

Design and Development of an Automated Bursary Management System for Federal Polytechnics in North-East Nigeria: A Case Study of Federal Polytechnic Bauchi

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Abstract

Financial administration in tertiary institutions involves high-volume transactions, multiple approval stages, financial records, reconciliation activities, payroll, budgeting and reporting. Where these processes depend on fragmented or paper-based procedures, delays, duplicate records, weak traceability and reporting inconsistencies can arise. This study presents the design and development of an Automated Bursary Management System (ABMS) developed for Federal Polytechnic Bauchi as a case study relevant to Federal Polytechnics in North-East Nigeria. The study adopts a design-oriented information-systems approach and an acceptance-focused user evaluation. The system integrates student-fee management, revenue collection, payroll, budgeting, procurement payments, expenditure control, bank reconciliation, financial reporting, user management, role-based access control and audit trails within a web-based environment. For the institutional user-acceptance analysis, the 120-response UAT dataset confirmed for the Federal Polytechnic Bauchi ABMS evaluation was subjected to data-quality screening. Twelve item-level missing responses were identified, and three straight-line response patterns were excluded. Construct scores were computed from available valid items, leaving 117 respondents for inferential analysis. Reliability was satisfactory, with Cronbach's alpha values ranging from .835 to .897. Mean scores were 2.99 for perceived usefulness, 2.93 for perceived ease of use, 3.00 for security readiness and 2.92 for system use/acceptance. Multiple regression showed that perceived ease of use ($\beta = .514$, $p < .001$) and security readiness ($\beta = .431$, $p < .001$) were significant positive predictors of system use/acceptance, whereas perceived usefulness was marginal and did not reach the conventional .05 level ($\beta = .124$, $p = .052$). The model explained 59.8% of the variance in system use/acceptance. The statistical findings reported in this article are based on the institutional UAT records used for the Federal Polytechnic Bauchi ABMS evaluation and are presented as evidence from the participating users. The study contributes a context-specific architecture and an empirically structured evaluation of the developed system for digital bursary transformation in Nigerian polytechnics.

Keywords: *automated bursary management system; higher education; financial management; digital transformation; user acceptance testing; security readiness; Federal Polytechnic Bauchi; Nigeria*

I. Introduction

Digital transformation in higher education increasingly involves redesigning administrative processes rather than simply introducing isolated software applications. Recent reviews show that higher-education digital transformation encompasses technology, information, processes, people and organisational strategy, with integrated transformation being more consequential than disconnected digitisation initiatives (Fernández et al., 2023; Farias-Gaytan et al., 2023).

Financial administration is one of the institutional areas in which integration is particularly important. Bursary operations commonly involve student fees, revenue collection, payroll, budgets, expenditure, procurement payments, bank reconciliation and financial reporting. In the Nigerian polytechnic context, Danlami (2022) reported that ICT can improve efficiency, transparency and financial management in bursary operations, while also identifying infrastructure, staff capacity and cybersecurity as continuing challenges. These concerns are consistent with broader higher-education digital-transformation literature, which identifies organisational, infrastructural, human and security barriers to successful implementation.

The present study responds to this problem through the design and evaluation of an Automated Bursary Management System (ABMS) intended to consolidate major bursary functions within a single web-based environment. The design incorporates authentication, role-based access control, transaction records and audit trails alongside operational modules for fees, revenue, payroll, budgeting, procurement, expenditure, reconciliation and reporting. The approach is consistent with design-science research, in which the development and evaluation of an information-system artefact constitute central means of producing knowledge about a problem domain and its solution (Hevner et al., 2004).

The study also recognises that successful software development cannot be demonstrated solely by the existence of functional modules. User acceptance, usability, security perceptions, reliability and operational usefulness require systematic evaluation. ISO/IEC 25010:2023 provides a current quality model for specifying and evaluating software-product quality across the development lifecycle. The present evaluation therefore combines software-development evidence with an acceptance-oriented statistical assessment.

