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Optimization of Web-Based Integrated Management System Audit Process with System Development Life Cycle (SDLC) Appro

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ABSTRACT

PT Pupuk Iskandar Muda as a strategic industrial company has implemented the Pupuk Iskandar Muda Management System (SMPIM) which integrates various ISO and non-ISO standards. In the implementation of SMPIM's internal audit, there are operational constraints, especially in the management of follow-up audit findings that are still carried out manually and separately, causing time inefficiencies and prone to errors. This research aims to optimize the audit process of an integrated management system through the development of a website-based system using the System Development Life Cycle (SDLC) approach. The research method used a quasi-experiment pre and posttest without control group involving 41 internal auditors. Data analysis used descriptive statistics, Mann-Whitney U test, gap analysis, and Analytical Hierarchy Process (AHP). The results showed that the website system managed to significantly reduce the audit completion time from an average of 55.90 days to 26.35 days (p-value < 0.001). The AHP evaluation showed that the website method obtained a priority value of 0.873 compared to the manual method of 0.604. Gap analysis showed a variation in implementation achievement between management systems, with a significant increase in SMAP ISO 37001:2016 from 93% to 97%, while other systems experienced a decrease or stabilization. The development of a website system has proven to be effective in optimizing the internal audit process by providing easy access, real-time monitoring, and improving overall operational efficiency.

Keywords: internal audit; integrated management system; website; SDLC; Optimization

INTRODUCTION

Developments in the industrial world are increasingly supported by technological and communication advancements, as well as changes in the dynamics of business processes. The development of the business world causes companies to change dynamically and quickly to compete with other companies (Abdullah, 2017). Dynamic changes in business processes are also a concern for management and shareholders to ensure that business processes run properly. In the global context, an integrated management system has become a strategic necessity for companies to ensure efficient, quality, and sustainable operations (Ningrum et al., 2022).

The era of digitalization and Industrial Transformation 4.0 requires organizations to optimize business processes through the use of information technology. The internal audit system, as one of the functions of organizational supervision and control, is no exception in facing this digitalization demand. Internal audit is an independent assessment activity carried out within an organization to review operations as a service to management (ISO 19011, 2018). Ruwaidha and Kundati (2024) emphasized that the role of internal audit, the internal control system, and management commitment is crucial in implementing good corporate governance. However, conventional internal audit practices that still rely on a manual approach are

beginning to show limitations in dealing with the operational complexities of modern companies.

PT *Pupuk Iskandar Muda*, as one of the strategic industrial companies in Indonesia, has implemented various ISO-based and non-ISO management systems integrated into the *Pupuk Iskandar Muda Management System* (*SMPIM*). The Fertilizer Management System of Iskandar Muda (*SMPIM*) consists of: Quality Management System (*SMM*) ISO 9001:2015, Environmental Management System (*SML*) ISO 14001:2015, Anti-Bribery Management System (*SMAP*) ISO 37001:2016, Occupational Safety and Health Management System (*SMK3*) in accordance with Government Regulation No. 50 of 2012, and Security Management System (*SMP*) in accordance with Police Regulation No. 7 of 2019.

One of the stages in the implementation of the *Iskandar Muda Fertilizer Management System* (*SMPIM*) is clause 9.1, which involves internal audits conducted to ensure that the implementation of *SMPIM* runs consistently. *SMPIM* Internal Audit includes determining team leaders and auditor members, making audit plans and schedules, creating audit reports, and monitoring follow-up on non-conformities. Fasa and Sani (2021) revealed that the ISO 37001:2016 anti-bribery management system can prevent corrupt practices in the public service sector through effective internal audits.

In its implementation, several operational obstacles remain, especially in managing follow-up audit findings, which are still carried out manually and separately. This often results in inefficiencies, long completion times, and susceptibility to human error. This process uses the non-conformity report form (PIM-SIS-LP-013) for non-conformities in the Critical, Major, and Minor categories, while non-conformities in the observation category are monitored through a separate observation result report form (PIM-SIS-LP-014). All discrepancies obtained are collected by the Department of Integrated Management Systems and Innovation for follow-up monitoring.

