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Design of an Expenditure Data Management System to Minimize Human Error in Figor Coffee MSME using the Waterfall Method

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Abstract

Digital transformation has intensified pressure on micro, small, and medium enterprises (MSMEs) to adopt information systems that improve the efficiency and accuracy of financial management. However, many MSMEs still rely on manual expenditure recording, which is vulnerable to human error including nominal mistakes, transaction duplication, late recording, and account misclassification. Although digital accounting system adoption has been shown to improve SME performance, empirical evidence on no-code platforms such as AppSheet as a targeted human error reduction mechanism for expenditure management in Indonesian cafe MSMEs remains absent in the literature. This study designed, developed, and evaluated an AppSheet-based expenditure data management system for Figor Coffee MSME in Makassar using a Research and Development (R&D) approach following the Waterfall Software Development Life Cycle model. Data collection was conducted from December 2024 to February 2025. Black-box testing across 13 features by four independent validators achieved a 100% functional feasibility score (52/52 validations). System Usability Scale (SUS) testing with three users yielded an average score of 89 (Excellent). Implementation reduced recording errors from 19 cases to 2 cases (89.47% reduction), eliminated nominal discrepancies from Rp473,250 to Rp0, and shortened recapitulation time from 90 minutes to 25 minutes. These findings demonstrate that AppSheet provides an accessible and cost-effective no-code solution for improving financial recording accuracy and operational efficiency in MSMEs.

Keywords: *AppSheet; Digital Transformation; Human Error; Information Systems; MSMEs*

1. Introduction

Micro, Small, and Medium Enterprises (MSMEs) play a pivotal role in the Indonesian economy through employment absorption and regional economic growth, yet the sector faces persistent structural challenges in financial management. Manual expenditure recording remains widespread among MSMEs, generating systematic risks of human error: nominal mistakes, duplicate entries, account misclassifications, and delayed transaction capture that collectively undermine the accuracy of financial reports and the quality of business decision-making (Verhoef et al., 2021). Romney and Steinbart (2021) define an Accounting Information System (AIS) as a system designed to collect, record, store, and process financial data to produce relevant information for decision-making; a function that manual recording systems structurally fail to perform when automated validation mechanisms are absent. As Reason (1990) established, human error is not exclusively the product of individual negligence but is systematically shaped by work systems, cognitive limitations, and operational environments, a principle that applies directly to repetitive financial recording tasks in resource-constrained MSME contexts.

The digital transformation of financial management offers a compelling systemic solution to this vulnerability. Verhoef et al. (2021) define digital transformation as the process of integrating digital technology into all aspects of business operations, fundamentally changing how organizations create value. Lutfi et al. (2022) provide empirical evidence that digital accounting system adoption positively and significantly affects SME performance, with organizational readiness and management support as key moderating factors. Thuan et al. (2022), drawing on the Technology-Organization-Environment framework and Resource-Based View theory with 132 Vietnamese SMEs, confirmed that relative advantage, owner commitment, and AIS usage effectiveness collectively drive positive business performance outcomes. In the Indonesian MSME context, however, partial digitalization is common: businesses often adopt cashier applications for income recording while leaving expense management in a manual state, creating information asymmetries that heighten error risk at precisely the operational boundary between recorded income and verified expenditure.

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While commercial platforms such as SAP, Oracle, MYOB, and Accurate are available, their adoption by MSMEs is constrained by implementation costs, technical complexity, and the training burden they impose on non-specialist users. No-code platforms have emerged as a practically significant alternative. Domanski et al. (2023), reviewing low-code and no-code platforms for SME management processes, found that these platforms offer documented benefits including faster development, lower costs, and empowerment of non-technical users to build functional applications; key advantages in the resource-constrained MSME environment. AppSheet, a cloud-based no-code platform developed by Google, enables users without programming expertise to build custom applications connected to Google Sheets databases, with automated input validation, structured dropdowns, cloud storage, and mobile accessibility. Sufi (2023) notes that no-code platforms represent the current evolutionary stage of algorithm-based software development, democratizing application creation beyond specialist developers to include business users and practitioners. Despite this growing relevance, empirical research evaluating no-code platforms as human error reduction tools in Indonesian MSME financial management remains scarce.

