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Evaluating Security And User Acceptance Of Iot-Based Smart Locker Systems In Urban Logistics

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Abstract:
The efficacy of urban parcel delivery system requires reliable, secure and convenient way of storage solutions. This research examines the usability, security and user acceptanceof an Internet of Things (IoT) enabled smart locker system deployed for the urban environment. The system integrates electronic locks, embedded sensors and mobile apps that ensures controlled access and real time monitoring. The study deployed prototype and stakeholder surveys and measures the improvement in delivery efficiency, parcel security and user satisfaction. The findings implies that IoT based lockers enhance locker utilization, lessen the risk of theft, and as well welcomed by end-users when designed with intuitive interfaces. This study highlights the possibility of scalable smart locker systems to improve urban logistics while handling the end-user adoption challenges.
Keywords: *IoT, Smart Locker, Urban Logistics, Security, User Acceptance, Blynk IoT*

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I. Introduction

Urban logistics are faced with an increasing issue as a result of electronic commerce rapid growth, high volumes of parcels and security alarms during last mile delivery [1],[2]. The old-style door to door model of delivery frequently to parcel theft, failed delivery attempted and inefficiencies especially in high populated settings [3]. The deployment of smart locker systems tends to offer a auspicious alternative through provision of highly secure, self service retrieval at designated sites/locations [4]. The research motivation is to examine the usability, security and end-user acceptance of an IoT based smart locker system using real world deployment mechanism and stakeholder feedback. The research objectives are to: Evaluate the enhancement in parcel security via IoT enabled monitoring system. Measure the proficiency gained in locker optimization and time of retrieval. Examine end-user acceptance and satisfaction through surveys.

II. Review Of Previous Designs

Existing Smart Locker Systems

The current solutions offered by DHL, InPost, Amazon locker and pack station prove convenient but shows deficiency in real time monitoring, easy mobile integration and modularity [4],[5]. Many of the smart locker systems are proprietary, thereby limiting its extensibility and adaptation to municipal environments [6].

IoT Integration for Security and Monitoring

IoT technologies, including ultrasonic sensors, RFID and cloud platforms provide support for real time parcel tracking, secure notifications and access control [2],[7]. Platforms such as Firebase and Blynk utilizes mobile cloud integration for authentication and monitoring [8],[9].

Research Gaps in Adoption and Usability

Previous research frequently neglects end-user experience evaluation, scalability for high population areas and modular system design [5],[10]. This research combine secure IoT enabled lockers with user centered valuation metrics. Based on these insights, the methodology employed in the implementation of the system and evaluation of its security, efficiency of operation and user acceptance in a real world urban deployment.

III. Methodology

System Architecture Overview

The proposed Internet of Things (IoT) based smart locker system would include three layers integration as shown in figure I.

i. Embedded Hardware Layer: Node MicroController Unit(NodeMCU) interfaces with the Radio-frequency identification (RFID) reader to provide a secure authentication, solenoid locks for cubicle or compartment

control, parcel detection using ultrasonic sensors and Light Emitting Diode (LED) indictors visual status feedback.

ii. Cloud Layer: It involves the integration of low-code IoT Platform called Blynk to deliver a real time authentication management, data synchronization and event logging to provide instantaneous and secure communication between the mobile interface and hardware.

iii. Mobile Application Layer: The Blynk IoT Android application will provides the end-users and courier personnel with the dashboard for performing parcel retrieval and deposit, receiving of One-time password (OTP)-based authentication and provide a notification as it concerns the locker status in real time mode.

