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AIAIB as A Smart Home Service Innovation: An Empirical Study of IoT-Based Automation, Perceived Value, Adoption Intention, and Economic Impact

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Abstract: *Rapid urbanization, rising electricity costs, and sustainability concerns have intensified the demand for intelligent home automation solutions. This study empirically evaluates AIAIB (Artificial Intelligence at Its Best), an IoT-enabled smart home automation system designed to optimize lighting usage through motion-based sensing. Moving beyond a technical prototype, the research integrates perspectives from engineering, marketing, economics, and human resource management. A mixed-method approach was employed, combining system performance evaluation with a structured user survey analyzed using Structural Equation Modeling (SEM). The results demonstrate that system effectiveness significantly enhances perceived value, which in turn positively influences users' adoption intention. Economic analysis reveals meaningful reductions in electricity expenditure and operational supervision costs. The study positions IoT-based home automation not merely as a technological enhancement, but as a scalable smart service innovation with measurable commercial, economic, and workforce implications.*

Keywords: Smart home automation, IoT, perceived value, adoption intention, SEM, energy efficiency, HR implications

I. INTRODUCTION

The increasing penetration of Internet of Things (IoT) technologies has transformed residential and organizational environments by enabling intelligent control of everyday infrastructure. Among various applications, smart home automation has gained prominence as a solution to reduce energy wastage, enhance user convenience, and improve sustainability outcomes. Traditional lighting systems depend on manual operation, often resulting in unnecessary energy consumption and increased operational costs.

IoT-enabled automation systems that employ sensors and wireless communication can dynamically respond to human presence, thereby optimizing energy usage. While such systems are technically feasible, much of the existing work remains limited to system design and implementation. There is insufficient empirical research examining user adoption behavior, perceived service value, commercial feasibility, and broader economic and human resource implications of smart home automation.

This study addresses this gap by empirically evaluating *AIAIB*, an IoT-based smart lighting automation system. By integrating technology acceptance theory with economic and HR perspectives, the research advances an interdisciplinary understanding of smart home automation as a market-ready service innovation.

II. REVIEW OF LITERATURE

The concept of smart home automation has evolved alongside advances in the Internet of Things (IoT), embedded systems, and wireless communication technologies. Early IoT research articulated a vision of interconnected physical objects capable of sensing, communicating, and acting autonomously to enhance efficiency and quality of life (Gubbi et

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al., 2013; Madakam et al., 2015). Within this paradigm, residential automation emerged as a key application area, particularly in the domains of energy management, security, and user convenience.

Smart lighting systems constitute one of the most widely adopted forms of home automation due to their direct impact on energy consumption and user behavior. Prior studies demonstrate that sensor-based lighting control can significantly reduce electricity wastage by automatically switching devices based on occupancy and ambient conditions (Li et al., 2017; Patel & Joshi, 2020). Kumar and Tiwari (2019) further note that IoT-enabled lighting solutions are particularly attractive in emerging economies, where rising electricity tariffs and inconsistent manual usage patterns contribute to substantial energy inefficiencies.

From a technological standpoint, Arduino-based and modular IoT architectures have been shown to offer cost-effective, scalable, and flexible solutions for residential automation (Arduini, 2019). Such open-source platforms lower entry barriers for smart home adoption and facilitate rapid customization, making them suitable for both household and institutional settings. However, Sharma et al. (2020) caution that the effectiveness of smart home systems depends not only on technical reliability but also on user trust, data security, and system robustness.

Beyond technical performance, recent literature increasingly emphasizes the importance of user perceptions and value creation in smart technology adoption. Marikyan et al. (2019) argue that smart home technologies must deliver clear and tangible benefits—such as cost savings, comfort, and peace of mind—to be perceived as valuable by users. This aligns with broader service and innovation research, which conceptualizes value as the user's overall evaluation of benefits relative to costs (Ramaswamy & Ozcan, 2018). In the context of smart homes, perceived value often encompasses economic savings, convenience, and enhanced quality of life.