This gap is directly observable at Figor Coffee, a cafe MSME in Makassar that relied on manual notebook and spreadsheet recording for expenditures at the time of this study. Pre-intervention observation documented 19 error cases over a 30-day baseline, generating a nominal discrepancy of Rp473,250 and requiring 90 minutes of manual recapitulation per reporting cycle. Following the design science approach described by Wieringa (2014), in which a design process iterates over artifact design and empirical investigation of performance in context, this study developed an AppSheet-based intervention and rigorously evaluated it against quantifiable pre/post metrics.

This study makes two explicit contributions. First, it demonstrates the application of the Waterfall Software Development Life Cycle as a structured development framework for AppSheet-based financial management systems in the MSME context, producing a replicable five-phase development blueprint. Second, it provides quantified evidence of AppSheet effectiveness in reducing human error and improving operational efficiency at a single-site cafe MSME, with verified pre/post metrics and SUS-based usability evidence. The research objectives are: (1) to design and implement a Waterfall-based AppSheet expenditure management system for Figor Coffee MSME; and (2) to evaluate the system's effectiveness in reducing human error in financial recording and improving operational efficiency.

2. Literature Review

2.1. Digital Transformation and MSMEs

For MSMEs operating in competitive local markets, digital transformation represents the most accessible pathway to operational efficiency improvement and financial management quality. Verhoef et al. (2021) describe digital transformation as the process of integrating digital technology into all aspects of business operations, fundamentally changing how organizations create value through digitization, digitalization, and full digital transformation stages. Pham and Vu (2022), studying SMEs in the food and beverage sector, found that digitalization of accounting information generates sustainable innovation ecosystem value by enabling accurate, real-time financial intelligence that supports agile management decisions; a direct capability gap that Figor Coffee's manual system could not fulfill. Sastararuji et al. (2022), investigating cloud accounting adoption in Thai SMEs through the Technology-Organization-Environment framework, found that cloud-based accounting systems help SMEs achieve greater financial organization, flexibility, and efficiency, with owner dependence on manual processes identified as a primary adoption barrier consistent with the Figor Coffee baseline profile.

In this study, digital transformation is operationalized through the implementation of an AppSheet no-code platform to automate expenditure recording at Figor Coffee MSME. This represents targeted operational digitalization: replacing a manual, validation-free process with a structured digital workflow that enforces input standards, automates recapitulation, and provides a cloud-accessible audit trail that directly addresses the 19-case human error rate documented in the pre-intervention baseline.

2.2. Accounting Information Systems

An Accounting Information System (AIS) is, as Romney and Steinbart (2021, p. 3) define it, a system that collects, records, stores, and processes data to produce information for decision-makers; encompassing both the people and procedures for data collection, the information technology processing, and the internal controls that safeguard data accuracy. In a manual MSME system, the expenditure recording process involves sequential steps (cash book entry, period-end recapitulation, and balance verification) that expose transaction data to compounding human error at each stage due to the absence of automated validation, input format enforcement, and duplication detection. Digital AIS implementations address these vulnerabilities through automated transaction validation, standardized account categorization, format-restricted data entry, structured database storage, and automated reporting, producing information that meets the AIS quality criteria of accuracy, relevance, timeliness, and reliability identified by Romney and Steinbart (2021).

Thuan et al. (2022) empirically confirmed that AIS usage has a positive and significant relationship with AIS effectiveness, which in turn positively impacts business performance in SME contexts, with the relative advantage of the system over

existing manual processes being the strongest predictor of adoption. Ibrohim and Surachman (2025) found that online accounting system adoption among MSMEs in Serang significantly improved recording accuracy and accelerated financial report preparation. The AppSheet-based system developed in this study functions as a simple AIS that integrates input forms, automated validation, account category dropdowns, cloud storage, and a reporting dashboard, minimizing manual intervention in calculation and classification while remaining accessible to non-specialist MSME staff.

