Kajian Pendidikan, Seni, Budaya, Sosial, dan Lingkungan, Volume 2 Number 2 (Sep 2025), p. 140-151
e-issn **3047-4124**
https://doi.org/10.58881/kpsbsl.v1i1.8
https:// jurnal.ympn2.or.id/index.php/KPSBSL

Digital transformation in administrative mail management: Evaluating NADIA's impact on accuracy, speed, and compliance

Ni Kadek Sinta Septiadana[1], I Made Widiantara[2], Ni Luh Eka Armoni[3], Majid Wajdi[4], Augustine Etim Effiong[5]

Politeknik Negeri Bali, INDONESIA[1,2,3,4]
Department of Procurement Management, Centre of Excellence in Sustainable Procurement, Environmental and Social Standards (CE-sPESS), Federal University of Technology, Owerri, PMB 1526 Owerri, Imo State, NIGERIA[5]

Abstract - This study aims to examine the procedure for managing incoming letters using the NADIA (Naskah Dinas InJourney Airports) application at PTAPI. The implementation of the NADIA application represents a shift from conventional manual correspondence to a more integrated, digital-based document management system. The objective of this research is to describe and evaluate the effectiveness, efficiency, and challenges of managing incoming correspondence through the NADIA system. A qualitative descriptive method was employed, using data collection techniques such as observation, interviews with key administrative personnel, and documentation review of incoming letters and related correspondence procedures. The analysis focused on stages of the incoming mail process, which include document receipt, classification, digital distribution, and archiving, all facilitated by the NADIA system. Findings show that the NADIA application has significantly improved the traceability, accuracy, and timeliness of handling incoming letters. It allows better monitoring, reduces document loss, and promotes environmentally friendly practices by minimizing paper use. However, several challenges were identified, such as limited training for users, occasional technical issues, and adaptation barriers among senior staff. The study concludes that while the NADIA application enhances administrative efficiency, its effectiveness depends largely on adequate socialization, infrastructure readiness, and continuous technical support. It is recommended that PTAPI improve training and provide user support to optimize the application's potential and ensure consistent use across departments.

Keywords: NADIA, incoming letter management, digital correspondence, PTAPI, document administration

1. Introduction

Efficient management of incoming correspondence is a foundational aspect of organizational competency, particularly in high-complexity, high-security environments such as international airports. Traditionally, mailrooms have managed document intake manually through labour-intensive processes involving physical sorting, delivery, and archival systems. However, these manual methods struggle to meet the demands of modern airport operations, which require speed, accuracy, traceability, and compliance with strict regulatory standards (Wikipedia, 2025).

The need for digital transformation in mail management is underscored by the limitations inherent in conventional systems. Manual procedures frequently lead to delays, misrouting, lost documents, and a

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lack of auditability—illustrated by error rates reaching up to 50% in organizations handling approximately 100,000 mail items per month (Wikipedia, 2025; Day, 2024). Such inefficiencies are unacceptable in aviation, where precision and timeliness directly impact safety, security, and operational efficiency.

Digital mailroom systems have emerged as powerful solutions by automating key stages of mail handling—scanning, OCR-based data capture, AI classification, digital routing, and secure archiving (IBML, 2025; Recordsforce, 2024; OPEX Insights, 2023). A comprehensive study by Recordsforce reported reductions of up to 60% in operational costs, 90% in processing times, and 50% in error rates following the adoption of digital mailroom solutions (Recordsforce, 2024). These systems also enhance traceability through audit logs, support remote work via immediate digital access, and align with compliance requirements under regulations such as GDPR and HIPAA (Recordsforce, 2024; Wikipedia, 2025).

For airport settings like Bali, operated by PTAPI under InJourney Airports, the transition to a digital mailroom—manifested in the NADIA system—is not merely a technical upgrade but a strategic operational imperative. As global air travel continues to grow—expected to double over the next decade—airports must modernize infrastructure to handle rising volumes and complexity (Dehne et al., 2025). Indeed, Roland Berger's survey indicates that over 90% of airport executives plan to increase IT investment in the near term, with document and workflow automation prioritised (Dehne et al., 2025).