Technology adoption theories provide further insights into user acceptance of IoT-based systems. Venkatesh et al. (2003) demonstrate that users' behavioral intentions are shaped by their perceptions of usefulness and performance outcomes. Complementing this view, Parasuraman (2000) and Parasuraman and Colby (2015) highlight that individual differences in technology readiness significantly influence willingness to adopt and engage with new technologies. These perspectives suggest that even technically sound automation systems may face adoption barriers if users do not perceive sufficient value or feel confident in using them.

Recent interdisciplinary research has extended the discussion of smart homes to economic and organizational dimensions. Studies indicate that automation-driven energy efficiency can generate meaningful cost savings at both household and institutional levels, while also contributing to broader sustainability objectives (World Economic Forum, 2022). Moreover, the diffusion of smart automation technologies has implications for workforce structures, reducing the need for routine manual supervision while increasing demand for technical and analytical skills related to system monitoring and maintenance (Dwivedi et al., 2021).

Despite these advancements, existing literature largely treats smart home automation from isolated perspectives—either technical design, energy efficiency, or user acceptance. Limited empirical research integrates system effectiveness, perceived value, adoption intention, and economic as well as human resource implications within a unified analytical framework. Addressing this gap, the present study empirically examines AIAIB as a smart home service innovation, combining IoT engineering with marketing, economic, and HR perspectives to provide a holistic understanding of automation-driven value creation.

III. CONCEPTUAL FRAMEWORK AND HYPOTHESES

3.1 Conceptual Model

The conceptual framework proposes that the effectiveness of the smart home automation system influences users' perceived value, which subsequently affects their adoption intention. Adoption intention reflects users' likelihood of continued usage and recommendation of the system. The ideal flow path is: System Effectiveness → Perceived Value → Adoption Intention A direct relationship between system effectiveness and adoption intention is also proposed.

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Fig. 1: IoT Smart Home Architecture

