ordering system is necessary to enhance service efficiency, minimize errors, and enable data-driven management of academic food services. Filling this gap not only improves the operations of food delivery on campuses but also leads to higher productivity among both staff and students.

1.2 Research Aim and Objectives

This study aims to design and implement a web-based food ordering platform that automates order placement, enhances service speed, and improves the user experience within the university community. The specific objectives of the study are to:

1. Develop an intuitive web platform that enables students and staff to browse menus, place orders, and make secure payments online.

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2. Provide vendors with a unified dashboard for managing orders, menus, and payments.
3. Evaluate the system's performance in terms of accuracy, usability, and efficiency compared to the existing manual process.

2.0 Literature Review

The application of digital technologies has dramatically changed food service activities worldwide, and today, online food ordering systems (OFOS) are key to enhancing efficiency, accuracy, and customer satisfaction [8]. Through web and mobile technologies, these systems utilize automated ordering processes, minimize food waste, and enhance the responsiveness of services. Although adoption has increased at an accelerated pace in business environments due to consumer preferences for convenience and time savings [9], it has yet to be implemented in educational settings (especially in developing countries) at the same rate.

2.1 Manual Food Ordering Systems

In developing nations and most institutional settings with limited or uneven digital infrastructure deployment, manual food ordering systems remain in use. These systems are based on verbal communication and written documents; thus, they are slow, sequential, and prone to congestion during peak times [5], [6]. Manual processes have consistently been identified in studies as vulnerable to issues of miscommunication, incorrect documentation, and duplication of orders, which have a detrimental effect on customer satisfaction and the workload of vendors [10].

In addition to the inefficiency in operations, manual systems lack data capture and analysis mechanisms. The absence of computerized records also leaves vendors unable to trace sales patterns, predict demand, and stock products in the proper order [11]. The disadvantage is especially problematic in highly demanded places, such as university cafeterias, where throughput is limited by human capacity and time-sensitive demand [7]. In addition, manual systems do not provide much support in terms of structured feedback, personalization, or service optimization, which makes them increasingly out of step with current service expectations [12]. These deficiencies highlight the need for alternative systems that can address scalability, accuracy, and responsiveness (see Figure 1).

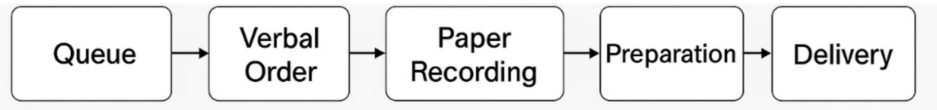

Fig. 1. Manual food ordering process

2.2 Digital Food Ordering Systems and Web-Based Implementations

Previous research has shown that online food ordering systems are more efficient in their operations and minimize human error. Indicatively, [10] was able to show that a web-based ordering system cut down processing time and enhanced accuracy in order tracking. On the same note, Ref [13] also developed a responsive OFOS that integrates with social media platforms, focusing on interaction among younger users, including university students. Although such systems highlight the advantages of digital ordering, most of them focus on user interface design or commercial scalability, and they place little emphasis on institutional limitations.

Recent implementations have added more advanced features, such as QR-code interfaces, real-time menu updates, and vendor dashboards [14]. In addition, Ref. [15] emphasized the potential of using OFOS to minimize food waste and inventory losses, particularly in the context of Food-Energy-Water Systems (FEWS) sustainability targets. The study conducted by [7] utilized a food ordering system built on Laravel in an academic setting in Indonesia, resulting in shorter queue times and improved coordination among vendors. Yet, this research tends not to be comparatively evaluated in contrast to manual systems or even to discuss the infrastructural issues that are characteristic of developing nations. This means that they can only apply to the Nigerian university settings to a limited extent.

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2.3 Usability, user experience, and human-centered system

The most important factors that determine the adoption of digital systems are usability and perceived usefulness. The model known as the Technology Acceptance Model (TAM) focuses on ease of use and usefulness as predictors of user acceptance [2], [16]. Although TAM has found numerous applications, some studies consider it to be descriptive in nature, lacking rigorous validation against empirical performance data. Human-centered design studies also indicate that user-friendly interfaces and responsive processes have a positive effect on user satisfaction and well-being [12].

In turn, research works such as [17] and [18] show that inadequate usability, inconsistent workflow, and underdeveloped feedback systems are the major barriers to adoption. Even with these findings, most studies on the use of OFOS, especially in the developing world, lack the use of standardized usability assessment instruments. The System Usability Scale (SUS) is a well-tested scale that is not fully utilized in food ordering research on campuses, thereby restricting the generalizability of usability results.

2.4 Architectural and technical components of OFOS

The majority of OFOS follows a three-level design that includes presentation, application, and database layers, as demonstrated in Figure 2, based on research conducted by Ref. [19].

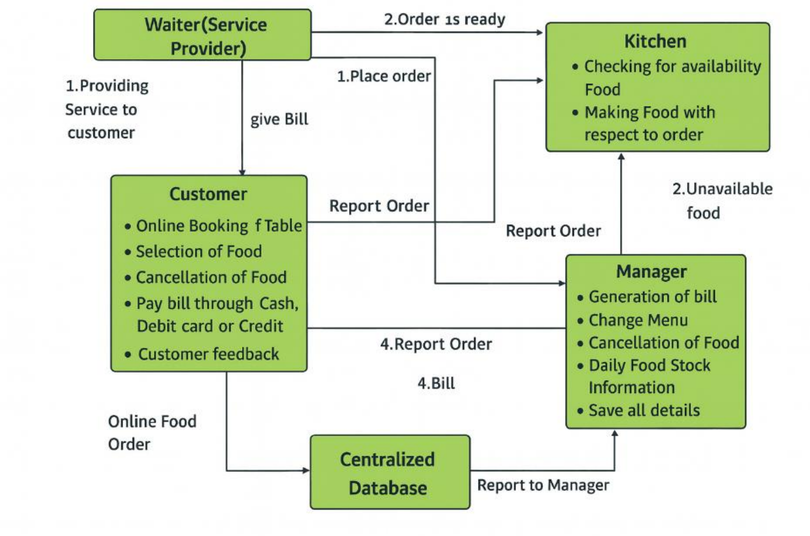

Fig. 2. Typical OFOS architecture [19]

Although this architecture promotes modularity and scalability, its performance is based on contextual implementation. The advanced systems are characterized by automated reporting, menu personalization and secure payment modules [11]. The most recent research has also incorporated elements into FEWS analysis, such as dynamic menu management based on inventory levels [15], geolocation-based order tracking [20], and demand forecasting user analytics [10].