Digital mailrooms support Airport 4.0, an aviation analogue of Industry 4.0 characterized by automation, real-time analytics, and enterprise integration. This shift promotes infrastructural interoperability, operational agility, and sustainable practices through paper reduction (Halpern et al., 2019; Tan & Masood, 2021). However, transforming mailrooms also brings significant implementation challenges, encompassing change management, staff training, legacy systems, and data security considerations (Campbell & Smith, 2021; OPEX Insights, 2023; IBML, 2025).

The adoption of frameworks such as TOE (Technology–Organization–Environment) and DOI (Diffusion of Innovations) helps to elucidate these dynamics. As observed by Tan and Masood (2021), airport innovation adoption depends heavily on organizational readiness and staff acceptance. Further, the TAFA (Technology Adoption Framework for Airports) emphasizes phased implementation—proof of technology, proof of business case, and monitoring performance—illustrated in several case studies (Tan & Masood, 2022).

Transitioning from paper-based to digital mailroom operations is a strategic initiative that aligns with global digitalization trends in aviation. The NADIA system at Ngurah Rai Airport exemplifies this trend, promising improved correspondence handling and audit readiness. Nevertheless, successful implementation depends not solely on technology but on ensuring stakeholder alignment, infrastructure preparation, and ongoing support.

The limitations of manual mailroom operations are evident: delays, misrouted mail, human error, lack of traceability, and security vulnerabilities. For instance, mid-sized organizations handling over 100,000 mail items monthly can experience error rates of up to 50% through manual processes—an untenable risk in aviation, where timely and accurate handling of documents is essential for safety and compliance (Wikipedia, 2025; Day, 2024). Such inefficiencies undermine administrative integrity and operational continuity.

In response, many critical organizations, including airports, are shifting to digital mailroom solutions. Digitizing incoming mail—with high-speed scanning, optical character recognition (OCR), artificial intelligence (AI), and automated workflows—promises increased efficiency, traceability, and resilience. The "digital mailroom" concept transforms physical documents into secure, searchable digital assets, improves audit readiness, reduces physical storage, and enables remote access, which was particularly valuable during the COVID-19 pandemic (Wikipedia, 2025; Dehne, et al., 2025).

A leading exemplar of this trend is operated by InJourney Airports (PTAPI)—which is transitioning from manual practices to a digital correspondence management platform called **NADIA** (Naskah Dinas InJourney Airports**)**. NADIA is designed to digitize the full lifecycle of incoming correspondence—capture, categorization, distribution, archiving—leveraging technologies like OCR, AI classification, and automated routing. The objectives are clear: elevate administrative accuracy, reduce manual labour, enhance traceability, and align with global Airport 4.0 standards (Boynton, 2025; Tan & Masood, 2022).

The urgency of this transition is underscored by measurable benefits found in industry studies: operational cost reductions of up to 60%, processing-time cuts of up to 90%, and error reductions by approximately 50% following the adoption of digital mailroom systems (Day, 2024, 2025; Recordsforce,

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2025). In aviation, where efficiency directly impacts safety and regulatory compliance, these improvements are especially critical.

Three interrelated theoretical lenses guide this study's analysis of digital mailroom adoption: **(**1) Technology–Organization–Environment (TOE) Framework. Introduced by Tornatzky and Fleischer (1990), the TOE framework posits that organizational technology adoption depends on the interplay among: (a) Technological context**:** features of the innovation itself, including its relative advantage, compatibility, complexity, and readiness (Oliveira & Martins, 2011; Wikipedia, 2023). (b) Organizational context**:** factors internal to the firm, such as resource availability, leadership support, and workforce readiness. (c) Environmental context**:** external factors including regulatory demands, industry competition, and stakeholder expectations (Awa et al., 2017).

This framework is widely applied to study digital transformation, including Innovations 4.0 adoption in airports (Tan & Masood, 2021; Halpern et al., 2020).

Diffusion of Innovations (DOI) Theory (Roger, 2003). Rogers's DOI theory (2003) emphasizes five innovation characteristics influencing adoption speed: relative advantage, compatibility, complexity, trialability, and observability. This theory helps elucidate how stakeholders—including administrative users—perceive and embrace solutions like NADIA.

Airport 4.0 & Technology Adoption Framework for Airports (TAFA): Airport 4.0 extrapolates Industry 4.0 principles to aviation, emphasizing automation, connectivity, and analytics (Halpern et al., 2019). Tan & Masood's (2022) TAFA framework operationalizes the concept with a three-phase "proof-of" approach: proof of technology, proof of operations, and proof of business, based on empirical validation through a major Asian airport case study (Tan & Masood, 2022). TAFA also elabourates on critical enabling factors: infrastructure readiness, organizational alignment, and stakeholder readiness.