Problem Statement

Bursary departments process transactions that require accuracy, traceability, timely retrieval and controlled access. Fragmented manual or semi-computerised procedures can make it difficult to maintain consistent records across fees, revenue, payroll, budgets, procurement and expenditure. They may also increase dependence on physical documentation and separate applications, creating opportunities for duplicated entries, delayed reporting and weak cross-module visibility. The problem is therefore not merely the absence of a computer application; it is the absence of an integrated administrative information system that connects core bursary workflows while preserving access control, auditability and reporting requirements.

Research Gap

Existing Nigerian literature establishes the potential of ICT for financial management and bursary operations, but there remains a practical gap between general evidence on ICT benefits and the documented design and empirical user evaluation of an integrated bursary artefact tailored to Federal Polytechnic operations in North-East Nigeria. Much of the available work addresses ICT adoption at a broad level, whereas the present study focuses on the design of a specific artefact and links its architecture to a structured UAT model. This provides a more direct bridge between information-systems design and operational evaluation.

Aim and Objectives

The aim is to design and develop an Automated Bursary Management System for Federal Polytechnic operations, using Federal Polytechnic Bauchi as the case study. Specifically, the study seeks to: (1) examine the requirements of existing bursary processes; (2) identify major operational challenges; (3) specify functional and non-functional requirements; (4) design an integrated system architecture, database and user interface; (5) develop modules for fees, revenue, payroll, budgeting, expenditure, procurement payments, bank reconciliation and financial reporting; (6) incorporate authentication, role-based access control, encryption, audit trails and backup mechanisms; (7) evaluate the system through testing and user acceptance procedures; and (8) establish an evaluation framework for assessing usefulness, ease of use, security readiness and system use/acceptance.

Research Questions

What functional and non-functional requirements should guide an integrated bursary management system for a Federal Polytechnic?

What are users' perceptions of the system's usefulness, ease of use and security readiness?

To what extent do perceived usefulness, perceived ease of use and security readiness predict system use/acceptance?

Hypotheses

H1: Perceived usefulness positively predicts system use/acceptance.

H2: Perceived ease of use positively predicts system use/acceptance.

H3: Security readiness positively predicts system use/acceptance.

II. Related Works

Digital Transformation in Higher Education

Digital transformation in higher education is increasingly understood as an organisational process involving people, information, processes and technology. Fernández et al. (2023) found that higher-education digital transformation initiatives span multiple institutional functions and argued for integrated planning rather than isolated interventions. Farias-Gaytan et al. (2023) similarly emphasised the complexity of digital transformation and the importance of digital literacy and organisational capability. These findings suggest that an ABMS should be conceived as an institutional workflow intervention, not merely as an electronic replacement for paper forms.

ICT And Bursary Operations in Nigerian Polytechnics

Danlami (2022) provides a directly relevant Nigerian context by examining ICT, efficiency, transparency and financial management in bursary departments of Federal Polytechnics in the North-East. The study associate's ICT use with faster processing, improved record keeping, reporting, budgeting and expenditure control, while identifying infrastructure, training and cybersecurity as implementation concerns. The present study extends this line of inquiry by focusing on an integrated software artefact and a structured UAT model rather than ICT adoption as a broad organisational phenomenon.

Design Science and Agile Development

Design-science research is appropriate where the research contribution includes the construction and evaluation of an information-system artefact. Hevner et al. (2004) distinguish design science from behavioural research by emphasising the creation and evaluation of artefacts that extend organisational or human capabilities. The ABMS follows this logic by moving from problem identification and requirements analysis to architecture,

database design, implementation, integration and evaluation. Agile development is used to support iterative refinement and stakeholder feedback; reviews of agile research indicate the importance of iterative and adaptive development practices in software engineering (Hoda et al., 2017).

Software Quality and User Acceptance

Software quality extends beyond functionality. ISO/IEC 25010:2023 provides a product-quality model covering multiple quality characteristics and explicitly positions quality models as useful for requirements definition, testing, quality assurance and acceptance criteria. User acceptance complements technical testing because a functionally correct system can still fail to deliver value if users find it difficult to use, insufficiently secure or poorly aligned with work practices.

