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Development Model of an AI-Based Context-Aware System on Smartphones Using Explainable AI (XAI) and Reinforcement Learning Approaches

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Abstract: This study analyzes requirements and designs an Artificial Intelligence (AI)-based context-aware smartphone system to support lecturers' work focus. It addresses the problem of disruptive notifications that ignore user context, which can reduce concentration during teaching and academic tasks. The research applies a modified Research and Development (R&D) approach, integrating Explainable Artificial Intelligence (XAI) and Reinforcement Learning (RL) to enable adaptive and transparent notification management. The process includes requirements analysis, system design, expert validation, and a small-scale trial with 10 respondents. Results show that the system meets its core function as a context-aware application, with minor interface improvements suggested by experts. User evaluations indicate generally positive performance across usability, effectiveness, efficiency, satisfaction, transparency, and reliability, all categorized as "good." Reliability and data consistency were also confirmed through statistical testing. The main contribution of this study is the development of an AI-based, context-aware notification management model that combines RL for adaptive decision-making and XAI for transparency, specifically tailored to lecturers' work contexts. This model offers a practical and theoretically grounded solution to improve focus and productivity, and it is feasible for further large-scale implementation and testing.

Keywords: Context-Aware System, Artificial Intelligence (AI), Work Focus Optimization

Introduction

This study analyzes requirements and designs an AI-based context-aware smartphone system to support lecturers' work focus by intelligently mediating disruptive notifications during teaching and academic tasks. The research gap lies in the limited integration of adaptive AI (especially RL) and transparency-oriented XAI in context-aware notification systems specifically tailored to higher-education lecturers' real work contexts, as existing CNMS and context-aware services rarely address explainability and educator-centric scenarios in depth. A modified R&D approach is employed, integrating Explainable AI and Reinforcement Learning across requirements analysis, system design, expert validation, and a small-scale trial with 10 lecturers.

Expert review confirms that the system has met its primary context-aware function, while suggesting minor interface refinements. User evaluations show that all quality dimensions (usability, effectiveness, efficiency, satisfaction, transparency, reliability) reach at least a "good" category without overemphasizing statistical indices. The main theoretical contribution is a model that combines RL-based adaptive decision-making with XAI-driven transparency for notification management in academic work settings. The practical contribution is a feasible prototype that demonstrably supports lecturers' focus and is ready for larger-scale deployment and evaluation in real campus environments.

The rapid advancement of smartphone technology has made it an integral part of lecturers' academic activities, including communication, scheduling, and access to learning resources (Chen et al, 2021) (Kumar & Gupta, 2022) (Zulkiplih et al, 2020). Despite its benefits, smartphones often introduce significant distractions due to frequent and context-insensitive notifications. Notifications from social media, messaging applications, and other services can interrupt lecturers' concentration, particularly during teaching sessions or formal meetings, thereby reducing productivity and the quality of interaction in academic environments (Heitmayer & Lahlou, 2021). This issue is critical, as teaching quality and lecturer behavior significantly influence student learning outcomes (Ramadhan et al, 2022).

To address this issue, context-aware computing combined with Artificial Intelligence (AI) has emerged as a promising approach. Technological advancements in the era of Industry 4.0 emphasize the importance of intelligent and adaptive systems in supporting human activities, including education (Yahya, 2018). Context-aware systems enable devices to sense, interpret, and respond to user conditions such as location, time, and activity (Zhang et al, 2022). By leveraging these capabilities, smartphones can adapt their behavior dynamically, for example, by automatically activating the "Do Not Disturb" (DND) mode when users are engaged in critical tasks (Zhang et al, 2014). However, previous studies highlight several challenges in developing effective context-aware systems, including the requirement for large datasets and the lack of transparency in AI decision-making processes (Wang et al, 2022) (Doshi Velez & Kim, 2022).

To overcome these limitations, the integration of Explainable Artificial Intelligence (XAI) and Reinforcement Learning (RL) offers a more robust solution. XAI enhances the interpretability of AI models by providing understandable explanations for automated decisions, thereby increasing user trust and system transparency (Arrieta et al, 2020) (Gunning & Aha, 2019). Meanwhile, RL enables systems to learn adaptively from user interactions and environmental feedback without relying heavily on predefined datasets (Sutton & Barto, 2018). The combination of these approaches allows the system to not only make intelligent decisions but also continuously improve its performance over time (Ras et al, 2022).

Based on these considerations, this study focuses on analyzing user requirements and designing a development model for an AI-based context-aware system on smartphones. The proposed model aims to support lecturers' work focus by minimizing unnecessary interruptions through adaptive and explainable automation. This research specifically addresses two main questions: (1) how to identify the requirements for developing an AI-based context-aware system on smartphones, and (2) how to design an appropriate development model based on these requirements. The results of this study are expected to contribute to the development of intelligent, adaptive, and user-centered mobile systems in academic environments.

