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Design and Implementation of a VBA-Based Uniform Inventory Accounting System: A Qualitative Case Study at SMA El Fitra Bandung

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Abstract

Purpose: Many educational institutions in Indonesia still use manual inventory recording, leading to recording errors, stock discrepancies, slow data retrieval, and weak financial control. This study develops a Visual Basic for Applications (VBA) based inventory accounting system in Microsoft Excel for SMA El Fitra Bandung to replace its handwritten school uniform inventory records.

Research Methodology: A qualitative case study was conducted using unstructured interviews, direct observation, and documentation of inventory records. The system was developed using the five-stage waterfall method and implemented in Microsoft Excel with VBA Macro, featuring five modules: Main Menu, Item Data, Incoming Goods, Outgoing Goods, and Save/Exit.

Results: Five system trials resulted in three successful tests, while two coding errors were resolved during maintenance. The final system accurately managed inventory transactions, generated reports, and improved efficiency, accuracy, accessibility, and data security.

Conclusions: The VBA-based system effectively replaced manual inventory recording, with the Waterfall method ensuring structured development and implementation.

Limitations: The system is limited to inventory recording and requires staff VBA competency and proper supplier receipt management for sustainable operation.

Contributions: This study offers a replicable VBA-based inventory system for small institutions, contributing to accounting system design and institutional informatics.

Keywords: *Accounting Information System, Indonesia, Inventory Accounting System, Microsoft Excel, Visual Basic for Applications (VBA)*

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1. Introduction

The rapid development of information technology has fundamentally transformed organizational management practices across economic sectors, educational institutions, and government agencies worldwide. Effective information systems, particularly accounting information systems, are increasingly recognized as essential infrastructure for accurate financial recording, efficient resource management, and evidence-based decision-making (Romney, & Steinbart, 2018; Gelinas, Dull,

Wheeler, & Hill, 2018). The shift from manual to computerized recording systems has been shown to yield measurable improvements in data accuracy, processing speed, retrieval efficiency, and information security across a wide range of organizational contexts (Grande, Estébanez, & Colomina, 2011; Laudon, & Laudon, 2022). This global transition toward digital information management has extended progressively to educational institutions, which increasingly manage complex procurement, distribution, and asset cycles that benefit from structured accounting information systems (Wongso, Watrianthos, & Nasution, 2021).

Inventory management constitutes a critical accounting function for organizations that buy, store, and distribute physical goods. For educational institutions managing student uniform procurement and distribution, which involves an annual transaction cycle encompassing supplier sourcing, receipt verification, storage, and student-level distribution, the absence of an adequate inventory accounting system creates recurring operational vulnerabilities. These include recording errors arising from manual arithmetic, physical-book stock discrepancies caused by inconsistent counting procedures, delayed reporting that prevents timely management responses, and difficulty in tracing individual transactions to their documentary sources (Mangoting, Sukoharsono, Rosidi, & Nurkholis, 2021; Rouhani, Ghazanfari, & Jafari, 2018). These vulnerabilities are particularly pronounced in institutions where responsible administrative staff lack formal accounting education, making systematic error prevention and stock control especially challenging. Across both commercial and non-commercial organizational contexts, research consistently demonstrates that transitioning from informal manual systems to structured computerized recording produces significant improvements in operational reliability, financial control, and reporting quality (Ogiemwonyi, Harun, Alam, Karim, Tabash, & Hossain, 2020; Daqar, & Smoudy, 2019).

The SMA El Fitra Bandung is a private Islamic senior high school operated by the El Fitra Educational Foundation, established to develop academically capable and morally grounded students through an integrated national curriculum incorporating science and Islamic education. The school manages an annual school uniform procurement and distribution cycle that serves all enrolled students at the start of each academic year. At the time of this study, SMA El Fitra had no formalized inventory accounting system: all records were handwritten, tracking daily receipts from the uniform supplier and outgoing distributions to students. This informal system generated three documented recurring problems: arithmetic errors causing physical-book discrepancies, lost supplier receipts creating unverifiable transaction histories, and size mismatch incidents between ordered and delivered uniforms requiring return processing. These problems represent classic manifestations of the inventory management deficiencies documented in comparable small institutional contexts (Mangoting et al., 2021; Susanto, 2017).

The Visual Basic for Applications (VBA) embedded in Microsoft Excel provides an accessible, low-cost platform for developing customized accounting information systems appropriate for small organizations without the budget or technical infrastructure for commercial enterprise resource planning software. The VBA approach has been validated across multiple organizational contexts in Indonesia and comparable developing economies, demonstrating that functional inventory recording systems can be constructed within the familiar Microsoft Excel environment without requiring dedicated server infrastructure, commercial software licensing, or specialized IT implementation expertise (Srinivasan, & Venkateswaran, 2021; Al-Fedaghi, & Alsaqa, 2019). Microsoft Excel is widely available and familiar to administrative staff in Indonesian educational institutions, reducing the software adoption barrier and training requirements relative to purpose-built accounting applications. This accessibility is particularly significant for small institutions such as SMA El Fitra, where budget constraints preclude commercial accounting software investment and where the technical capacity to implement and maintain complex systems is limited (Ogiemwonyi et al., 2020).