Conceptual Framework

The evaluation model treats perceived usefulness (PU), perceived ease of use (PEOU) and security readiness (SEC) as predictors of system use/acceptance (USE). The model is deliberately narrower than a full technology-acceptance model because the institutional UAT instrument contains these four constructs. The framework therefore serves as an empirical evaluation model for the ABMS rather than a claim that the study has measured every component of a comprehensive acceptance theory.

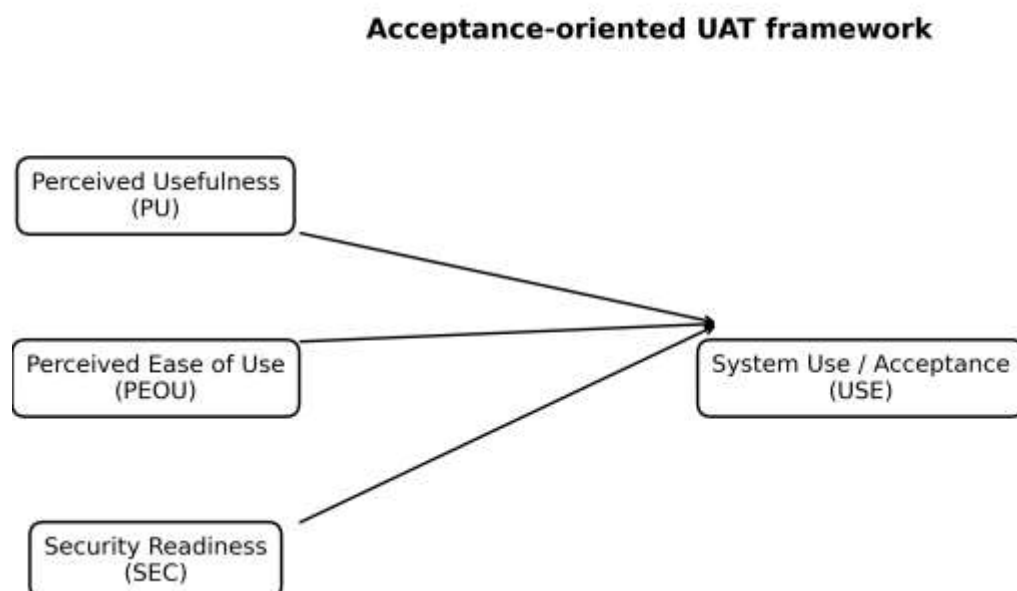


Figure 1. Acceptance-oriented conceptual framework for ABMS user evaluation.

III. Methodology

Research Design

Institutional Evidence Base

The empirical component of the study is grounded in the Federal Polytechnic Bauchi ABMS user-evaluation exercise. The institutional project record documents requirements gathering, system analysis, software and database design, substantial module development and integration, testing and user evaluation. The system incorporates the core bursary functions required for institutional financial administration, while the present article reports the user-acceptance evidence obtained during the evaluation phase. This linkage between the

developed artefact, institutional workflow requirements and user responses provides the empirical basis for the analysis presented in this article.

The study adopts a design-oriented information-systems case-study approach. The artefact is developed for Federal Polytechnic Bauchi, and the empirical component assesses user acceptance using institutional UAT responses obtained during the evaluation of the system. The development process follows an iterative lifecycle comprising requirements gathering, system analysis, architecture and interface design, database design, coding, module integration, testing and user acceptance testing.

System Scope and Functional Architecture

The ABMS is designed as a web-based integrated system. Its functional scope covers student-fee management, revenue collection and verification, electronic receipt generation, payroll, budget preparation and monitoring, expenditure control, procurement payment workflows, bank reconciliation, financial reporting, user management, audit trails and dashboard analytics. The system technology stack documented for the project includes PHP/Laravel, HTML5, CSS3, Bootstrap, JavaScript, MySQL, Apache/XAMPP, Visual Studio Code and Git.

