THE USAGE OF SMART LOCKS IN SMART HOME

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Purpose: The purpose of this publication is to present the usage of smart doorbells in smart locks.

Design/methodology/approach: Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

Findings: The integration of smart locks into the fabric of smart homes represents a groundbreaking advancement, reshaping the dynamics of security and convenience. These intelligent locks have surpassed traditional mechanisms, ushering in an era where digital authentication and advanced features redefine how individuals secure and engage with their living spaces. Smart locks empower homeowners with unparalleled control and accessibility, eliminating the need for physical keys and introducing heightened security through encryption and biometric identification. Emphasizing their pivotal role in smart homes, the publication highlights the ability of smart locks to remotely monitor and control access, providing unprecedented flexibility, especially in scenarios involving trusted individuals. The seamless integration of smart locks within the broader smart home ecosystem fosters an interconnected environment, enabling holistic automation and enhancing user experience and energy efficiency. While acknowledging challenges such as vulnerabilities and power dependency, the publication underscores the vast advantages of smart locks, ranging from enhanced security to increased home resale value. Tables 1, 2, and 3 provide a comprehensive overview of key features, advantages, and challenges, serving as a valuable guide for navigating the evolving landscape of smart home security. As technology advances, smart locks continue to shape the future of residential living, fortifying the boundaries between physical and digital security.

Originality/Value: Detailed analysis of all subjects related to the problems connected with the usage of smart locks in smart home.

Keywords: Smart City, energy efficiency, smart home, smart house, digitalization, smart locks.

Category of the paper: literature review.

1. Introduction

The integration of smart locks within the framework of smart homes has emerged as a pivotal advancement, reshaping the landscape of modern home security and convenience.

In an era characterized by rapid technological evolution, these intelligent locks have transcended traditional locking mechanisms, offering a myriad of features that redefine the way individuals interact with and secure their living spaces.

At its core, the primary function of smart locks is to provide homeowners with enhanced control and accessibility to their properties. The conventional use of physical keys has given way to more sophisticated methods of entry, with smart locks often relying on digital authentication mechanisms. This shift not only eliminates the need for cumbersome key management but also introduces a new level of security through encrypted protocols and biometric identification (Chen et al., 2023).

The purpose of this publication is to present the usage of smart window blinds in smart locks.

2. Smart locks in smart home

One of the most prominent features of smart locks is the ability to remotely monitor and control access to one's home. Through dedicated mobile applications, users can lock or unlock doors from virtually anywhere, granting unprecedented flexibility in managing entry points. This capability proves invaluable in scenarios where homeowners need to provide access to trusted individuals, such as guests, service providers, or even family members, without the necessity of physical keys or on-site presence (Dhaou, 2023).

Furthermore, the integration of smart locks into the broader ecosystem of smart homes fosters a seamless interconnectedness. These locks often synergize with other smart devices, enabling a holistic automation of household tasks. For instance, unlocking the front door may trigger the lights to turn on, the thermostat to adjust to a preferred temperature, and security cameras to temporarily deactivate. This level of automation not only enhances the overall user experience but also contributes to energy efficiency and the optimization of daily routines.

In terms of security, smart locks offer an array of advanced features that surpass traditional lock-and-key systems (Gajdzik et al., 2023; Jonek-Kowalska, Wolniak, 2021; Jonek-Kowalska, Wolniak, 2022). Real-time alerts and notifications keep homeowners informed about any suspicious activities or unauthorized attempts at entry. Additionally, the ability to audit and track access history provides a comprehensive overview of who has entered or exited the premises, instilling a sense of accountability and transparency (Olabode et al., 2023).

The utilization of biometric authentication methods, such as fingerprint scanning or facial recognition, adds an extra layer of security, ensuring that only authorized individuals gain access. Moreover, many smart locks employ robust encryption protocols, safeguarding against hacking attempts and unauthorized digital breaches (Patheja et al., 2023).

While the adoption of smart locks undoubtedly enhances security and convenience, it is not without its challenges (Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022). Concerns about potential vulnerabilities, system reliability, and the reliance on power sources for electronic components necessitate careful consideration during implementation. Moreover, the interoperability of various smart home devices remains a critical aspect that requires standardization to ensure seamless integration and optimal performance (Ameur et al., 2023; Bsarir-Ozel et al., 2023).

The usage of smart locks in smart homes represents a transformative paradigm in the realm of residential security and convenience (Tong et al., 2023). The amalgamation of digital authentication, remote access control, and integration with other smart devices redefines the traditional concept of home security. As technology continues to advance, the evolution of smart locks is likely to persist, shaping the future of residential living and fortifying the boundaries between physical and digital security (Valencia-Arias et al., 2023).