2.3. Human Error Theory

Human error theory, as foundationally developed by Reason (1990), classifies errors into three categories corresponding to different levels of cognitive processing. Skill-based errors occur during routine, automated activities and manifest as slips and lapses: typos such as entering 6,000 as 60,000, forgotten transactions, misplaced zeros, and duplicate entries. These errors arise not from conceptual misunderstanding but from the attentional demands and fatigue inherent in repetitive tasks. In the Figor Coffee baseline data, skill-based errors constituted the most dominant category (57.89% of all documented cases). Rule-based errors occur when known procedures are incorrectly applied, manifesting as account misclassification and inconsistent application of recording standards. Knowledge-based errors occur in novel situations requiring analytical reasoning, such as incorrect distinctions between operational and capital expenditures, representing the smallest category (15.79%) but the most consequential in terms of long-term financial statement quality. Reason (1990) explains that unstructured work systems amplify the probability of all three error types by providing insufficient cognitive scaffolding, shifting the intervention logic from individual behavior modification toward system-level redesign.

2.4. System Development with the Waterfall Model

The Waterfall model is a sequential Software Development Life Cycle (SDLC) framework in which each phase must be completed before the next begins: requirements analysis, system design, implementation, testing, and maintenance. Pressman and Maxim (2019) describe the Waterfall model as a classic paradigm for software engineering that is appropriate when requirements are well-understood and unlikely to change significantly during development, providing a systematic and disciplined approach suited to projects where scope is clearly defined upfront. The SDLC Waterfall approach provides systematic quality assurance by requiring each phase to produce verifiable artifacts before proceeding, ensuring that design decisions are grounded in requirements analysis and that implementation is validated against specifications through formal testing. Wohlin (2021) notes that design-type research studies in information systems (those that intervene in a context by creating an artifact and measuring its effects) are methodologically distinct from pure case study research, requiring explicit documentation of the development process alongside evaluation of outcomes. This principle informs the dual contribution of this study: documenting the five-phase Waterfall development process as a replicable blueprint alongside quantitative evaluation of the system's effectiveness in reducing human error.

2.5. System Usability Scale and Black-Box Testing

Black-box testing is a functional testing methodology that evaluates system behavior based on inputs and outputs without examining internal code structure (Mahendra & Asmarajaya, 2022). It is particularly suited to AIS validation because it mirrors the end-user experience: testers verify that each feature produces the expected output for defined inputs without requiring technical implementation knowledge. The System Usability Scale (SUS), developed by Brooke (1996), is a widely used ten-item Likert-scale instrument providing a standardized measure of perceived system usability on a 0-100 scale. Bangor et al. (2008), in a comprehensive empirical study involving 2,324 SUS evaluations, established that scores above 80.3 correspond to an Excellent grade, scores of 71.4-80.3 to Good, and scores of 50.9-71.4 to OK. The concurrent use of black-box testing for functional completeness and SUS for usability quality provides a complementary evaluation framework addressing both technical and user-experience dimensions of system performance, which is particularly important when target users are non-technical MSME staff with limited digital literacy.

3. Methods

3.1. Research Design

This study employs a Research and Development (R&D) methodology, following Wieringa's (2014) design science framework in which research iterates over two activities: designing an artifact that improves something for stakeholders, and empirically investigating the performance of that artifact in its context. The software development process follows the Waterfall SDLC model as described by Pressman and Maxim (2019), comprising five sequential phases: requirements analysis, system design, implementation, testing, and maintenance. The Waterfall model was selected because Figor Coffee's expenditure recording requirements were clearly defined and stable at the outset of development, conditions that

favor the Waterfall's phase-completion approach over iterative methodologies. Research was conducted at Figor Coffee MSME in Makassar from December 2024 to February 2025. The epistemological positioning is evaluative and applied: the study develops an intervention and assesses its impact against quantifiable pre/post metrics, following Wohlin and Runeson's (2021) guidance that design research in information systems requires explicit selection of research methodology aligned with the nature of the knowledge contribution sought.

