



A User-Centered Architecture for E-Budgeting: Designing Role-Based Interfaces for Public Administration

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Abstract

Public financial platforms often transfer inflexible manual processes directly into digital environments (a phenomenon termed "e-bureaucratism"), heightening cognitive strain and threatening adherence to intricate policies like Presidential Regulation No. 72 of 2025. Therefore, this study aims to design an official travel administration interface prototype accommodating strict bureaucratic workflows while preserving cognitive ergonomics. Employing the ISO 9241-210:2019 User-Centered Design (UCD) standard, the methodology encompassed analyzing user contexts via in-depth interviews with three key participants: one Head of Department, one Master Administrator, and one Department Administrator. Engaging these specific roles was critical to capture firsthand administrative constraints, ensuring the resulting interface accurately aligns with users' mental models to mitigate cognitive overload. This analysis guided the specification of functional requirements and design solutions, involving mapping hierarchical user flows and developing low-fidelity wireframes tailored for these actors. The results yield a role-based architecture enforcing functional isolation. Providing macro-level financial dashboards for central administrators and task-specific modules for departmental executors minimizes information overload. Additionally, structured user flows operationalize seamless integration by embedding statutory constraints like quotas and tariff validations into backend automation. This actively shields users from manual cross-referencing, aligning the interface with their mental models, and ensuring strict regulatory compliance without sacrificing operational efficiency.

Keywords: *User-Centered Design, E-Budgeting, Role-Based Interface, Digital Transformation*

INTRODUCTION

Digital transformation through e-budgeting serves as a strategic element and economic innovation in public financial governance reform to enhance transparency and accountability (Lakat et al., 2026). However, the transition from legacy systems presents unique structural and technological challenges (Shonubi, 2025). Current conventional systems still face significant constraints, primarily characterized by passive, rigid, and manual input-dependent validation mechanisms. This poses a risk of non-compliance with the latest regulatory frameworks, specifically Presidential Regulation Number 72 of 2025 concerning Regional Unit Price Standards, potentially triggering miscalculations in official travel unit costs and leading to budget inefficiencies. The long-term urgency of this issue necessitates the development of an intelligent solution capable of automating verification processes while simultaneously considering the psychological aspects of users. Nevertheless, as a fundamental prerequisite for materializing such a system, an interface design must be established to accommodate complex bureaucratic workflows without imposing a cognitive overload on the user.

Prior studies have highlighted that digital transformation in public governance often leads to "e-bureaucratism," where traditional bureaucratic rigidities are merely transferred into digital

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environments (Shovkovyy, 2024). This issue is particularly prevalent in administrative cultures that emphasize hierarchical control over user empowerment (Toening Winarni & Bundianto, 2024). Furthermore, recent studies indicate that public sector digital systems continue to face challenges related to usability and a misalignment between interface design and actual user needs, which can lead to adoption failures (Savoldelli et al., 2014; Wibisono & Tjhin, 2025). To address these issues, a User-Centered Design (UCD) approach is widely advocated as a critical strategy to improve usability and reduce extraneous cognitive load in administrative e-services (Balasm et al., 2025; Faudzi et al., 2024). However, there remains a significant research gap. Existing literature has not adequately addressed how to design a hierarchical, role-based interface that seamlessly integrates strict regulatory compliance mechanisms such as Presidential Regulation Number 72 of 2025, without overwhelming the users' cognitive capacity (Balasm et al., 2025; Wibisono & Tjhin, 2025).

Therefore, this study designs an official travel system prototype using the ISO 9241-210:2019 User-Centered Design (UCD) standard. By mapping workflows and developing role-specific wireframes for three key actors (Head of Department, Master Administrator, and Department Administrator), the design overcomes validation rigidity. Theoretically, it demonstrates how UCD and Cognitive Load Theory balance strict bureaucratic compliance with user ergonomics. Practically, it delivers a role-based architecture that mitigates 'e-bureaucratism' by streamlining approvals. Although modeled on a specific case, its core principles, functional isolation and backend automation, are highly adaptable for other public institutions facing similar hierarchical constraints.