Methodology

This study employed a Research and Development (R&D) approach to design and develop an AI-based context-aware system on smartphones aimed at supporting lecturers' work focus. The R&D method was selected because it enables the systematic development and validation of a product based on real user needs and empirical data (Sugiyono, 2018). To better suit the objectives of this study, a modified development model was constructed by integrating several established instructional and system development models, including Borg and Gall, ADDIE, Dick and Carey, Hannafin and Peck, and the 4D model (Aka, 2019) (Waldan et al., 2024) (Nugraha et al, 2024) (Nazliati et al, 2024) (Sari & Wibowo, 2023).

The integrated model combines Reinforcement Learning (RL) as the decision engine with Explainable AI (XAI) as a transparency layer around the agent's policies. RL is used to learn when and how to filter or postpone notifications based on contextual signals (time, location, calendar, activity), while XAI methods generate human-readable explanations of the chosen action (for example, "muted because you are teaching and the meeting is marked as high priority"), aligning with recent work on explainable reinforcement learning for user-facing systems. Methodologically, this hybrid design is justified by literature arguing that RL provides robust adaptation to dynamic environments, whereas XAI is needed to build user trust and accountability in sensitive, high-stakes or work-related applications.

The study uses a purposive sampling strategy, targeting lecturers who regularly use smartphones for work communication and teaching coordination. A small, 10-participant sample is appropriate for early-stage R&D, where the primary goals are feasibility testing, usability evaluation, and initial model validation rather than broad generalization, consistent with prior context-aware and experience-sampling tool evaluations.

Result and Discussion

The proposed development model consists of five main stages: (1) problem identification, (2) solution design, (3) product development, (4) user evaluation, and (5) evaluation and refinement. In the problem identification stage, data were collected through interviews, observations, and literature review to understand the challenges faced by lecturers regarding smartphone distractions. The solution design stage involved defining system requirements and designing the architecture of a context-aware application integrating Explainable AI (XAI) and Reinforcement Learning (RL).

Theoretically, this study extends explainable reinforcement learning literature by demonstrating how an RL agent and XAI layer can be co-designed for everyday, sequential decision-making in human–computer interaction, not only for safety-critical domains. It empirically supports claims that explanations can enhance transparency and calibrated trust without sacrificing task performance, and it offers a lecturer-focused model of "contextual receptivity" that links notification timing, perceived fairness of system decisions, and sustained work focus.

The product development stage focused on building a prototype application that operates locally on Android devices using embedded AI frameworks. The system integrates multiple components, including a context detection module, an AI-based decision engine, and local data storage. The application utilizes smartphone sensors such as GPS, accelerometer, and usage data to identify user context and automatically activate the Do Not Disturb (DND) mode when necessary.

Participants

The study involved lecturers from the Faculty of Engineering, Universitas Negeri Makassar, as research subjects. A user evaluation was conducted with 10 lecturers selected randomly to assess the usability and functionality of the application.

Data Collection

Data were collected using multiple techniques, including semi-structured interviews, questionnaires, and direct observation. The questionnaire employed a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to assess user perceptions of the system.

The evaluation instrument was designed based on the ISO/IEC 25010 software quality model, which includes characteristics such as functional suitability, performance efficiency, usability, reliability, and security [22]. In this study, several dimensions were emphasized, including usability, performance efficiency, effectiveness, user satisfaction, transparency, and reliability.

Data Analysis

The collected data were analyzed using descriptive and inferential statistical methods. Descriptive analysis was used to calculate mean scores, minimum and maximum values, and standard deviation for each evaluation dimension. To ensure the validity of the analysis, a normality test was conducted using the Shapiro–Wilk method. Additionally, the reliability of the instrument was assessed using Cronbach's Alpha to measure internal consistency.The results of expert validation and user evaluation were used to refine the application through an iterative development process.

Result and Discussion

Expert Validation Results

Expert validation was conducted to evaluate the feasibility and functionality of the developed application. The results indicate that the application successfully fulfills its primary objective as a context-aware system, enabling smartphones to recognize user activities and automatically adjust behavior accordingly. However, several improvements were suggested, particularly in terms of user interface design. These include the addition of icons to clarify button functions, the use of color variations to enhance visual appeal, and adjustable font sizes to improve readability. These recommendations were implemented to enhance usability prior to user evaluation.

User Evaluation Results

A user evaluation was conducted involving 10 lecturers to assess the performance and usability of the application. The evaluation instrument consisted of 15 items, which were grouped into six dimensions: usability, performance efficiency, effectiveness, user satisfaction, transparency, and reliability.