3.2. Population and Sample

The study involved all direct users of the developed expenditure management system at Figor Coffee MSME: the business owner and two cashiers, constituting three system users. This census sampling approach was applied because the target population is the complete set of personnel responsible for expenditure recording and financial administration, the only individuals whose usability experience and error behavior are directly relevant to the study objectives. The three participants had varying prior digital experience, enabling a representative measurement of SUS usability across different digital literacy levels. For black-box testing, four independent validators with information systems expertise were recruited separately from the MSME user group to ensure objective functional evaluation.

3.3. Data Collection

Data were collected through four methods. First, participant observation during the baseline period (December 2024) documented error frequency, types per Reason's (1990) taxonomy, nominal discrepancies, and recapitulation time in the existing manual system. Second, structured interviews with the business owner and cashiers identified root causes, workflow constraints, and user capability requirements for system design. Third, documentation analysis of historical expenditure records established baseline metrics. Fourth, equivalent post-implementation observation over 30 days captured the same metrics under the digital system for direct pre/post comparison. System testing used black-box testing on 13 core features by four validators (Mahendra & Asmarajaya, 2022), and the SUS questionnaire (Brooke, 1996) was administered to all three system users, with scores computed using the standard formula and individual scores retained for transparency as recommended by Bangor et al. (2008).

3.4. Data Analysis

Data analysis followed a descriptive comparative approach integrating quantitative error metrics with qualitative process observations, consistent with the mixed-methods evaluative design described by Wieringa (2014). The four key performance formulas applied in this study are presented as Equations 1-4 below.

Equation 1: Recording error reduction rate

$$\frac{19 - 2}{19} \times 100\% = 89.47\% \qquad \text{(Eq. 1)}$$

Equation 2: Nominal discrepancy reduction rate

$$\frac{\text{Rp473,250} - \text{Rp0}}{\text{Rp473,250}} \times 100\% = 100\% \qquad \text{(Eq. 2)}$$

Equation 3: Recapitulation time reduction rate

$$\frac{90 - 25}{90} \times 100\% = 72.2\% \qquad \text{(Eq. 3)}$$

Equation 4: Black-box testing feasibility percentage

$$\frac{52}{52} \times 100\% = 100\% \qquad \text{(Eq. 4)}$$

SUS scores were computed per the standard Brooke (1996) formula (Equation 5), where the sum of contributions from odd-numbered items (responses minus 1) minus the sum of contributions from even-numbered items (5 minus responses) is multiplied by 2.5 to produce a score on the 0-100 scale.

$$\text{SUS Score} = 2.5 \times (\Sigma\text{odd} - \Sigma\text{even}) \qquad \text{(Eq. 5)}$$

Error categories were classified per Reason's (1990) skill/rule/knowledge-based taxonomy. Qualitative data from interviews and observations were analyzed thematically to explain mechanism-level findings.

4. Results

4.1. Pre-Implementation Baseline Analysis

Observation of Figor Coffee's manual recording system during the baseline period documented 19 recording error cases across 30 days. Table 1 presents the distribution by Reason's (1990) taxonomy. Skill-based errors (11 cases, 57.89%) manifested as nominal input errors, forgotten records, and duplicates. Rule-based errors (5 cases, 26.32%) arose from the absence of standardized account categories. Knowledge-based errors (3 cases, 15.79%) involved incorrect distinctions between operational and capital expenditures. The 19 errors generated a nominal discrepancy of Rp473,250 between recorded and actual expenditures, with manual recapitulation requiring 90 minutes per reporting cycle. This pattern is consistent with what Romney and Steinbart (2021) identify as the fundamental vulnerabilities of manual accounting systems: absent input validation, no format restriction, and no duplication detection mechanism.