LITERATURE REVIEW

To understand the necessity of this proposed UCD approach, it is crucial to first examine the theoretical challenges of public sector digitalization. The digital transformation of public governance fundamentally alters the operational relationship between state institutions and their users. However, practical experience reveals that information technologies often fail to streamline these processes, instead giving rise to "e-bureaucratism," where the rigid rules and intricate forms of traditional bureaucracy simply migrate to the digital realm (Shovkovyy, 2024). In the Indonesian context, this transition is heavily influenced by a hierarchical administrative culture, resulting in digital systems that are frequently designed to reinforce bureaucratic control rather than to empower the user (Toening Winarni & Bundianto, 2024).

When complex regulatory constraints are directly mirrored onto the digital interface, they force users to simultaneously manage their primary tasks and navigate inflexible bureaucratic protocols. From a Human-Computer Interaction (HCI) perspective, Cognitive Load Theory dictates that a poorly designed user interface places an unnecessary burden on the user's cognitive system (Faudzi et al., 2024). Specifically, this design failure drastically increases extraneous cognitive load, meaning users must expend their limited mental resources on understanding system navigation rather than processing the actual task. High cognitive load in user interfaces can ultimately lead to reduced comprehension, increased errors, and a lack of user engagement (Balasm et al., 2025).

Therefore, constructing an effective e-government strategy requires shifting the focus toward improved, role-specific administrative e-services that actively manage this mental effort. Resolving this institutional friction demands a holistic, user-centric approach that minimizes extraneous load through clear visual hierarchies, information chunking, and consistent design. By concealing administrative complexities behind an optimized interface, the system can reduce cognitive overload and significantly improve the actual quality and efficiency of public administration (Balasm et al., 2025).

The User-Centered Design (UCD) framework, which is based on ISO 9241-210:2019, places human capabilities and psychological frameworks at the center of system development as a theoretical answer to the high cognitive load and the issue of "e-bureaucratism" discussed earlier. The failure of e-government adoption frequently results from the direct conversion of manual processes into digital interfaces without taking user experience into account, which emphasizes the importance of this strategy (Savoldelli et al., 2014). UCD avoids the inflexible transition of old bureaucracy into the digital sphere by putting the user at the center of the development process.

Balancing users' cognitive ergonomics with stringent adherence to intricate state requirements, such as budgetary constraints specified in Presidential requirements, is a major difficulty in the design of a governmental e-budgeting system. The issue is resolved by the UCD method through the idea of seamless integration, in which backend automation hides bureaucratic validation requirements and computational complexity behind the interface (Lindgren et al., 2019). As a result, a user-centered design guarantees that the screen only displays pertinent and useful information, which in theory promotes work efficiency and error prevention in the face of strict budgetary constraints.

Furthermore, UCD principles support an early and ongoing focus on particular user tasks and roles within a hierarchical bureaucratic structure involving multiple actors with different levels of authorization, from the Head of Department (KPA) and the Master Administrator (PPK) to the Department Administrator. Gulliksen et al. (2003) state that in order to create functionally segregated, role-based digital environments, user-centered systems must be specifically developed to accommodate the users' actual workflow and duties. By putting this idea into practice, the system architecture optimizes the overall operational workflow by ensuring that each actor only interacts with the resources and data required for their particular administrative responsibilities.

To translate these broad role-based principles into a functional system, designers must first establish the logical pathways users will navigate. A user flow represents the cognitive and navigational pathway required to complete specific tasks, serving as a critical mechanism to map hierarchical authorization processes onto intuitive, sequential interactions (Cooper et al., 2014). By explicitly defining these pathways, designers can systematically structure role-based interactions and identify potential navigational bottlenecks. This deliberate mapping ensures that the interface's logical progression aligns with the user's mental model, effectively shielding administrative actors from the convoluted structure of backend bureaucratic rules (Norman, 2013).

Following the establishment of these logical pathways, wireframing acts as a fundamental visual abstraction that prioritizes information architecture, spatial layout, and functional affordances over aesthetic design (Abdullah et al., 2011). This removal of visual complexity allows developers to focus exclusively on cognitive ergonomics, such as information chunking and visual hierarchy, to evaluate whether the layout successfully minimizes extraneous cognitive load (Faudzi et al., 2024). Ultimately, user flow modeling and wireframing function as the theoretical testing ground where UCD principles are operationalized, ensuring that strict administrative constraints are seamlessly integrated into the interface layout to maintain both compliance and operational efficiency.