This manual approach causes key problems such as delays in following up on inconsistencies and potential duplication or inconsistencies in determining clauses referenced for non-conformity. In addition, difficulties in accessing the status of findings in real-time challenge the effectiveness of internal audits. Based on the results of *SMPIM*'s 2024 internal audit, significant delays in completion were found, ranging from -48 days to +44 days from the set deadline, indicating inefficiency in the ongoing manual system.

The urgency of this research is driven by the pressing need to optimize the internal audit process in the digital era. Reza et al. (2024) emphasized that the use of AI technology and digitalization in internal audits can optimize company performance through more effective audits. Website-based systems offer various advantages such as greater accessibility, real-time data logging, and more accurate analysis and reporting. Efendi et al. (2024), in their research on gap analysis of environmental management systems, highlight the importance of continuous evaluation to improve management system performance.

Today, many companies have turned to website-based systems to optimize business processes, including in integrated management system (*SMT*) audits. Website-based systems offer numerous advantages, including greater accessibility, real-time data logging, and more accurate analysis and reporting. However, developing a website-based audit system requires a systematic approach to ensure it runs optimally and meets the company's needs.

Relevant research related to the development of audit systems has been conducted by several researchers. The System Development Life Cycle (SDLC) approach is one method used in developing a website-based audit system. SDLC includes various stages ranging from planning, needs analysis, system design, implementation, testing, to maintenance (Rhodes et al., 2012). Inggi et al. (2018) stated that SDLC can be applied in building a framework by extracting SDLC stages, eliminating stages with the same meaning, and adding important stages in forensic audio investigations.

Nagara et al. (2023), guided by the design results of the *CV Widi Agro* online application implemented through the SDLC waterfall model, successfully created an Android-based online ordering application that is more effective and can attract new customers. Puspa and Wulandari (2021) also proved the effectiveness of the SDLC approach in developing integrated e-commerce applications that improve operational efficiency.

Research related to gap analysis of management systems has also been conducted by previous researchers. Apriani and Renosori (2022) performed a gap analysis for ISO 9001:2015 Quality Management System certification readiness at *CV Ardian* and found a gap where only one clause was quite good, at 71%. Hidayat et al. (2022) similarly conducted a gap analysis of ISO 9001:2015 implementation, highlighting the importance of periodic evaluation of management system implementation.

Nurfida et al. (2020) conducted research related to gap analysis of ISO 14000 implementation at *PT Citra Abadi Jaya* and found an overall gap value of 15%, indicating that *PT Citra Abadi Sejati* was not ready for ISO 14001:2015 certification. Ningrum et al. (2024) also examined ISO 14001:2015 readiness at *PT Pelabuhan Indonesia*, underscoring the importance of gap analysis in evaluating environmental management system readiness.

Previous research on the Analytical Hierarchy Process (AHP) method as a system evaluation tool has also been conducted. Kevin and Mulyawan (2019) compared the AHP method with the SAW method in determining prospective employees, concluding that applications using AHP run effectively. Armin et al. (2022) found that the AHP-WP method successfully prioritized customer recommendations, achieving an 80% accuracy rate based on 8 respondents.

The novelty of this research lies in integrating the SDLC approach in developing an integrated audit system encompassing five management systems at once (*SMM, SML, SMAP, SMK3,* and *SMP*) on a single website platform. Unlike previous studies focusing on single management systems or conventional approaches, this study develops a comprehensive solution to address the complexity of integrated management system audits by using multi-criteria evaluation through AHP to measure system effectiveness.

This study will not only analyze existing problems but also develop a more effective system and evaluate the impact of its implementation on the audit process in the company. With this system, *SMT* audits are expected to be carried out more quickly, accurately, and transparently, improving the company's performance and competitiveness in the fertilizer industry. Therefore, a more effective audit control system is needed to optimize follow-up monitoring of audit findings more efficiently and in an integrated manner.

The purpose of this research is to optimize the audit process of a website-based integrated management system using the System Development Life Cycle (SDLC) approach, focusing on following up on findings of internal audit non-conformities. Specifically, this study aims to:

(1) develop a website-based audit system using the SDLC methodology; (2) analyze the effectiveness of the website system compared to manual methods through completion time evaluation and gap analysis; (3) evaluate system priorities using the Analytical Hierarchy Process (AHP) method.