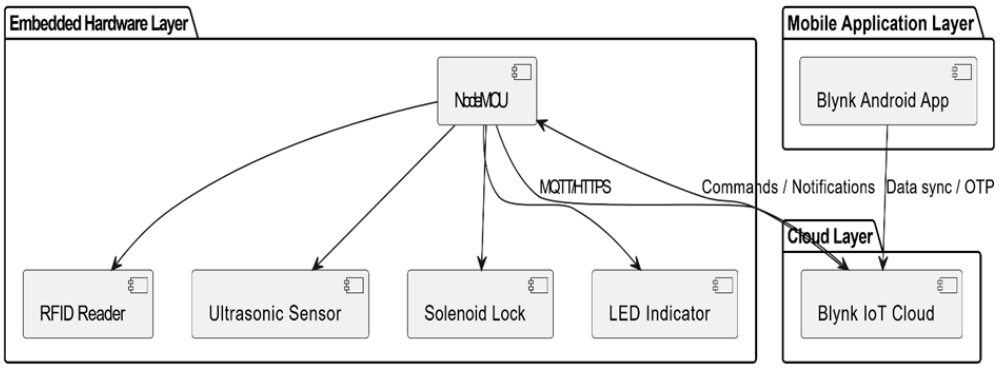

Fig. 1. System Architecture

IoT-Enabled Features

The smart locker system integrates numerous IoT enabled features that ensures efficient and secured parcel management. The ultrasonic sensors integrated into the system is designed for parcel detection and the OTP mechanisms would provide multifactor authentication for end-users and courier personnel. The NodeMCU controller accepts and process the input by triggering certain actions such as secure lock and unlock operations. The synchronization of data in real time, management of users authentication and event notifications are handled by the Blynk IoT platform, thereby providing a continuous system updates to both the end-users and administrators. The mobile app displays the status of the locker, receive notifications and allows for OTP input, thereby finalizing the user interaction loop. Fig. 2 demonstrates the control and flow of information among sensors, Blynk cloud, the controller and the mobile app. The arrows are showing the action triggers and direction of data.

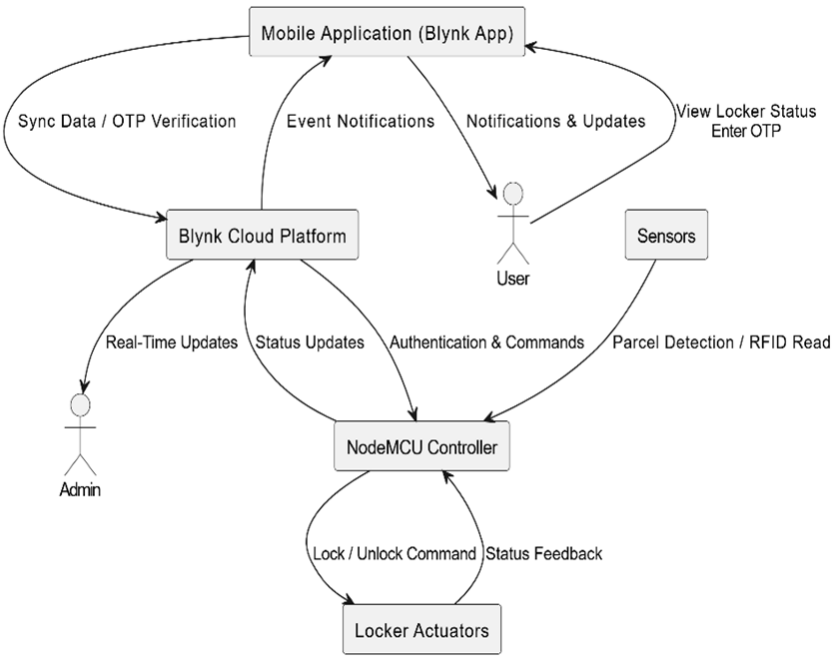

Fig 2. IoT Feature Flow Diagram

User Study Design

A structured/controlled user research was carried out to measure the performance, user acceptance and security of the IoT based smart locker system. Three different model locker units were deployed in selected municipal locations, letting real world interaction by courier personnel and end-users. A total of Fifty (50) respondents, comprising of delivering agents, regular end-users and administrators participated in the study survey. The study adopted a survey and structured feedback forms design for collection of both qualitative and quantitative data. The major metrics assessed throughout the research include the average parcel retrieval time, frequency of security incidents and over-all usability ratings. The research was conducted over a span of two (2) weeks, thereby giving sufficient time to observe its reliability and pattern of usage. To complement the narrative description, table 1 shown the summary of the key parameters and methodology adopted in the study.

Table 1: Summary of User Study Parameters

Parameter	Description / Methodology
Prototype Units	3 smart locker units deployed in urban locations
Participants	50 (users, delivery personnel, administrators)
Data Collection	Surveys, structured feedback forms
Metrics Evaluated	Security incidents, parcel retrieval time, usability
Study Duration	2 weeks

IV. Results

Security Analysis

The smart locker system integrates IoT logging mechanism that keeps track of events in the system. During the evaluation period, unauthorized attempts was successfully averted with no form of security breach. The logs demonstrated that OTP based and RFID multi-factor authentication performed reliably, providing adequate controlled access to storage compartments.

Efficiency Metrics

The deployed system showed a great improvement when itcomes toefficiency of the operations compared to the manual method of handling parcels. Major performance metrics demonstrated quicker retrieval times, high utilization of lockers and lesser delivery errors.
Table 2 shows the comparative efficiency of the metrics.

Table 2: Efficiency of the Metrics

Metric	Baseline	IoT Smart Locker	Improvement
Average retrieval time	7.5 min	2.5 min	~66% faster
Locker utilization	60%	81%	+35% increase
Delivery errors	8%	3%	62% reduction

User Acceptance

Based on the end-user feedback collection during research surveys. It shown sturdy acceptance of the system. The respondents ranked the solution highly in terms of reliability, convenience and user interface design.