RESEARCH METHODOLOGY

Based on the ISO 9241-210:2019 standard, the UCD approach aims to improve usability and user experience while minimizing negative impacts on user performance. This approach focuses on three main stages, ranging from analysis to designing an interactive prototype. These three stages include: (1) Understanding and Specifying the Context of Use to identify who the users are and under what conditions the system is used; (2) Specifying the User to formulate the characteristics and needs of the target users; and (3) Producing a Design Solution by creating

interface designs or prototypes that meet these needs. These detailed stages are illustrated in Figure 1.



Figure 1. UCD Process

The first stage, Understanding and Specifying the Context of Use, identified system user challenges via in-depth interviews with three key participants: a KPA, PPK, and Unit Admin. Inclusion required direct involvement in travel administration, excluding non-administrative traveling staff. Role-specific questions explored assignment letter issuance, fund disbursement requirements, and foundational regulations. These insights directly informed the User Personas and a comprehensive understanding of administrative constraints.

Next, the Specifying the User stage mapped user personas, journeys, and functional requirements to balance user-friendly interfaces with strict financial compliance. This produced a requirement list serving as the primary reference for visual design.

Finally, the Producing Design Solution stage translated these requirements into visual and functional interfaces. This involved creating a structural framework to map the interaction flow and decision hierarchy of the three main actors (Head of Department/KPA, Master Administrator/PPK, and Department Administrator). As illustrated in Figure 2, this user flow was developed to:

1. A structural framework was created to map the interaction flow and decision hierarchy of the three main actors, namely the Head of Department (KPA), the Master Administrator (PPK), and the Department Administrator, across the three operational phases of the official travel system. As illustrated in Figure 2, this user flow was specifically developed to:
 - a. Structure the process, from assignment and planning, through implementation and reporting, to final verification and payment.
 - b. Map decision logic, including travel quota checks and receipt verification, establishing clear branching for valid documents to proceed and invalid ones to be returned for revision.
 - c. Integrate regulatory control (annual limits, 5-day reporting deadlines), ensuring compliance with Rector's and Presidential Regulations.
 - d. Delineate actor responsibilities, clearly distinguishing the authorization function (KPA), administrative and financial management (PPK), and on-site technical execution (Department Administrator).
 - e. Establish system features by translating flow steps into functionalities like automatic validations, document uploads, and multi-level approvals.
2. Designing Wireframes: Based on the established user flow, low-fidelity visual frameworks were developed to structure the system's user interface. This step involved logically arranging the positions of input elements, budget allocation data, approval buttons, and navigation structures prior to developing the final high-fidelity visual design. The comprehensive outcomes of this wireframing process, including the detailed interface layouts for each actor, will be presented and discussed further in Chapter 4.