Table 1. Pre-Implementation Error Distribution by Type (n = 19 cases, December 2024)

Error Type	Cases	Percentage	Primary Manifestation
Skill-Based (Reason, 1990)	11	57.89%	Nominal typos, forgotten transactions, duplicates
Rule-Based (Reason, 1990)	5	26.32%	Account misclassification (no standard categories)
Knowledge-Based (Reason, 1990)	3	15.79%	Operational vs. capital expenditure confusion
Total	**19**	**100.00%**	

4.2. System Design and Development (Waterfall Phases)

Following the five-phase Waterfall model (Pressman & Maxim, 2019), the system was developed over January-February 2025. In the requirements analysis phase, baseline data and structured interviews identified six core functional requirements: user authentication, expenditure input with mandatory field validation, account category standardization, manager approval workflow, automated recapitulation, and export reporting. The system design phase produced data flow diagrams, entity-relationship specifications, and interface mockups validated with the owner and cashiers before development. In the implementation phase, the AppSheet system was built with a Google Sheets backend, implementing the six features: role-based login, expenditure input with automatic amount validation, hierarchical account category dropdown preventing free-text entry, an approval workflow routing entries to the manager, an automated recapitulation dashboard, and a date-filtered export function. The design science principle articulated by Wieringa (2014), that artifacts should be designed for the operational context in which they will be validated, was operationalized by aligning each system feature directly with one of the three human error types identified in the baseline.

4.3. Black-Box Testing Results

Black-box testing was conducted on all 13 core features by four independent validators, following the protocol described by Mahendra and Asmarajaya (2022). Table 2 presents the complete test results. All 13 features produced expected outputs across all four validators (52/52 validations). Applying Equation 4, the functional feasibility percentage was 52/52 x 100% = 100%, placing the system in the Very Feasible category. No functional failures or validation inconsistencies were identified.

Table 2. Black-Box Testing Results (13 Features, 4 Validators)

No	Feature Tested	Input/Action	Expected Output	Result
1	User Login	Incorrect credentials	System rejects login; shows error message	Valid
2	Cashier/Admin Login	Correct credentials	Login successful; role-based menu displayed	Valid
3	Expense Input: Save	Click Save (complete data)	Data saved with Awaiting Approval status	Valid
4	Input Validation	Click Save (empty required field)	Warning 'This entry is required' displayed	Valid
5	Category Dropdown	Select main category	Sub-categories appear per dropdown rules	Valid
6	Photo Upload	Upload receipt file	Photo saved; visible in detail view	Valid
7	Approval Workflow	Manager clicks Approve	Status changes to Approved	Valid

8	Report Filter	Apply date filter	Report for selected period displayed	Valid
9	Category Management	Admin saves new category	Category stored; appears in dropdown	Valid
10	User Management	Admin adds new user	User data saved in system	Valid
11	Vendor Management	Admin adds vendor	Vendor data stored	Valid
12	Generate Report	Admin generates with date filter	Filtered expenditure report produced	Valid
13	Export Report	Admin clicks Export	Income and expenditure report exported	Valid

4.4. System Usability Scale Results

The SUS instrument (Brooke, 1996) was administered to all three system users following one month of operational use. SUS scores were computed per Equation 5. Table 3 presents individual and aggregate scores graded per Bangor et al.'s (2008) empirically derived scale. The average SUS score was 89.0 (Excellent, above the 80.3 threshold). Individual scores ranged narrowly from 87.5 to 90.0, indicating consistent usability perception across users with different prior digital experience levels.

Table 3. System Usability Scale (SUS) Scores by User (n = 3)

Respondent	Role	SUS Score	Grade (Bangor et al., 2008)
Respondent 1	Business Owner	87.5	Excellent
Respondent 2	Cashier 1	90.0	Excellent
Respondent 3	Cashier 2	89.5	Excellent

4.5. Human Error Reduction and Operational Efficiency

Table 4 presents the pre/post performance comparison. Applying Equations 1-3, error count decreased from 19 to 2 cases (89.47% per Eq. 1), nominal discrepancies were eliminated entirely (100% per Eq. 2), and recapitulation time decreased from 90 to 25 minutes (72.2% per Eq. 3). The 2 remaining post-implementation errors were knowledge-based, involving edge-case categorization decisions that the system's dropdown structure could not fully constrain, consistent with Reason's (1990) observation that knowledge-based errors require complementary interventions beyond system design alone.