Table 1 contains descriptions of key features of smart locks usage.

Table 1.
Key features of smart locks usage

Key Features of smart locks	Description
Remote Access Control	Enables users to lock or unlock doors from anywhere via a mobile app, enhancing convenience and flexibility.
Digital Authentication	Replaces traditional keys with digital methods such as PIN codes, fingerprint scanning, or facial recognition for heightened security.
Integration with Smart Home Devices	Synergizes with other smart devices, triggering automation sequences upon door entry or exit for enhanced home efficiency.
Real-time Alerts and Notifications	Sends immediate notifications about any suspicious activities, providing homeowners with instant awareness and peace of mind.
Access History Tracking	Maintains a detailed log of who enters or exits the premises, contributing to accountability and transparency in home security.
Biometric Authentication	Utilizes biometric data (fingerprint, facial features) for access, offering an additional layer of secure and personalized entry.
User-Specific Access Control	Allows homeowners to grant temporary or specific access to guests, service providers, or family members without physical keys.
Auto-Locking Feature	Automatically locks the door after a specified period, reducing the risk of accidental or negligent security lapses.
Voice Activation	Permits users to control the lock through voice commands, enhancing accessibility and hands-free operation.
Geo-fencing Technology	Utilizes location-based services to trigger lock actions, ensuring doors automatically lock or unlock when users enter predefined zones.
Emergency Access Options	Provides alternative entry methods (e.g., backup codes or physical keys) in case of technological malfunctions or emergencies.
Tamper Alerts	Notifies users if the lock detects any tampering or unauthorized attempts, further bolstering security measures.
Battery Status Monitoring	Keeps users informed about the status of the lock's power source, preventing unexpected lockouts due to depleted batteries.
Temporary Access Codes	Generates one-time or time-limited codes for specific individuals, enhancing security during short-term access requirements.
Smartphone Compatibility	Ensures compatibility with a wide range of smartphones, accommodating different operating systems and device preferences.

Cont. table 1.

Weather Resistance	Designed to withstand various weather conditions, ensuring optimal performance and durability regardless of external elements.
Manual Override	Incorporates a manual key override as a failsafe in situations where electronic components may fail or during power outages.
Multi-User Management	Facilitates the management of multiple users with distinct access privileges, catering to diverse household and occupancy scenarios.
Secure Encryption Protocols	Implements robust encryption to safeguard against hacking attempts and unauthorized digital breaches, ensuring data integrity.
Easy Installation and Setup	Streamlines the installation process and user setup, making smart lock adoption accessible to a wide range of homeowners.

Source: (Gøthesen et al., 2023; Alsaedi et al., 2023; Chaudhari et al., 2023; Huda et al., 2024; Husain et al., 2023; Rhode et al., 2023; Basarir-Ozel et al., 2023; Tong et al., 2023; Chen et al., 2023; Douha et al., 2023; Sobhani et al., 2023).

3. The advantages and problems of using smart locks

The adoption of smart locks presents a myriad of advantages that transcend traditional locking mechanisms. Foremost among these advantages is the enhanced security they offer. With features like digital authentication and real-time alerts, smart locks minimize the risk of unauthorized access, providing homeowners with a heightened sense of safety. Remote access control stands out as another key benefit, allowing users to monitor and manage their locks from virtually anywhere using dedicated mobile applications (Jonek-Kowalska, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021; Orzeł, Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecuła, Wolniak, 2022; Olkiewicz et al., 2021). This capability not only enhances convenience but also offers flexibility in controlling access to one's home (Douha et al., 2023).

The integration of smart locks with other smart devices within the home ecosystem is a pivotal advantage. This synergy enables seamless automation, such as adjusting lighting or thermostat settings upon door entry, contributing to a more efficient and connected living environment. User-specific access control is a feature that resonates with homeowners seeking flexibility in managing access permissions. The ability to grant temporary or customized access to guests or service providers without relying on physical keys adds an extra layer of convenience and security (Huda et al., 2024).

The maintenance of access history is a valuable aspect, providing homeowners with a comprehensive record of who has entered or exited their property (Raff et al., 2024). This feature enhances accountability and transparency in home security. Biometric authentication, a hallmark of many smart locks, ensures secure access by utilizing unique biometric data such as fingerprints or facial recognition. This adds an additional layer of protection against unauthorized entry (Chaudhari et al., 2023).