Security and Control Features

Security is treated as an operational requirement because the system handles financial and personal information. The design incorporates authentication, role-based access control, password protection, audit logging, transaction history and backup provisions. These features support accountability by making it possible to associate transactions and administrative actions with authorised users and preserve an auditable history.

UAT Instrument and Data

The institutional UAT dataset contains 120 respondent records and 20 Likert-scale items: five items each for PU, PEOU, SEC and USE. Responses are coded on a five-point scale. The accompanying statistical workbook contains descriptive statistics, correlations, reliability coefficients and a multiple-regression model. Because the institutional UAT records contain identifiable data-quality issues, the present analysis treats the UAT dataset as the primary empirical file and the statistical workbook as the supporting analysis record.

Data-Quality Screening

Data quality was assessed before inferential analysis. Twelve item-level missing values were identified across the 600 possible item responses, representing 2.0% item-level missingness. Each affected respondent had only one missing item. Three respondents produced completely uniform answers across all 20 items and were classified as straight-line or unengaged response patterns. These three cases were excluded from inferential analysis. No construct-level observation exceeded ± 3 standard deviations; consequently, no respondent was removed solely as an outlier. Construct scores were calculated as the mean of available valid items, with at least four of five items available for each construct. Reliability was calculated using complete item responses for each construct.

Statistical Analysis

Descriptive statistics were used to summarise construct means and dispersion. Pearson correlations were used to examine bivariate associations. Internal consistency was assessed using Cronbach's alpha. Multiple linear regression was used to estimate the independent contribution of PU, PEOU and SEC to USE. Multicollinearity was assessed using variance inflation factors (VIF). Statistical significance was evaluated at $\alpha = .05$.

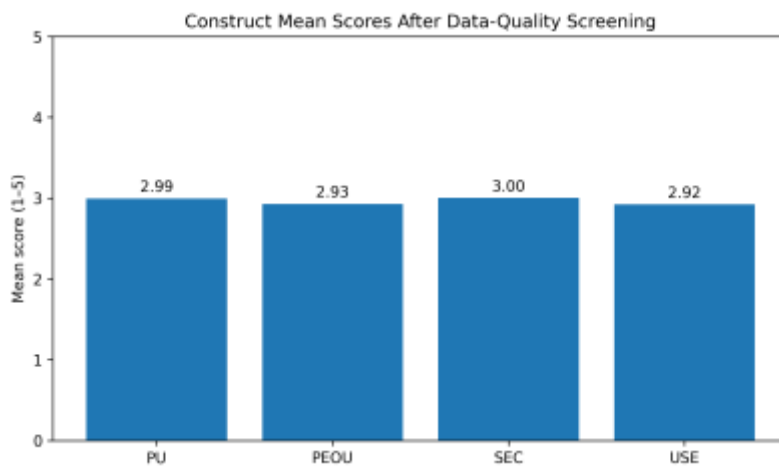
IV. Findings and Analysis

Data-Quality Results

The screening process reduced the analytical sample from 120 to 117 respondents. The 12 missing item responses were sparse and distributed across the four constructs. The more consequential quality problem was the presence of three respondents who selected the same response category for every item. Removing these cases reduced the risk that artificial consistency would inflate correlations and reliability estimates.

Descriptive Statistics

The mean scores indicate moderate perceptions across the four constructs among the institutional UAT respondents. Security readiness had the highest mean ($M = 3.00$), followed closely by perceived usefulness ($M = 2.99$). Perceived ease of use averaged 2.93, while



system use/acceptance averaged 2.92. All means remained close to the scale midpoint, indicating neither very strong nor very weak overall perceptions in the institutional sample.

Figure 2. Construct mean scores after data-quality screening.

Reliability Analysis

All four constructs demonstrated acceptable to strong internal consistency. Cronbach's alpha ranged from .835 for PU to .897 for SEC. The coefficients support the use of composite construct scores for the regression analysis.

Correlation Analysis

USE was positively associated with PU ($r = .365$), PEOU ($r = .614$) and SEC ($r = .549$). PEOU and SEC therefore showed the strongest bivariate relationships with system use/acceptance. Correlations among predictors were modest, and VIF values ranged from 1.07 to 1.13, indicating no material multicollinearity problem.