This study aims to design and implement a VBA-based uniform inventory accounting system for SMA El Fitra Bandung using the Waterfall development method. The research addresses three questions, first, what are the current weaknesses of SMA El Fitra's manual uniform inventory recording system and their operational consequences, second, what system architecture and functional

modules are required to address these weaknesses within the constraints of the school's technical and financial capacity, and third, what are the outcomes and challenges of implementing a VBA-based system in the school context, and what lessons does this implementation offer for comparable institutional deployments. The study contributes to the applied accounting information systems literature by documenting a complete system development cycle from problem identification through testing and maintenance in a small Indonesian educational institution, providing a replicable design template and documented lessons for comparable deployments.

2. Literature Review

2.1 Accounting Information Systems and Inventory Recording

Accounting Information System (AIS) is an organizational instrument designed to support data management and financial-economic control, enabling the accurate recording, classification, summarization, reporting, and interpretation of financial transactions (Romney, & Steinbart, 2018; Hall, 2019). AIS encompasses both human procedures and technological infrastructure through which financial data are captured, processed, and communicated to decision-makers. The foundational value of an AIS lies not merely in its technological components but in its capacity to produce reliable, timely, and complete financial information that supports management decision-making and accountability (Gelinas, Dull, Wheeler, & Hill, 2018; Kanellou, & Spathis, 2013). This value is directly dependent on the quality of the underlying recording processes: an AIS that captures incomplete or inaccurate transaction data at source will produce unreliable outputs regardless of the sophistication of its processing and reporting capabilities (Poston & Grabski, 2001).

The relationship between AIS quality and organizational financial performance has been extensively documented in the empirical literature. Grande, Estébanez, and Colomina (2011), in a study of Spanish Small and Medium-sized Enterprises (SMEs), demonstrate that AIS adoption produces statistically significant improvements in financial reporting quality, cost control, and decision-making effectiveness, with the magnitude of improvement being greatest for organizations transitioning from entirely manual to computerized systems. Wieder, Booth, Matolcsy, and Ossimitz (2006) similarly confirm that Enterprise Resource Planning (ERP) based AIS implementations produce significant improvements in business process performance and reporting quality across diverse organizational types. Daqar and Smoudy (2019) confirm this pattern across a broader international sample, finding that organizations transitioning from manual to digital accounting systems experience the largest operational performance gains, suggesting that the gap between manual and basic digital recording is larger than the gap between different digital system sophistication levels. Spathis and Ananiadis (2005) further demonstrate that organizations adopting enterprise information systems report improved information quality, enhanced management reporting, and reduced time for financial report preparation, outcomes directly relevant to the present study's motivation. These findings directly motivate the present study's focus on providing SMA El Fitra with a structured computerized inventory recording system as a first-stage AIS improvement (Maditinos, Chatzoudes, & Tsairidis, 2012).

Inventory accounting specifically refers to the systematic recording of inventory movements, including receipts from suppliers, transfers between storage locations, distributions to end-users, and returns, to maintain accurate real-time knowledge of stock quantities, values, and locations (Weygandt, Kimmel, & Kieso, 2019; Nair, & Jayan, 2021). Two inventory recording methods are recognized under international and Indonesian accounting standards: the periodic method, in which physical counting determines stock balances at specified intervals, and the perpetual method, in which every receipt and issuance is individually recorded to maintain a continuously updated balance (Staubus, 2019). The perpetual method, implemented in the present study's VBA system, provides superior real-time stock visibility and audit trail capability but requires a more disciplined recording infrastructure than the periodic method (Chen & Paulraj, 2004). SMA El Fitra's existing system did not systematically use either method, relying instead on informal daily notations without formal stock cards or ledger infrastructure, creating the systematic discrepancies and unverifiable transactions documented in the study's problem analysis.

The importance of adequate inventory controls extends beyond operational efficiency to financial governance and accountability. Nicolaou (2000), in a widely cited study of AIS system quality and organizational performance, demonstrates that inventory control weaknesses are among the most common sources of material misstatement in financial reports of small organizations, and that implementing basic inventory recording controls produces the largest per-unit improvement in financial reporting reliability. This finding underscores the significance of the present study's intervention: while the VBA system is modest in technical sophistication, its impact on SMA El Fitra's financial governance capacity is substantial relative to the baseline of entirely informal recording.

2.2 Microsoft Excel and VBA for Organizational System Development

Microsoft Excel is the world's most widely deployed spreadsheet software, offering a rich environment for data management, formula-based calculation, and structured reporting across Windows, MacOS, and mobile platforms (Grossman, 2015). For small organizations without dedicated accounting software, Excel provides a familiar and accessible platform for building customized recording systems that can be tailored to the specific transaction types, reporting requirements, and user workflows of the organization without requiring commercial software configuration or vendor customization. The widespread availability and staff familiarity of Excel in Indonesian educational and commercial organizations makes it particularly appropriate as the platform for low-cost AIS implementations (Mangoting, Sukoharsono, Rosidi, & Nurkholis, 2021).

Visual Basic for Applications is a macro programming environment embedded within Microsoft Office applications that enables automated task execution, custom form development, and dynamic data processing through code-driven manipulation of Excel workbooks (Srinivasan & Venkateswaran, 2021). VBA enables developers to create structured user interfaces within Excel with input forms, navigation menus, search functions, and print capabilities that function analogously to dedicated software applications while remaining fully contained within a standard Excel workbook file. This containment within a familiar file format eliminates the installation, licensing, and server infrastructure requirements associated with commercial accounting software, making VBA-based systems particularly practical for organizations at the entry level of AIS adoption. Al-Fedaghi and Alsaqa (2019) demonstrate that structured information system design using formal data flow modelling, applied within the VBA-Excel environment, produces significantly fewer implementation errors and better user adoption outcomes than ad hoc macro development.

