

Improving Sales Workflow Efficiency through Process Automation in Web-Based CRM Information Systems

Muhammad Naufal^{1*}, & Muhammad Fadhlan²

¹*Universitas Putra Indonesia "YPTK" Padang, Indonesia, ²Universitas Putra Indonesia "YPTK" Padang, Indonesia

*Co e-mail: Naufalmuhammad@gamial.com¹

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ABSTRACT

Small and medium-sized enterprises frequently manage customer and sales data through manual, spreadsheet- and communication-app-based processes that are prone to delay, data inconsistency, and lost follow-up opportunities. This study designs, develops, and empirically evaluates a web-based Customer Relationship Management (CRM) information system with an integrated workflow automation layer, targeting eight core sales workflow tasks: lead data entry, lead assignment, follow-up scheduling, quotation generation, deal stage status update, approval routing, customer follow-up reminders, and monthly sales report generation. The system was developed using the Rapid Application Development (RAD) method and evaluated through three complementary testing approaches: black-box functional testing using the equivalence partitioning technique, System Usability Scale (SUS) usability assessment ($n = 30$ respondents), and a controlled process-time efficiency comparison between manual and automated task execution ($n = 20$ trials per task per condition, 160 paired observations in total). Black-box testing across seven system modules (76 test cases) achieved a 96.05% pass rate. The System Usability Scale assessment yielded a mean score of 80.75 ($SD = 6.62$), corresponding to an "Excellent" to "Good" usability grade and exceeding the commonly cited industry-average benchmark of 68. A paired-samples t -test comparing manual and automated task completion time across all 160 trials showed a highly significant reduction in process time ($t(159) = 8.64, p < 0.001$), with an overall time reduction of 82.17% across the eight measured tasks, ranging from 71.99% (quotation generation) to 87.09% (monthly sales report generation). These findings demonstrate that workflow automation integrated into a web-based CRM information system can substantially and measurably improve sales process efficiency while maintaining high functional reliability and user-perceived usability, offering an empirically validated reference architecture for small and medium enterprise sales digitalization.



INTRODUCTION

Customer Relationship Management (CRM) information systems have become a foundational tool for organizing sales operations, centralizing customer and lead data, and coordinating the multi-step process by which a prospective lead is converted into a closed sale. Despite the widespread commercial availability of CRM platforms, many small and medium sized enterprises in Indonesia continue to rely on manual, spreadsheet- and messaging-application based processes for core sales tasks such as lead logging, follow-up scheduling, and sales reporting, a pattern well documented in the Indonesian information systems literature on small business digitalization. This reliance on manual coordination is a recognized source of operational inefficiency: sales tasks that must be manually re-entered, tracked across multiple communication channels, and manually escalated for approval are inherently more prone to delay, data inconsistency, and lost follow-up opportunities than tasks executed through a structured, rule-driven information system.

Workflow automation - the use of rule-based logic and triggers to execute or route routine business process steps without requiring manual initiation at every step has been identified in the broader sales technology literature as a primary mechanism by which CRM systems reduce the manual burden on sales personnel, enabling tasks such as automatic lead assignment, templated document generation, and automated follow-up reminders to execute with minimal human intervention while preserving points for human judgment at decision-critical steps. However, much of the published Indonesian information systems research on web-based CRM and sales information system development has concentrated on functional correctness and general usability evaluation - typically assessed through black-box testing and the System Usability Scale (SUS) without directly and quantitatively measuring the process-time efficiency gained by introducing workflow automation relative to the manual process it replaces, leaving a gap between demonstrating that a system works correctly and is perceived as usable, and demonstrating that it delivers a measurable operational efficiency improvement.

This gap is practically significant because process-time efficiency, rather than functional correctness or usability alone, is the metric most directly tied to a CRM system's return on investment for adopting organizations: a system that functions correctly and is well liked by users but does not measurably reduce the time required to complete core sales tasks offers a weaker business case for adoption than one that demonstrably does. Established software testing methodology including black-box testing using the equivalence partitioning technique and System Usability Scale evaluation provides the standard toolkit for verifying that a newly developed information system functions as specified and is usable, and this study retains both as necessary validation steps, while extending the evaluation framework to directly quantify process-time efficiency gains through a controlled, paired comparison of manual and automated task execution.