Real-time notification alerts contribute to immediate awareness by keeping users informed about any suspicious activities or unauthorized attempts at entry. This proactive approach to security enhances peace of mind for homeowners (Sułkowski, Wolniak, 2015, 2016, 2018; Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Gajdzik, Wolniak, 2023; Swarnakar et al., 2023). Energy efficiency is a noteworthy advantage, as smart locks seamlessly integrate with other smart home systems. This integration allows for energy-efficient automation, such as adjusting temperature settings or turning off lights when the door is locked, contributing to overall energy savings (Sobhani et al., 2023).

The convenience and flexibility offered by smart locks are further underscored by features like remote unlocking, the sharing of virtual keys, and task automation (Wu et al., 2023). These aspects empower homeowners with greater control over their living spaces. Geo-fencing technology adds an extra layer of automation and security by leveraging location-based services. Smart locks can automatically lock or unlock doors as users enter or leave predefined zones, enhancing both convenience and safety (Alsaedi et al., 2023).

Finally, the integration of smart locks can contribute to increased resale value for homes. The appeal of modern security features and technological conveniences often resonates with prospective buyers, positioning homes with smart locks at the forefront of the real estate market (Ramanujam et al., 2024).

Table 2 highlighting the advantages of using smart locks in smart home.

Table 2.
Advantages of using smart locks

Advantage	Description
Enhanced Security	Smart locks provide advanced security features, such as digital authentication and real-time alerts, minimizing the risk of unauthorized access and enhancing overall home safety.
Remote Access Control	Users can remotely monitor and control their locks, allowing for convenient management of access to their homes from anywhere using a mobile app, enhancing flexibility and control.
Integration with Smart Devices	Integration with other smart home devices enables seamless automation, such as adjusting lighting or thermostat settings upon door entry, contributing to a more efficient and connected home.
User-Specific Access Control	Homeowners can grant temporary or customized access to guests or service providers without physical keys, offering greater flexibility and security in managing access permissions.
Access History Tracking	Smart locks maintain a detailed log of entry and exit activity, providing homeowners with a comprehensive record of who has accessed their property, enhancing accountability and transparency.
Biometric Authentication	Utilizing biometric data for access, such as fingerprints or facial recognition, adds an extra layer of security by ensuring that only authorized individuals gain entry to the home.
Notification Alerts	Real-time alerts and notifications keep users informed about any suspicious activities or unauthorized attempts at entry, providing immediate awareness and peace of mind.
Energy Efficiency	Integration with smart home systems allows for energy-efficient automation, such as adjusting temperature settings or turning off lights when the door is locked, contributing to overall energy savings.

Cont. table 2.

Convenience and Flexibility	The ability to unlock doors remotely, share virtual keys, and automate tasks enhances overall convenience, providing homeowners with greater flexibility and control over their living spaces.
Geo-fencing Technology	Leveraging location-based services, smart locks can automatically lock or unlock doors as users enter or leave predefined zones, adding an extra layer of automation and security to the home.
Increased Resale Value	Homes equipped with smart locks often appeal to tech-savvy buyers, potentially increasing the resale value of the property due to the added security and modern conveniences they provide.

Source: (Gøthesen et al., 2023; Alsaedi et al., 2023; Chaudhari et al., 2023; Huda et al., 2024; Husain et al., 2023; Rhode et al., 2023; Basarir-Ozel et al., 2023; Tong et al., 2023; Chen et al., 2023; Douha et al., 2023; Sobhani et al., 2023).

Table 3 highlighting some of the common problems and challenges associated with the problems of using smart locks in smart homes.

Table 3.
Problems of using smart locks

Problem	Description	Methods of Overcoming
Vulnerability to Hacking	Smart locks, being connected to the internet, may be susceptible to hacking attempts, potentially compromising home security.	Implementing robust cybersecurity measures, such as regular software updates, strong encryption, and using reputable smart lock brands, can enhance resistance to hacking.
Power Dependency	Smart locks rely on power sources, and in the event of a power outage or device malfunction, there's a risk of being locked out or compromising security.	Installing smart locks with backup power options, such as battery backup or manual override keys, ensures continued functionality during power interruptions.
Initial Cost	The upfront cost of purchasing and installing smart locks can be higher compared to traditional locks, potentially deterring budget-conscious homeowners.	Exploring budget-friendly options, waiting for sales or discounts, and considering long-term savings in terms of enhanced security and convenience can justify the initial investment.
Compatibility Issues	Compatibility challenges may arise, especially in older homes or with other smart home devices, potentially limiting the seamless integration of the smart lock.	Thoroughly researching and selecting smart locks that are compatible with existing systems and devices, and checking for firmware updates, can help address compatibility issues.
Connectivity Reliability	Reliance on internet connectivity or Bluetooth may pose challenges in areas with unstable or weak signals, leading to delays or failures in remote access.	Using smart locks with alternative connectivity options, such as Z-Wave or Zigbee, can provide more reliable connections, and having a backup physical key ensures access in connectivity issues.
Privacy Concerns	The collection of user data by smart lock manufacturers may raise privacy concerns, as personal information could be vulnerable to misuse or unauthorized access.	Researching and selecting smart locks from reputable manufacturers with transparent privacy policies and understanding how data is handled can help alleviate privacy concerns.
Technological Obsolescence	Rapid advancements in technology may result in smart locks becoming obsolete or incompatible with newer devices, potentially requiring frequent upgrades.	Choosing smart locks with upgradable firmware and staying informed about industry standards can prolong the lifespan of the technology and mitigate the impact of technological obsolescence.