The VBA approach to inventory system development has been validated across multiple organizational contexts. Wongso, Watrianthos, and Nasution (2021) demonstrate successful VBA-based system implementations for school asset management in Indonesian educational contexts, documenting improvements in recording accuracy and retrieval speed that are directly analogous to the outcomes sought in the present study. Srinivasan and Venkateswaran (2021) confirm that Excel-based system implementations are viable and cost-effective alternatives to commercial ERP for organizations with fewer than 50 staff, with automation of calculation functions identified as the highest-value feature. Rouhani, Ghazanfari, and Jafari (2018), in a systematic review of ERP adoption in SMEs, further demonstrate that modular system design, in which functional capabilities are added incrementally rather than implemented comprehensively at once, reduces implementation risk and is better suited to resource-constrained organizational contexts. This modular principle informed the five-module architecture of the present study's system design.

The limitation of VBA-based systems lies primarily in their dependency on individual users' Excel environments, limited scalability as transaction volumes grow, and the requirement for VBA coding competency for ongoing maintenance (Grossman, 2015; Seethamraju, 2015). These limitations are acknowledged in the present study's limitation and recommendation sections, which identify staffing continuity and coding competency as key operational prerequisites for system sustainability. Helo, Anussornnitisarn, and Phusavat (2008) note that end-user perceptions of system complexity and the gap between developer and user expectations are among the most frequently cited challenges in small-scale information system implementations, reinforcing the importance of user training and documentation in the present study's maintenance phase. Despite these limitations, for organizations at

SMA El Fitra's stage of AIS development, VBA-Excel provides an appropriate balance of accessibility, functionality, and cost that more sophisticated platforms cannot match.

2.3 The Waterfall System Development Method

The Waterfall method is a structured sequential approach to software and system development, in which each phase must be completed and formally validated before the subsequent phase begins (Hussain, Mkpojiogu, & Kamal, 2019). The five canonical stages are requirements analysis, system design, implementation, testing, and maintenance. The Waterfall model was originally proposed remains one of the most widely applied system development methodologies, particularly in organizational contexts where requirements are well-defined, stable, and comprehensively specifiable at the outset of the project (Petersen, Wohlin, & Baca, 2009; Esteves, & Pastor, 2001). Its sequential structure provides clear phase boundaries, explicit deliverables at each stage, and well-defined quality gates, making it highly suitable for small-scale system development projects with non-technical user communities and bounded scope. Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) further argue that structured design science methodologies, of which the Waterfall model is a canonical exemplar, produce more transferable and reproducible system design artefacts than iterative development approaches, a property directly relevant to the present study's objective of producing a replicable design template for comparable institutions.

Hussain et al. (2019), in a comparative study of Waterfall and agile methodologies in small-scale system development, find that the Waterfall method outperforms agile approaches for projects with stable, well-defined requirements and non-technical user bases, conditions that characterize the present study's context. The structured requirements analysis phase of the Waterfall model is particularly valuable in small organizational contexts where users lack technical vocabulary to articulate system requirements iteratively: the structured interview and observation-based requirements gathering conducted in the present study demonstrates this value by translating observed operational problems into specific functional requirements before any system design work begins. Al-Fedaghi and Alsaqa (2019) similarly argue that explicit requirements specification preceding design is the most reliable predictor of system-user fit in organizational information system projects.

The Waterfall method's structured testing phase provides a systematic quality assurance mechanism that is especially important for small organizations where system failures have an outsized operational impact relative to organizations with redundant systems and larger IT support capacity. Petersen et al. (2009), in a systematic review of Waterfall method applications, demonstrate that formal testing phases in Waterfall projects identify significantly more functional defects than equivalent informal testing, and that defects identified during the testing phase are substantially less costly to correct than those discovered post-deployment. This finding is directly relevant to the present study, where two significant coding errors were identified and corrected during the testing phase, demonstrating the method's quality assurance value in preventing these errors from affecting the live operational system.

2.4 Prior Empirical Studies

Table 1. Summary of prior studies on inventory system design and implementation

Author(s) & Year	Setting / Context	Method	Key Finding on Inventory System Design
Ogiemwonyi et al. (2020)	SME inventory management, Malaysia	Survey, quantitative	Technology adoption in inventory management significantly reduces errors and improves operational efficiency; user training is the primary success factor
Srinivasan & Venkateswaran (2021)	Spreadsheet-based ERP for SMEs	Case study	Excel-based ERP systems are viable and cost-effective alternatives to commercial ERP for organisations with fewer than 50 staff; automation of calculations is the highest-value feature
Al-Fedaghi & Alsaqa (2019)	Inventory information system modelling	Design science	Structured system design with explicit data flow modelling produces significantly fewer implementation errors than ad hoc development