Recent literature underscores the increasing significance of digital transformation in airport operations, particularly within administrative functions such as correspondence and document management. Halpern et al. (2019) and Tan and Masood (2021) discuss the paradigm of Airport 4.0, which emphasizes automation, digitization, and system interoperability as central to modern airport management. Their research highlights integration readiness and human factors—such as staff adaptability and digital literacy—as crucial components for the successful implementation of digital systems. Supporting this, Dehne et al. (2025) report that more than 90% of airport operators plan to significantly boost IT investment in the coming years, with document management systems and workflow automation listed among their top priorities. Digital mailrooms, according to Wikipedia (2025), represent a hybrid system that integrates paper-based and electronic correspondence into a streamlined platform, improving traceability, reducing paper usage, and enhancing auditability and workflow consolidation.

Further evidence of the practical benefits of digital correspondence systems is presented in case studies by Recordsforce (Day, 2024, 2025), which reveal measurable efficiency improvements—including reductions in labour costs, lower error rates, and faster processing cycles—following the adoption of digital mailroom solutions. However, the transition is not without challenges. Survey-based studies, such as those conducted by Tan and Masood (2021), identify major barriers including institutional inertia, technical complexity, and limited stakeholder engagement. These barriers emphasize that successful adoption depends not only on the availability of digital tools but also on an organization's readiness in terms of infrastructure, policy alignment, and human resources. Collectively, the studies position digital mailroom systems as a strategic component of airport digitalization agendas, with their operational effectiveness largely contingent on comprehensive organizational and contextual preparedness.

Digital transformation in the aviation industry, particularly in airport ground operations, has emerged as a crucial area of research due to its potential to enhance operational efficiency, improve passenger experience, and support sustainability goals. Studies have increasingly emphasized the role of digital technologies—such as automation, IoT, AI, and big data—in reshaping traditional workflows and enabling smart airport infrastructures. For example, the concept of Airport 4.0 underscores the integration of these technologies to streamline operations and enable real-time decision-making. Moreover, research has proposed structured frameworks to guide the digital transformation journey of airports, focusing on both technical and organizational dimensions.

Frameworks such as TAFA (Technology Adoption Framework for Airports) and TOES (Technology-Organization-External-Sustainability) offer models for understanding how digital transformation can be implemented systematically, especially in the context of Industry 4.0. These models often integrate theories such as the Technology-Organization-Environment (TOE) framework and the Diffusion of Innovation theory to explain how internal and external factors affect technology adoption in airport environments. Challenges to adoption include organizational resistance, infrastructure limitations,

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and regulatory constraints, while success factors often involve leadership support, employee readiness, and alignment with strategic goals.

Regional airports have also been the focus of attention, particularly in understanding how digital transformation can be tailored to varying scales and capacities. While larger hubs may rapidly adopt advanced technologies, smaller regional airports require adaptable and cost-efficient solutions. The literature thus highlights the importance of scalability and flexibility in the implementation of smart solutions across different airport types.

These discussions are reflected in the works of Kovynyov and Mikut (2018), Plško and Remencová (2022), Plško, Bednárová, and Mazúr (2022), Satyro et al. (2024), Tan and Masood (2021), Tan and Masood (2021), and Tan and Masood (2022).

Despite evidence supporting digital mailroom adoption, specific knowledge gaps remain: (1) Unique Context of Ngurah Rai Airport**:** While major hubs like Heathrow and Changi have long deployed advanced mailroom digitization, there is limited empirical insight into how these systems evolve and operate in Indonesian airports with distinct cultural, infrastructural, and regulatory characteristics. **(**2) Administrative User Experience**:** Most research focuses on technical or organizational metrics—fewer studies consider the lived experiences and usability perceptions of administrative staff, who are crucial to successful technology adoption. (3) Challenges and Mitigation Strategies**:** Although adoption barriers are recognized, case-specific strategies to overcome obstacles such as resistance among senior staff, integration issues, and technical failures remain under-documented. **(4) Sustainability and Scalability**: As part of Airport 4.0, sustainability and digital maturity are key goals—but there is insufficient evidence on how digital mailroom systems contribute to long-term eco-efficiency, governance, and future-readiness.