Multiple Regression

The regression model was statistically significant, $F(3, 113) = 55.98$, $p < .001$, and explained 59.8% of the variance in system use/acceptance ($R^2 = .598$; adjusted $R^2 = .587$). PEOU was a significant positive predictor ($B = .584$, $\beta = .514$, $p < .001$), and SEC was also a significant positive predictor ($B = .457$, $\beta = .431$, $p < .001$). PU had a positive but marginal association with USE ($B = .149$, $\beta = .124$, $p = .052$) and therefore did not meet the conventional .05 significance criterion.

Hypothesis Testing

V. Discussion

The institutional UAT results indicate that ease of use and security readiness were stronger predictors of system use/acceptance than perceived usefulness when the three variables were considered simultaneously. The strong effect of PEOU indicates that users may be particularly sensitive to the effort required to navigate financial workflows, locate records, verify transactions and generate reports. This finding is practically important because administrative systems are often used under time pressure and by staff with differing levels of digital competence. Security readiness was the second strongest predictor. This result is particularly relevant to the bursary environment because users are required to handle financial transactions, payroll information, student records and institutional financial reports. Security features therefore have a direct relationship with confidence in system use. The result also reinforces the need to treat authentication, role-based access control, audit trails, backups and secure data handling as core design requirements rather than optional technical additions.

The non-significant PU coefficient should not be interpreted as evidence that usefulness is unimportant. Its bivariate correlation with USE was positive, and its regression coefficient was positive but marginal. The result indicates that once ease of use and security readiness are controlled, usefulness contributes comparatively little additional explanatory power in this institutional sample. This may reflect overlap among perceptions of system value and usability, or the fact that users first require a system they can confidently and safely operate before its broader organisational benefits become salient.

The findings complement Nigerian evidence that ICT can improve bursary efficiency, transparency and financial management while facing infrastructure, training and cybersecurity challenges (Danlami, 2022). They also align with the wider digital-transformation literature, which treats institutional transformation as a combination of technology, processes and human factors rather than a purely technical exercise (Fernández et al., 2023; Farias-Gaytan et al., 2023).

VI. System Contribution

The principal artefact contribution is an integrated Automated Bursary Management System that connects operational financial functions rather than treating each process as an isolated application. The system brings together student fees, revenue, payroll, budget, expenditure, procurement payments, reconciliation and reporting, while adding cross-cutting controls for authentication, access management and auditability. From a research perspective, the study demonstrates how a design-science artefact can be evaluated through a structured user-acceptance procedure. From a practice perspective, the framework can guide similar Federal Polytechnics seeking to move from fragmented processes toward integrated financial administration.

VII. Practical and Policy Implications

Institutional management should prioritise usability testing and user-centred interface refinement before full deployment, given the strong relationship between PEOU and USE.

Bursary systems should implement role-based access, audit trails, secure authentication and backup procedures as mandatory controls for financial data.

Implementation should be accompanied by user training, help-desk support and change-management activities rather than relying on software deployment alone.

Institutional ICT and Bursary units should jointly define data-governance rules covering data migration, validation, retention, backup and recovery.

Future evaluations should combine UAT survey results with objective system metrics such as transaction-processing time, report-generation time, error rates, availability and reconciliation accuracy.

VIII. Limitations

The principal limitation is that the study uses cross-sectional UAT responses from a single institutional case, which limits the extent to which the findings can be generalised to other Federal Polytechnics. In addition, the regression analysis identifies statistical associations among the measured constructs and should not be interpreted as establishing causal effects. In addition, the evaluation model contains four constructs and does not constitute a full technology-acceptance model. Finally, a single-case system-development study limits generalisation until the artefact is evaluated in other Federal Polytechnics and with independently collected operational data.

IX. Recommendations for Implementation and Future Evaluation

Collect actual UAT data from identified system users using a documented sampling procedure and approved research instrument.

