The Board of International Journal of Research and Innovation in Social Science

ISSN: 2454 -6186

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Enhancing Patrol Management With Smart Technology: A Case Study Of SPT System

Published In IJRISS Online Journal

Page No. 371-387 Volume VIII Issue XIV Month December Year 2024

Chief Editor

IJRISS
International Journal of Research and Innovation in Social Science
A Unit of Research and Scientific Innovation Society

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Enhancing Patrol Management with Smart Technology: A Case Study of SPT System

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DOI: https://dx.doi.org/10.47772/IJRISS.2024.814MG0032

Received: 03 December 2024; Accepted: 07 December 2024; Published: 26 December 2024

ABSTRACT

Effective management of security operations is critical for safeguarding assets and personnel across large or high-risk premises. Traditional patrol systems are often reliant on manual processes and outdated technologies that suffer from inefficiencies such as delayed reporting and human errors, which compromise operational effectiveness. To address these challenges, this study introduces the Smart Patrol Tech (SPT) system, an innovative management solution that uses NFC, GPS, and cloud-based technologies to optimize security operations. SPT streamlines security operations across large or high-risk premises by facilitating real-time tracking and incident reporting. Security staff can employ NFC-enabled checkpoints through a mobile application to automate patrol tasks. Their activities are then automatically linked to a cloud server. SPT enhances patrol management by automating routine tasks, enabling real-time tracking, and facilitating instant incident reporting through a mobile application integrated with a web-based dashboard. Administrators can monitor patrol activities, generate detailed reports, and respond proactively to anomalies, ensuring streamlined operations and improved accountability. By minimizing human error and reducing downtime, the SPT system significantly improves the efficiency and reliability of patrol management. This work highlights how SPT bridges critical gaps in traditional systems, offering a robust, technology-driven approach to modernizing security management.

Keywords: Guard Patrolling Management, Internet-of-Things (IoT), Near Field Communication (NFC), smartphones.

INTRODUCTION

One of the biggest challenges facing security professionals around the world is ensuring the safety and security of different locations, including public areas, corporate buildings, and educational institutions. Modern security demands are being met by traditional security patrol systems, which frequently rely on manual procedures for recording activities and reporting events. The guards will follow their designated

patrol routes and notify their arrival by scanning the tags with the reader device. By enhancing the protection of the assets and premises, the guard patrolling system assists the organization in implementing standard operating procedure (SOP) in an exceptional and efficient manner. These systems typically involve the use of outdated digital tools, which lead to delays in data collection and hinder real-time communication.

Among the earliest guard tour mechanisms currently in use by certain security officers worldwide is the watchclock. Like most modern locks, this mechanical system is operated by a set of keys and paper tape. At different checkpoints, security personnel place the keys into designated boxes, which stamp the checkpoint number and current time onto the tape. The guards can only be observed when they have completed all checkpoints after finishing their rounds. This outdated system necessitates frequent tape replacements and incurs substantial maintenance expenses since it cannot compile patrol reports in a timely manner and lacks real-time tracking capabilities.

Hicham El Mrabet [1] has introduced an advanced monitoring and reporting system that harnesses connected devices and RFID technology to enhance security operations. Currently, digital RFID data loggers are among the most widely adopted tools by security personnel. Unlike traditional watchclocks, which rely on mechanical components, RFID systems use electronic components that facilitate more efficient data handling. The RFID system allows security guards to carry handheld RFID readers, compact devices that typically resemble a pen or small stick. Passive RFID chips that are positioned strategically at several checkpoints throughout the building communicate with these readers. The RFID chip transmits data back to the device and becomes active when a guard scans it with the reader, enabling real-time logging of patrol actions. Comparing this electronic technique to traditional approaches reveals various advantages. First off, digital data collection is far less than that of heavy paper cassettes, which results in more effective management and storage. Administrators can also easily upload electronic data to a central database, which allows them to make reports, track any discrepancies in patrol actions, and monitor patrols in real time.