This study addresses this gap by designing, developing, and empirically evaluating a web-based CRM information system with an integrated workflow automation layer targeting eight core sales workflow tasks, with three objectives: (1) to develop a functionally reliable and usable web-based CRM system incorporating rule-based workflow automation for lead management, approval routing, and reporting; (2) to verify the system's functional correctness through black-box testing and its perceived usability through System Usability Scale evaluation; and (3) to quantitatively measure and statistically test the process-time efficiency improvement achieved by the automated system relative to the manual process it is designed to replace, providing an empirically grounded efficiency benchmark for sales workflow automation in a web-based CRM context.



METHODS

1. System Development Method

The system was developed using the Rapid Application Development (RAD) method, selected on the basis of its suitability for small-to-medium-scope information systems with a relatively well-defined functional scope and a need for iterative user feedback during development, consistent with recent comparative analyses of software development methodologies (Waterfall, Prototype, Iterative, Spiral, and RAD) in the Indonesian information systems literature, which identify RAD as well suited to projects prioritizing accelerated delivery and close user involvement over extensive upfront specification. The RAD process followed four phases: requirements planning, in which core sales workflow tasks and automation requirements were identified through stakeholder consultation; user design, in which system prototypes (user interface mockups and workflow diagrams) were iteratively reviewed and refined; construction, in which the system was built and internally tested; and cutover, in which the system was deployed for user acceptance testing and the evaluation reported in Section 3.

2. System Architecture and Workflow Automation Design

The system was implemented as a three-tier web application (Figure 5), comprising a presentation layer (a responsive web interface built with standard HTML5, CSS3, and JavaScript technologies), an application/business logic layer containing the core sales, workflow automation, notification, and reporting modules, an automation and integration layer implementing the rule engine, task scheduler, and notification gateway responsible for executing automated workflow logic, and a data access and database layer (a relational MySQL/MariaDB database accessed through an object-relational mapping layer). This layered architecture separates the automation logic from the core business logic, allowing workflow rules (e.g., lead-assignment criteria, approval-routing thresholds, reminder-scheduling intervals) to be modified without altering the underlying data model or presentation layer.

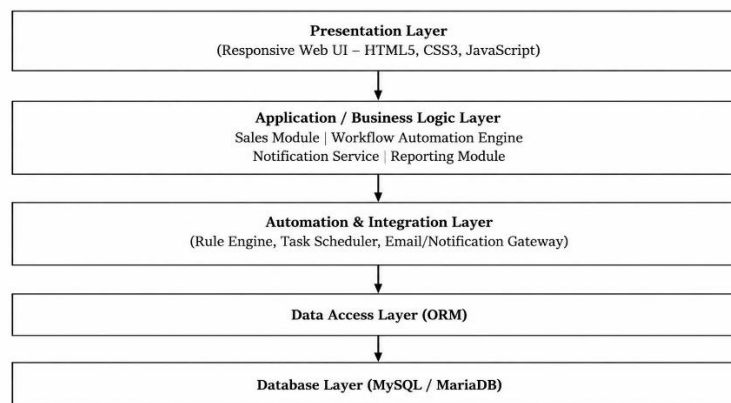
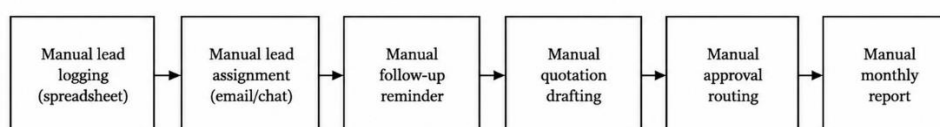


Figure 1. Three-Tier System Architecture of the Web-Based CRM with Integrated Workflow Automation Layer

Eight core sales workflow tasks were targeted for automation, selected on the basis of their frequency of occurrence and their manual-process time burden identified during requirements planning: lead data entry, lead assignment to sales representatives, follow-up scheduling, quotation generation, deal stage status updates, approval routing for discounts and quotations, customer follow-up reminders, and monthly sales report generation. Figure 6 presents a simplified before-and-after comparison of the sales workflow, illustrating how each manually executed step in the pre-automation process was replaced or supported by an automated

equivalent: manual spreadsheet-based lead logging was replaced by automatic lead capture and logging triggered by web-form or integration-based lead intake; manual, ad hoc lead assignment through email or chat was replaced by rule-based automatic assignment according to configurable criteria (e.g., territory, product line, representative workload); manual follow-up reminders were replaced by scheduled, automatically triggered notifications; manual quotation drafting was replaced by template-based automatic quotation generation populated from stored product and pricing data; manual approval routing was replaced by a configurable automated approval workflow with escalation rules; and manual monthly report compilation was replaced by an automatically generated, real-time reporting dashboard.