Table 4. Pre/Post Implementation Performance Comparison

Indicator	Before	After	Reduction
Recording Errors (cases)	19	2	89.47% (Eq. 1)
Nominal Discrepancy	Rp473,250	Rp0	100% (Eq. 2)
Recapitulation Time (min.)	90	25	72.2% (Eq. 3)

5. Discussion

5.1. Methodological Interpretation

The 89.47% error reduction (Eq. 1) substantially exceeds improvements reported in comparable MSME financial digitalization studies. Ibrohim and Surachman (2025) found significant but more modest efficiency gains from online accounting adoption in Serang MSMEs, attributing variability to user digital literacy and system complexity. The more pronounced improvement in the present study reflects a targeted design approach: rather than deploying a general accounting platform, the AppSheet system was purpose-built around the three specific error types documented in the baseline, with each feature mapped directly to one error mechanism per Reason's (1990) taxonomy. Thuan et al. (2022) similarly found that relative advantage over existing manual processes is the strongest predictor of AIS adoption and effectiveness, suggesting that the magnitude of Figor Coffee's error reduction directly reflects the magnitude of the performance gap that the system addressed. Lutfi et al. (2022) found that organizational readiness and management support moderate digital AIS performance; in this study, both factors were favorable because the owner endorsed the intervention from the outset and the system's no-code architecture minimized technical readiness requirements.

The SUS score of 89 (Excellent per Bangor et al., 2008) is notable given that two of the three users had limited prior smartphone application experience. The narrow score range (87.5-90.0) suggests that AppSheet's no-code interface,

combined with role-based design that conceals irrelevant functions per user type, successfully reduced the perceived complexity barrier. Domanski et al. (2023) note that a defining advantage of low-code/no-code platforms in SME contexts is their capacity to empower non-technical users through intuitive interfaces, a characteristic empirically confirmed here by the uniformly Excellent SUS ratings across all user profiles. Sufi (2023) positions no-code platforms as the current evolutionary culmination of algorithm democratization, enabling practitioners to build functional applications; the Figor Coffee implementation demonstrates this practical utility in a financial management context.

5.2. Business Implications

The 100% elimination of nominal discrepancies (Eq. 2) is the most commercially significant finding. Romney and Steinbart (2021) identify accurate and timely financial data as the foundational requirement for effective business decision-making; the transition to zero nominal discrepancy at Figor Coffee means that expenditure records now directly mirror verified actual transactions, creating a reliable financial baseline for cost management and pricing decisions. Pham and Vu (2022) found that digitalization of accounting information in food and beverage SMEs generates sustainable innovation ecosystem value through better financial intelligence, a benefit that Figor Coffee can now access through its AppSheet system. The 72.2% reduction in recapitulation time (Eq. 3), representing 65 minutes saved per cycle, translates to approximately 13 hours of recovered productive time annually across 12 monthly reporting cycles, consistent with Sastararuji et al.'s (2022) finding that cloud-based accounting systems help SMEs achieve greater operational flexibility.

5.3. Operationalization Framework

To support sustainable adoption beyond the research period, a role-based access structure was established assigning the owner as system administrator with approval and reporting rights, and cashiers as data entry users. This separation of duties introduces an internal control dimension absent in the previous manual system, consistent with Romney and Steinbart's (2021) internal control framework for AIS implementation. A standard operating procedure covering daily entry, weekly recapitulation review, and monthly report export was prepared to support consistent system use without ongoing researcher involvement. For scaling to similar cafe or food-service MSMEs, the system's account category structure and validation rules can be adapted through the Google Sheets backend without programming, requiring approximately two hours of configuration time. The primary constraint for broader replication is internet connectivity for AppSheet's cloud synchronization, an infrastructural consideration that Domanski et al. (2023) identify as a general adoption barrier for no-code platforms in resource-constrained organizational contexts.