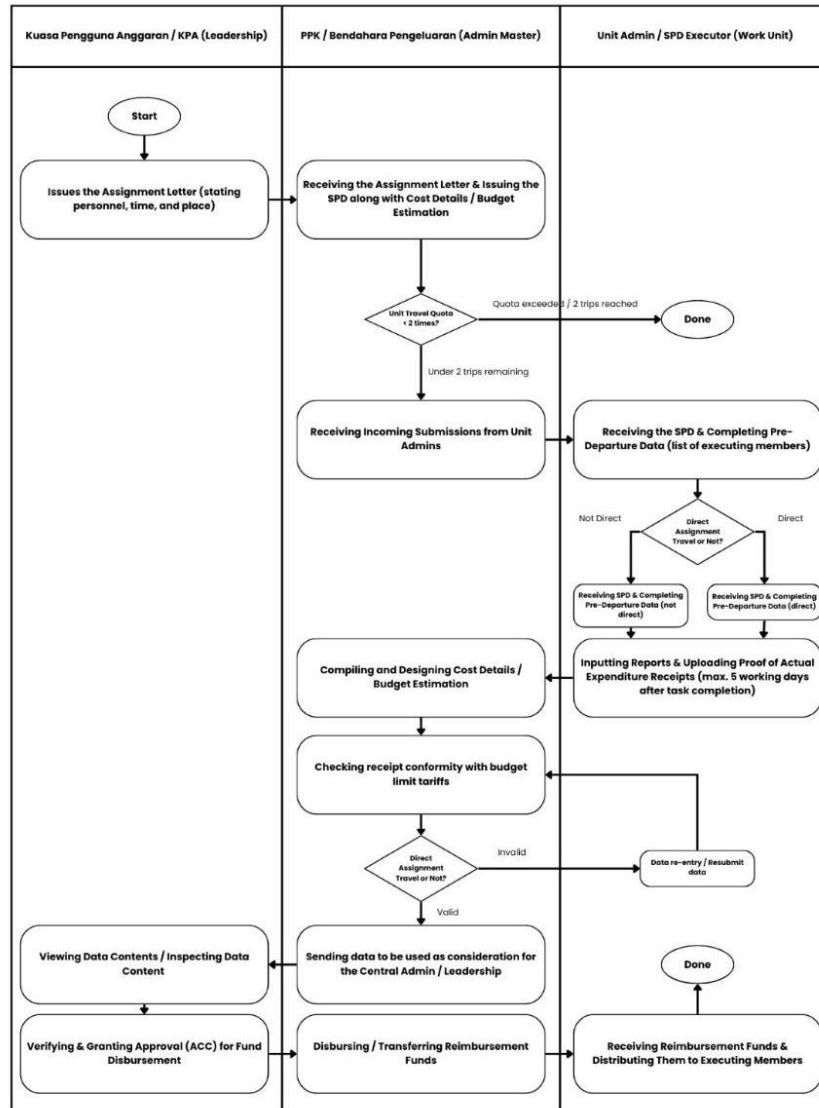


Figure 2. User Flow Official Travel Assignment & Reimbursement

FINDING AND DISCUSSION

Drawing upon the insights gathered from the comprehensive literature review and in-depth user interviews, a structured user flow was established. Guided by this logical framework, wireframes were subsequently developed and categorized according to the distinct roles of the system's three main actors: the Head of Department (KPA), the Master Administrator (PPK), and the Department Administrator. The low-fidelity designs, illustrated in Figures 3 through 13, were structured into the following key role-based modules:

General Access Interface

Login Page as presented in Figure 3: This page was designed as the initial access point for all users. It integrated standard credential inputs with a biometric authentication option (fingerprint scanning) to ensure secure and efficient system entry.

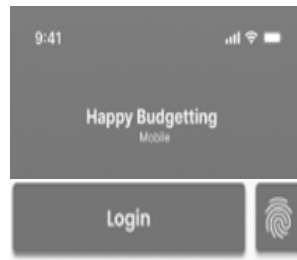


Figure 3. Login page

Centralized Administration and Executive Interface (KPA and Master Admin)

Designed for macro-level financial control and executive authorization, this module accommodates the interconnected workflows of both the Master Administrator (PPK) and the Head of Department (KPA). It encompasses several key interfaces:

1. Dashboard and Unit Management illustrated in Figure 4 and Figure 5:

The Home Page and Unit Management Page were structured to display global budget summaries, active assignments, and allow the Master Admin to manage fund allocations or quotas across various departments efficiently (e.g., *Informatika*, *Teknik Industri*).

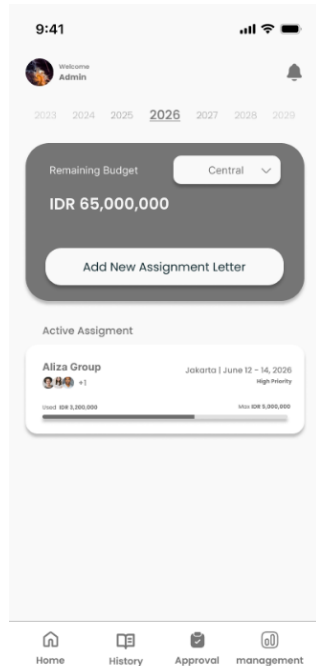


Figure 4. Master admin home page

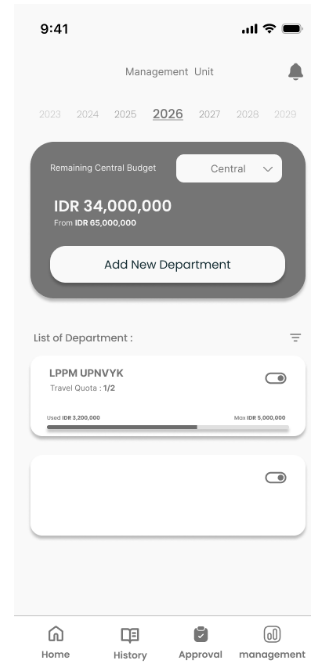


Figure 5. Unit management page

2. Monitoring and Authorization as depicted in Figures 6 and 7:

The Assignment History and List of Approvals pages were created to categorize travel requests based on their current progress (e.g., ongoing, waiting for validation, completed), providing a streamlined queue for verification. For the Head of Department (KPA), this interface serves as an executive dashboard to monitor overall activities and pending approvals seamlessly, shielding them from technical data entry tasks.