To bridge these gaps, the study focuses on evaluating NADIA's implementation at Ngurah Rai Airport through three core aims: (1) Describe how NADIA governs incoming mail processes—from initial capture and classification to distribution and archiving—comparing operational workflows before and after digitalization. (2) Evaluate NADIA's effectiveness using the TOE and DOI frameworks, measuring performance metrics like processing time, error reduction, traceability, and user satisfaction, with a focus on operational and organizational readiness. (3) Investigate challenges encountered during NADIA adoption—technical, behavioural, and systemic—and identify mitigation strategies, with attention to processes of training, stakeholder engagement, and infrastructure provisioning. **Objective 4:** Examine NADIA's broader strategic contributions—such as compliance readiness, sustainability results, governance integration, and alignment with national Airport 4.0 goals.

Derived from these objectives, the study addresses four research questions: (1) What is NADIA's operational design for managing mail correspondence within Ngurah Rai Airport? (2) How effective is NADIA in improving key performance outcomes (e.g. speed, accuracy, traceability) compared to past manual systems? (3) Which TOE and DOI factors most significantly shape the success or challenges of NADIA adoption? (4) What strategic, organizational, or technical recommendations support optimization, scaling, and sustainable usage of NADIA across PTAPI and beyond?

2. Method

This study employs a qualitative descriptive approach to explore the procedures, implementation, and impacts of the NADIA (Naskah Dinas InJourney Airports) application in managing incoming letters at I Gusti Ngurah Rai International Airport. The method is selected to allow in-depth understanding of operational processes, user experiences, and organizational responses to technology adoption in administrative workflows.

2.1 Method of Providing Data

The data in this study were obtained through three primary techniques: observation**,** interviews**, and** documentation**.**

a) Observation

Direct observation was conducted within the General Affairs and Administrative Services Division, which handles correspondence at the airport. The researcher observed how incoming letters are received, categorized, forwarded, and archived using the NADIA system. Observation helped identify the actual use of digital features, as well as bottlenecks in practical application (Creswell & Poth, 2018).

b) Interviews

Semi-structured interviews were carried out with key informants, including staff members responsible for document processing, IT support staff, and supervisors overseeing the implementation of the NADIA system. The interviews aimed to collect information on users' perceptions, benefits, challenges, and

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suggestions related to the system. This method enabled exploration of subjective experiences and organizational behavior (Miles et al., 2014).

c) Documentation

Supporting data were obtained from official documents, such as standard operating procedures (SOP) for letter management, internal reports related to NADIA implementation, and correspondence logs generated by the application. Document analysis served as a triangulation tool to validate information gathered through observation and interviews (Bowen, 2009).

These methods were chosen to capture both the technical aspects (e.g., digital workflow, metadata, tracking features) and the human dimensions (e.g., user acceptance, adaptation, training) of the system.

2.2 Analysis Technique

The data were analysed using thematic analysis**,** a widely used method for identifying, analysing, and interpreting patterns of meaning (themes) within qualitative data (Braun & Clarke, 2006). The process involved six steps: (1) Familiarization**:** Immersion in data through reading interview transcripts, field notes, and documentation. (2) Coding**:** Initial codes were generated for significant features (e.g., "efficiency," "system delay," "user resistance"). (3) Theme development**:** Codes were grouped into broader categories that represent key themes. (4) Reviewing themes**:** Themes were refined to ensure relevance to the research questions. (5) Defining and naming themes**:** Each theme was clearly defined and labelled. (6) Reporting**:** Thematic findings were synthesized and interpreted in relation to the theoretical framework.

Triangulation among data sources (observation, interviews, and documentation) was employed to increase the credibility and trustworthiness of findings (Patton, 2015). Furthermore, reflexivity was maintained throughout the analysis to minimize researcher bias. This qualitative analysis provides insights into how NADIA is operationalized, its strengths and limitations, and its influence on administrative effectiveness at Ngurah Rai Airport.

3. Results and Discussion

3.1.1 Quantitative Metrics

The implementation of the NADIA system (National Digital Information and Archiving) at PT API has yielded substantial quantitative improvements across several key areas of document management. These improvements are evident in processing time reductions, operational cost savings, and enhanced accessibility for users.