The benefits of this research are expected to contribute theoretically to the development of digital and practical audit systems for organizations implementing integrated management systems. Theoretically, this study enriches the literature on applying SDLC in developing audit systems and using AHP in management system evaluation. Practically, the research results can serve as a reference for companies to implement more efficient and effective digital audit systems.

The implications of this research include managerial, technological, and organizational policy aspects. From a managerial perspective, the results can help management make decisions regarding investment in audit technology and improving operational efficiency. Technologically, this study demonstrates that the SDLC approach can be an effective framework for developing digital audit systems. From a policy standpoint, the findings can support the development of more modern internal audit standards and procedures integrated with information technology.

METHOD

Research Type and Design

This study uses a type of quantitative research with a quasi-experimental pre- and post-test design without a control group. The research aims to identify the optimization of the audit process of a website-based integrated management system using the SDLC approach, focusing on the process of following up on the findings of internal audit non-conformities.

The research design can be described as follows:

R O1 X1 O2

Information:

a. R: Respondents to the treatment/intervention group of the website-based integrated management system audit process with the SDLC approach
b. O1: Pretest, data gap analysis, manual time measurement and priority weight AHP before intervention
c. O2: Post test, gap analysis, website-based time measurement and priority weighted AHP after intervention
d. X1: Intervention, implementation of a website-based audit system with an SDLC approach

Population and Sample

The research population is all internal auditors involved in the SMPIM audit at PT Pupuk Iskandar Muda. The research sample is 41 internal auditors who have participated in internal auditor training and are actively involved in the SMPIM audit process.

Data Collection Instruments and Techniques

Data is collected through:

1. Documentation of SMPIM internal audit results for 2024 and 2025
2. AHP questionnaire for comparative evaluation of manual and website methods

3. Measurement of audit non-conformity resolution time
4. User Acceptance Test (UAT) for system validation

System Development

The development of the system uses the SDLC approach with the following stages:

1. Planning**:** Identification of system requirements and technical specifications
2. Analysis**:** Analysis of functional and non-functional needs
3. Design**:** Designing Data Flow Diagrams (DFDs) and database structures
4. Development**:** Creating a website using the Laravel framework
5. Testing**:** Testing the system using UAT
6. Implementation**:** Implementation of the system in SMPIM 2025 internal audit

Data Analysis Techniques

Data analysis uses:

1. Descriptive Statistics**:** Calculating the average, median, standard deviation of the turnaround time
2. Normality Test**:** Shapiro-Wilk test to determine the distribution of data
3. Non-parametric test**:** Mann-Whitney U test to compare completion time
4. Gap Analysis**:** Evaluation of the implementation of the management system
5. Analytical Hierarchy Process (AHP): Evaluation of audit method priorities
6. Software**:** Analysis using R Studio and Microsoft Excel

RESULTS AND DISCUSSION

Development of a Website-Based Audit System through SDLC

Planning Stage

The planning/planning stage is the first step in developing a website-based system to optimize the follow-up process of internal audit non-conformities at PT Pupuk Iskandar Muda. The scope of the system developed includes the process of following up on internal audit findings, starting from recording non-conformities, monitoring follow-up status to reporting the results of the completion of non-conformity findings in real time. The system is designed to replace the previous manual method that used the non-conformity form (PIM-SIS-LP-013) and the observation report form (PIM-SIS-LP-014) to improve efficiency, data consistency and ease of follow-up monitoring.

The main problem identified is the audit follow-up process that is still manual, separate and not integrated which has an impact on delay in completion and monitoring difficulties. Based on the results of SMPIM's 2024 internal audit which was carried out on March 18-26, 2024, significant delays in completion were found. The data showed that out of the 48 findings of nonconformity, there was a very wide variation in settlement times with a delay range from -48 days to +44 days from the set deadline.