Many of these architectural improvements, however, presuppose the presence of stable internet connections and high technical capacity, which cannot always be provided in the Nigerian university environment. In this regard, architectural designs optimized for commercial settings may not be suitable for academic institutions in developing countries without contextual modifications.

2.5 Adoption barriers in developing countries

Although global progress has advanced in the field of OFOS, it remains a challenge in certain parts of Africa and Asia due to infrastructural and socio-economic reasons [21]. Previous studies have found inconsistent internet connections, low use of digital payment systems, low confidence in online transactions, and poor digital literacy among sellers to be key impediments [5], [6]. These problems are especially notable in Nigerian universities, where food sellers typically work informally and receive little technical assistance. The available literature acknowledges these obstacles but seldom proposes low-cost, replicable interventions tailored to such situations.

2.6 Research Gap

Although there are many solutions for OFOS, few address the specificities of an academic setting, and even fewer consider the contextual realities of universities in Nigeria. The campus-based systems currently used outside Africa [7], [19] typically require well-developed infrastructure, technical skills, and institutional resources, and thus their applicability to developing situations is limited. Notably,

i. Not many studies use standardized measures of usability, such as the System Usability Scale (SUS), to make a rigorous assessment of user experience.
ii. Empirical research comparing manual and digital food ordering systems on Nigerian university campuses, based on objective performance indicators, is lacking.

This research fills these gaps by developing and testing a web-based food ordering system specifically tailored to an academic setting in Nigeria. The study makes practical and methodological contributions to digital change in higher education food service by comparatively evaluating manual and digital ordering processes by using standardized usability testing.

3.0 Theoretical and Conceptual Framework

The Technology Acceptance Model (TAM), originally proposed by Davis and widely adopted in research on information systems [22], provides the theoretical foundation for analyzing user acceptance of digital platforms, including web-based food ordering systems. TAM states that the intention to use a system largely depends on two constructs, which are Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU is defined as the level of confidence that the user has regarding the improvement of task performance by the system, and PEOU is the level of ease and non-effort required to use a system [23].

Within the context of online food ordering systems, past research has indicated that online users tend to adopt and maintain the utilization of online platforms when they perceive the online platforms to be efficient, intuitive, and reliable [2], [16]. Minimizing cognitive load, reducing time to complete a task, and providing clear interaction flows tend to enhance PEOU, which in turn positively influences PU and overall acceptance. The Technology Acceptance Model, as depicted in Figure 3, illustrates these relations.

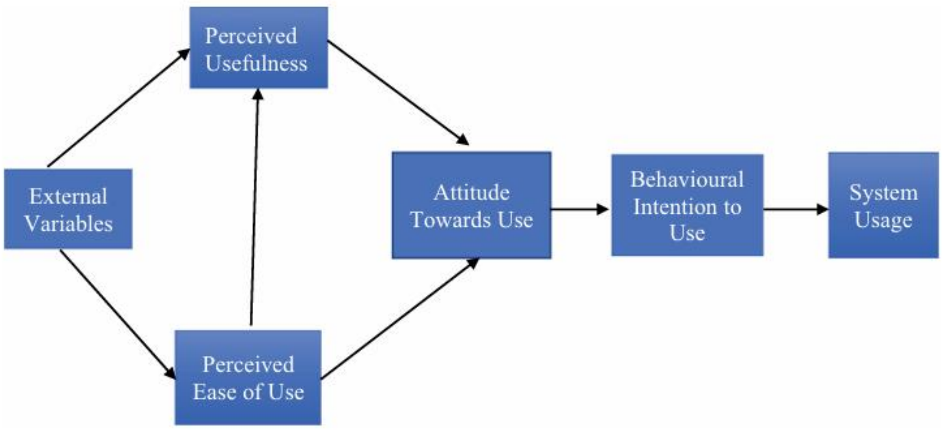

Fig. 3. Model of Acceptance (Technology Acceptance Model) [22].

In this study, TAM was used as a conceptual model to determine the design rationale, as well as the explanation of the outcome of user acceptance. TAM influenced design choices, including simplifying order processes, minimizing processing time, and enhancing the interface clarity, by focusing on the perceived ease of use and usefulness. However, TAM was not used as a statistical framework in testing a hypothesis.

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Rather, empirically, user acceptance and usability were measured based on the System Usability Scale (SUS), the valid and standardized tool of usability. The SUS findings are assessed through the lens of TAM, where high scores of usability represent high PEOU, and an increase in efficiency and accuracy represents higher PU. This complementary application of TAM and SUS makes them coherent. TAM is the theoretical explanation of acceptance behavior, whereas SUS is a quantitative measure of usability results.

The study provides a strong theoretical and empirical connection between adopting digital food ordering systems and the use of TAM as a framework, as well as SUS as an evaluation instrument in an academic setting.

4.0 Methodology

This section describes the research design, development framework, participants, data collection procedures, performance metrics, usability evaluation criteria, and statistical analysis techniques adopted in the study.

4.1 Research Design and Development Framework

This research utilized the Rapid Application Development (RAD) methodology as its software development approach. RAP emphasizes iterative prototyping, active user involvement, modular approaches to software deployment, and rapid delivery of the system under consideration. Figure 4 illustrates the conceptual foundation of this methodology, as proposed by Ref. [24]. This software methodology would be most effective in those applications that are user-centric in nature and involve continuous system requirements through constant system feedback [25].