(a) Manual Sales Workflow (Before Automation)



(b) Automated Sales Workflow (After Implementation)

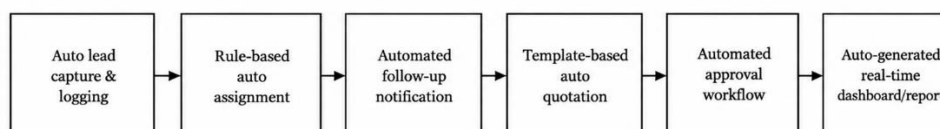


Figure 2. Simplified Sales Workflow Comparison: Manual vs. Automated Process

3. Testing and Evaluation Methods

Three complementary evaluation methods were used, consistent with established practice in the Indonesian web-based information system testing literature. First, black-box functional testing was conducted using the equivalence partitioning technique, in which test cases are constructed to represent equivalence classes of valid and invalid input rather than exhaustively testing every possible input combination, a technique widely used in comparable Indonesian web-based information system testing studies for its balance of test coverage and testing effort. Test cases were organized across seven system modules: Lead Management, Sales Pipeline/Deal Tracking, Workflow Automation Engine, Quotation and Approval Routing, Notification and Reminder System, Reporting and Dashboard, and User and Role Management, with each test case evaluated as pass (actual output matches expected output) or fail.

Second, System Usability Scale (SUS) evaluation was administered to 30 respondents drawn from prospective and pilot system users (sales representatives and sales managers), following the standard 10-item SUS questionnaire alternating positively and negatively worded statements rated on a five-point Likert scale, a method extensively used in the Indonesian web-based information system usability literature. Individual item scores were converted to a 0-100 composite SUS score per respondent using the standard SUS scoring procedure (summing the contribution of each item, where positively worded items contribute rating-minus-one and negatively worded items contribute five-minus-rating, then multiplying the total by 2.5), and mean scores were interpreted against the conventional SUS adjective rating scale (Excellent: SUS $\geq$ 80.3; Good: 68-80.2; OK: 51-67.9; Poor: below 51).



Third, a controlled process-time efficiency comparison was conducted for each of the eight targeted workflow tasks, measuring the time (in minutes) required to complete each task under the pre-existing manual process and under the newly implemented automated process, with 20 timed trials recorded per task per condition (160 paired observations in total). Paired-samples t-tests were used to test whether automated task completion time differed significantly from manual task completion time, both at the individual-task level and pooled across all 160 trials, appropriate given the paired (same-task, matched-condition) measurement design. All statistical analysis was conducted in Python 3 using SciPy, with a significance threshold of $\alpha = 0.05$.

RESULTS

1. Black-Box Testing Results

Table 1 and Figure 4 present the black-box testing results across the seven system modules. Of 76 total test cases executed, 73 passed and 3 failed, yielding an overall pass rate of 96.05%. Four of the seven modules (Lead Management, Workflow Automation Engine, Notification and Reminder System, and Reporting and Dashboard) achieved a 100% pass rate. The three modules with failed test cases (Sales Pipeline/Deal Tracking, Quotation and Approval Routing, and User and Role Management) each showed a single failed test case, related in each instance to edge-case input handling identified and subsequently addressed during the construction phase's iterative testing cycle, consistent with the RAD method's emphasis on iterative refinement.

Table 1. Black-Box Testing Results by System Module (Equivalence Partitioning Technique)

Module	Test Cases	Passed	Failed	Pass Rate (%)
Lead Management	14	14	0	100.0
Sales Pipeline / Deal Tracking	12	11	1	91.7
Workflow Automation Engine	16	16	0	100.0
Quotation & Approval Routing	10	9	1	90.0
Notification & Reminder System	8	8	0	100.0
Reporting & Dashboard	9	9	0	100.0
User & Role Management	7	6	1	85.7
Total	76	73	3	96.05