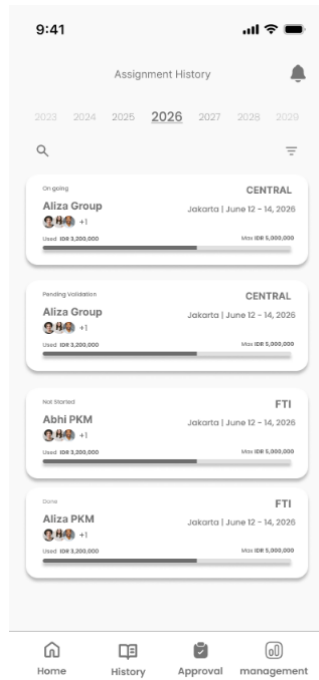


Figure 6. Assignment history

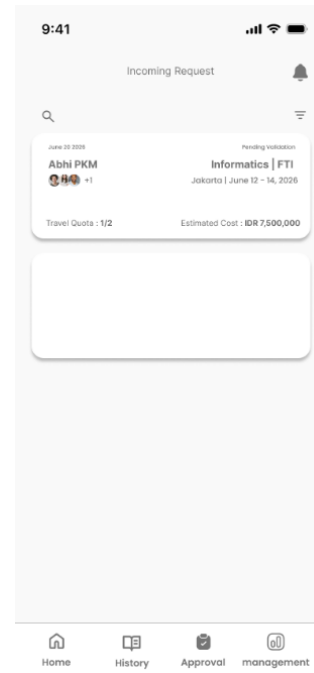


Figure 7. List of approvals

3. Validation Details shown in Figures 8 and 9:

The Assignment and Approval Details pages were designed to present comprehensive data, including expense allocation charts, historical expenditures, and member lists. Crucially, Figure 9 incorporates clear action buttons (Approve and Return) to execute the validation process. The Master Admin utilizes this to verify tariff compliance, while the KPA utilizes the same streamlined view to grant the final fund disbursement approval, aligning precisely with the established authorization flow.