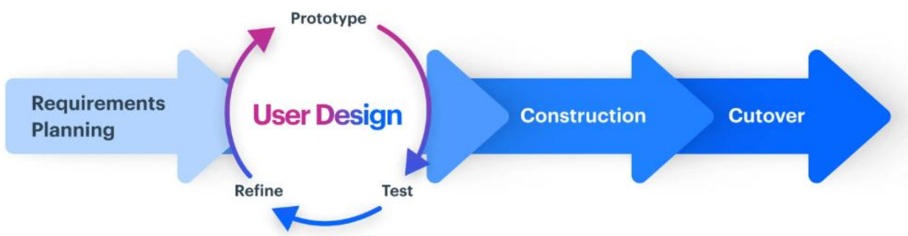

Fig. 4. Rapid Application Development model (adapted from Ref. [24])

Figure 3 shows four iterative phases: Requirements Planning, User Design, Construction, and Cutover, organized in a sequential yet feedback-driven development cycle, which applies to this research as follows:

Requirements Planning: Preliminary consultations and semi-structured interviews were conducted with food vendors and students to identify operational pains, inefficiencies in student business workflows, and system requirements.

User Design: Low-fidelity prototypes of the web interface were developed. This stage involves collective design phases, where users interact with prototypes and suggest improvements.

Construction: The functional system was implemented using PHP for server functionality, MySQL for database functionality, and CSS/HTML/JavaScript for client functionality. Continuous validation with users ensured that all functions upheld usability and functionality expectations.

Cutover: The system has been implemented in a live environment for testing purposes. The end users executed the ordering process in a realistic setting context to provide data necessary for testing the system.

The use of RAD enabled fast iteration, overcame developmental setbacks, and allowed system functionalities to be developed based on the users' interests.

4.2 Participants, Sampling, and Recruitment

The participants for the research were approached through purposive sampling at Ebonyi State University in Abakaliki to ensure a well-represented sample of the key stakeholders participating in the campus food service delivery. The overall sample for the research was composed of students, food vendors, and administrative staff.

This study utilized two complementary datasets:

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Performance dataset: Fifty observed food order transactions made during the peak service hours to analyze the efficiency of the manual food order system and the digital food order system.

Evaluation dataset: Thirty participants participated and completed the User Acceptance Testing (UAT) and the System Usability Scale (SUS) questionnaire after interacting with the system.

Ebonyi State University was chosen as a case study because it has a large student population, a decentralized food vending structure, and challenges related to congestion during peak hours. A total of thirty participants were used to conduct usability evaluations, which is in line with accepted usability testing practices. We also logged fifty order transactions to compare performances statistically.

4.3 Data Collection Procedures

To provide a realistic comparison between the manual and digital ordering systems, the current manual process has been observed during three peak period days (11:00-14:00). The observers recorded:

i. average waiting times,
ii. ordering procedures,
iii. fulfilment patterns,
iv. frequency of ordering errors,
v. vendor-customer interaction dynamics.

The baseline data observations were recorded using structured observation sheets to maintain consistency.

Data for User Acceptance Testing (UAT) and the System Usability Scale (SUS) were collected using a structured Google Form questionnaire administered to thirty purposively selected participants, consisting of students, food vendors, and others (administrative staff) of Ebonyi State University in Abakaliki.

4.4 Measurement of System Performance System

Order Processing Time: The time taken for order processing under both manual and digital methods. The protocol followed in the measurement of the time taken for the ordering process completion is defined:

Start time

i. Manual system: The customer arrived at the supplier's location or placed the order orally.
ii. Digital system: after the user clicks the 'Place Order' button on the platform.

End time

i. Manual system: when the supplier handed over the completed order.
ii. Digital system: After the supplier confirms the order is ready for pickup in the system.

Every transaction was timed fifty times by digital timers. To ensure a fair evaluation of the services, all measurements were taken during peak hours.

Order Accuracy: The accuracy of the completed orders was measured as the percentage of orders that were carried out correctly. Correctness in this respect meant the absence of any mistake. The error in this context refers to

i. wrong item delivered,
ii. missing item(s),
iii. incorrect portion/variation,
iv. mismatch between the ordered and delivered meal.

Accuracy calculated as:

$$\text{Order Accuracy (\%)} = \frac{\text{Number of Correct Orders}}{\text{Total Orders Processed}} \text{x}\, 100 \qquad (1)$$

All errors were recorded in real-time upon vendors' confirmation (computerized process). The unrefined data included accurate counts. It is calculated as:

$$\text{Error Rate (\%)} = \frac{\text{Number of Incorrect Orders}}{\text{Total Orders}} \times 100 \qquad (2)$$

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4.5 Evaluation of System Usability Scale (SUS) and User Acceptance Testing

The study measured usability using the System Usability Scale (SUS), developed by Ref. [26], a well-established tool for evaluating the perceived usability of digital systems. After performing ordering tasks in the web-based system, UAT participants were asked to complete the 10-item SUS scale using the 5-point Likert scale.

The SUS scoring followed these steps:

Adjust scores for odd-numbered items (1, 3, 5, 7, 9):

Adjusted Score = (User Score) – 1 (3)

Adjust scores for even-numbered items (2, 4, 6 8, 10):

Adjusted Score = 5 – (User Score) (4)

Sum of all adjusted scores:

$$\text{Total Raw Score} = \sum_{i=1}^{n=10} \text{Adjusted Score}_i \qquad (5)$$

Multiply by 2.5 to convert to a 0 – 100 scale:

SUS Score = (Total Raw Score) x 2.5) (6)

The average SUS value and standard deviation were calculated in this study in order to determine the overall usability.

4.6 Data Analysis and Statistical Testing

Quantitative data analysis was performed using R.

Comparative Performance: Independent sample t-tests were conducted to compare the average processing times of both manual and online orders. Chi-square tests of independence were performed to assess the proportion of accurate and inaccurate data in both systems.

Statistical Significance: All statistical testing was conducted using a significance level of 0.05; where possible, confidence intervals were set at 95% to determine whether observed correlations or levels of performance were significant or, instead, due to random variation.

5.0 System Design

A three-tier client-server-based system was designed to maintain a modular, scalable, and maintainable system. The three levels, presentation layer, application logic layer, and database layer, collaborate to ensure smooth user interactions, order processing in real-time, and safe data management.