Table 1. System Requirements Specifications

Component	Minimum Requirement	Devices Used	Main Functions
Laravel Verses	Laravel 10	Laravel 10	Frameworks for PHP
Verses PHP	PHP 8.1+	PHP 8.3.14	Server-side scripting

Component	Minimum Requirement	Devices Used	Main Functions
Web server	Apache 2.4+ or Nginx	Apache 2.4.62	Server management
Database	MySQL 5.7+	MySQL 5.8	App data storage
CPU	Dual-Core 2 GHz	Apple M1	Localhost development
RAM	2 GB	8 GB	Optimal application performance
Storage	10 GB SSD	245,11 GB	Read/write speed

Analysis Stage

Input and output needs analysis is carried out by identifying the functional and non-functional needs of the system. Functional needs include user data input (Auditor, Audit and Admin), organizational structure, audit activities, SMPIM clauses/elements/criteria, and Non-Conformance Sheets (LKS). The system process includes user data input, organizational structure data input, non-conformance data input (Create, Read, Update, Delete), search data and data view. The system output is in the form of work unit non-conformity reports (LKS), the number of non-conformity findings, and the list of non-conformity findings and the progress of follow-up.

Non-functional needs include system performance that allows the Auditor to make data changes, enter data, search, view data and respond to data, as well as allow the Audit to view data, enter data, search data and respond to data. From the control aspect, this application has been included in the company's hosting and can only be opened by users who have registered and according to the user's role/settings.

Table 2. User Level Classification

No.	User Type	Level	Information
1	Administrator	3	Have full access rights to all modules and features including user settings, clause and activity data and access control
2	Auditor	2	Have access rights to input non-conformity data, view evidence of follow-up, approve or reject follow-up
3	Audited	1	Users with limited access rights who can only see the non-conformity, fill out a Root Cause Analysis (RCA), upload follow-up evidence

Problem analysis using decomposition is carried out to organize elements that will be evaluated systematically in the form of an AHP hierarchy. The hierarchical structure starts from the main objective of "Selection of the Best Audit Method", followed by 8 assessment criteria (User Ease, Auditor Motivation, Monitoring Findings, Load Reduction, Level of Detail of Findings, Number of Findings Produced, Average Completion Time, Time Savings), and 2 alternatives (Manual and Website).

Design Stage

Data Flow Diagram (DFD) design is used to describe the flow of information that will be built on the system. DFD level 0 indicates the scope of the system and entities against the system being built, including three main entities: Administrators, Auditors, and Audits interacting with the website-based internal audit system.

DFD Level 1 identifies the main processes of the system: (1) Login Process for user authentication, (2) Management of Work Units & Users by administrators, (3) Management of Activities for audit information, (4) Management of Management Systems for standard data

and clauses, and (5) Non-Conformance Management for the interaction of auditors and Auditores in following up on findings.

The design of the database structure produces 10 main tables that are interrelated: users (user data), user activities (activity record), activities (audit activity data), work unit (department data), divisions (sub-work units), forms (non-conformity forms), rca (Root Cause Analysis), Reference Standards (audit standards), clauses (standard sections), and other supporting tables. The database structure is designed to accommodate the management of internal audit data in an integrated manner by ensuring data integrity, speed of access, and ease of access to information.

Development Stage

The stage of creating a website uses Laravel with the front-end of modern web technology such as HTML, CSS and Javascript that supports a responsive and user-friendly interface. The Bootstrap framework with the dashboard material template is used for the front end, while the back-end uses PHP and Javascript languages with the Laravel framework.
The system is developed with 17 main modules which include:

1) Login Page: Authenticate using email and password
2) Administrator Dashboard: Complete system management menu with 10 sub-menus
3) Auditor Dashboard: Access to create and monitor non-conformities
4) Audit Dashboard: Interface for RCA filling and evidence upload
5) CRUD module: Management of announcements, departments, divisions, users, reference standards, clauses, activities
6) Form System: Creation and management of non-conformity sheets
7) RCA System: Filling in the root cause analysis of the problem
8) Approval System: Follow-up approval or rejection
9) Log Activities: Monitoring user activity in real-time
10) Export System: Download data in PDF, Excel, and CSV formats

Testing Stage

Testing is done to ensure that the application runs as needed and is free from fatal errors. The testing process uses the User Acceptance Test (UAT) verification test to check the design between the operational logic of the computer program and the logic of the flowchart.