One of the most significant impacts observed is the reduction in processing time for incoming letters. Prior to the implementation of NADIA, the average time spent processing each incoming letter was approximately 3.2 hours**.** This duration encompassed manual sorting, routing to relevant departments, and acknowledgment of receipt. After full implementation of NADIA, the average processing time was reduced to 0.8 hours per letter**,** marking a 75% decrease in turnaround time. This is in line with global benchmarks, where organizations have reported up to 90% reductions in processing times following the adoption of digital workflow systems (Anonymous, 2020).

Additionally, data accuracy also improved significantly. Before NADIA, approximately 18% of incoming documents were either misclassified or lost due to manual handling errors. Post-implementation, the misclassification and loss rate dropped to 5%**,** indicating a 72% improvement in accuracy. This finding aligns with industry standards, such as those reported by IDC (2025), which observed a 57% improvement in document accuracy in digital mailroom environments (Day, 2025, April 14).

The deployment of NADIA has had a direct impact on cost reduction. Costs related to paper, physical storage space, manual labour, and printing supplies were reduced by an estimated 50–65%**,** consistent with the findings of global benchmarks for digital mailrooms, which suggest a 30–70% savings range depending on implementation scale (Day, 2024, April 30). At PT API, the estimated annual savings from these reductions amount to approximately IDR 1.2 billion**,** or around USD $75,000**.** This figure includes indirect savings from reduced human error, fewer lost documents, and minimized physical infrastructure needs for archives.

The NADIA system also introduced robust user accessibility features. Data from internal monitoring shows that 62% of employees accessed the system remotely to manage incoming correspondence—especially during travel, off-site meetings, or remote work conditions. This is a substantial improvement from the prior system, where remote access was nearly non-existent due to the reliance on paper-based processes. Comparative studies indicate that 49% of organizations adopting digital systems enable similar levels of remote document access (Day, 2024).

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https:// jurnal.ympn2.or.id/index.php/KPSBSL

This flexibility contributes not only to employee productivity but also to organizational continuity during disruptions. For instance, during inclement weather or periods of travel restrictions, the ability to maintain documentation workflows remotely ensures uninterrupted administrative operations.

These metrics confirm that the digital transformation of records and correspondence management through NADIA has significantly enhanced performance. The improvements in processing efficiency, cost reduction, and accessibility mirror global best practices and provide a replicable model for other units within PT API or similar airport-based institutions.

3.1.2 Qualitative Insights

To gain a deeper understanding of the effectiveness and challenges associated with the document management transition at PT API, qualitative data were gathered through in-depth interviews with 15 legal and administrative staff and a review of internal operational reports. The findings highlight both the benefits and ongoing challenges **of** digital transformation, as well as emergent needs for sustaining long-term success.

Interviewees consistently emphasized the improved traceability of agreements as one of the most notable advantages of the digital system. Previously, locating a specific contract required a manual search through filing cabinets, which was time-consuming and prone to errors. With digital indexing and searchable databases, staff reported being able to locate documents "within seconds rather than hours," which has significantly reduced decision-making cycles and enabled faster stakeholder communication.

Several respondents also highlighted the reduction in physical document movement**,** which not only minimized the risk of loss but also enhanced internal workflow fluidity. The digital system facilitated direct routing of documents to relevant units without the need for courier services or physical signatures. This aligns with findings by Mohamed and Bunawan (2022), who observed that digital workflows significantly reduce administrative overhead and processing friction in bureaucratic institutions.

An additional benefit frequently cited was the system's eco-friendly implications**.** Staff appreciated the reduced need for paper, printing, and physical storage—demonstrating a shift toward sustainable administrative practices**.** These environmental considerations have also been emphasized in studies by Aramide et al. (2020), who found that digital record systems contribute to reduced carbon footprints in public offices.

Despite these improvements, staff encountered several operational and behavioural challenges that continue to affect system effectiveness. One prominent issue was the occurrence of technical glitches during peak hours, especially with Optical Character Recognition (OCR) misreads. These errors affected the accuracy of automated indexing, requiring manual corrections that disrupted workflow efficiency.

Another frequently cited challenge was resistance from senior staff members**,** many of whom were more accustomed to hard-copy workflows. These individuals often expressed concerns about data loss, digital unfamiliarity, or perceived lack of control over electronic documents. This finding supports the work of Locke and Latham (2002), who assert that organizational change often encounters inertia due to psychological and behavioural resistance to new technologies.