Table 1.
User Evaluation Results

No	Dimension	Items	Min	Max	Mean	Std. Dev.	Category
1	Usability	5	2	5	3.68	0.98	Good
2	Performance Efficiency	3	2	5	3.72	1.02	Good
3	Effectiveness	3	2	5	3.74	1.01	Good
4	User Satisfaction	2	2	5	3.70	1.05	Good
5	Transparency	1	2	5	3.65	1.00	Good
6	Reliability	1	2	5	3.60	1.08	Good

The results indicate that all evaluated dimensions fall within the "good" category, demonstrating that the application performs well across multiple quality aspects. Among these, effectiveness (mean = 3.74) and performance efficiency (mean = 3.72) achieved the highest scores, suggesting that the application not only functions effectively but also provides meaningful benefits in supporting lecturers' work focus.
The usability dimension (mean = 3.68) indicates that users can understand and operate the application with relative ease, reflecting an intuitive interface and navigation structure. In addition, user satisfaction (mean = 3.70) shows that users generally have a positive experience when using the application.

Normality and Reliability Testing

To ensure the validity and consistency of the collected data, normality and reliability tests were conducted.

Table 2.
Normality and Reliability Test Results

Test Type	Value	Description
Shapiro–Wilk (Sig.)	0.402	Normally distributed data
Cronbach's Alpha	0.981	Very high reliability

The Shapiro–Wilk test result (Sig. = 0.402 > 0.05) indicates that the data are normally distributed, confirming that the statistical analysis is valid. Furthermore, the Cronbach's Alpha value of 0.981 demonstrates excellent internal consistency, indicating that the measurement instrument is highly reliable.

Discussions

The results of this study demonstrate that the proposed AI-based context-aware system is capable of supporting lecturers' work focus by reducing unnecessary smartphone interruptions. The findings from expert validation confirm that the system meets its primary functional objective, particularly in enabling automatic context recognition and adaptive behavior. This aligns with previous studies which emphasize that context-aware systems can significantly improve user productivity by adjusting device behavior based on situational factors such as time, location, and activity [4,5].

The user evaluation results further indicate that the application performs well across all evaluated dimensions, with effectiveness and performance efficiency achieving the highest mean scores. This suggests that the system not only operates reliably from a technical perspective but also delivers tangible benefits to users. These findings are consistent with prior research highlighting the role of AI-driven context-aware applications in enhancing user productivity and task focus [6,20]. The relatively high usability score also indicates that the system is easy to learn and operate, which is a critical factor in user acceptance of new technologies.

Despite these positive outcomes, the transparency dimension received comparatively lower scores, indicating that some users experienced difficulty in understanding how the system makes automated decisions. This result reflects a common challenge in AI-based systems, where decision-making processes are often perceived as opaque or difficult to interpret [8]. The integration of Explainable AI (XAI) in this study was intended to address this issue; however, the findings suggest that further improvements are needed in presenting explanations in a more user-friendly and accessible manner. Previous studies have emphasized that effective XAI implementation should not only provide explanations but also ensure that these explanations are meaningful and understandable to end-users (Wang et al, 2022) (Zhang et al, 2014).

Another important finding is the high reliability of the evaluation instrument, as indicated by the Cronbach's Alpha value. This confirms that the collected data are consistent and can be trusted to represent user perceptions accurately. Additionally, the normal distribution of data supports the validity of the statistical analysis conducted in this study. These results strengthen the credibility of the overall findings and indicate that the evaluation process was methodologically sound.

From a practical perspective, the findings suggest that the proposed system has strong potential for real-world application in academic environments. By automating the activation of Do Not Disturb mode based on contextual information, the system can help lecturers maintain focus during critical activities such as teaching and meetings. However, the study also highlights the importance of user education and system transparency to ensure optimal adoption and user trust.

This study has several limitations. First, the number of participants in the user evaluation was relatively small, which may limit the generalization of the findings. Second, the evaluation focused primarily on initial user perceptions rather than long-term usage behavior. Future research should involve a larger number of participants and conduct longitudinal studies to evaluate the long-term effectiveness and adaptability of the system.

Conclusions

This study has successfully analyzed user requirements and designed a development model for an AI-based context-aware system on smartphones aimed at supporting lecturers' work focus. The findings indicate that the proposed system is capable of automatically adapting to user contexts and reducing unnecessary interruptions through intelligent activation of the Do Not Disturb (DND) mode. The integration of Explainable Artificial Intelligence (XAI) and Reinforcement Learning (RL) provides both adaptability and transparency, making the system more responsive to user needs.

The results of expert validation and user evaluation demonstrate that the developed application meets key quality aspects, including usability, performance efficiency, effectiveness, and reliability, all of which fall within the "good" category. However, the transparency aspect still requires improvement to ensure that users fully understand the system's automated decisions. Overall, the proposed model shows strong potential for practical implementation in academic environments. Future work should focus on enhancing explainability features and conducting broader evaluations to further validate the system's effectiveness in real-world scenarios.

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