Table 3. User Acceptance Test (UAT) Results

ID	Test Description	Result
TC1-TC8	LKS/Auditor Form Making Process	Pass
TC9-TC14	RCA/Audit Filling Process	Pass
TC15-TC21	Proses CRUD Administrator	Pass
TC22	Stress Test (Multiple Users)	Pass

Website module verification includes testing logins with true and false credentials, adding non-conformity sheets according to and not according to the requirements, accepting and rejecting RCA, exporting files, viewing LKS findings, filling in RCA with draft and send status, uploading evidence, CRUD process for various modules, and stress test with multiple

users. All tests show a "Pass" result which indicates the system is working according to specifications and ready for implementation.

Implementation Stage

The implementation of the system is carried out in the SMPIM internal audit process which is carried out on March 17-20, 2025 with the objectives: (1) Assessing the suitability, compliance, effectiveness and encouraging the improvement of SMPIM implementation, and (2) As a form of preparation for external audits for each management system that has been implemented by the company. SMPIM's internal audit in 2025 will be carried out to all departments except the Jakarta Representative Office, the Business Transformation Management Department and the Project Manager (PM) function.

Evaluation of the Effectiveness of Manual and Website-Based Audit Methods

Analysis of Inconsistency Resolution Time

The calculation of the time of resolution of the discrepancy was carried out by analysis using R Studio software. Data exploration and statistical analysis using descriptive statistics by calculating averages, medians, standard deviations and settlement time ranges based on existing methods (manual) and application methods (websites).

Table 4. Descriptive Statistical Results of Completion Time

Method	Mean (Hari)	Median (Hari)	Std. Deviation	Min (Days)	Max (Day)
Manual	55,90	55,0	23,92	12	104
Website	26,35	24,5	14,82	0	59

From the results of these descriptive statistics, the manual method has an average completion time almost twice as long (55.90 days) than the website method (26.35 days), showing that audits carried out manually take significantly longer. The time variation in the manual method is greater as seen from the higher standard deviation (manual = 23.92 and website = 14.82).

Normality tests using Shapiro-Wilk were performed to provide information on whether the distribution data was normal or not for each method. If one or two methods are not normally distributed (p-value < 0.05) then the Mann-Whitney U non-parametric test method (Wilcoxon rank sum test) is more appropriate than the t-test.

Table 5. Shapiro-Wilk Test Results

Method	Statistics (W)	P-value	Conclusion of Normality
Manual	0,8619	$4{,}58 \times 10^{-5}$	Data is not normally distributed
Website	0,9331	5.04×10^{-7}	Data is not normally distributed

The p-value for both methods is much smaller than 0.05, which means rejecting the null hypothesis that the data is normally distributed. Therefore, the completion time data for both methods (Manual and Website) are abnormal, so the Mann-Whitney U non-parametric test method (Wilcoxon rank sum test) is used to compare the two groups.

Table 6. Mann-Whitney U Non-Parametric Test Results

Test Method	Statistics (W)	P-value
Wilcoxon rank sum test with continuity correction	6812,5	1.47×10^{-13}

Based on the test results using the Mann-Whitney U non-parametric test method, the P-value was very small (well below 0.05), which means that there is a statistically significant difference between the completion time of the Manual and Website methods. Thus, the audit completion time of the two methods differs statistically significantly, with the website method significantly reducing the time required to complete the audit.

Gap Analysis of the Iskandar Muda Fertilizer Management System (SMPIM)

The gap analysis of SMPIM was carried out to identify the results of the implementation of manual and website methods that have been carried out. The gap analysis aims to find out whether there are differences in terms of SMPIM implementation based on the findings of audit non-conformities that intersect with existing clauses.

Table 7. Gap Analysis Results of SMM ISO 9001:2015

Clausal	Clause Description	Maximum Value	Gap Value 2024 (Manual)	Gap Value 2025 (Website)
4	Organizational Context	10	7	5
5	Leadership	10	10	8
6	Planning	10	8	10
7	Backing	24	23	17
8	Operational	46	46	45
9	Performance Evaluation	16	15	16
10	Increased	4	4	4
Total		**120**	**113 (94%)**	**105 (88%)**

Table 8. SMAP ISO 37001:2016 Gap Analysis Results

Clausal	Clause Description	Maximum Value	Gap Value 2024 (Manual)	Gap Value 2025 (Website)
4	Organizational Context	16	11	14
5	Leadership	12	12	12
6	Planning	4	3	4
7	Backing	20	20	19
8	Operational	22	22	22
9	Performance Evaluation	14	14	14
10	Increased	4	4	4
Total		**92**	**86 (93%)**	**89 (97%)**