Author(s) & Year	Setting / Context	Method	Key Finding on Inventory System Design
Wongso et al. (2021)	School asset management system, Indonesia	System design, qualitative	VBA-based systems for institutional asset management reduced manual recording errors and improved retrieval speed in Indonesian school contexts
Mangoting et al. (2021)	Accounting information system adoption in SMEs	Qualitative case study	Lack of formal AIS is the primary source of financial reporting inaccuracy in Indonesian SMEs; VBA-Excel systems represent the most accessible entry-level AIS solution
Rouhani et al. (2018)	ERP system adoption in SMEs	Systematic review	Small organisations benefit more from modular system design than comprehensive ERP; modular adoption reduces implementation risk and allows incremental capability building
Hussain et al. (2019)	Waterfall vs agile in small-scale system development	Comparative analysis	Waterfall method outperforms agile for system development in organisations with stable, well-defined requirements and non-technical user bases
Laudon & Laudon (2022)	Management information systems, general	Textbook / review	Information systems that automate record-keeping processes produce measurable improvements in accuracy, speed, and auditability across all organisational types
Daqar & Smoudy (2019)	ERP and operational performance in SMEs	Quantitative survey	ERP system adoption improves operational performance; the magnitude of improvement is largest for organisations transitioning from fully manual to digital systems

Table 1 shows a synthesis of ten prior studies alongside the present study, spanning surveys, case studies, design science research, systematic reviews, and comparative analyses across diverse organizational and national contexts. The evidence base consistently identifies three primary success factors for inventory system implementation: structured requirements analysis prior to system design, modular system architecture that matches functional complexity to organizational capacity, and structured user training that ensures operational staff can use and maintain the system independently. The prior studies also converge on identifying the VBA-Excel platform as appropriate for small organizations in developing country contexts where commercial ERP software is financially and technically out of reach. The present study's Indonesian educational institution context is directly comparable to the SME and small institutional contexts documented in the prior literature, confirming the applicability of these evidence-based design principles to the SMA El Fitra implementation.

3. Research Methodology

3.1 Research Design

A qualitative case study design was employed, which is appropriate for a system development study in which the primary research objectives are descriptive (characterizing the current system), prescriptive (designing an improved system), and evaluative (assessing implementation outcomes) rather than hypothesis testing (Yin, 2018; Creswell, & Poth, 2018). The case study focuses on SMA El Fitra Bandung as the bounded system under investigation, with the uniform inventory management process as the specific unit of analysis. The qualitative approach enables the researcher to develop a nuanced, contextually grounded understanding of the operational problems, institutional constraints, and user requirements that shape the system design, a depth of understanding that quantitative methods alone cannot provide for system development research (Creswell and Poth, 2018; Braun, & Clarke, 2006).

The system development methodology follows the Waterfall model (Hussain, Mkpojiogu, & Kamal, 2019; Petersen, Wohlin, & Baca, 2009), incorporating elements of technology diffusion and technology substitution as conceptual frameworks for understanding the process through which the new digital system replaces the prior manual system (Rogers, 2003). Technology diffusion theory,

originally developed by Rogers (2003), provides a framework for understanding why and how organizations adopt new technologies, identifying relative advantage, compatibility with existing practices, simplicity, trialability, and observability as the five key attributes determining adoption success. Davis (1989), in the seminal Technology Acceptance Model, further demonstrates that perceived usefulness and perceived ease of use are the two most powerful determinants of individual user acceptance of information systems, a finding directly relevant to the present study's emphasis on interface simplicity and familiarity. Venkatesh, Morris, Davis, and Davis (2003) extend this framework into a unified theory of user acceptance, confirming that performance expectancy and effort expectancy are the strongest predictors of system adoption across diverse organizational contexts. These attributes guided the system design decisions, particularly the emphasis on password protection as a security feature with high observability, and the use of familiar Excel-format reports that are compatible with existing staff documentation practices.

3.2 Data Collection Methods

Three complementary data collection methods were employed to ensure a comprehensive and triangulated understanding of the current system's weaknesses and the information needs that the new system must address (Merriam & Tisdell, 2016). Unstructured interviews were conducted with the school's finance and warehouse administrative staff to understand their current recording practices, pain points, and information needs, using an open-ended questioning approach that allowed informants to describe their experiences in their own terms without being constrained by researcher-imposed categories. Direct observation of the physical inventory management environment, including the uniform storage rack system, current notebook recording format, transaction documentation practices, and physical stock count procedures, provided contextual information that interviews alone could not fully capture. The documentation collection encompassed existing transaction records, supplier receipts, student distribution lists, and the school's annual uniform procurement history, providing primary source evidence for the problem analysis and requirements specification.

Data analysis followed a qualitative descriptive approach comprising three analytical stages Miles, Huberman, and Saldana (2020) data reduction, which involved filtering and organizing the large volume of collected information into thematically coherent categories relevant to the system design requirements; data display, which organized the reduced information into structured representations including process maps and requirement specifications that could directly inform the system design phase; and conclusion drawing and verification, which synthesized the organized findings into a problem statement and system requirements specification that was reviewed with key informants for accuracy and completeness. This analytical approach ensured that the system design was firmly grounded in the empirically identified needs of the institution rather than in generic inventory system templates.

3.3 System Development Stages

The five Waterfall development stages were implemented sequentially at SMA El Fitra, as described in Table 2.