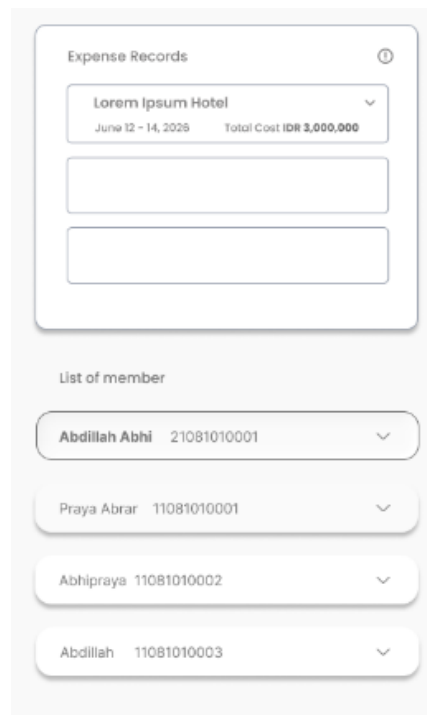
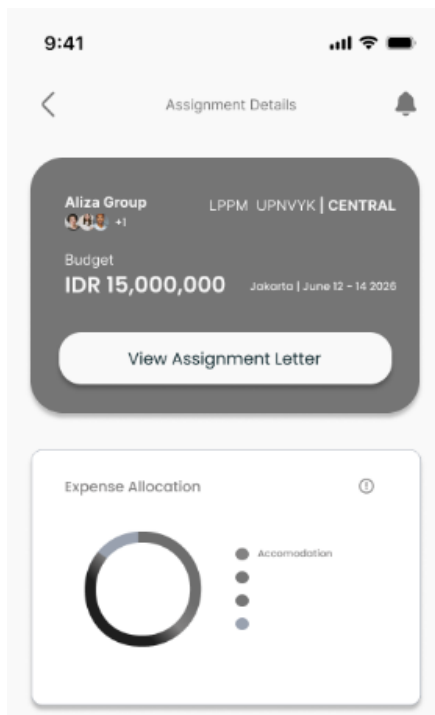
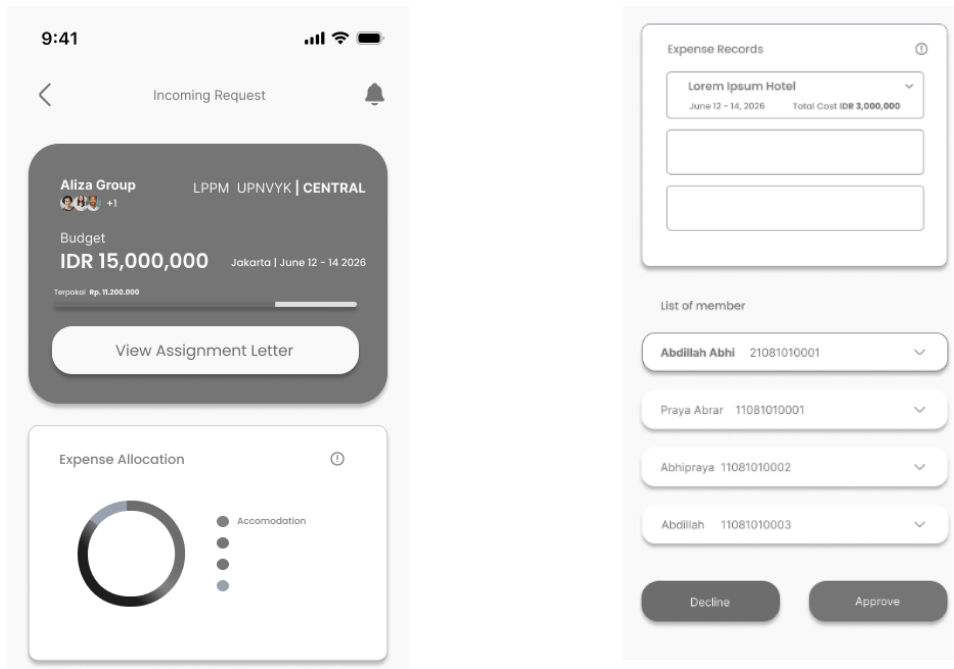


Figure 8. Assignment details**Figure 9.** Approval details

4. Department Admin Interface

While the KPA and Master Admin require macro-level oversight and authorization, departmental executors face different operational needs. Tailored for on-site execution and technical reporting, this module focuses on practical usability during travel. The Department Admin module (Figures 10-13) integrates a localized dashboard, interactive reporting with receipt uploads, detailed expense history logs, and geolocation tracking to facilitate real-time accountability and seamless auditing. Specifically, Figure 10 displays a scaled-down unit budget view. Figure 11 enables real-time receipt uploads and daily expense logging. Figure 12 provides a seamless transition to itemized transaction audits, while Figure 13 logs chronological visit timelines with map integration for precise location verification.