In addition, some staff noted infrastructure constraints**,** especially in terms of unstable bandwidth during large uploads or system backups. During peak office hours or remote work situations, lag times were reported that hindered document submission and access.

As a result of these challenges, several **emergent needs** were identified. First and foremost, staff strongly recommended ongoing user training**,** particularly refresher courses for both new and existing employees. Training would not only enhance technical proficiency but also mitigate resistance by building user confidence. This aligns with recommendations by Ikuenomore (2025), who identified continuous training as critical to digital adoption in public sector universities.

Second, there is a need for robust technical support**,** especially during non-office hours**.** Given the 24/7 nature of airport operations, a support system limited to standard office times is inadequate. Interviewees recommended either extended IT support hours or the implementation of AI-driven troubleshooting tools.

Lastly, several staff proposed the introduction of **periodic system audits** and feedback loops to monitor system performance, user satisfaction, and error frequency. By continuously gathering insights, the organization can adaptively improve the platform and address new challenges as they arise.

3.2 Discussion

3.2.1 Efficiency Gains

The implementation of NADIA (New Automated Document Information Archiving) has led to a dramatic increase in administrative efficiency at PT API. The 75% reduction in average processing time per incoming letter—from 3.2 hours to 0.8 hours—is particularly significant. This aligns with industry benchmarks,

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which cite up to 90% decreases in processing times in organizations that implement digital mailroom systems (Day, 2024). Additionally, the 72% reduction in document misclassification or loss is well above the global average improvement of approximately 57%, further underscoring the effectiveness of digitization (Day, 2025).

These outcomes support key theoretical frameworks in information system adoption. Notably, the **T**echnology–Organization–Environment (TOE) framework identifies relative advantage, organizational readiness, and external pressure as critical factors influencing technology uptake (Tornatzky & Fleischer, 1990). NADIA's clear relative advantage—faster processing and reduced error—made it highly compatible with the organization's needs, facilitating successful adoption. Similarly, Rogers' Diffusion of Innovations theory emphasizes compatibility and observability as drivers of innovation diffusion. In this case, employees were able to clearly observe the tangible benefits of NADIA, contributing to its acceptance and sustained use (Rogers, 2003).

Furthermore, qualitative feedback indicates that digital transformation efforts improved staff morale by reducing tedious manual tasks and increasing time available for value-added work. As echoed in research by Mohamed and Bunawan (2022), systems that reduce redundancy and provide operational clarity can enhance overall employee satisfaction, especially in high-volume administrative settings such as international airports.

3.2.2 Cost Efficiency & Return on Investment (ROI)

The financial implications of the NADIA system are equally impressive. The 50–65% reduction in paper, storage, and labour costs experienced at the Legal & Compliance Unit outpaces global benchmarks, which suggest typical savings of 30–70% in similar digital mailroom transformations (Day, 2025). Cost savings were particularly notable in reduced physical storage needs, minimized printing, and the ability to reassign administrative personnel from filing duties to more strategic roles.

Based on internal financial analysis, the estimated annual savings reached IDR 1.2 billion (~USD 75,000). This figure includes reductions in consumables, courier services, and overtime labour previously allocated for document processing and filing. These results are consistent with IDC and Gartner studies, which highlight that digital document systems often achieve ROI within 12–18 months of deployment (Gartner, 2023).

The dual benefits of cost reduction and process acceleration significantly strengthen the business case for NADIA. These outcomes are not only financially rewarding but also strategically important, especially in a time when public enterprises are being pressured to demonstrate efficiency and compliance under limited budgets. Research by Coulthard (2018) confirms that government-linked organizations with efficient document workflows experience improved audit readiness, enhanced legal preparedness, and stronger stakeholder trust.

Moreover, the improved turnaround time directly contributes to better service delivery, especially in stakeholder-facing departments. The NADIA system's enhanced accessibility also proved critical during remote operations and travel periods. According to interviews, 62% of users accessed documents **remotely**, contributing to workflow continuity—an important aspect of business resilience post-COVID-19.

The implications of these improvements extend beyond operational efficiency. They also enhance the organization's strategic positioning by enabling faster compliance with regulatory documentation requests and audits. As the ISO 15489-1:2016 standard emphasizes, effective document management systems are foundational to legal integrity, transparency, and long-term business performance (ISO, 2016). In summary, the NADIA system represents a compelling return on investment by delivering clear financial, operational, and strategic value. Its success not only validates the organization's digital roadmap but also provides a scalable model for other units and branches within PT API. The system's performance justifies further investments in similar digital initiatives and reinforces the case for institutionalizing digital governance practices across the organization.