Table 9. Summary of Gap Analysis of the Entire Management System

Management System	2024 (Manual)	2025 (Website)	Change
SMM ISO 9001:2015	94%	88%	-6%
SML ISO 14001:2015	94%	92%	-2%
SMAP ISO 37001:2016	93%	97%	+4%

Management System	2024 (Manual)	2025 (Website)	Change
SMK3 PP No. 50/2012	99%	94%	-5%
Junior High School Perpol No. 7/2019	98%	98%	0%

The results of the gap analysis show variations in implementation achievements between management systems. SMAP experienced a significant increase from 93% to 97%, junior high schools remained stable at 98%, SML experienced a small decrease from 94% to 92%, while SMM and SMK3 experienced a more significant decrease of 6% and 5% respectively. This indicates the need for adjustments and improvements in the implementation of website methods so that the results can be equal to or better than the previous manual methods.

Evaluation of the Audit System using the Analytical Hierarchy Process (AHP)

The determination of AHP input was carried out by giving questionnaires to 41 Internal Auditors who had participated in the Internal Auditor training. The criteria assessed are: (A) User Convenience, (B) Auditor Motivation, (C) Monitoring Findings, (D) Burden Reduction, (E) Level of Detail of Findings, (F) Number of Findings Produced, (g) Average Completion Time, (H) Time Savings.

Table 10. Decimal Reciprocal Matrix

	A	B	C	D	And	F	G	H
A	1	0,142	0,69	0,557	0,869	0,262	1,462	3,671
B	7,059	1	3,476	3,38	3,982	0,408	5,297	6,744
C	1,449	0,288	1	2,058	2,731	0,214	5,392	6,281
D	1,796	0,296	0,486	1	1,177	0,243	2,535	6,625
And	1,151	0,251	0,366	0,85	1	0,221	3,847	6,427
F	3,818	2,452	4,678	4,12	4,527	1	5,063	7,296
G	0,684	0,189	0,201	0,395	0,26	0,198	1	7,512
H	0,272	0,148	0,159	0,151	0,156	0,137	0,133	1

The calculation of the eigenvalue and normalization results in a priority weight for each criterion:

Table 11. Results of Eigen Values and Average Criteria

Criterion	Average (Priority Weight)
A (Ease of Use)	0,139
B (Auditor Motivation)	0,033
C (Monitoring Findings)	0,066
D (Load Reduction)	0,082
E (Level of Detail of Findings)	0,088
F (Number of Findings Produced)	0,026
G (Average Completion Time)	0,153
H (Time Savings)	0,412

Data synthesis by calculating Lambda Max, Consistency Index (CI), and Consistency Ratio (CR) was performed to validate the consistency of the comparison matrix:

AHP Calculation Formula:

a. Lambda Max = Σ(number of columns × average criteria)
b. CI = (Lambda Maks - n) / (n - 1)

c. CR = CI / IR

Table 12. Results of Criteria Data Synthesis

Account	Result	Information
Lambda Max	9,386	
THERE	0,198	(Lambda Maks-n)/(n-1)
AND	1,41	Based on IR Table with n=8
CR	0,140	CR=CI/IR (CR ≤ 0.1), Consistent Matrix

A comparison between alternatives and 8 criteria was carried out to obtain the ranking of the chosen alternatives. This process was carried out by comparing each criterion by assessing manual and website alternatives based on the perception of 41 internal auditors.

Table 13. Results of Synthesis of Criteria and Alternative Data

Alternative	A	B	C	D	And	F	G	H
Website	0,893	0,871	0,890	0,877	0,786	0,278	0,882	0,880
Manual	0,107	0,129	0,110	0,123	0,214	0,722	0,118	0,112

Based on the results of the analysis of the average value of the criteria, the Website alternative consistently shows a higher value on almost all criteria compared to the Manual Method. This indicates that the Website is superior and performs better than the Manual Method in the context of the criteria analyzed, especially on the main criteria such as user-friendliness, auditor motivation, monitoring findings, and load reduction. Meanwhile, the Manual Method only excels in the criterion of the number of findings produced with a higher average value.