5.1 System Architecture

The design employs a three-tier architecture comprising presentation, application, and data layers (see Figure 5). A responsive web interface facilitates interaction with both users and vendors. A 3NF-compliant MySQL database enables data storage.

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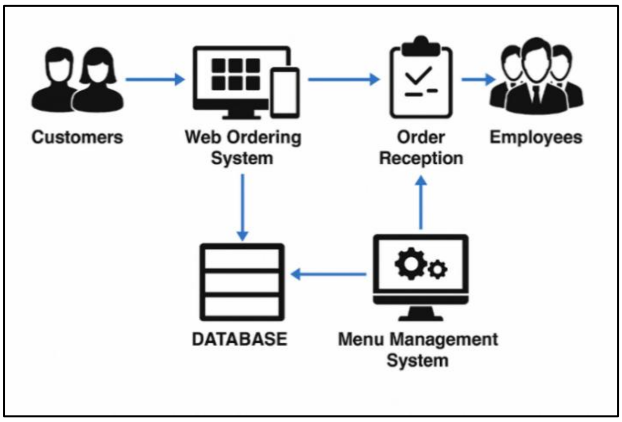

Fig. 5. System architecture

5.2 System Modules

The system has several foundation modules that support a given functional component.

User Registration and Authentication: This module is useful for registering and logging into secure accounts using hashed passwords. Sessions guarantee verified access to user-specific details, such as previous orders and profile preferences.

Menu Management: This module provides a list of available food menus with their corresponding prices, allowing customers to make selections.

Order Management: Customers are allowed to select from the food menu and place orders. The vendors are notified instantly about new orders and can change the status (pending, processing, ready) of the orders. The system facilitates automatic timestamping of activities in the orders.

Payment Gateway Integration: The system architecture is designed to accommodate integration with external payment gateways, facilitating electronic transactions. The existing implementation features a simple checkout system that is applicable to other systems, such as Paystack or Flutterwave, although it is not scalable. The mechanism enhances financial transparency, reduces the risk associated with money transactions, and provides a documentable audit trail of vendors and administrators.

5.3 System Workflow

The process begins when one enters the platform, navigates through the menu, places an order, and completes checkout. An order is then logged, and the vendor is informed via the system upon confirmation. The user would be provided with real-time updates and will collect the order when it is marked ready. The workflow will eliminate the inefficiencies of manual ordering by automating communication, minimizing queue times, and offering increased visibility to both users and vendors. Figure 6 illustrates the system workflow design.

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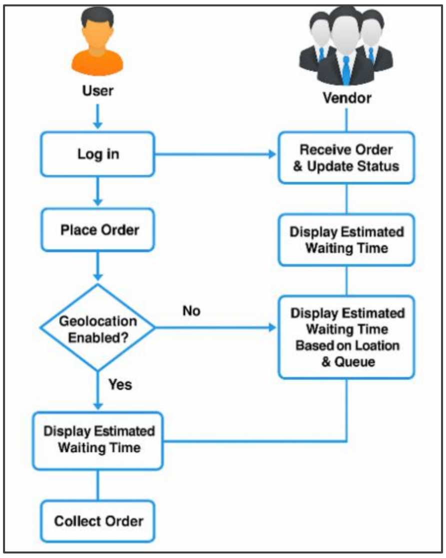

Fig. 6. System Workflow

5.4 Security Considerations

The design is universal in terms of security. Key measures include hashing of passwords and session management, verification of input and prepared statements to eliminate SQL injection, role-based access control between vendor and user access, and all transactions should be validated on the server side.

5.5 Data Modelling

Data Flow Diagram (DFD): A Data Flow Diagram shows the flow of information between the system, the user, and the vendor. On the web, users register and navigate through the menu, forwarding information to the Order Processing module, which retrieves availability and waiting-time information from the central Menu and Queue data store. New orders are verified and sent to Order Fulfillment, where they are received, revised, and finalized with the vendors. The resulting order status is sent back to the data store and displayed to the user in real-time. The flow chart illustrates a lean flow of information that promotes right ordering, effective processing, and continual alignment of various components within the system, as shown in Figure 7.

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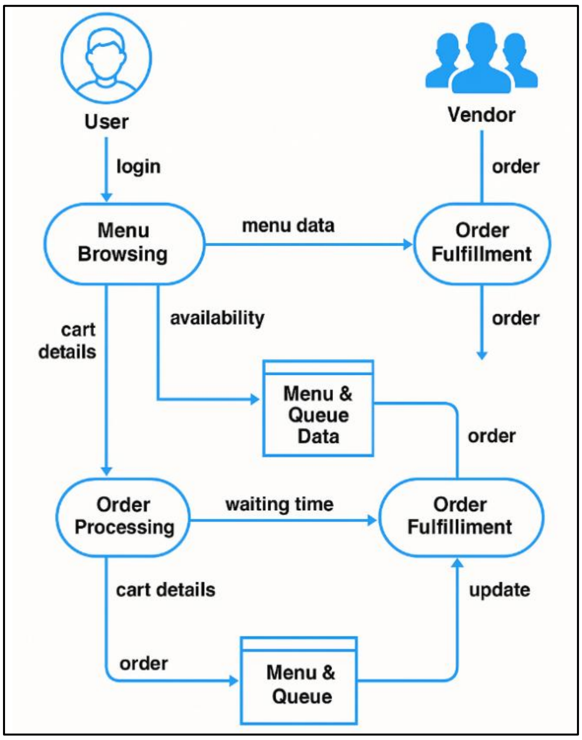

Fig. 7. Dataflow diagram of the system

Entity-Relationship Diagram (ERD): The Entity-Relationship Diagram (ERD) presents four major entities: User, Order, Vendor, and Menu Item, along with the relationships between them. The orders are placed by the user, taken and fulfilled by the vendor, and each order typically consists of one or more items from the menu. Both vendors and users are attached to orders using unique identifiers, whereas menu items are attached to orders through many-to-many data models. The ERD displays the basic data required to support ordering, menu, and vendor processes (see Figure 8).