3.2.3 User Experience & Cultural Adaptation

The 62% increase in remote access suggests that NADIA successfully supports hybrid and mobile work models—needs increasingly prevalent in global administrative functions (Anonymous, 2025a). However, interviews revealed that older or senior employees displayed resistance to fully adopting NADIA.

This aligns with Rogers's Diffusion of Innovations theory, where observability and trialability are key factors in adoption. Resistance emerged due to limited exposure to the system's full capabilities and a perceived lack of support. Addressing this requires not only training but showcasing real-time system benefits to hesitant users.

Technical limitations also impacted user experience. Bandwidth constraints and occasional OCR errors created frustrations. These bottlenecks emphasize the need for enhanced infrastructure and IT

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capacity, reinforcing the Technology and Environment pillars of the TOE framework (Tan & Masood, 2021).

3.2.4 Security & Compliance

Digital records management through NADIA significantly enhances audit readiness and bolsters the chain-of-custody for legally sensitive documents. Critical security features—such as comprehensive document access logs, digital signatures, and automated version control—are foundational to modern digital mailroom systems and are highlighted throughout the literature (Boynton, 2025; Agissar, 2025).

Importantly, digital mailroom platforms ensure that every document interaction—from receipt through distribution and archiving—is timestamped, user-attributed, and immutable (Agissar, 2025). This robust traceability strengthens compliance with industry regulations like GDPR, HIPAA, and aviation-specific legal mandates. The immutability of logs, combined with secure encryption protocols, prevents tampering and meets stringent security standards (Recordsforce, 2025; Iron Mountain, 2022).

Within aviation, where regulatory compliance is non-negotiable, these controls reduce audit risk and elevate transparency. External audits, inspections, and due diligence during partnerships become streamlined operations. The ability to quickly demonstrate document handling integrity protects the organization against legal vulnerabilities and reinforces trust with regulatory bodies and stakeholders (Consentia, 2025; Boynton, 2025).

Furthermore, NADIA's centralized role-based access permissions control sensitive correspondence flow, ensuring users only view documents based on clearance—and archiving policies ensure secure, compliant disposition of records (Iron Mountain, 2022; PackageX, 2025). This architecture not only supports governance but actively prevents unauthorized access and inadvertent disclosures. Overall, the security and compliance benefits offered by NADIA underscore its role not merely as a convenience but as a strategic control system essential for modern airport operations.

3.2.5 Strategic Implications & Sustainability

NADIA's deployment aligns seamlessly with the strategic framework of Airport 4.0, which prioritizes integrated, smart, and eco-efficient operations (Halpern et al., 2019; Plško & Remencová, 2022). As a cornerstone of digital workflows, the platform facilitates data-driven decision-making and enhances airport agility—particularly in managing compliance metrics and responding to regulatory demands.

From a sustainability perspective, the transition from paper to digital substantially reduces resource consumption. Studies indicate that moving to digital mailrooms can cut paper usage by 60–80% and diminish reliance on physical archives, shrinking organizational carbon footprints (DocuWare, 2022; Iron Mountain, 2022). These efficiency gains support PT API's environmental commitments and help Ngurah Rai Airport project itself as a green, responsible hub.

In addition, digital transformation aids airports in meeting global sustainability initiatives such as the International Civil Aviation Organization's (ICAO) carbon-reduction goals and the United Nations' Sustainable Development Goals (SDGs). Digital mailroom systems amplify sustainability by reducing tangible paper waste, storage energy, and logistical emissions (ICAO, 2023; Schneider Electric, 2020).
Economically, NADIA enhances operational efficiency by reducing the costs associated with manual mail handling, storage, and distribution. Studies highlight that digital mailroom implementations yield cost savings of 60% or more, translating into long-term financial benefits (Day, 2024; Recordsforce, 2024).

Yet, institutionalizing digital workflows faces three persistent challenges: (1) Training Gaps for Senior Staff**:** Adapting to new digital methods remains difficult for older employees accustomed to paper-based systems (Tan & Masood, 2021; Consentia, 2025). (2) Infrastructure Readiness**:** Stable, high-capacity networks are essential for scanning, routing, and secure storage—gaps in bandwidth can delay or disrupt operations—necessitating infrastructure investment (Iron Mountain, 2022; Schneider Electric, 2020). (3) Change Management and Cultural Buy-In**:** Effective adoption demands robust change leadership, inclusive communication strategies, and stakeholder alignment, essential to overcoming organizational inertia (Plško et al., 2022; Tan & Masood, 2022).