Security personnel use an RFID reader to scan the area at each checkpoint while on patrol. For precise tracking of the patrol path, the system automatically logs each checkpoint's location and timestamp. Guards are required to manually move the data via USB to a computer after finishing their rounds. To avoid losing important data, this procedure must be done before the device's data storage capacity is reached. Traditional digital data loggers have a few important drawbacks, including the inability to monitor patrol activity on a real time basis due to internal storage. Furthermore, replacing or repairing broken equipment can be expensive. It's also essential to charge batteries on a regular basis because they can lose performance over time and raise maintenance expenses. Most importantly, these devices do not support instant reporting, making it impractical for security personnel to access data remotely. Security procedures could become even more complicated if the gadget malfunctions and all saved records are lost forever.

Such inefficiencies create significant vulnerabilities, as security personnel may not receive timely information about incidents, thus impeding their ability to respond quickly and effectively [2]. Furthermore, the reliance on manual data entries increases the risk of human error, which can result in incomplete or inaccurate records of patrol activities. This lack of real-time oversight not only compromises the safety of individuals but also undermines the overall effectiveness of security operations. The efficacy of security operations is also compromised by this absence of real-time control, so jeopardizing human safety.

Given these obstacles, a more advanced and comprehensive strategy for managing security patrols is desperately needed. Prior studies have indicated the possibility of utilizing contemporary technologies, like NFC, GPS, and IoT, to augment operational effectiveness and elevate incident documentation. Nevertheless, current technologies are still unable to fully automate these procedures and deliver real-time updates, which leaves administrators and security staff with insufficient resources to handle their duties.

In response to these problems, state-of-the-art technology known as SPT, the improved version of our previous system [2], has been developed as a way to automate patrol tasks, improve overall security

management, and streamline communication. SPT seeks to both bridge the gaps left by conventional systems and change the norms of security operations by providing real-time tracking and incident reporting.

BACKGROUND STUDIES

Effective patrolling systems are essential for maintaining safety in various environments. Manual checks and logging are common components of traditional patrolling techniques, which can cause reporting delays and increase vulnerability. Recent technological developments have brought forward creative solutions that provide real-time surveillance and improve patrol efficiency in order to get beyond these restrictions [2]. This background research examines the many technologies and methods that are currently being used to enhance security operations, emphasizing both their advantages and disadvantages.

Karakaya [3]suggested a wireless control system for patrol auditing that makes use of iBeacon and smart Bluetooth technologies. To enhance security, this system utilizes smartphones equipped with iBeacon technology. It also includes a web application for generating and retrieving patrol reports. After each patrol, all data is stored in a central database. However, the system's efficiency can be affected by the size of the area being monitored or patrolled. For example, larger premises require more checkpoints to be scanned, which may increase the risks faced by guards during their patrols.

Similarly, GuardExpert PRO, an application-centric Internet of things (IoT) solution for guard touring systems (GTS), was introduced by Faizul [4]. This system ensures that guard patrol responsibilities are accurately tracked and managed, therefore guaranteeing the reliable completion of daily patrols. The GTS uses IoT technology to establish a connection to the internet through cellular networks, facilitating the flow of data from NFC readers to a cloud server. This data is conveniently accessible to administrators. However, GuardExpert PRO primarily focuses on patrolling management, overlooking the safety of guards while on duty.

Mobile devices with integrated NFC and GPS technology are becoming increasingly prevalent in modern management and security systems. Asadullah Shaikh [5] discussed several smartphone applications that utilize GPS for enhanced security monitoring. Alexopoulou [6] investigated the impact of mobile and sophisticated information technology on cognitive flexibility. The Smart-Hadir system, created by Keau [7], tracks and records student attendance in real time by using NFC or QR code scanning, guaranteeing precise and prompt data capture during sessions. Similar to this, a smart patrolling system may track guard patrols in real time using GPS or NFC technology, guaranteeing that patrols are finished at predetermined checkpoints and that data is kept effectively. Both technologies improve operational efficiency and accountability by utilizing centralized data storage and real-time scanning.

Saare [8]conducted a systematic review of mobile tracking applications, emphasizing the importance of usability characteristics such as effectiveness, efficiency, usefulness, and accuracy. Ching [9] also investigated the usability and acceptance of a measurement application that runs on Android.