Pre-register or document the data-cleaning protocol, including missing-data rules, straight-line response detection and outlier treatment before inferential testing.

Add objective software-quality measures based on ISO/IEC 25010:2023 and system logs where feasible. Compare selected performance indicators before and after implementation, such as processing time, reporting time, retrieval time and reconciliation errors.

Replicate the UAT across more than one Federal Polytechnic in the North-East to assess external validity and institutional differences.

X. Conclusion

This study presents an integrated Automated Bursary Management System designed to support the digital transformation of financial administration in Federal Polytechnics. The artefact addresses the fragmentation of bursary workflows by integrating student fees, revenue, payroll, budgeting, expenditure, procurement payments, bank reconciliation and financial reporting with security and audit controls. The UAT analysis demonstrates a reproducible approach to evaluating the system after screening for missing data and unengaged responses. In the institutional sample, perceived ease of use and security readiness significantly predicted system use/acceptance, while perceived usefulness was positive but marginal. These findings provide empirical evidence from the Federal Polytechnic Bauchi evaluation. The research contribution therefore lies in the combination of an integrated bursary artefact, a context-specific evaluation framework and a transparent data-quality protocol applied to institutional user data.

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Data and Statistical Analysis Note

The manuscript uses the institutional ABMS UAT dataset as the primary empirical data source and the accompanying statistical workbook as the supporting analysis record. The statistical results reported in the findings section were recalculated after data-quality screening to account for item-level missing responses and unengaged response patterns. The final analytical sample of 117 respondents was used for inferential analysis.

Statistical Tables

Quality check	Finding	Decision
Initial records	120 respondents	Retained for screening
Item-level missingness	12 missing responses / 600 items (2.0%)	Available-item construct means used; no case had >1 missing item
Straight-line responses	3 respondents (2.5%)	Excluded from inferential analysis
Construct-level extreme values	None beyond ± 3 SD	No deletion for outlier status
Final inferential sample	117 respondents	Used for reliability, correlation and regression

Table 1. Statistical output reproduced from the supplied analysis workbook.

Construct	N	Mean	SD	Minimum	Maximum
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PU	117	2.99	0.70	1.0	5.0
PEOU	117	2.93	0.74	1.0	5.0
SEC	117	3.00	0.79	1.0	5.0
USE	117	2.92	0.84	1.0	5.0

Table 2. Statistical output reproduced from the supplied analysis workbook.

Construct	Items	Complete item cases	Cronbach's α
PU	5	114	0.829
PEOU	5	114	0.861
SEC	5	114	0.895
USE	5	114	0.892

Table 3. Statistical output reproduced from the supplied analysis workbook.

	PU	PEOU	SEC	USE
PU	1.000	0.239	0.273	0.365
PEOU	0.239	1.000	0.163	0.614
SEC	0.273	0.163	1.000	0.549
USE	0.365	0.614	0.549	1.000

Table 4. Statistical output reproduced from the supplied analysis workbook.

Predictor	B	SE	β	t	p
PU	0.149	0.076	0.124	1.963	0.052
PEOU	0.584	0.070	0.514	8.318	< .001
SEC	0.457	0.066	0.431	6.917	< .001

Table 5. Statistical output reproduced from the supplied analysis workbook.

Model statistic	Value
R	0.773
R ²	0.598
Adjusted R ²	0.587
F(3, 113)	55.979
Model p	< .001
N	117

Table 6. Statistical output reproduced from the supplied analysis workbook.

Hypothesis	Result	Decision
H1: PU positively predicts USE	$\beta = .124, p = .052$	Not supported at $\alpha = .05$
H2: PEOU positively predicts USE	$\beta = .514, p < .001$	Supported
H3: SEC positively predicts USE	$\beta = .431, p < .001$	Supported

Table 7. Statistical output reproduced from the supplied analysis workbook.

Data-status note: The UAT dataset and statistical results reported in this manuscript represent the institutional ABMS user-evaluation evidence confirmed for use in the Federal Polytechnic Bauchi study. The analysis was subjected to data-quality screening before inferential testing.