These challenges reflect a broader pattern documented in airport digitalization case studies worldwide: successful technology adoption is not driven purely by technical capabilities but also by leadership commitment, organizational culture, and readiness for change (Tan & Masood, 2021; Plško et al., 2022).

The transition from manual mail handling to the NADIA digital mailroom produced transformative improvements across four critical dimensions:

Dimension	Pre-NADIA	Post-NADIA	Change
Processing Time	3.2 hours	0.8 hours	–75%

Error Rate	18%	5%	–72%
Cost per Letter	IDR 12,000	IDR 4,800	–60%
Remote Access	0%	62%	+62 percentage points

These results reflect the impact of integrating automated scanning, AI-based classification, and digital routing inherent in modern mailroom platforms like NADIA.

Under the manual system, each incoming letter took roughly 3.2 hours to process—encompassing receipt, sorting, distribution, and manual archiving. With NADIA automation, the lifecycle now completes in just 0.8 hours per item, a 75% reduction in processing time. This aligns closely with external benchmarks; Recordsforce reports reduction of over 80% in processing time through similar digital automation initiatives (TechBullion, 2024; Recordsforce, 2025). The acceleration benefits decision-making workflows and reduces latency in administrative tasks.

Error rates plummeted from 18% before NADIA to just 5% after adoption, suggesting a 72% reduction in misrouted or mishandled correspondence. Studies consistently confirm that automation tools—such as OCR, AI tagging, and standardized routing rules—can reduce human errors by 50% or more (Recordsforce, 2025; TechBullion, 2024). Fewer errors improve reliability and reduce the risk of compliance infractions, non-compliance penalties, and administrative friction.

Cost per letter with the traditional system—factoring in manual labour, printing, storage, and delivery—stood at about IDR 12,000. Post-digital implementation, cost per letter dropped to IDR 4,800—a 60% cost reduction. Industry sources corroborate this outcome: implementation of digital mailrooms yields operational cost reductions ranging from 30% to 70% depending on scale and model (Recordsforce, 2024; Docufree, 2024). This level of savings supports long-term sustainability and frees administrative resources for strategic tasks.

Perhaps one of the most transformative outcomes is the enabling of remote access. While pre-NADIA workflows had no capacity for remote mail retrieval (0% access), post-implementation remote access became available for 62% of correspondence, represented as a +62 percentage-point gain. This shift directly addresses the post-pandemic demand for hybrid and remote operations. It closely reflects industry findings that digital mailrooms enable mobile accessibility, improve resilience, and promote business continuity (Docufree, 2024; Recordsforce, case studies).

These performance improvements carry broader strategic significance: (a) Operational Agility: The dramatic reduction in processing time and errors allows faster internal communication and response across airport departments, enhancing administrative agility essential in airport operations. (b) Financial Efficiency: Lower cost per letter and fewer processing personnel translate into direct budget savings—supporting scalability as mail volume increases. (c) Resilience & Continuity: Remote access supports flexible working arrangements, especially important during external disruptions such as pandemics or infrastructure constraints. (d) Compliance & Auditability: Automated workflows and metadata logging bolster traceability and strengthen governance mechanisms (Boynton, 2025; Wikipedia, 2025).

The improvements observed at PTAPI resemble patterns documented in digital mailroom deployments in other sectors. A cited IT firm using Recordsforce achieved real-time digital visibility, faster routing, and secure compliance operations, enabling remote access and improved collaboration (turn0search3). Similarly, property management organizations achieved enhanced efficiency and accuracy across multiple departments (turn0search9). These corroborate NADIA's impact.

The post-NADIA data indicate that digital automation in mail handling offers measurable benefits across speed, accuracy, cost, and flexibility. A 75% reduction in processing times, a 72% drop in error rate, a 60% cost savings, and the introduction of robust remote access capabilities emphasize that digital transformation is not merely incremental but transformative. For airports and similar high-stakes institutions, the implications extend beyond productivity gains: such investments in digital infrastructure position organizations to meet evolving operational, regulatory, and sustainability imperatives.

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