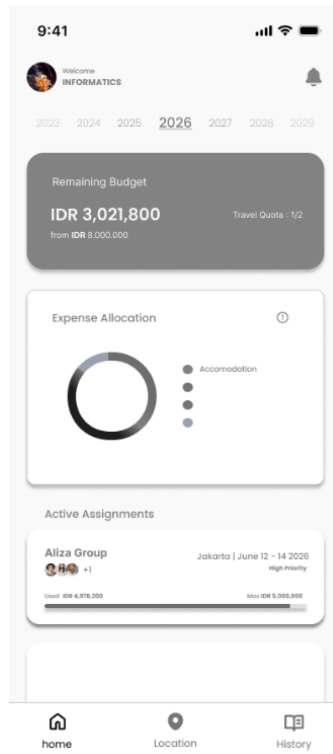


Figure 10. Home page

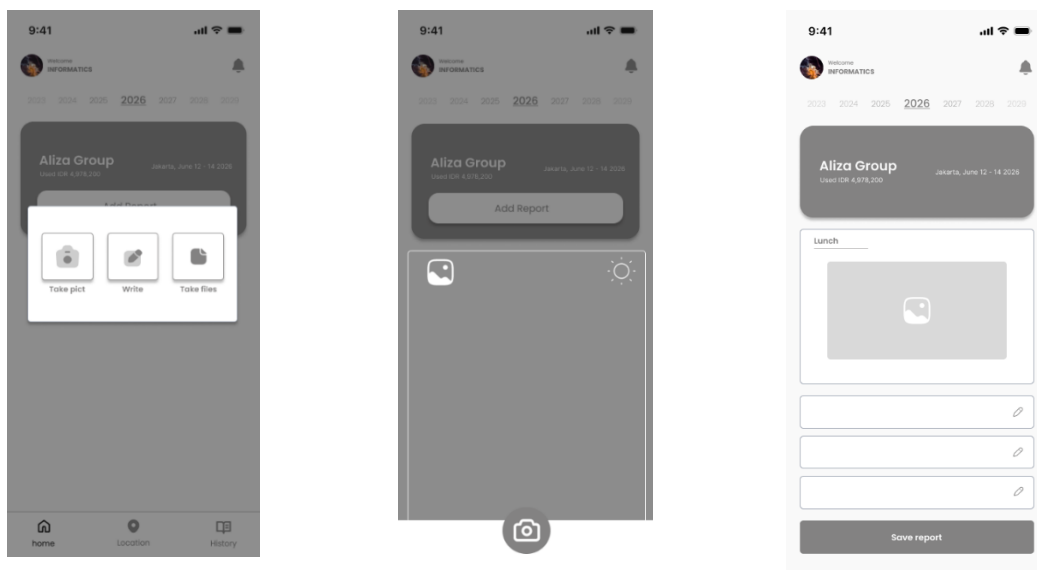


Figure 11. Input and report details pages

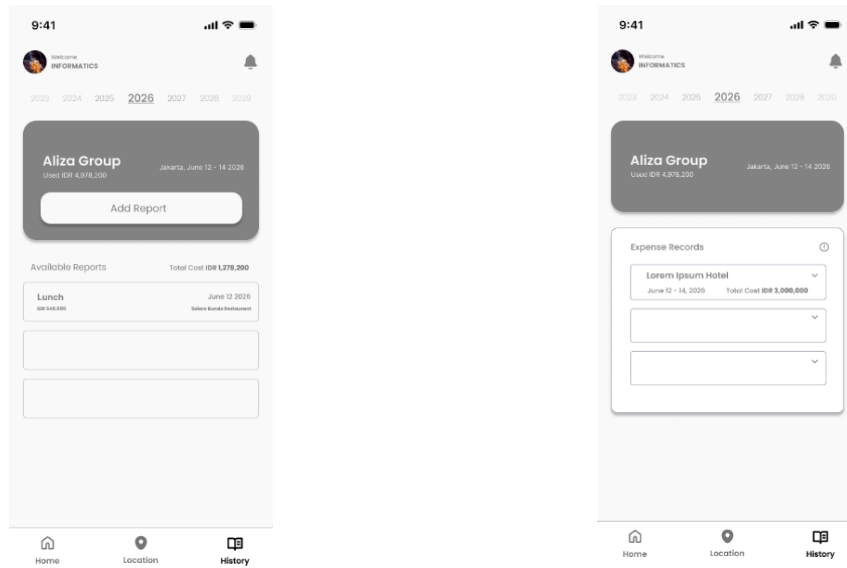


Figure 12. History and detailed reports

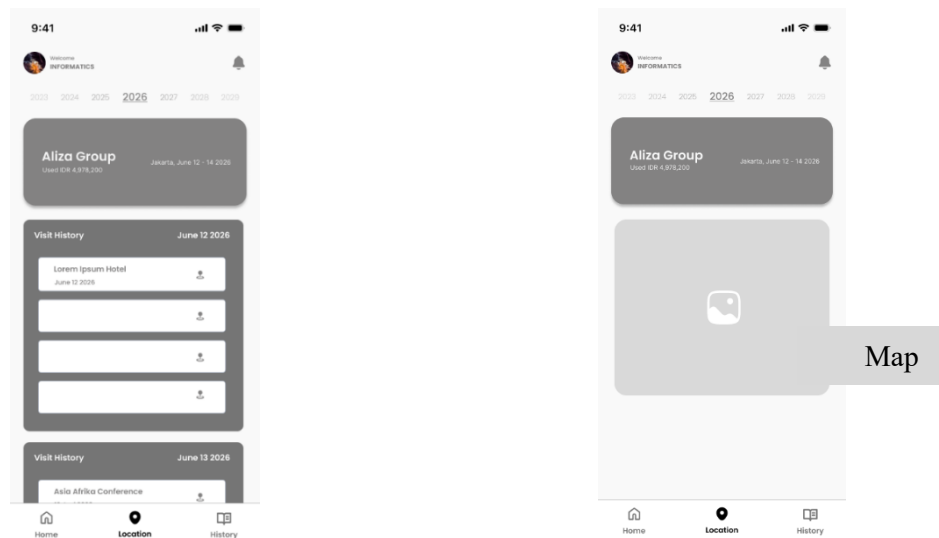


Figure 13. History and detailed location

By integrating these distinct role-based modules into a cohesive system, the proposed interface architecture theoretically resolves the tension between rigid bureaucratic compliance and user cognitive ergonomics. By translating ISO 9241-210:2019 principles into role-based functional isolation (Gulliksen et al., 2003), the design actively mitigates "e-bureaucratism" (Savoldelli et al., 2014). This is evident in the structural divergence between the actors' interfaces: while the Master Admin requires macro-level orchestration of global budgets (Figures 4-9), the Department Admin dashboard (Figures 10-13) intentionally scales down to localized metrics. By shielding users from irrelevant financial data, the system successfully minimizes extraneous cognitive load, enabling Department Admins to focus their cognitive resources solely on technical execution and reporting (Faudzi et al., 2024).

In order to facilitate the Head of Department's (KPA) smooth integration into the operational ecosystem, the interface purposefully abstracts technical administrative complexities. When faced with raw, unverified operational data, the KPA, as the ultimate authorization figure, is

particularly vulnerable to information overload. Before presenting the final disbursement request, the architecture automatically handles backend verifications, such as tariff compliance and travel quota adherence, by situating the system as a smart validation agent. As demonstrated in Figures 6 and 9, this executive dashboard method guarantees that the KPA only engages with high-level financial information and unambiguous binary decision prompts (Approve/Decline). As a result, the design not only maintains the KPA's cognitive resources for strategic decision-making, but it also reinforces the main objective of eliminating inflexible "e-bureaucratism" by means of intelligent, role-specific functional isolation.