In his thorough assessment of the literature, Ali [10] explored the integration of mobile applications, big data analytics, and IoT in facility management procedures, demonstrating how these technologies significantly reduce management costs while enhancing performance and service quality. Similarly, in a smart patrolling system, integrating mobile applications and IoT can streamline patrol tracking, improve response times, and enhance overall security management. Fan [11] achieved comparable results by combining hybrid wearable sensor networks with IoT for safety and health monitoring applications, which parallels how IoT can be used to monitor guards' safety and ensure real-time updates in security patrols.

Recent research has suggested a number of NFC-enabled systems to enhance security patrolling and administration, including Incentive Lynx Security, inViu NFC-tracker, and NFC Patrol [12], [13], [14], [15]. Security personnel scan the tags with NFC-enabled devices, which send the unique tag identifiers in real

time to a server over the internet. These systems use NFC tags that are positioned at specific checkpoints within buildings. Even GPS technology is used by certain systems, such as Incentive Lynx Security, to track the whereabouts of security officers while they are on patrol.

Table. 1 Summary of Background Studies

Author and Reff	System/ Technology	Key Features	Limitations
Karakaya **[3]**	iBeacon and Bluetooth Patrol System	Wireless control, mobile integration, Web-based report generation	Time-consume for large areas, increase risks to guards in larger patrol zones
Faizul [4]	GuardExpert PRO (IoT Solution)	IoT for patrol management, cloud-based data storage	Lacks real-time tracking, does not address guard safety during patrols
Shaikh [5]	Mobile GPS App	GPS-based mobile app for location tracking	Focused on general tracking, lacking security features
Keau [7]	Smart-Hadir Attendance System	NFC/QR code-based attendance tracking	limited features to security patrols
Saare [8]	Usability Evaluation of Mobile Tracking	Emphasize efficiency, and accuracy	More focused on mobile tracking without specialized security use cases
Ali [10]	IoT, Big Data, Mobile in Facility Management	Improved facility management performance, reduced costs	Lacks real-time tracking, does not address guard safety
Jiang [12]	NFC technology integrated with cloud computing	Provides timely alerts and reports, improving response to incidents.	Requires reliable internet and NFC-enabled devices.

Advancements in automated and networked systems across various fields have driven improvements in efficiency, safety, and data management. Azman et al. [16] demonstrated optimized network protocols for agriculture, a concept that aligns with how smart patrolling systems utilize real-time data handling in dynamic security environments. Lee et al. [17] highlighted the importance of reliable communication in challenging terrain, a feature reinforced in the smart patrolling system through GPS and NFC integration. Automated traffic control and adaptive congestion management [18, 19] by Subramaniam et al. are examples of safety-focused innovations that complement the system's emergency alerts and adaptive routing in high-density locations. Furthermore, the automatic scheduling and reporting characteristics of the smart patrolling system mirrored a concept that the author in [20] emphasized. When taken as a whole, these technologies highlight how smart patrolling systems enhance security management by providing robust, flexible solutions.

Some of studies explores advancements in security patrolling systems, focusing on IoT technologies such as Bluetooth, NFC, GPS, and wireless control. While technologies such as Faizul's GuardExpert PRO and Karakaya's iBeacon have enhanced patrol management, issues with real-time monitoring and guard safety still exist. Mobile devices equipped with GPS and NFC capabilities have become standard in modern security systems. IoT and big data analytics have been shown in studies to improve security management and patrol effectiveness.

Challenges and Advancements in AI-Driven Security Patrol Management

Security patrolling systems have changed because of the quick development of smart technology. Numerous studies have looked at ways to use optimization, artificial intelligence (AI), and machine learning (ML) to increase patrolling efficiency. In order to maximize the efficiency of security patrols and lower related

expenses, these initiatives concentrate on enhancing patrol route planning, crime prediction, and resource allocation.

In one such work, Guevara and Santos [21] suggest a smart patrolling algorithm that creates police patrol routes using AI and ML approaches. Their study predicts crime hotspots by integrating spatial-temporal trends using crime data from Quito, Ecuador. The system creates optimum patrol routes that improve security while using less resources by integrating crime probability, distances, and time (using OpenStreetMap data). This method effectively distributes patrols based on real-time data analysis, demonstrating the potential of AI to enhance urban security.