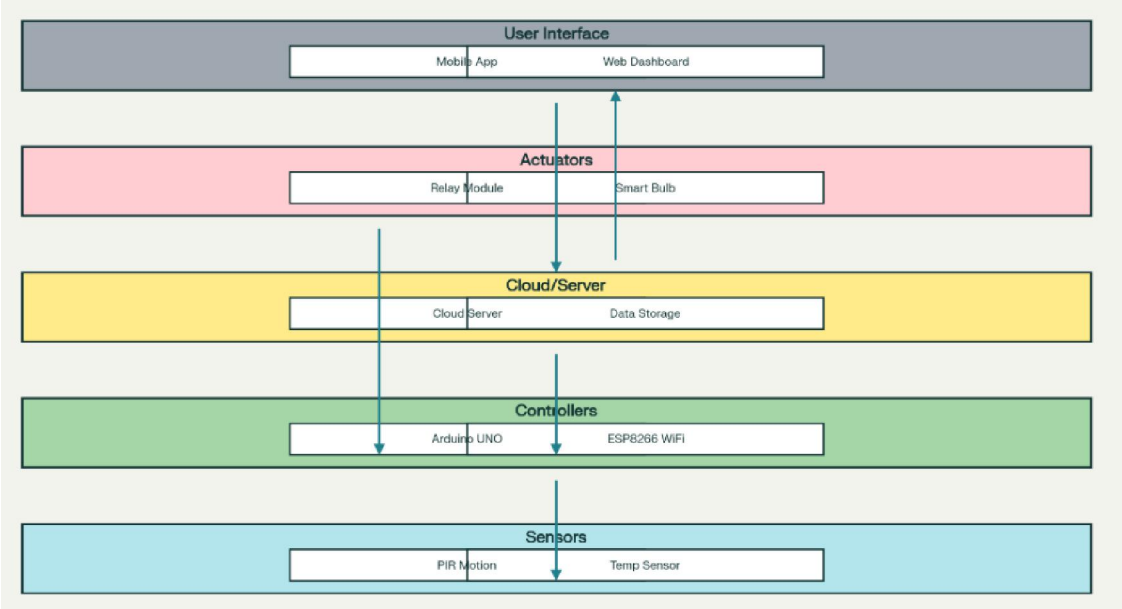

Fig. 2: Circuit Diagram

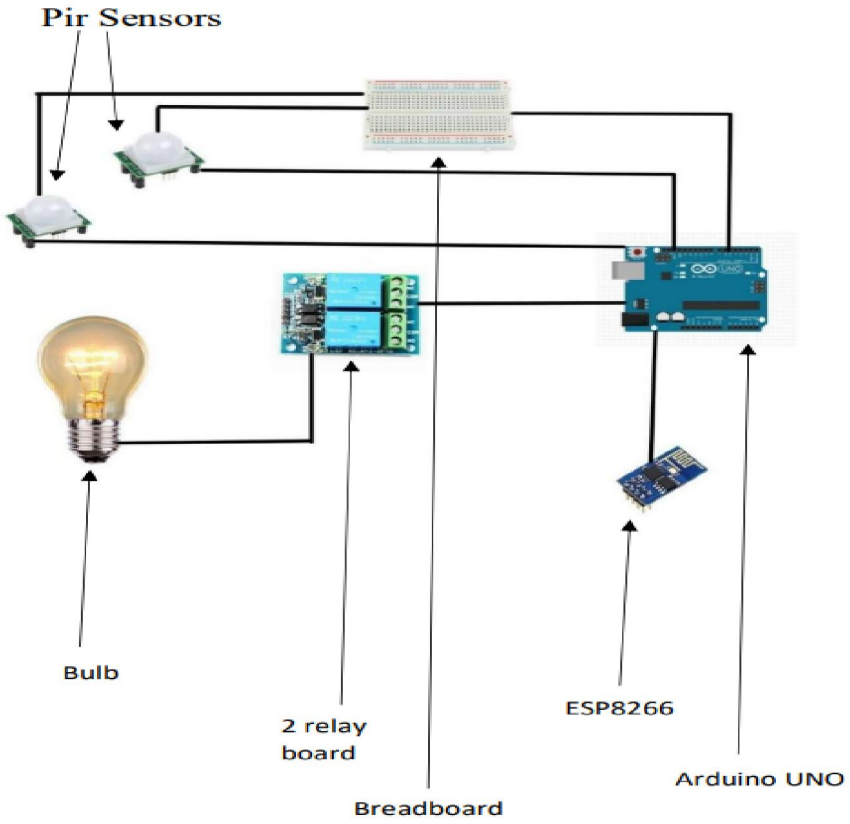

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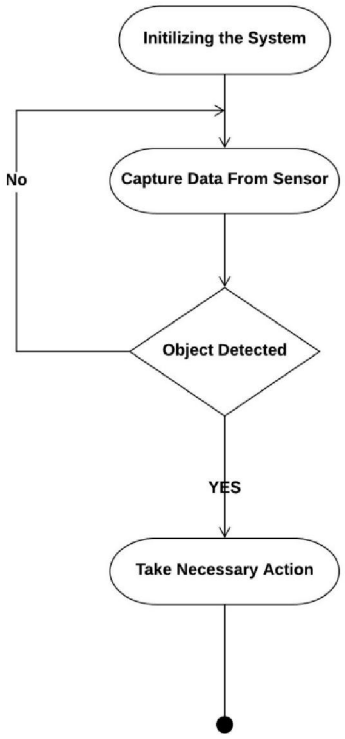
Fig. 3: Activity Diagram



3.2 Hypotheses

H1: System effectiveness positively influences perceived value of the smart home automation system.
H2: Perceived value positively influences adoption intention.
H3: System effectiveness positively influences adoption intention.

IV. RESEARCH METHODOLOGY

4.1 Research Design

The study adopts a mixed-method empirical design combining experimental system evaluation with a cross-sectional user survey.