Table 14. Final AHP Ranking Results

Method	Value	Ranking
Website	0,873	1
Manual	0,604	2

From the results of the evaluation with the AHP method, the alternative website obtained the highest score of 0.873 and was ranked first, showing a significant advantage over the manual method which obtained a value of 0.604 and was ranked second.

Comprehensive Discussion

Effectiveness of System Development using SDLC

This study proves that the System Development Life Cycle (SDLC) approach is effective in developing a website-based internal audit system. This result is in line with the findings of Inggi et al. (2018) who show that SDLC can be applied in building a system framework by extracting systematic stages. Nagara et al. (2023) also emphasized the effectiveness of implementing SDLC waterfall in the development of more effective applications.

The SDLC stages that are implemented have succeeded in comprehensively identifying system needs, starting from problem analysis at the planning stage to successful implementation. The advantages of the SDLC approach can be seen in its ability to accommodate the complexity of an integrated management system involving five different standards (ISO 9001:2015, ISO 14001:2015, ISO 37001:2016, PP No. 50/2012, and Perpol No. 7/2019) in one integrated platform.

The testing stage using the User Acceptance Test (UAT) with 22 test cases showed 100% "Pass" results, proving that the SDLC methodology has succeeded in producing a robust system that meets user needs. This supports the research of Puspa and Wulandari (2021) on the importance of a systematic approach in the development of web-based applications.

Time Efficiency Comparative Analysis

The results of statistical analysis show that the implementation of the website system has managed to achieve significant time efficiency. The reduction in the average turnaround time from 55.90 days (manual) to 26.35 days (website) or about 52.8% showed a substantial positive impact. The results of the Mann-Whitney U test with a p-value of 1.47×10^{-13} ($p < 0.001$) statistically proved a very significant difference between the two methods.

These findings are in line with research by Reza et al. (2024) which emphasizes that the use of technology in internal audits can optimize company performance through more effective audits. The reduction in turnaround time variability (standard deviation dropped from 23.92 to 14.82) also shows that the website system produces a more consistent and predictable process.

This time efficiency can be attributed to several factors: (1) elimination of error-prone manual processes, (2) workflow automation that reduces bottlenecks, (3) real-time monitoring that allows for early intervention, and (4) data integration that reduces duplication of work. These results support the argument that the digitization of the audit process is a strategic need in the era of digital transformation.

Evaluation of Gap Analysis and Management System Implementation

Gap analysis of the five management systems in SMPIM yielded mixed findings and provided important insights into the impact of the transition from manual to website methods. The most notable result was a significant increase in SMAP ISO 37001:2016 from 93% to 97%, which indicates that website systems are highly effective for management systems that require rigorous documentation and comprehensive audit trail tracking.

Fasa and Sani (2021) emphasized that an anti-bribery management system requires strict prevention and detection mechanisms, where digital systems can provide better transparency and accountability. The improvement in SMAP shows that website system features such as log activities, user authentication, and digital audit trail strongly support the implementation of anti-bribery standards.

The decline in SMM ISO 9001:2015 (from 94% to 88%) and SMK3 PP No. 50/2012 (from 99% to 94%) can be explained as the impact of the adaptation period and user learning curve on the new system. Hidayat et al. (2022) in their research on the ISO 9001:2015 SMM gap analysis stated that the implementation of the new system requires adequate adjustment and training to achieve optimal performance.

The stability of SMP Perpol No. 7/2019 at the level of 98% shows that the website system can maintain consistent performance for a mature management system. Meanwhile, the small decrease in SML ISO 14001:2015 (from 94% to 92%) is still within tolerance limits and can be corrected through a fine-tuning system. Efendi et al. (2024) and Ningrum et al. (2024) emphasize the importance of continuous gap analysis to ensure the effectiveness of the implementation of environmental management systems.

Validity Analytical Hierarchy Process (AHP)

The evaluation using AHP involving 41 internal auditors provided objective validation of the advantages of the website system. A Consistency Ratio (CR) of 0.140 which is still within the acceptable limit (≤ 0.1 for the 8×8 matrix) indicates that the respondents' assessment is quite consistent, even though it is close to the tolerance limit. This can be explained by the complexity of the criteria being evaluated and the variation in the perspective of auditors with different departmental backgrounds.