Table 2. Waterfall system development stages applied at SMA El Fitra

Phase	Stage Name	Activities	Output / Deliverable
1	Requirements Analysis	Identify current manual recording problems; interview finance and administrative staff; collect existing transaction documents (receipts, stock records)	Problem statement; specification of system requirements; inventory flow documentation
2	System Design	Design system architecture; design user interface forms for inventory data, incoming goods, outgoing goods, save, and exit menus; design data flow between modules	System design specification; user interface wireframes; data flow diagram

Phase	Stage Name	Activities	Output / Deliverable
3	Implementation	Convert design into VBA code in Microsoft Excel; build Main Menu, Item Data, Incoming Goods, Outgoing Goods, Save, and Exit modules; integrate search and print features	Functional VBA-based inventory recording system prototype in Microsoft Excel
4	Testing	Five trial runs with finance and warehouse staff; test incoming goods input, outgoing goods input, search, and stock update automation; identify system failures and coding errors	Test results: 3 successful trials; 2 failed (menu and search coding errors); user feedback and error documentation
5	Maintenance	Correct identified coding errors; provide user training and operating manual; advise on backup procedure and human resource competency for system continuity	Corrected system; trained users; operating documentation; maintenance recommendations

Table 2 shows the five sequential stages of the Waterfall methodology as applied in the present study, together with the specific activities undertaken at each stage and the outputs produced. The structured sequential character of the Waterfall method is evident in the progression from problem identification and requirements specification in Stage 1, through design and implementation in Stages 2 and 3, to formal quality assurance in Stage 4 and corrective action in Stage 5. Each stage produced explicit documented outputs, a feature that distinguishes the Waterfall approach from informal system development and provides an auditable record of the development process. The testing phase outputs of three successful and two failed trials demonstrate the quality assurance function of the structured testing stage, while the maintenance phase outputs of a corrected system and trained users represent the completed deliverable of the development process.

4. Results and Discussions

4.1 Current System Assessment: Problem Identification

An initial investigation at SMA El Fitra Bandung confirmed the complete absence of any formal inventory accounting system for school uniform management. The current practice consisted entirely of handwritten daily records in student notebooks, maintained by finance and administrative staff without standardized forms, stock cards, or reconciliation procedures. Two recording modes were identified in practice: physical counting, in which staff physically counted remaining stock at irregular intervals, and book recording, which was intended to track movements continuously but was too inconsistent to serve as a reliable stock balance source. The coexistence of these two inconsistently applied modes without formal reconciliation procedures created the persistent discrepancies that constitute the system's primary operational failure.

This dual-mode gap produced four documented operational problems that motivated system development. First, recording errors: manual arithmetic in handwritten notebooks generated frequent calculation mistakes, and the absence of automatic cross-referencing between physical counts and book records created persistent physical-book discrepancies. These errors are directly attributable to the absence of automated calculation, a deficiency confirmed by multiple studies of manual inventory systems in comparable small organizational contexts (Wongso, Watrianthos, & Nasution, 2021; Mangoting, Sukoharsono, Rosidi, & Nurkholis, 2021). Second, receipt management failures: supplier receipts from the uniform manufacturer were frequently misplaced or lost, eliminating the documentary evidence needed to verify incoming quantities and initiate returns of defective or incorrectly sized items. Third, size specification failures: on multiple occasions, uniforms delivered by the manufacturer did not match the ordered size specifications, creating return logistics complications that the existing system had no formal mechanism to handle. Fourth, distribution mismatches: some uniforms distributed to students did not match the sizes ordered, requiring post-distribution corrections that undermined student and parental confidence in the school's administrative competence.

These problems are consistent with the vulnerability typology documented in the AIS implementation literature for small organizations transitioning from informal to formal recording systems. Rouhani, Ghazanfari, and Jafari (2018) identify receipt management failures and reconciliation discrepancies as the two most common manifestations of inadequate inventory control in small organizational contexts, while Ogiemwonyi, Harun, Alam, Karim, Tabash, and Hossain (2020) demonstrate that these failures are addressable through basic computerized recording systems even in resource-constrained environments. The present study's problem identification phase therefore confirms both the severity of SMA El Fitra's inventory control deficiencies and the appropriateness of a VBA-based computerized system as the primary remediation mechanism.

4.2 System Design: Architecture and Module Description

Based on the requirements analysis, the inventory accounting system was designed around five functional modules integrated within a single Microsoft Excel workbook, controlled through a VBA-driven Main Menu interface. The five-module architecture was selected to match the specific transaction types and reporting needs identified during the requirements analysis phase while maintaining system simplicity appropriate for non-technical administrative staff users. The modular design principle, recommended by Rouhani, Ghazanfari, and Jafari (2018) for small organizational AIS implementations, ensures that each module can be understood, operated, and troubleshot independently, reducing the training burden on users and the maintenance burden on the institution. Table 3 describes the functions, features, and data integration of each module within the broader system architecture.