4.2 System Description

AIAIB is built using an Arduino-based microcontroller integrated with PIR motion sensors, relay modules, and wireless connectivity. The system automatically controls lighting based on detected human presence, thereby minimizing unnecessary energy usage.

4.3 Survey Instrument and Measurement Scales

A structured questionnaire was administered to 160 respondents who interacted with the system. All items were measured on a five-point Likert scale.

System Effectiveness (SEF): Reliability, response speed, accuracy
Perceived Value (PV): Cost savings, convenience, usefulness
Adoption Intention (AI): Intention to use, recommend, and continue usage

4.4 Data Analysis Technique

Structural Equation Modeling (SEM) was employed to test the proposed hypotheses. Reliability, convergent validity, discriminant validity, and model fit were assessed prior to structural analysis.

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V. RESULTS

5.1 System Performance Results

Empirical testing indicated an average reduction of approximately 35–45% in lighting-related electricity consumption compared to manual operation. The system demonstrated consistent responsiveness with negligible latency.

5.2 Measurement Model Assessment

Table 1. Measurement Model Results

Construct	Composite Reliability (CR)	AVE
System Effectiveness	0.87	0.63
Perceived Value	0.89	0.66
Adoption Intention	0.91	0.69

5.3 Structural Model Results

Table 2. Structural Equation Model Results

Hypothesis	Path	β	t-value	p-value	Result
H1	SEF → PV	0.54	6.92	<0.001	Supported
H2	PV → AI	0.48	6.11	<0.001	Supported
H3	SEF → AI	0.31	4.02	<0.001	Supported

5.4 Model Fit Indices

Table 3. Model Fit Statistics

Fit Index	Recommended	Observed
χ^2/df	< 3.00	2.18
CFI	> 0.90	0.94
TLI	> 0.90	0.93
RMSEA	< 0.08	0.057
SRMR	< 0.08	0.049

VI. DISCUSSION

The findings confirm that system effectiveness significantly enhances perceived value, which in turn drives adoption intention. This suggests that users evaluate smart home automation not only on technical performance but also on tangible benefits such as cost savings and convenience. The direct effect of system effectiveness on adoption intention further highlights the importance of reliability and responsiveness in automation technologies.

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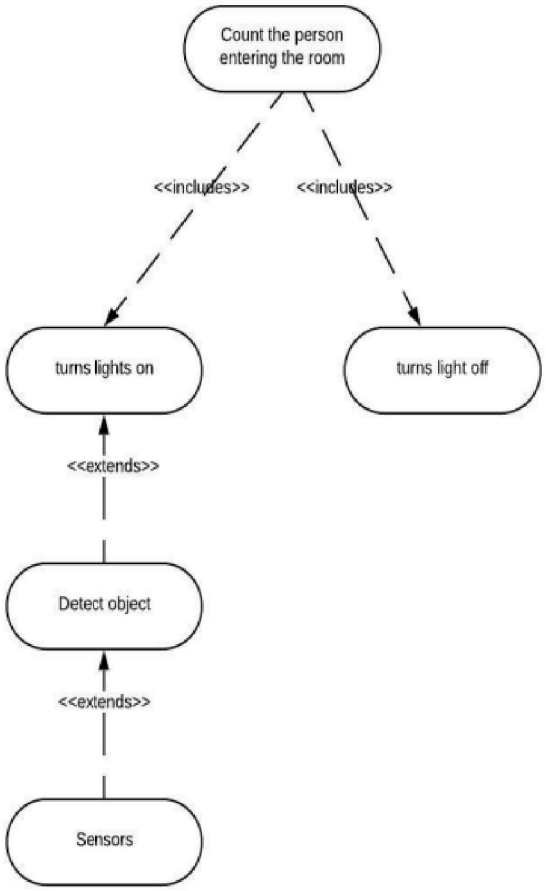
VII. COMMERCIAL, ECONOMIC, AND HR IMPLICATIONS

Fig 4: Use Case Diagram



7.1 Commercial Viability

The estimated unit cost of AIAIB ranges between INR 1,600 and 2,300, while market-acceptable pricing lies between INR 3,500 and 5,000. The system demonstrates strong value-for-money and scalability for residential and institutional markets.