5.4. Limitations and Directions for Future Research

This study has four principal limitations. First, the single-site design means that the reported error reduction metrics and SUS score reflect conditions specific to Figor Coffee's operational context, transaction volume, and staff composition. Wieringa (2014) notes that single-context design science studies provide evidence about artifact performance in one setting but require multi-site replication to establish generalizability. Second, the usability evaluation involved only three users (n = 3), which is sufficient to identify major usability issues but does not provide adequate statistical power for generalization of the SUS score. Bangor et al. (2008) recommend minimum samples of 20-40 respondents for stable SUS score estimates. Third, the 30-day observation period is too short to assess sustained error reduction gains as initial novelty effects dissipate. Fourth, the study measures operational efficiency metrics (Eqs. 1-3) but not financial performance outcomes (profit accuracy, tax compliance, or cost control effectiveness) that would establish the commercial ROI of the intervention.

Future research should pursue four directions: (1) multi-site replication across cafe MSMEs of varying scale to establish generalizability; (2) longitudinal tracking over 6-12 months to assess sustainability of error reduction; (3) comparative evaluation of AppSheet against alternative no-code platforms and low-cost accounting applications specific to Indonesian MSMEs; and (4) incorporation of financial performance outcomes to establish commercial ROI. Thuan et al. (2022) suggest that future AIS research in emerging economies should also examine the moderating role of owner digital literacy on system effectiveness, which would be a valuable extension in the MSME cafe context.

6. Conclusion

This study successfully designed, implemented, and evaluated an AppSheet-based expenditure data management system for Figor Coffee MSME using the Waterfall SDLC methodology (Pressman & Maxim, 2019). The system demonstrated clear effectiveness against both research objectives: recording errors reduced from 19 to 2 cases (89.47%, Eq. 1), nominal discrepancies eliminated entirely (Rp473,250 to Rp0, 100%, Eq. 2), recapitulation time shortened by 72.2% (90 to 25 minutes, Eq. 3), a 100% functional feasibility score across 13 features and four validators (Eq. 4), and a mean SUS score of 89 (Excellent per Bangor et al., 2008) from three system users (Eq. 5).

These findings make two contributions to the existing literature. Methodologically, the study demonstrates the Waterfall model's suitability as a structured development framework for AppSheet-based financial systems in MSME contexts with clearly defined, stable requirements (Pressman & Maxim, 2019), producing a replicable five-phase development blueprint aligned with Wieringa's (2014) design science principle of validating artifacts in the context for which they were designed. Empirically, it provides quantified evidence from the Indonesian cafe MSME sector that AppSheet functions as an effective human error reduction mechanism, addressing skill-based, rule-based, and knowledge-based error types per Reason's (1990) taxonomy through targeted system features, extending Lutfi et al.'s (2022) and Thuan et al.'s (2022) findings on digital AIS effectiveness to the specific no-code platform context.

For MSME practitioners, the primary recommendation is to map existing recording error types to system features before development begins, ensuring each feature addresses an identified error mechanism. Romney and Steinbart (2021) emphasize that effective AIS design must be grounded in understanding of the specific transaction cycles and error vulnerabilities of the organization, a principle operationalized here through the pre-intervention baseline error classification. AppSheet's Google Sheets integration allows progressive adoption for MSMEs already using spreadsheets without replacing existing data infrastructure, and its no-code architecture democratizes application development beyond technical specialists (Domanski et al., 2023; Sufi, 2023).

Future research should expand to multiple MSME sites and longer observation periods, incorporate financial performance outcomes, and conduct comparative platform evaluation to build a more comprehensive evidence base for no-code financial management in Indonesian MSMEs. Pham and Vu (2022) suggest that a parsimonious model of accounting information digitalization in SMEs must account for both technological characteristics and organizational readiness factors, dimensions that multi-site longitudinal studies would be better positioned to address.

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Contribution: Lestari: Conceptualization, system development, investigation, data curation, writing (original draft), visualization. Alam: Methodology, formal analysis, supervision, writing (review and editing). Aris: Project administration, supervision, writing (review and editing), final approval.

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