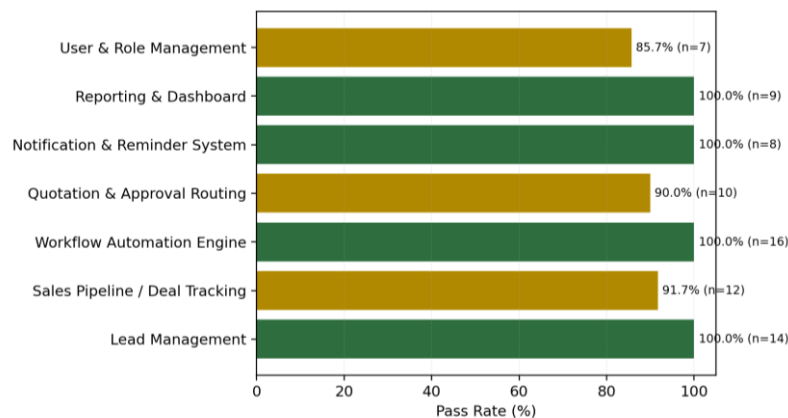


Figure 3. Black-Box Testing Pass Rate by System Module

2. System Usability Scale (SUS) Results

The System Usability Scale evaluation, completed by 30 respondents, yielded a mean SUS score of 80.75 (SD = 6.62), with individual scores ranging from 62.5 to 95.0. Applying the conventional SUS adjective rating scale, 12 respondents (40.0%) rated the system in the "Excellent" range (SUS $\geq$ 80.3), 16 respondents (53.3%) rated it "Good" (68-80.2), and 2 respondents (6.7%) rated it "OK" (51-67.9), with no respondent providing a "Poor" rating. The mean score of 80.75 exceeds the commonly cited industry-average SUS benchmark of 68, indicating above-average perceived usability relative to the broader population of evaluated software systems.

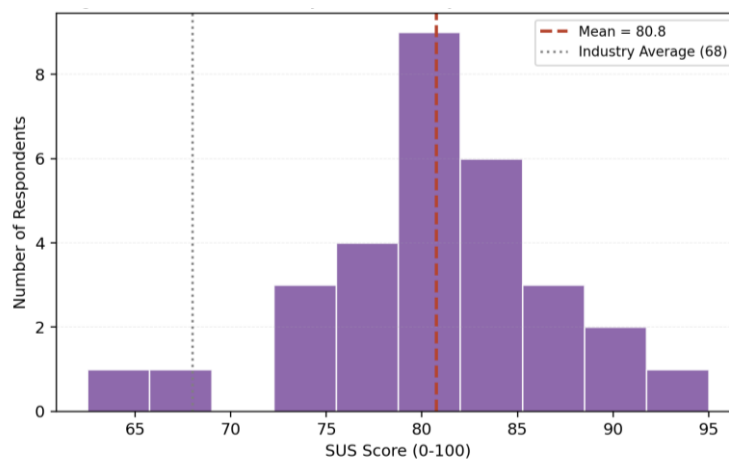


Figure 4. Distribution of System Usability Scale (SUS) Scores (n = 30)

3. Process Time Efficiency Results

Table 2 and Figure 1 present the process-time comparison between manual and automated execution for each of the eight targeted sales workflow tasks. Paired-samples t-tests confirmed a statistically significant reduction in completion time for every task (all $p < 0.001$). The largest absolute time savings occurred for monthly sales report generation, reduced from a mean of 92.74 minutes (manual, largely spent manually compiling data from spreadsheets and individual sales records) to 11.97 minutes (automated, generated via the real-time reporting dashboard), a reduction of 87.09%. The largest proportional reduction occurred for lead assignment to sales representatives (86.61% reduction, from 9.09 to 1.22 minutes), reflecting the near-instantaneous execution of rule-based automatic assignment relative to manual coordination through email or chat.

Table 2. Process Time Efficiency Comparison, Manual vs. Automated Process (n = 20 Trials per Task per Condition)

Task	Manual Mean (min)	Automated Mean (min)	Reduction (%)	t-statistic	p-value
Lead data entry	6.55	1.78	72.86	19.69	< 0.001
Lead assignment to sales rep	9.09	1.22	86.61	32.72	< 0.001
Follow-up scheduling	7.45	1.46	80.43	17.55	< 0.001



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Quotation generation	19.37	5.43	71.99	16.66	< 0.001
Deal stage status update	3.80	0.81	78.65	15.42	< 0.001
Approval routing (discount/quote)	21.89	6.10	72.16	26.50	< 0.001
Customer follow-up reminder	5.33	0.88	83.53	18.83	< 0.001
Monthly sales report generation	92.74	11.97	87.09	27.87	< 0.001