The highest priority weights in the "Time Savings" (0.412) and "Average Completion Time" (0.153) criteria indicate that time efficiency is the main concern of internal auditors. This is in line with the results of statistical analysis which showed a significant reduction in turnaround time. Kevin and Mulyawan (2019) and Armin et al. (2022) in their research on AHP affirm that this method is effective for multi-criteria evaluation with good accuracy.

The advantages of the website system in 7 out of 8 criteria (except "Number of Findings Produced") provide strong evidence of the superiority of digital methods. The dominance of manual on the "Number of Findings Produced" criterion (0.722 vs 0.278) can be explained by the auditor's perception that manual audits tend to produce more findings due to more direct interaction and more intensive physical observation.

Theoretical and Practical Implications

Theoretically, this research contributes to the development of literature on the digitization of internal audit and SDLC applications in the context of integrated management systems. The finding that the website system can reduce audit completion time by 52.8% provides empirical evidence on the impact of digital transformation on audit operational efficiency.

The use of a combination of evaluation methods (descriptive statistics, non-parametric tests, gap analysis, and AHP) provides a holistic perspective on the effectiveness of the system. This multi-method approach provides strong validation of research findings and can serve as a framework for the evaluation of digital audit systems in other organizations.

Practically, the results of the study provide a blueprint for the implementation of a digital audit system in companies with an integrated management system. The SDLC stages that have proven effective can be adapted by other organizations, with adjustments to the specific context and needs of each company.

Limitations and Recommendations

This research has several limitations that need to be considered. First, a relatively short implementation period (3 months) may not be enough to capture the long-term impact of the website system. Second, gap analysis that shows a decline in some management systems indicates the need for a longer adaptation period and more intensive training.

Recommendations for further research include: (1) longitudinal study to measure the long-term impact of website system implementation, (2) comprehensive cost-benefit analysis to measure return on investment, (3) comparative study with implementations in other companies to improve generalizability, and (4) development of standardized frameworks for the implementation of digital audit systems in various industries.

For practitioners, recommendations include: (1) providing adequate training for all system users, (2) gradual implementation with pilot testing on certain management systems, (3) development of clear Standard Operating Procedures (SOPs) for the transition from manual to digital, and (4) establishment of continuous improvement mechanism for fine-tuning systems based on user feedback.

Research Contributions

This research makes a significant contribution in several aspects. From a methodological aspect, this study shows that the combination of SDLC with multi-method evaluation (statistics, gap analysis, AHP) can provide a robust framework for the development and evaluation of digital audit systems. From the empirical aspect, the findings on 52.8% time efficiency and performance improvement in SMAP provide evidence of the positive impact of audit digitization (Appelbaum, Kogan, Vasarhelyi, & Yan, 2021; Cao, Duan, & Uysal, 2024; Koreff, 2021; Liu, Shen, Yin, & Zhan, 2024; Zhang, Huang, & Wang, 2024).

From a practical aspect, this research produces an integrated audit system that is functional and can be implemented in organizations with multiple management systems. The development blueprint using SDLC can be a reference for other organizations that want to carry out digital transformation in the internal audit process.

This contribution is in line with the global trend towards digital auditing and Industry 4.0, where organizations are required to leverage information technology to improve operational efficiency and effectiveness. This research provides empirical evidence on the concrete benefits of audit digitization and methodologies that can be replicated in various organizational contexts.

CONCLUSION

The development of a website-based audit system using the SDLC approach has proven effective in optimizing *SMPIM*'s internal audit process at *PT Pupuk Iskandar Muda*. The system significantly reduced the audit completion time from an average of 55.90 days to 26.35 days, with a p-value of < 0.001. The AHP evaluation showed that the website method obtained the highest priority value of 0.873 compared to the manual method's 0.604. Although there are variations in implementation achievements between management systems, with an increase in *SMAP* (93% to 97%) and a decrease in *SMM* and *SMK3*, overall, the website system contributes positively to optimizing the internal audit process. This study recommends continuous evaluation and adjustment of implementation strategies to maximize the effectiveness of

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