Table 3. System module architecture: Functions, features, and integration

Module	Function	Key Features	Data Integration
Main Menu	Central navigation interface; links to all system modules	Password-protected access; navigation buttons to all submodules; session management	Directs to Item Data, Incoming Goods, Outgoing Goods, Save, Exit
Item Data	Master inventory registry listing all uniform types and codes	Item ID, item name, current stock, storage location (rack code); search function; total item count display; update-enabled records	Auto-updated by Incoming/Outgoing modules; source data for all other modules
Incoming Goods	Records all uniform receipts from supplier	Transaction ID, date, Item ID, item name, unit, initial stock, incoming quantity; auto-calculation of final stock; date-range search; print function	Auto-updates stock in Item Data module upon input
Outgoing Goods	Records all uniform distributions to students	Transaction ID, date, Item ID, item name, unit, storage rack, initial stock, outgoing quantity; auto-calculation of remaining stock; date-range search; print function	Auto-reduces stock in Item Data module upon input
Save / Exit	Data persistence and session management	Save function stores all session transactions to Excel workbook; Exit function closes application safely	Operates on VBA workbook save mechanism; data persists across sessions

Table 3 shows the five modules of the VBA inventory system, their primary functions, key features, and data integration relationships. The hub-and-spoke data architecture, in which the Item Data module functions as the central inventory registry automatically updated by both the Incoming Goods and Outgoing Goods modules, represents the architectural core of the perpetual inventory recording system. This architecture ensures that the current stock balance displayed in the Item Data module always reflects the cumulative net of all recorded receipts and issuances, eliminating the physical-book discrepancies documented in the problem analysis. The transaction ID system implemented in the Incoming and Outgoing Goods modules creates a traceable audit trail for every stock movement, addressing the receipt management vulnerability identified in the current system assessment. The

date-range search functionality directly addresses the slow retrieval problem, while the password-protected Main Menu addresses the data security weakness of the prior paper-based system.

The system employs a hub-and-spoke data architecture in which the Item Data module functions as the central inventory registry automatically updated by every transaction recorded in the Incoming Goods and Outgoing Goods modules. This ensures that the current stock balances in the Item Data module always reflect the cumulative net of all recorded receipts and issuances, providing a perpetual inventory system that continuously displays real-time stock without requiring periodic physical counting for basic stock balance information. The perpetual inventory method implemented by this architecture is consistent with best-practice inventory accounting standards and provides a substantially more reliable stock balance than the inconsistent hybrid method previously employed by the school (Weygandt, Kimmel, & Kieso, 2019; Staubus, 2019).

Three key usability features that were absent from the previous manual system were incorporated into the design. First, a transaction ID system assigns unique identifiers to each incoming and outgoing transaction, creating a traceable audit trail for every stock movement in the warehouse. Second, date-range search functionality allows staff to retrieve transaction histories for any specified period, replacing the laborious manual search through handwritten notebooks. Third, print functionality enables the generation of paper-format transaction records and stock reports, supporting the school's requirement for physical documentation of stock opname and distribution records. These three features directly address the most operationally significant weaknesses of the prior system identified during the requirements analysis phase.

4.3 Implementation: System Build

The system was built using VBA Macro coding within Microsoft Excel, implementing the form designs and data flow architectures specified during the design phase. Each module was coded as a separate VBA UserForm, with event-driven procedures triggered by button clicks and field interactions including auto-population of item name from item ID lookup and automatic stock calculation from input quantities. The Main Menu was designed as the system's entry point, displaying navigation buttons to all submodules and requiring password authentication before granting access to the inventory management functions, providing a security feature that the manual system was entirely incapable of delivering. The password protection mechanism implements one of the most basic but most impactful information security controls: access restriction that prevents unauthorized users from viewing, entering, or modifying inventory data (Romney, & Steinbart, 2018; Ifinedo, 2011). DeLone and McLean (2003), in their widely applied model of information systems success, identify system quality and information quality as the two foundational determinants of IS use and user satisfaction, dimensions that the present system addresses through automated calculation accuracy and structured data entry controls.

The implementation process encountered two significant challenges that were subsequently addressed during the testing and maintenance phases. First, the automatic stock update logic, designed to trigger an Item Data stock recalculation whenever an Incoming or Outgoing Goods transaction was saved, contained a referencing error that in some configurations failed to update the correct cell range. This error caused the system failure documented in Trial 4, in which the stock balance did not update after incoming goods input. Second, the date filtering logic of the search function contained a data type comparison error that prevented the function from returning results when dates were entered in certain formats, causing the system failure documented in Trial 5. Both errors represent typical implementation challenges in VBA development and are consistent with the finding of Petersen, Wohlin, and Baca (2009) that structured testing phases identify substantially more functional defects than informal testing, underscoring the value of the Waterfall method's formal testing stage in the present project.

4.4 Testing Results

Five trial tests were conducted with SMA El Fitra finance and warehouse staff to evaluate the system's functional performance against the requirements specification developed during the requirements

analysis phase. Table 4 presents the detailed results of all five trials.

Table 4. System testing results: Five riatl runs at SMA El Fitra

Trial	Activity Tested	Result	Status	Issue Identified
1	Incoming goods input; stock update validation	System correctly recorded incoming goods; Item Data stock updated automatically	Successful	None
2	Outgoing goods input; date-range search	System correctly recorded outgoing goods; stock reduced automatically; search returned correct date-filtered results	Successful	None
3	Full cycle: Incoming + Outgoing + Save + Print	Full recording cycle completed; saved data persisted; print output generated correctly	Successful	None
4	Incoming goods input (Week 3, April)	Stock balance did not update after incoming goods input; system failed to reflect new inventory total	Failed	Coding error in Main Menu module: stock update function referenced incorrect cell range
5	Item search function	Search query did not return expected results; item lookup function unresponsive	Failed	Coding error in search function module: date type comparison error prevented result matching

Table 4 shows the outcomes of the five trial tests conducted during the system testing phase. The three successful trials (Trials 1, 2, and 3) demonstrated that the system's core functions performed correctly: incoming and outgoing goods recording with automatic stock balance update, date-range transaction search, complete recording cycle execution, and save and print functionality. The two failed trials (Trials 4 and 5) identified specific VBA coding errors in the stock update referencing logic and the date type comparison in the search function respectively. Both errors were specific, identifiable, and correctable, rather than indicative of fundamental system design flaws, and were fully resolved during the maintenance phase. The 60% initial pass rate followed by complete error correction is consistent with normal iterative quality assurance in Waterfall development projects, as documented by Petersen, Wohlin, and Baca (2009) and Hussain, Mkpojiogu, and Kamal (2019). The testing process also revealed three external operational challenges: missing supplier receipts, delivery size mismatches, and distribution size mismatches, which require complementary procedural improvements alongside the technical system.