In the study by Chen et al. [22], a multi-objective, risk-aware reinforcement learning framework is used to optimize patrol routes. The method tackles path planning difficulties by considering both risk and efficiency considerations when optimizing routes. It makes the patrolling system more successful in a variety of situations, including high-risk and metropolitan areas, by allowing it to adjust dynamically. By incorporating reinforcement learning, this approach seeks to improve patrolling task decision-making while striking a balance between operational and safety objectives.

In [23], the author describes a game-theoretic method for creating the best patrol routes. The technique simulates situations in which a defender seeks to apprehend an evader in a controlled space (e.g.warehouse). This is done by presenting patrolling as an evader-defender game. To estimate the Stackelberg Equilibrium, the authors use Monte Carlo Tree Search (MCTS). This is using a special technique called Mixed-UCT. This allows the defender to develop a plan that takes the evader's awareness of the defender's patrol routes into account while optimizing the likelihood of an interception. This approach offers scalability and near-optimal results.

The author in [24] systematically reviews strategies for optimizing police patrol routes, examining land, marine, and air patrol techniques. It emphasizes data-driven approaches, such as predictive analytics and optimization algorithms, to enhance patrol coverage and effectiveness in high-risk areas. By aligning resources with structured patrol strategies, the study supports law enforcement efforts to improve crime prevention and response, contributing valuable insights into efficient public safety management. Key issues are highlighted in the assessment, including enhancing crime prediction algorithms and striking a balance between police coverage and reaction times. For further study, particularly in the creation of AI-driven systems that may enhance urban security, their work offers a strong basis.

Finally, the author in [25] investigates how multi-agent systems and evolutionary algorithms might be used to optimize security patrol routes in urban areas. Their study shows that by mimicking patrol agent behavior and increasing route efficiency, genetic algorithms may identify the best answers. According to the research, their suggested strategy works better than conventional patrol techniques by boosting coverage and cutting down on patrol time, offering a workable way to improve community security.

All of these studies highlight how AI, ML, and optimization algorithms have revolutionized security patrol systems. Through enhanced route efficiency, crime hotspot prediction, and resource allocation optimization, these technologies provide workable answers to the changing problems in urban security management.

Even with significant advances in AI, ML, and optimization techniques, there are still a number of issues that prevent security patrol systems from being fully implemented in real-world environments, Since the availability and quality of data directly affect the accuracy of crime prediction and patrol route optimization, relying on huge and high-quality datasets is a major difficulty. Biased or incomplete datasets may provide less-than-ideal results, which lowers the system's overall efficacy. Furthermore, these algorithms' computational complexity, especially when it comes to multi-objective optimization techniques, might present issues with processing speed and the need for significant computer resources, which in some situations makes real-time application challenging. Additionally, AI-based systems' capacity to react to abrupt environmental changes - like emergencies or major public gatherings - remains a restriction since

these systems can find it difficult to make dynamic adjustments without human assistance. Nevertheless, by providing real-time monitoring, incident reporting, and automated patrol procedures, SPT, which integrates NFC, GPS, and cloud-based technologies, overcomes some of these constraints. The SPT system overcomes some of the fundamental limitations of AI-driven security patrol systems by streamlining data flow, reducing mistakes in human data input, and providing fast updates. This allows for more responsive and effective patrol management.

SPT MANAGEMENT SYSTEM

The system architecture, shown in Fig. 1, illustrates that the SPT system consists of an admin dashboard (the SPT web interface) and an enhanced mobile application for security guards and supervisors. All components connect to a cloud server via cellular or Wi-Fi networks, enabling remote data storage. To streamline patrols, NFC tags are strategically placed around the premises as checkpoints. The operation of SPT is summarized as follows.