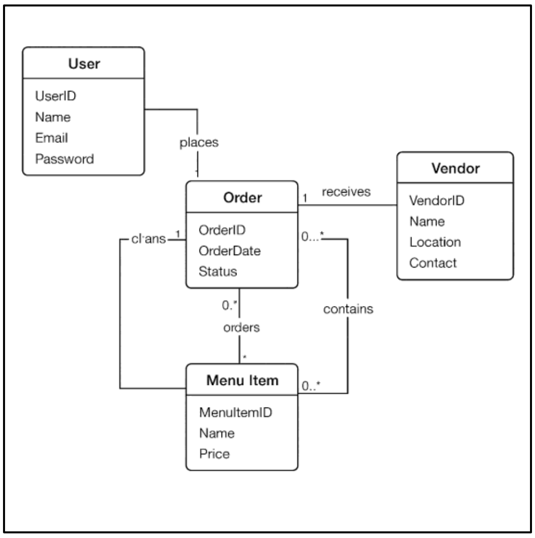

Fig. 8. Entity-Relationship Diagram of the system

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6.0 System Implementation

The implementation of the system consisted of frontend and backend development to have a working and effective application. The home page offers users featured food items and serves as a navigation hub to other sections of the application. The menu list provides all items offered in the menu, along with their descriptions and prices, allowing users to easily navigate and place orders. The payment system was introduced to facilitate various payment options, including card payments, bank transfers, USSD, and cash on delivery. Geolocation was also used during payments to ensure faster and more precise delivery of goods. The backend utilized a MySQL relational database to store user information, orders, menu items, and transactional information, using normalization and referential integrity constraints to ensure data consistency, reduce redundancy, and enhance query performance, thereby improving the reliability and efficiency of the system.

7.0 Advanced System Features

The system also features enhancements aimed at improving service delivery, efficiency, and user experience. The system is equipped with a customer feedback module that allows users to leave comments on completed orders. Customer feedback will be recorded and associated with the corresponding orders, used for future analyses to understand vendor performance and customer satisfaction levels regarding services delivered.

There is also an option to track the delivery process based on geolocation, with the user's consent. Suppliers can approximate the customer's distance to optimize the sequence of orders and the preparation process. Location information is only temporary to maintain privacy and is not stored.

A waiting time estimation model predicts the time until orders are ready based on the vendor's workload, past preparation times, and customer proximity. This estimated wait time is displayed during and after orders are placed. The waiting time is estimated as:

$$\text{Estimated Time} = (\text{Average Preparation Time x Queue Length}) + \text{Distance Adjustment Factor}$$

Such a dynamically generated estimate is presented to users at the time of order placement and thereafter. Empirically, real-time waiting-time information provision has been demonstrated to enhance user satisfaction, facilitate enhanced planning in order collection, and promote general system transparency.

8.0 System Testing and Evaluation

System testing was conducted to confirm the functionality, performance, accuracy, and usability of the food ordering system. The testing procedure ensured that every combined part of the software, including menu choices, order placement, payment clearance, geolocation capture, and receipt printing functionalities, worked as anticipated under both regular and exceptional working conditions. Valid and invalid inputs were also tested to ensure that user interactions were handled accurately by the system and that the correct outputs were generated, thereby ensuring the system's security and user-friendliness.

The essential modules tested during functional testing included food order submission, payment method choice (bank transfer, cards, USSD, and cash on delivery), geolocation detection, order receiving, order cancellation, and receipt printing. All test cases performed at this stage yielded anticipated results, and no critical failures were reported, confirming compliance with the stated functional requirements of the system.

To further assess the system's performance, statistical analysis was conducted in RStudio to compare the digital food ordering system with a traditional manual ordering system. Two statistical tests were used: an independent samples t-test to analyze the time, and a chi-square test of independence to assess the order accuracy. All tests were evaluated at a significance level of 0.05.

9.0 Results

Three analytical procedures were applied to evaluate system performance and user perceptions, namely, using an independent samples t-test to test the differences in order processing time between the digital system and the manual system, a chi-square test to test the differences in the accuracy of the order, and a usability test using the System Usability Scale (SUS).

The t-test outcomes revealed a significant difference in order processing time between the two systems ($p < 0.001$), with the digital food-ordering system being significantly faster than the manual system in terms of

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processing time. The chi-square test also revealed a significant correlation between the method of ordering and the accuracy of the orders ($p < 0.05$), indicating a difference in the level of accuracy between manual and electronic ordering.

Analysis of order accuracy indicated that the digital system had a 92 percent accuracy rate, compared to the manual system, which had a rate of 32 percent. Accordingly, the digital system had an error rate of 8%, and the manual system had an error rate of 68%, which was significantly higher.

The evaluation of usability, as measured by the SUS, yielded a mean score of 85.33 with a standard deviation of 4.33, indicating a high perception of usability. The ease-of-use items (Q3, Q5, Q7, Q9) mean scores were 4.5 and 4.6, and the negatively worded items (Q2, Q4, Q6, Q8, Q10) showed low mean scores. The mean scores during system acceptance indicators were also high, indicating that people were willing to use the system extensively.

10 Discussion

This study aims to design, develop, and evaluate a web-based food ordering platform for academic environments. The results show that the web-based food ordering system significantly improves efficiency, accuracy, and usability compared to the manual method. The outcome of the t-test statistically supports that web orders significantly minimize order processing time. This is especially true for food outlets that experience heavy traffic, such as those on university campuses, where congestion during peak hours has become a familiar occurrence. This confirms similar findings from previous researchers who pointed out that efficiency in institutional services has improved thanks to web automation.

Chi-square test results also indicate a significant relationship between order accuracy and the ordering process. The accuracy level of the electronic ordering system is significantly higher (92%), with an error rate of only 8%, compared to the manual process (32% accuracy and 68% error rate); this again reveals the effectiveness of a structured digital input process in overcoming errors related to humans during the process of order communication and choice. All the above observations are supported by previous research on food ordering on other campuses and food chains.