The testing process revealed that user interaction with the system was generally positive after initial orientation. Finance staff found the form-based input interface significantly more accessible than expected, attributing this to its similarity in visual layout to the notebook-format records they had previously used. Warehouse staff particularly valued the automatic stock update feature, which eliminated the need for manual recalculation that had been the most common source of arithmetic errors in the prior system. These user response observations are consistent with the technology adoption literature's finding that compatibility with existing workflow practices is among the strongest predictors of adoption success (Rogers, 2003; Ogiemwonyi, Harun, Alam, Karim, Tabash, & Hossain, 2020). Abugabah and Sanzogni (2010), examining ERP system adoption in higher education institutions, similarly find that perceived ease of use and perceived alignment with existing work processes are the dominant determinants of system acceptance among non-technical administrative users, a pattern directly reflected in the present study's positive user responses. Ram, Wu, and Corkindale (2013) further demonstrate that user involvement in the testing phase of system implementation is a critical success factor that significantly improves post-implementation satisfaction and reduces resistance to adoption, reinforcing the value of the participatory testing approach employed in this study. Aremu, Shahzad, and Hassan (2019) confirm that information system

implementations in medium-scale enterprises achieve the greatest operational performance improvements when end-user training is integrated into the testing and maintenance phases, consistent with the present study's combined testing and training approach.

4.5 Implementation Outcomes: Before and After Comparison

Table 5 presents a structured comparison of the manual system's performance against the VBA-based system across six operational dimensions identified as critical during the requirements analysis phase.

Table 5. Comparative performance: Manual system vs VBA-based system

Dimension	Before (Manual System)	After (VBA-based System)
Recording Method	Handwritten in notebook; error-prone; time-consuming	Digital form input via VBA interface; automated calculation
Data Accuracy	Frequent arithmetic errors; physical vs. book inventory discrepancies	Automated stock calculations reduce arithmetic errors; real-time stock balance
Data Retrieval	Manual search through handwritten notebooks; slow and error-prone	Search by date range or item ID; immediate results display
Data Security	Paper records susceptible to loss, damage, and unauthorized access	Password-protected system; data stored in Excel workbook; backup possible
Time Efficiency	High time cost for manual calculation, verification, and reporting	Reduced recording and reporting time; automated stock update upon transaction input
Reporting Capability	Manual compilation required; delay in stock opname reporting	Print-ready transaction reports; supports monthly stock opname documentation

Table 5 shows the improvements achieved by the VBA-based system relative to the prior manual system across six operational dimensions. The most significant gains are in data accuracy, where automated stock calculation eliminates the manual arithmetic errors that were the most frequent and impactful source of recording failures in the prior system; in data retrieval speed, where the search-by-date-range and search-by-item-ID functions replace time-consuming notebook searches; and in data security, where password-protected access and digital backup capability replace vulnerable paper records that were susceptible to physical loss, water damage, and unauthorized access. The reporting capability improvement is strategically significant because it enables the school to generate print-ready stock opname documentation that supports both internal management and external accountability requirements. The time efficiency improvement, which reduces the administrative burden on finance and warehouse staff, has a secondary benefit of freeing staff time for verification and quality control activities that the prior system did not support.

These outcomes are consistent with the comparative improvements documented across the prior empirical literature for analogous small organizational system implementations. Wongso, Watrianthos, and Nasution (2021) document similar improvements in recording accuracy and retrieval speed for VBA-based institutional asset management systems, Srinivasan and Venkateswaran (2021) confirm comparable efficiency gains for Excel-based systems replacing manual processes in SME contexts, and Daqar and Smoudy (2019) demonstrate that organizations transitioning from entirely manual to basic digital recording systems achieve the largest operational performance improvements in the AIS adoption literature. The present study extends these findings to the specific context of educational institutions managing procurement and distribution cycles, confirming the applicability of the VBA-Excel inventory system approach to non-commercial organizational settings.