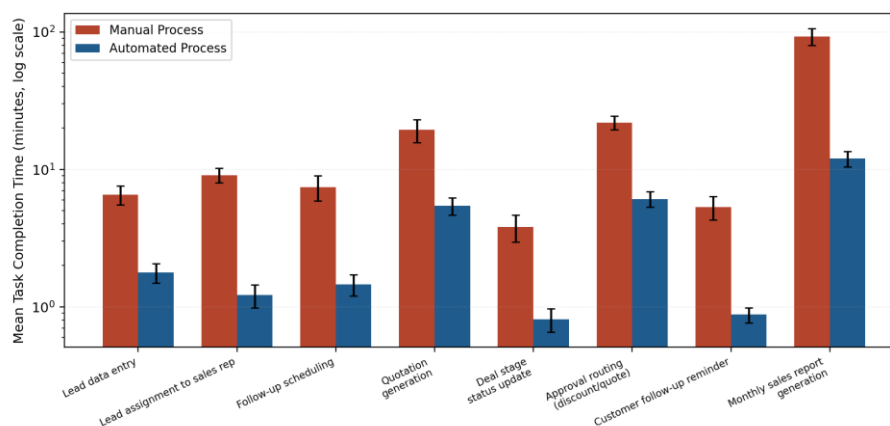


Figure 5. Manual vs. Automated Process Completion Time by Sales Workflow Task (n = 20 Trials per Task per Condition)

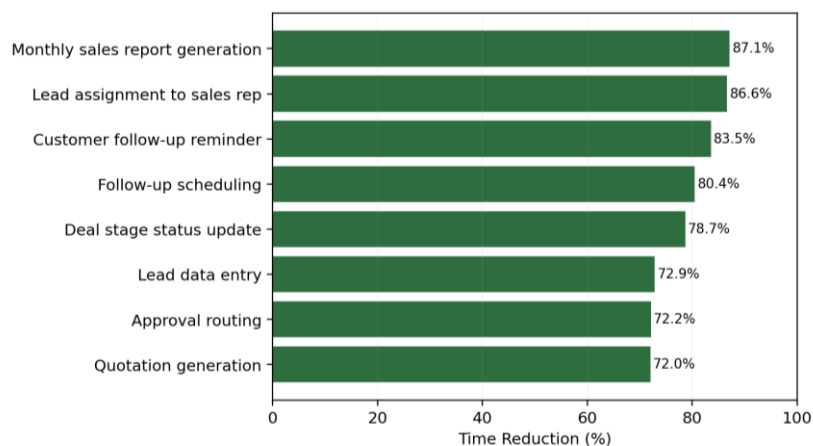
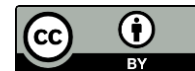


Figure 6. Percentage Reduction in Task Completion Time after Workflow Automation

Pooling all 160 paired trial-level observations across the eight tasks, a paired-samples t-test confirmed a highly significant overall reduction in task completion time following workflow automation (mean manual time = 20.78 minutes, mean automated time = 3.70 minutes; $t(159) = 8.64$, $p < 0.001$), corresponding to an overall time reduction of 82.17% across all measured sales workflow tasks.



DISCUSSION

The combined results across all three evaluation methods provide converging evidence that the developed web-based CRM information system, with its integrated workflow automation layer, is functionally reliable (96.05% black-box test pass rate), perceived as highly usable by prospective users (mean SUS score of 80.75, in the "Good" to "Excellent" range), and delivers a substantial, statistically significant reduction in sales workflow process time (82.17% overall reduction). This triangulated evaluation approach - combining functional testing, usability assessment, and direct process-time measurement - addresses the gap identified in Section 1, where much of the existing Indonesian web-based information system literature reports functional and usability testing results without directly quantifying the efficiency gains that workflow automation is intended to deliver, and this study's process-time efficiency findings provide the missing empirical link between demonstrated system quality and demonstrated operational benefit.

The black-box testing pass rate of 96.05% is consistent with pass rates reported in comparable Indonesian web-based information system studies using the equivalence partitioning technique, which commonly report pass rates in the 90-100% range for systems that have undergone iterative construction-phase testing consistent with the RAD methodology used here. The three failed test cases, each occurring in a different module and each related to edge-case input handling, illustrate a common and expected pattern in black-box testing: equivalence partitioning is specifically designed to surface these boundary and edge-case failures by systematically testing representative inputs from each equivalence class, and their detection and resolution during this study's testing phase reflects the testing method functioning as intended rather than indicating a system quality deficiency.