The high score on the System Usability Scale, at 85.33, indicates an exceptional level of usability and acceptance among users. This means that the system's interface, workflow, and ease of use are ideal for both one-time and returning users, including students and vendors. The usability level can also be interpreted to mean that other universities in developing areas with manual food service operations will find success in using systems that are similarly designed.

In general, the combination of the findings on efficiency, accuracy, and usability outcome measures suggests that the proposed system has relevance beyond the context of the case study setting. The findings of this research provide empirical justification for the more general application of web-based food-ordering systems in institutions of higher learning worldwide.

11.0 Limitations and Future Research

Although the study has a substantial amount of evidence to support the efficiency and usability of the digital food-ordering system, several limitations should be noted. The first issue is that the dataset was produced in a controlled environment, which may not be fully representative of the variations occurring in actual commercial food service settings. The ranking of behaviors, error rates, and peak-time pressures is likely to vary in larger or more heterogeneous populations. Second, the statistical tests and the System Usability Scale (SUS) provided important information; however, a small sample ($n = 30$) was used for user acceptance testing, which is a rather limited source of generalizability. Moreover, the participants were also accustomed to using digital tools, which might have positively affected their usability perceptions and minimized the risk of identifying technological barriers.

The evaluation should further be increased in the future to cover larger and more diverse groups of users, as well as include those with a limited level of digital literacy. Future research may investigate long-term adoption trends, the integration of vendors' workflows, and how the system performs under full operational load. At the same time, integrating sophisticated analytics, such as machine learning, to offer personalized food suggestions or predictive congestion models can also be beneficial in terms of functionality. Finally, comparative research in

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various institutions or commercial ventures would provide a better understanding of the scalability and cross-context performance of systems.

12.0 Conclusion

In this study, the digital food-ordering system proved to be more efficient, accurate, and user-friendly than the manual approach to processing orders. The statistical analyses (t-test and chi-square) verified the presence of significant differences in performance, and the high SUS result (85.33) and positive user feedback suggest high usability and acceptability among students and vendors. Hence, the system is a solid and user-friendly solution that supports service delivery in the university environment and has a strong foundation for future extension and development.

13.0 Acknowledgment

The authors also wish to express their utmost gratitude to all the participants who took the time to contribute to the data collection and evaluation process of the systems. The authors also acknowledge the significant contributions of other researchers who provided crucial work and academic support in this research.

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Declarations

Conflict of interest: The authors declare there is no conflict of interest related to this study.

Funding: No specific grant was received for this research from any funding agency, commercial sector, or non-profit sector.

Journal of Digital Food, Energy & Water Systems [JD-FEWS]

JDFEWS 6 (2): 16 - 24, 2025
ISSN 2709 - 4529

Natural Language Processing (NLP) for Agric-based Industrial Skills Development in Nigerian Polytechnics

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Received: 30 November 2025
Review: 3 December 2025
Accepted: 27 December 2025
Published: 30 December 2025

Abstract—Artificial Intelligence (AI) involves the use of a computer system capable of performing tasks that require human intelligence. In Technical and Vocational Education and Training (TVET), integrating generative AI fosters digital literacy and lifelong learning. Limited studies have explored the use of Natural Language Processing (NLP) AI tools, such as ChatGPT, Meta AI, and DeepSeek, among agriculture students in Nigerian Polytechnics, as many have largely focused on universities. This study examined the demographic profile, usage levels, impact, and challenges associated with NLP AI tools among students in agriculture-related programs in Nigerian polytechnics. Using a descriptive quantitative design, data were collected through structured questionnaires from 300 students of 10 Polytechnics in Southwest Nigeria. Findings revealed that 43% of the participants were aged 20–22, and 50% were enrolled in National Diploma 2. A high level of engagement with NLP tools was reported, with ChatGPT (35%) and Meta AI (56.7%) being the most frequently used, primarily for research (60%), assignments, and learning (30.7%). Respondents noted significant improvements in understanding (88.7%), application (93.2%), and problem-solving skills (76.6%) relevant to agricultural competencies. Despite these benefits, students encountered challenges such as limited access, technical difficulties, and issues interpreting AI-generated content. The findings highlight the transformative potential of AI in agricultural TVET if inclusive access and usability are enhanced. It is recommended that the strategic use of NLP AI tools can support skills development in Nigeria's agricultural sector, particularly within polytechnic education.

Keywords-Natural Language Processing, Artificial Intelligence, Agric-based industrial skill development, Nigeran Polytechnics.

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1. Introduction

1.1 Background of the study

This rapidly evolving area of artificial intelligence (AI) encompasses the development of intelligent machines capable of performing tasks that typically require human intelligence, such as comprehending natural language, identifying patterns, and making data-driven decisions across various industries, including medical diagnosis, autonomous vehicles, and education. AI is described as an attempt to replicate human capabilities with machines, creating computer-controlled robots or software that can think intelligently and imitate decision-making, problem-solving, data utilization for various tasks, multitasking, synthesis, analysis, and prediction [1-5]. It was similarly described as utilizing algorithms and computational models to simulate intelligent behaviors, such as reasoning, perception, language processing, spatial processing, and vision recognition, thereby enabling machines to gather information from a pool of data and make human-like decisions [6].

Generative AI is increasingly used across various economic sectors, including finance [7,8], transportation [9], education [10], healthcare, agriculture [11], drug discovery, language translation, and scientific research. As generative AI continues to penetrate different areas of society, its transformative effects are set to reshape industries, redefine human-computer interactions, and open new avenues for innovation [11]. Generative Artificial Intelligence tools such as ExperAI, Paperpal, Chat Bing, Humata, Paperdigest, Elicit, Copilot, Paper Brain, Trinkin.ai, and ChatGPT can analyze student data, including test scores, attendance records, research, assignments, term papers, and academic projects, and provide feedback and recognize areas of weakness and strength, making these processes more efficient [12-16].