4.6 Inventory Procedure under the New System

The formal inventory procedure implemented alongside the VBA system comprises ten sequential steps designed to integrate documentary control with system data entry. The warehouse department receives a Goods Receipt Letter signed by the supervising manager; the warehouse department verifies the received goods against the letter; if quantities match, goods are admitted to the warehouse and a three-copy receipt is distributed to the supervising manager, warehouse, and sales administration; goods are stored on shelves according to rack codes on stock cards; the warehouse

administration inputs incoming goods data into the system, automatically updating the stock balances in the Item Data module; the administration prepares five copies of the invoice signed by the supervising manager; based on the invoice, the warehouse verifies stock availability; if available, goods are prepared for student distribution and outgoing goods data are entered into the system; if unavailable, distribution is deferred and a replenishment request is raised; return transactions trigger a Return Memo; and monthly, the warehouse conducts physical stock opname and generates incoming, outgoing, stock opname, return, and stock card reports. This procedural framework addresses the documentary control weakness of the prior system by mandating formal Goods Receipt Letters and systematic receipt filing, directly tackling the receipt management failure identified in the problem analysis (Boonstra, 2013). Bag, Gupta, and Luo (2020) demonstrate that the integration of structured physical verification procedures with digital data entry is among the most effective mechanisms for ensuring data integrity in inventory systems deployed in logistics and distribution contexts, a finding applicable to the present study's uniform distribution cycle. The integration of physical verification procedures with system data entry ensures that the system's stock balances are grounded in verified physical quantities rather than relying solely on data entry without independent confirmation (Iskandar, 2015; Alaskari, Ahmad, & Pinedo-Cuenca, 2021).

5. Conclusions

5.1 Conclusion

This study designed and implemented a VBA-based uniform inventory accounting system at SMA El Fitra Bandung using the five-stage Waterfall development methodology. The implementation addressed four documented weaknesses of the prior manual system: recording inaccuracy attributable to manual arithmetic; slow and error-prone data retrieval from handwritten notebooks; inadequate data security through reliance on paper records susceptible to loss and unauthorized access; and time-inefficient recording processes that diverted administrative staff from verification and quality control activities. The designed system incorporates five functional modules integrated through a VBA-driven Microsoft Excel workbook, providing a perpetual inventory recording system with automated stock balance updates, date-range transaction search, print-ready report generation, and password-protected access control.

Testing produced three successful and two failed trials, with both failures attributable to specific VBA coding errors that were identified and corrected during the maintenance phase, demonstrating the quality assurance value of the Waterfall method's structured testing stage. Four practical operational outcomes were demonstrated relative to the prior manual system: improved time efficiency, improved recording accuracy, improved data accessibility, and improved data security. Three external operational challenges were identified that require complementary management procedure improvements: supplier receipt management requiring systematic filing at the point of receipt, manufacturer size quality control requiring physical sampling at the point of delivery verification, and student distribution size matching requiring enhanced pre-distribution quality checks. These challenges underscore that technical system implementation must be accompanied by complementary procedural reforms to achieve the full operational benefits available from the system.

For SMA El Fitra management, three operational recommendations are proposed. First, all supplier receipts must be systematically collected and filed by responsible finance staff at the time of goods receipt, as they constitute the primary documentary basis for system data entry and supplier return claims. Second, goods verification at the point of delivery should include physical size sampling by both school staff and the manufacturer's representative to minimize size mismatch incidents before goods are admitted to the warehouse. Third, at least one staff member should maintain VBA coding proficiency to support system maintenance and error correction, reducing dependence on external developers for routine corrections and ensuring system sustainability across staff changes. The broader policy implication of this study is that small educational institutions in Indonesia can effectively implement basic inventory accounting information systems using widely available tools at minimal cost, provided that system design is grounded in structured requirements analysis, development follows a structured methodology, and implementation is accompanied by adequate staff training and procedural documentation.

5.2 Research Limitations

First, the current system scope is limited to incoming goods, outgoing goods, and current stock quantity tracking; it does not include financial valuation of inventory consistent with PSAK No. 14 (cost of goods distributed calculations), return processing modules, or integration with the school's broader financial and accounting system. These scope limitations mean that the system, while representing a substantial improvement over the manual baseline, does not yet constitute a complete inventory accounting system in the full sense of PSAK No. 14 compliance. Second, the system was tested only five times in a single implementation period, limiting the assessment of system stability across the full academic year cycle including peak distribution periods at the start of each semester and the full monthly stock opname cycle. Third, the system's sustainability depends on the continued availability of staff with sufficient VBA and Microsoft Excel competency, a human resource prerequisite that may be challenging to maintain given staff turnover rates in smaller educational institutions.

5.3 Suggestions and Directions for Future Research

Future research and system development should address the current scope limitations in three complementary directions. First, system expansion should incorporate a financial valuation module applying inventory costing methods consistent with PSAK No. 14 and IAS 2 to calculate the cost of distributed uniforms and the value of remaining stock, enabling integration with the school's financial statements and supporting management accounting functions currently absent from the system. Second, a returns management module should be developed to formally record size exchange transactions and manufacturer return claims, addressing the operational challenges identified during testing and completing the full inventory transaction cycle. Third, future implementations should develop a comprehensive user training manual and formal disaster recovery protocol, including workbook backup procedures and manual recording fallback, to ensure operational continuity during system failures and to support staff onboarding as turnover occurs.

Future comparative studies examining VBA-based inventory system implementations across multiple Indonesian educational institutions of different sizes, resource levels, and operational contexts would establish generalizable design principles and critical success factors for this class of system. Such comparative research would address a current gap in the AIS implementation literature: while the effectiveness of VBA-Excel systems for SME and commercial contexts is well-documented, the specific design and implementation requirements of educational institutions, with their distinctive procurement cycles, non-commercial distribution logic, and administrative staff profiles, have received comparatively limited scholarly attention. Future research adopting mixed-methods designs that combine system performance metrics with organizational and user behaviour outcomes would also deepen understanding of the conditions under which VBA-based AIS implementations achieve sustained operational improvements beyond the initial implementation period.

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