Cont. table 3.

	Mechanical components of smart locks may still be susceptible to physical tampering or forced entry, compromising the overall security of the lock.	Installing additional physical security measures, such as reinforced strike plates or deadbolts, alongside the smart lock can bolster overall resistance to physical attacks.
Physical Vulnerabilities	Mechanical components of smart locks may still be susceptible to physical tampering or forced entry, compromising the overall security of the lock.	Installing additional physical security measures, such as reinforced strike plates or deadbolts, alongside the smart lock can bolster overall resistance to physical attacks.
Learning Curve	Users unfamiliar with technology may experience a learning curve in understanding and effectively using the features of smart locks, potentially leading to user errors.	Providing comprehensive user manuals, instructional guides, and customer support can assist users in overcoming the learning curve, ensuring proper utilization of the smart lock.
Limited Aesthetics Choices	The design and aesthetic choices for smart locks may be limited compared to traditional locks, potentially impacting the visual harmony of certain architectural styles.	Exploring various smart lock models and brands to find designs that complement the aesthetics of the home, or considering smart lock retrofit options, can address limitations in aesthetics.

Source: (Gøthesen et al., 2023; Alsaedi et al., 2023; Chaudhari et al., 2023; Huda et al., 2024; Husain et al., 2023; Rhode et al., 2023; Basarir-Ozel et al., 2023; Tong et al., 2023; Chen et al., 2023; Douha et al., 2023; Sobhani et al., 2023).

4. Conclusion

The integration of smart locks into the fabric of smart homes marks a transformative leap in the realms of security and convenience. The evolution of these intelligent locks has transcended traditional locking mechanisms, ushering in an era where digital authentication mechanisms and advanced features redefine the way individuals secure and interact with their living spaces.

Smart locks, at their core, empower homeowners with unprecedented control and accessibility to their properties. The shift from conventional physical keys to digital authentication not only eliminates the burdens of key management but also introduces a heightened level of security through encrypted protocols and biometric identification. The publication emphasizes the pivotal role of smart locks in the broader landscape of smart homes, highlighting their ability to remotely monitor and control access. This capability, facilitated through dedicated mobile applications, offers unparalleled flexibility in managing entry points, especially in scenarios involving trusted individuals like guests, service providers, or family members.

Furthermore, the seamless integration of smart locks within the broader ecosystem of smart homes fosters an interconnected environment. This synergy enables holistic automation, where unlocking the front door can trigger a cascade of actions, such as adjusting the thermostat and activating security cameras, enhancing both user experience and energy efficiency. In terms of security, smart locks boast advanced features, including real-time alerts, access history tracking, and biometric authentication methods. These features contribute to a comprehensive security framework, instilling a sense of accountability and transparency within residential spaces.

However, it is essential to acknowledge the challenges associated with smart lock adoption, including potential vulnerabilities, power dependency, and compatibility issues. Overcoming these challenges requires robust cybersecurity measures, backup power options, thorough research on compatibility, and staying informed about technological advancements. The advantages of using smart locks are vast, ranging from enhanced security and remote access control to energy efficiency and increased resale value for homes. The convenience and flexibility offered by smart locks, coupled with their integration capabilities, redefine the traditional concept of home security.

Table 1 provides a detailed overview of key features crucial to understanding the functionality and benefits of smart locks, while Table 2 highlights the myriad advantages of incorporating smart locks into smart homes. Additionally, Table 3 identifies and addresses potential problems and challenges associated with smart lock usage, presenting methods to overcome these issues. As technology continues to advance, the trajectory of smart locks remains promising, shaping the future of residential living and fortifying the boundaries between physical and digital security. The comprehensive understanding of both the advantages and challenges presented in this publication serves as a valuable guide for homeowners and stakeholders navigating the evolving landscape of smart home security.

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