In the context of Technical and Vocational Education and Training (TVET), harnessing generative AI in academic practices to build digital literacy is particularly important, as it not only enhances employability but also fosters lifelong learning. TVET constitutes a vital segment of the education system, offering courses and training programs geared towards equipping individuals with skills relevant to employment [17,18]. TVET enhances workforce readiness, critical thinking, and problem-solving skills [19], contributes to economic development by providing a highly trained workforce to meet industry demands [20], and plays a crucial role in mitigating skills gaps and addressing unemployment in certain fields [21]. According to the National Policy on Education of the Federal Republic of Nigeria, TVET encompasses educational processes involving general education, technology studies, practical skills, and knowledge acquisition related to various occupations, adapting to the evolving demands of the digital economy [22, 23].

Despite the necessity for digital literacy and skills acquisition, Nigerian TVET institutions face numerous challenges in integrating generative AI into academic practices. These challenges include inadequate curricula, insufficient tools, a lack of professional development, limited access to technological infrastructure, a shortage of qualified instructors, and a lack of relevant learning resources [5]. Tertiary institution teachers face challenges in acquiring digital skills due to inadequate opportunities for information and communication technology (ICT) training, the high cost of ICT literacy programs, insufficient ICT facilities, and limited sponsorship [24,25]. Moreover, understanding the workings of generative AI and the issues it can address is essential for developing educators' and learners’ digital literacy and laying the groundwork for future career development and learning [26-28].

Although there are a few studies on the use of technology for educational purposes [29-31], there remain few findings, particularly on the use of natural language processing AI tools. Additionally, there is limited existing research on its influence on the development of agricultural-based industrial skills among polytechnic students in Nigeria. This gap in research highlights the need for thorough research into the impacts of natural language processing AI tools in TVET and their influence on agri-based industrial skill development among Nigerian polytechnic students.

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1.2 Objectives of the Study

The objectives of this study are to:

1. Determine the demographic characteristics of Nigeria Polytechnic students studying agricultural-related courses
2. Determine the level of usage of Natural Language Processing (NLP) AI tools among Agricultural Students in Nigerian Polytechnics.
3. Investigate the Natural Language Processing (NLP) AI tools (ChatGPT, Meta AI, and DeepSeek) and the learning outcomes of polytechnic students in Nigeria.
4. Examine the challenges and limitations faced by students in using NLP AI Tools and explore ways to improve their effectiveness.

2.0 Methodology

This research employed a quantitative method to gather data from Nigerian polytechnic students enrolled in agriculture-based industrial skill development programmes as participants. Stratified random sampling was used to select participants from ten (10) polytechnics in Southwest Nigeria to ensure representation from different states in Southwest Nigeria. Validity and reliability of the study was secured with Cronbach's alpha value of 0.90 expert review of validity and 0.92 internal consistency of measuring instrument, from a pilot study of 10% of the respondents after which a sample size of 300 participants (students) was selected for quantitative research, using the approved structured questionnaire designed to gather qualitative data on the awareness and use of NLP AI tools among students, the impact of NLP AI tools on agric-based industrial skill development, and the challenges confronting the adoption of NLP AI tools in TVET. It was also used to investigate the specific ways in which NLP AI tools are integrated into agriculture-based TVET programmes. Limitations and benefits of using NLP AI tools for skill development and recommendations for improving the adoption of NLP AI tools in TVET. The data collected were analyzed using descriptive statistics (e.g., frequencies and percentages) and the chi-square test to determine if there is an association between the categorical variables.

3.0 Results and Discussion

3.1 Demographic Characteristics of Agricultural Students in Nigeria Polytechnic

Table 1 indicates that most respondents (43%) were aged 20–22, indicating that most students in the agriculture-related programs are in their early adulthood, a stage commonly associated with high technology engagement and openness to digital learning tools [32]. This demographic is ideal for interventions involving technology, such as NLP AI tools, as younger adults typically exhibit higher digital literacy [33]. Most students (50%) were in National Diploma 2 and were primarily studying Agricultural Technology (47.7%). This distribution suggests a potential focus group for further intervention or studies, as Agricultural Technology appears to be the most enrolled discipline, and National Diploma 2 students are likely to have more exposure to AI tools due to increased academic requirements compared to National Diploma 1 students.

Table 1: Demographic Characteristics of Nigeria Polytechnic students Studying Agriculture

Demographic Characteristics	Frequency	Percentage (%)
Age		
14-16	8	2.7
17-19	60	20.0

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20-22	129	43.0
23-24	55	18.3
25-Above	48	16.0
Total	300	100
Class		
National Diploma 1	55	18.3
National Diploma 2	150	50.0
High National Diploma 1	20	6.7
High National Diploma 2	75	25.0
Total	300	100
Agriculture program		
Agricultural Technology	143	47.7
Agricultural Engineering	27	9.0
Crop Production	40	13.3
Animal Production	48	16
Agricultural Extension	42	14
Total	300	100

3.2 Usage of NLP AI Tools among Agricultural Students in Polytechnic

Table 2 presents the level and purpose of NLP AI tool usage. Daily (40.3%) and weekly (30.3%) use demonstrated strong integration into students' routines. MataAI (56.7%) and ChatGPT (35%) were the dominant tools. These tools provide natural language responses that are useful for learning complex agricultural concepts, simulations, and skill acquisition. Recent studies support the use of AI-powered tools such as ChatGPT to enhance cognitive learning and reduce the burden of rote learning in technical education environments [34].
The primary use was for research and assignments (60%), followed by studying (30.7%) and a smaller proportion for communication (9.3%). This aligns with NLP's design to simplify information retrieval, assist in writing, and clarify complex concepts [35].

Table 2: Level of Use of NLP AI Tools among Agricultural Students in Polytechnic

Level of Use of NLP AI Tools	Frequency	Percentage (%)
How often are NLP tools used?		
Daily	121	40.3
Weekly	91	30.3
Rarely	88	29.4
Total	300	100
Types of NLP AI tools used		
ChatGPT	105	35
MataAI	170	56.7
DeepSeek	12	4.0
Others	13	4.3
Total	300	100
Purpose for the use of NLP AI		
Research and assignments	180	60.0
Studying and learning	92	30.7
Communication and collaboration	28	9.3

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Total	300	100

3.3 NLP AI Tools and Learning Outcomes

Table 3 reveals that a significant majority (88.7%) agreed or strongly agreed that AI tools improved their understanding of agricultural industry skills. Over 93% of respondents stated that these tools helped them apply agricultural-based industrial skills. This reflects strong educational utility, consistent with the findings of Ukala and Iheukwumere [36], who reported improved engagement and learning outcomes in vocational education due to AI integration.