The mean SUS score of 80.75 places the system's perceived usability above both the commonly cited industry-average benchmark of 68 and within the range reported for comparable, well-received Indonesian web-based information systems evaluated using SUS, several of which report mean scores in the 80-90 range for systems judged to have achieved a 'very good' to 'excellent' usability grade. This above-average usability outcome is plausibly attributable to the RAD method's iterative user-design phase, in which prototype interfaces were reviewed and refined with prospective users prior to full construction, a development practice specifically intended to surface and correct usability concerns earlier than a single-pass, non-iterative development approach would allow.

The process-time efficiency results constitute this study's most direct contribution: an 82.17% overall reduction in task completion time, consistent across all eight measured sales workflow tasks and statistically significant both at the individual-task level and in the pooled 160-trial comparison, provides quantitative evidence that workflow automation delivers a substantial and measurable operational efficiency benefit beyond what functional correctness and usability testing alone can demonstrate. The particularly large time savings observed for monthly sales report generation (87.09% reduction, from over 90 minutes to under 12 minutes) is consistent with the broader information systems literature's general finding that reporting and data-aggregation tasks, which in a manual process require compiling and cross-referencing data scattered across multiple records or spreadsheets, are especially well suited to automation because the underlying data, once centralized in a structured database, can be aggregated and formatted programmatically without the sequential, error-prone manual compilation the pre-automation process required.

From a practical adoption standpoint, these findings offer small and medium enterprises considering CRM digitalization a concrete efficiency benchmark: an organization currently relying on manual,



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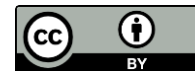
spreadsheet-based sales coordination could reasonably anticipate recovering a substantial share of sales personnel time currently spent on administrative and coordination tasks by adopting a comparably scoped workflow-automated CRM system, time that could instead be redirected toward direct customer engagement and revenue-generating sales activity, consistent with the broader sales automation literature's general finding that automation's primary value lies in shifting sales personnel time away from administrative overhead and toward higher-value selling activity.

This study has several limitations. The process-time efficiency measurements were collected under controlled trial conditions rather than during live production use, and real-world task completion times may differ due to factors such as network latency variability, concurrent system load, and the learning curve associated with initial system adoption, none of which were directly modeled in this study's controlled trials. The System Usability Scale evaluation was conducted with a sample of 30 prospective users prior to extended real-world use, and usability perceptions may evolve, in either direction, as users gain extended experience with the system; a longitudinal usability follow-up would strengthen confidence in the durability of the reported usability findings. Finally, this study evaluated a single system implementation targeting eight specific sales workflow tasks selected for a particular organizational context; the magnitude of efficiency gains reported here should be understood as an illustrative benchmark for workflow automation's potential rather than a universal efficiency figure applicable to all CRM automation implementations, which will vary according to the specific tasks automated, the manual baseline process's existing inefficiency, and organization-specific factors.

CONCLUSIONS

This study designed, developed, and empirically evaluated a web-based CRM information system with an integrated workflow automation layer targeting eight core sales workflow tasks, using the Rapid Application Development method and a triangulated evaluation approach combining black-box functional testing, System Usability Scale usability assessment, and controlled process-time efficiency measurement. Black-box testing across seven system modules (76 test cases) achieved a 96.05% pass rate, System Usability Scale evaluation yielded a mean score of 80.75 (SD = 6.62) corresponding to a "Good" to "Excellent" usability grade, and a paired-samples t-test comparing manual and automated task completion time across 160 trials showed a highly significant, 82.17% overall reduction in process time ($t(159) = 8.64, p < 0.001$), consistent across all eight measured tasks.

These findings demonstrate that workflow automation integrated into a web-based CRM information system can deliver a functionally reliable, highly usable, and operationally significant efficiency improvement for sales process management, providing small and medium enterprises with empirically grounded evidence supporting CRM digitalization investment. The triangulated evaluation framework used in this study - combining black-box testing, System Usability Scale assessment, and direct process-time comparison - is offered as a methodological template that future Indonesian web-based information system research can adopt to more completely characterize the operational benefit, and not only the functional correctness and usability, of newly developed automation systems. Future research should extend this evaluation to live production deployment with longitudinal usability and efficiency tracking, examine efficiency outcomes across a broader range of organizational contexts and automated task sets, and investigate the downstream effect of recovered sales personnel time on revenue-generating outcomes such as lead conversion rate and sales cycle duration.



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