The average scores were:
i. Convenience: 4.7 / 5
ii. Reliability: 4.5 / 5
iii. Interface usability: 4.6 / 5

These outcome shows that the system is well received by courier/delivery personnel and parcel recipients. Fig. 3 demonstrates the distribution of user satisfaction scores in a bar chart while fig. 4 illustrate system prototype. The RFID card is swiped to lock the items.

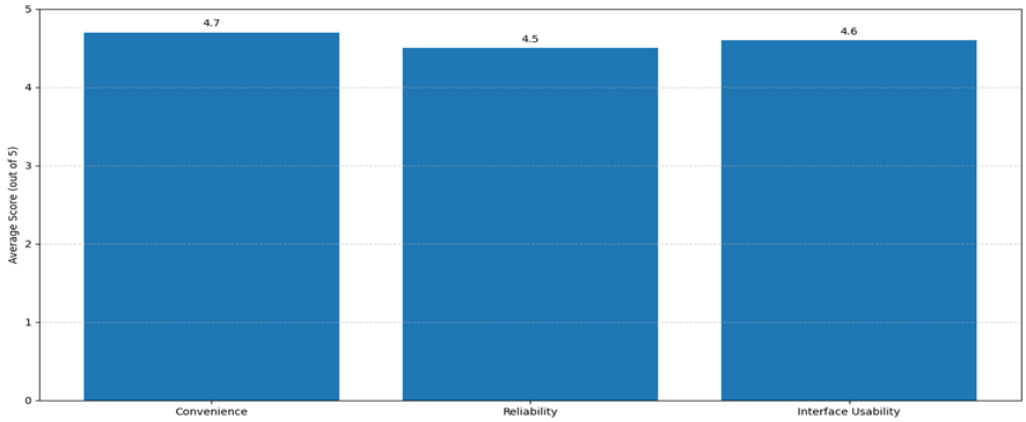

Fig. 3: Average user satisfaction scores (out of 5) for reliability, convenience and interface usability (N = 50)

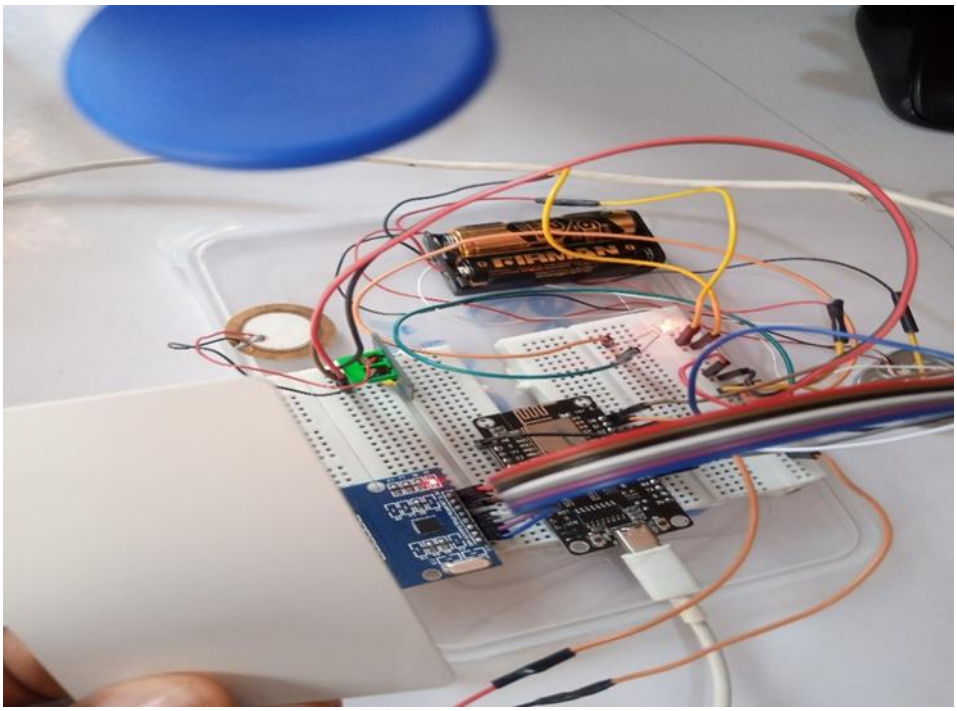

Fig. 4: System Prototyping

V. Discussion

The results of the evaluation shows that IoT enabled smart locker offer considerable enhancements over traditional last mile methods of delivery in urban environments. The systems multi-factor authentication, real time monitoring, and automated system of event logging contributed to the improvement of parcel security with no record of unauthorized access discovered during the research. These results aligned with the earlier studies highlighting the role of IoT in securing asset management [4],[7].