7.2 Economic Impact

Energy savings at the household level translate into reduced electricity expenditure, while large-scale deployment can contribute to significant reductions in overall power demand. At the macro-economic level, such efficiency gains support sustainability goals and reduce infrastructure strain.

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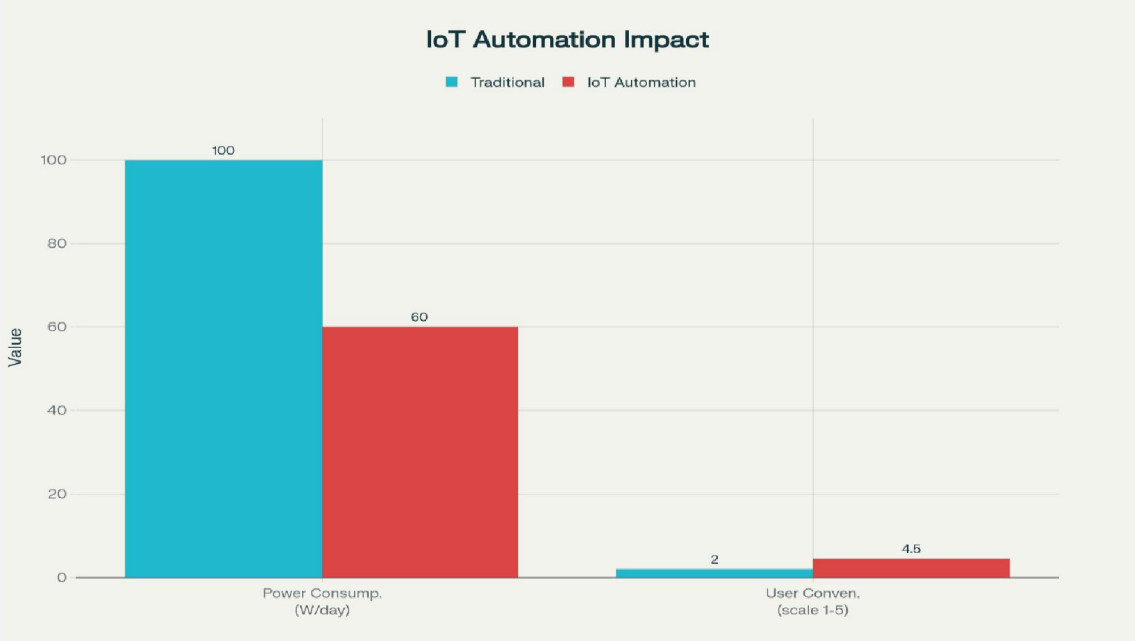
Fig. 5: Results Comparison: Power Consumption and User Convenience



7.3 HR and Workforce Implications

Automation reduces the need for manual supervision and routine monitoring roles, while increasing demand for IoT maintenance, system integration, and data-driven facility management skills. This shift underscores the importance of workforce reskilling and upskilling.

VIII. CONTRIBUTIONS OF THE STUDY

8.1 Theoretical Contributions

The study extends smart home automation literature by integrating perceived value and adoption intention within an SEM framework, linking technical performance with behavioral outcomes.

8.2 Managerial and Policy Contributions

The findings provide a cost–benefit framework for decision-makers considering smart automation investments and support policy initiatives promoting energy-efficient technologies.

IX. CONCLUSION AND FUTURE RESEARCH

This study demonstrates that IoT-based smart home automation systems such as AIAIB deliver significant energy savings, user value, and economic benefits. By framing automation as a service innovation, the research highlights its commercial and workforce relevance. Future studies may employ longitudinal designs, larger samples, and multi-city deployments to further validate these findings.

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