Furthermore, the design operationalizes seamless integration (Lindgren et al., 2019) to enforce statutory compliance specifically Presidential Regulation Number 72 of 2025, without burdening the user's mental model. Instead of relying on manual cross-referencing, the system's backend automates travel quota checks and tariff validations (Figure 2). By synthesizing complex bureaucratic rules into visual expense allocations and clear actionable choices, such as the Approval features in Figures 8 and 9, the interface aligns with the user's logical progression (Cooper et al., 2014; Norman, 2013). Consequently, the system acts not merely as a data entry tool, but as an active cognitive partner that guarantees regulatory compliance while preserving mental ergonomics.

CONCLUSION AND FURTHER RESEARCH

This study effectively designed the user interface for an official travel administration system using the User-Centered Design (UCD) approach, guided by the ISO 9241-210:2019 standard. By thoroughly comprehending the context of use and defining user requirements, a structured user flow was created to map the decision hierarchy among the three primary actors: the Head of Department (KPA), the Master Administrator (PPK), and the Department Administrator. These specifications were methodically translated into low-fidelity wireframes, organized into discrete modules according to each actor's unique operational roles.

The suggested design successfully bridges the gap between user-friendly interactions and strict bureaucratic compliance. By positioning the system as a smart validation agent, the architecture simplifies multi-level approvals through intelligent, role-based functional isolation, separating executive authorization, central financial management, and on-site technical execution into targeted interfaces. This approach actively mitigates "e-bureaucratism" and prevents information overload, effectively preserving the users' cognitive resources for strategic tasks while ensuring that statutory constraints, such as budget quota limits and reporting deadlines, are seamlessly enforced through backend automation.

This study acknowledges two main limitations. First, the role-based architecture is tailored to a specific institutional hierarchy, meaning its generalizability to other bureaucratic structures requires contextual adjustments. Second, the design remains at the low-fidelity wireframing phase without empirical validation. Therefore, future research must advance these wireframes into high-fidelity interactive prototypes and conduct empirical usability testing (e.g., using the System Usability Scale) with actual stakeholders to evaluate user satisfaction, validate cognitive ergonomics, and ensure readiness for software development.

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