As regards to efficiency, reduction in retrieval time and enhanced locker utilization shows that IoT based lockers simplify parcel handling and provide higher throughput. This is particularly important for dense metropolitan areas that suffers delays in package delivery, failures in deliveries and congestion. The survey respondents further show robust acceptance with participants emphasizing about the convenience, ease of usage and reliability. User acceptability is paramount for adoption in a large scale and also to reinforce the need for user centred IoT system design.

The Modular and Object-Oriented Architectural Design (OOAD) allows for scalability letting numerous lockers to be networked and centrally managed. This attribute makes the solution versatile for integration into larger smart-city infrastructures where devices are jointly interconnected thereby enhancing security service and urban logistics.

Though various system limitation were acknowledged. The solution rely on steady internet connectivity, which may affect its deployment in areas with unreliable network coverage.The RFID modules

and solenoid locks are hardware components that add to the initial cost of deployment, which possibly affect the adoption by small logistics firms.Furthermore, the current analysis was conducted on a limited-scale and wider deployment across many urban regions is required to fully authentic the system robustness.

Regardless of these constraints, the implications for policy and industry are important. Logistics companies can leverage on IoT smart lockers in order to minimize the risk of theft, improve efficiency of delivery and reduction of operational costs as it relates with failures in deliveries.City planners may contemplate on integration of secured locker areas/zones in high traffics regions to provide easy accessibility and reduce congestion resulting from door-to-door delivery using vans.Policymakers may also provide guidelines concerning shared multicarrier locker system to endorse sustainability and interoperability in urban logistics.

VI. Conclusion And Recommendations

This study evaluated the security performance, efficiency of operations and end-user acceptability of an IoT enabled smart locker system developed for urban logistics. The results shows that the incorporation of IoT sensors, real-time monitoring mechanism and multi-factor authentication extensively enhances parcel protection and efficiency of retrieval. Direct feedback was used to further confirm its acceptability and satisfaction as a result of convenience and reliability. These findings highlight the possibilities of smart locker technologies in addressing the last mile delivery defies in fast growing cities.

To maximize the impact of IoT-based smart lockers, the following actions are recommended:

i. Deploy lockers in high-density urban zones, with support for multiple logistics carriers to increase utilization and improve accessibility.
ii. Integrate AI-driven analytics for predicting locker availability, optimizing delivery routes, and enhancing resource planning.
iii. Strengthen system-wide security, including robust encryption, secure communication protocols, and authentication hardening to ensure scalability for large urban deployments.

Further research should explore the automation of smart lockers system with autonomous delivery vehicles and drones. Thorough cybersecurity examinations, that include penetration test and threat model are required to ensure the resilience of the system. Additional, cost optimization should be prioritized and integration of energy efficiency components that support system sustainability and large-scale deployment.

References

[1]. Q. Zhang And E. Demir, “Parcel Locker Solutions For Last Mile Delivery: A Systematic Literature Review And Future Research Directions,” Frontiers In Future Transportation, Vol. 6, 2025.
[2]. W. U. Khan, “Iot-Based Smart Lockers: A Validation For The Saudi Arabian Market,” Journal Of Business And Management Studies (Jbms), Vol. 7, No. 1, 2025.
[3]. T. Gundu, “Smart Locker System Acceptance For Rural Last-Mile Delivery,” In Proc. Ict4d Conf., 2020.
[4]. A. F. S. Luís, G. M. C. Martins, J. M. L. Caldeira, And V. N. G. J. Soares, “Prototype Implementation Of A Smart Locker,” Int. J. Of Eng. And Adv. Tech., Vol. 12, No. 2, 2022.
[5]. Y. M. Tang, K. Y. Chau, D. Xu, And X. Liu, “Consumer Perceptions To Support Iot-Based Smart Parcel Locker Logistics In China,” J. Of Retailing And Consumer Services, Vol. 62, 2021.
[6]. R. Sharma, “Smart Lockers: Design And Implementation Challenges,” In Proc. Ieee Int. Conf. Iot, 2019, Pp. 101–107.
[7]. J. Li, Y. Wang, And M. Zhao, “Iot-Based Smart Parcel Locker System,” Ieee Iot J., Vol. 7, No. 9, Pp. 8892–8902, 2020.
[8]. K. Chen, H. Zhang, And P. Wang, “Iot-Enabled Last-Mile Delivery: Challenges And Solutions,” Ieee Trans. Ind. Informatics, Vol. 16, No. 12, Pp. 7580–7590, 2020.
[9]. S. H. Ahmed, “Smart Lockers In Urban Logistics: A Review,” Ieee Access, Vol. 8, Pp. 56789–56801, 2020.
[10]. F. K. Mustapha, “Evaluation Of Smart Locker Systems For Dense Urban Areas,” Ieee Access, Vol. 8, Pp. 102345–102357, 2020.