Additionally, 76.6% of the students agreed or strongly agreed that AI tools have enhanced their problem-solving skills. While only 13.6% reported no improvement or negative impact, this suggests broad acceptance of these tools as effective learning aids. Problem-solving is a critical 21st-century skill, and NLP-based tools are known to support cognitive scaffolding, leading to a deeper understanding of concepts [47].

The chi-square value for problem-solving skills was significant ($\chi^2 = 24.29$, $p < 0.01$), indicating the strongest statistical evidence. This suggests that NLP AI tools greatly improve decision-making, troubleshooting, and analytical thinking abilities. This result is consistent with constructivist learning theory, which emphasizes problem-based, learner-centred and interactive learning environments made possible by digital technologies [38].

Table 3: NLP AI Tools and Learning Outcomes

NLP AI Tools and Learning Outcome	Frequency	Percent (%)	x^2
It has improved understanding of agric-based industrial skills			
Strongly Agree	96	32.0	
Agree	170	56.7	
Neutral	34	11.3	
Total	300	100	7.18NS
NLP AI Tools have aided my ability to apply Agric-based industrial skills			
Significantly improved	157	52.3	
Somewhat improved	123	41.0	
No impact	20	6.7	
Total	300	100	6.87NS
It has enhanced my problem-solving skills in agriculture-based industrial skills			
Strongly Agree	40	13.3	
Agree	190	63.3	
Neutral	29	9.8	
Disagree	7	2.3	
Strongly Disagree	34	11.3	
Total	300	100	24.29**

x^2 - Chi-square, ** - reflect highly significant

3.4 Challenges and Limitations with the use of NLP AI Tools and ways of improvement

Table 4 outlines the Major Challenges, level of friendliness, and suggested improvements for optimal usage of NLP AI tools. Limited access (28.7%), technical issues (22.7%), and difficulty in understanding outputs (21.7%) were the key barriers. These results reflect issues common in digital learning environments in developing countries, especially in resource-constrained settings [39].

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Students suggested clearer responses (15.6%), comprehensive content (11.7%), and error minimization (21%). A notable concern was subscription cost (20.3%), highlighting financial barriers that could impede equitable access. These responses align with global best practices for AI tool design, which emphasize localization, accessibility, and affordability to enhance effectiveness [40]. Additionally, a combined 86.1% of respondents agreed or strongly agreed that NLP tools are user-friendly. This suggests that, although access and clarity are issues, the interface design is largely successful.

Table 4: Challenges and Limitations with the use of NLP AI Tools and ways of improvement

Challenges and Limitations	**Frequency**	**Percent (%)**
Challenges faced by students		
Difficulty in understanding the tool's output	65	21.7
Limited access to the tool	86	28.7
Technical issues with the tool	68	22.7
Others	81	27.0
Total	300	100
NLP AI Tools level of user friendliness		
Strongly Agree	117	39.0
Agree	142	47.3
Neutral	41	13.7
Total	300	100
How best NLP Tools can be improved for students use		
No Idea	50	16.7
Make response clearer and real	47	15.7
Make Response comprehensive	35	11.7
Reduced the price of subscription	61	20.3
Minimise error	63	21.0
Make it more user friendly	19	6.3
Make response faster	25	8.3
Total	300	100

4.0 Conclusion and Recommendation

This research demonstrates that the use of an NLP AI tool facilitates skill development in agricultural-based TVET programs. With most students reporting improved understanding, skill application, and problem-solving ability, NLP tools appear to be effective as educational aids. However, technical barriers, affordability, and output clarity remain challenges in its application. Addressing these issues could improve the effectiveness and inclusiveness of the tools, especially in polytechnic environments.

It is hereby recommended that government agencies (e.g., NBTE, NITDA) and educational institutions partner with NLP AI tool developers to provide subsidized or institutional licenses for students. Developers should localize AI tools by training models with agricultural content relevant to Nigeria's curriculum and ensuring that the output is simplified and context-aware. A total of 37.3% of students requested clearer and more accurate responses, indicating a need for the customization and refinement of AI output.

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Also, Agricultural TVET Curriculum designers should formally integrate AI tool usage into coursework and skill development modules with guided exercises and case studies. Over 90% of students reported enhanced learning and application of industrial skills through AI tools, and formal curriculum integration can amplify this.
In addition, collaborations should be fostered between polytechnics, tech startups, and agricultural industries to co-develop AI tools tailored for TVET applications. Such partnerships can ensure that the tools are practical, novel, and aligned with the labor market needs in the agricultural sector.

5.0 Ethical and legal perspective on the use of generative AI

Although generative AI can enhance the efficiency of administrative and grading tasks, its use in academic settings raises significant ethical and legal concerns. However, the potential bias and lack of transparency in automated grading systems may impact fairness and students' ability to challenge academic decisions. Legally speaking, the Nigeria Data Protection Act 2023 (NDPA), which requires lawful processing, purpose limitation, and data minimization, must be followed when processing students' personal data, including names, academic records, and biometric attendance information. Adopting such tools requires institutions to guarantee informed consent and sufficient protection against data misuse. Academic integrity is also compromised when generative AI is used to create assignments, research papers, and other academic content. Submitting AI-generated work as original student work could violate the Copyright Act of 2022 and be considered plagiarism, especially if the AI outputs duplicate protected works. Since Nigeria lacks a stand-alone AI law, compliance with current frameworks, such as the General Application and Implementation Directive (GAID) 2025, is required to guarantee responsibility, openness, and the responsible use of AI technologies in educational settings. Higher education institutions should implement AI-detection and disclosure systems, create explicit policies outlining acceptable and unacceptable uses of AI, and encourage ethical AI literacy among staff and students to reduce these risks.

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