To prevent unauthorized access, security personnel must first log into the SPT system through a secure interface before starting their patrol. Only pre-registered guards are allowed to log in, and any new users must be registered via the web dashboard. Before accessing the main interface, guards are required to enable GPS and NFC on their devices. If these features are not activated, the system prompts a reminder. Once enabled, guards can view the number of checkpoints they need to patrol, along with historical data from previous patrols for reference.

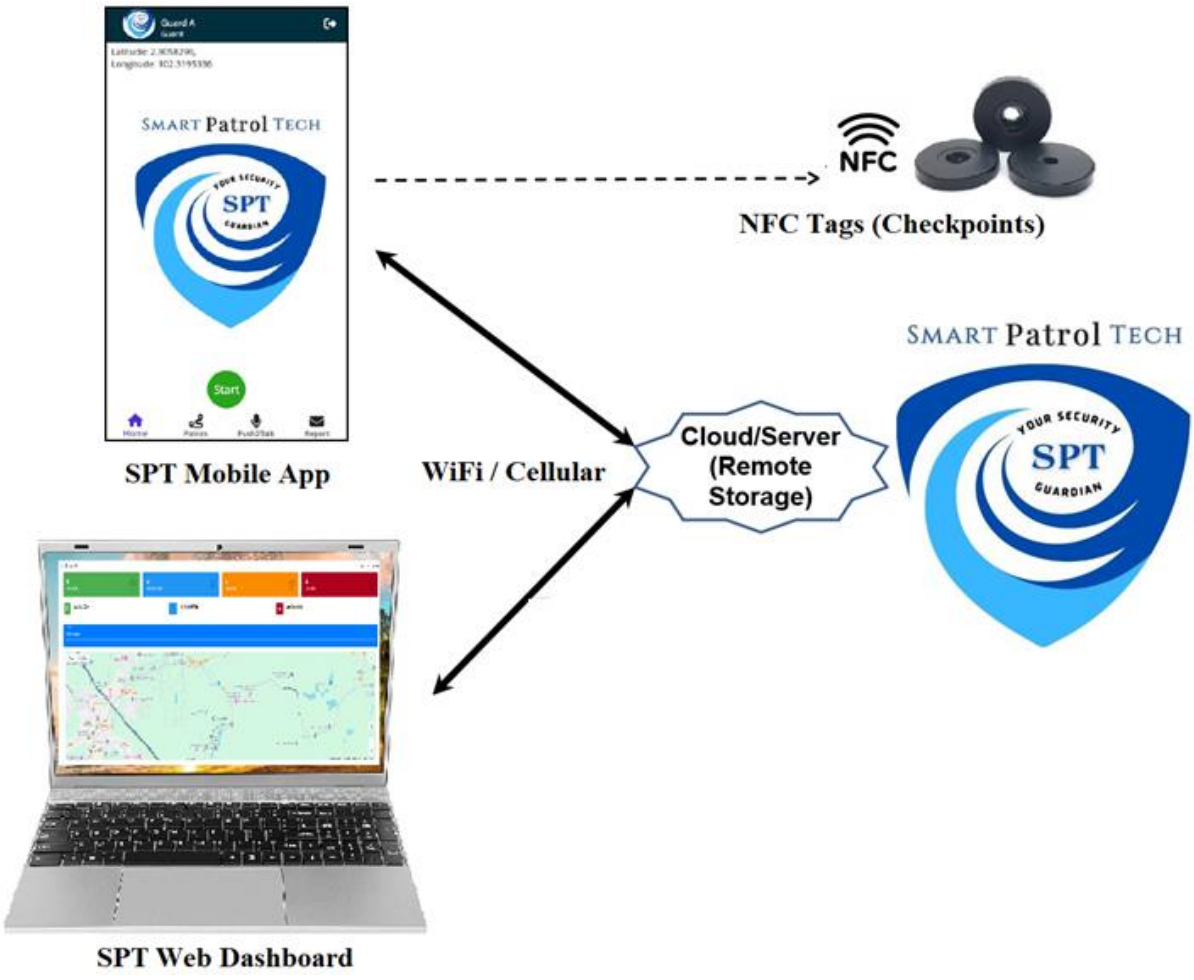

Fig. 1. SPT System Architecture

NFC tags are strategically positioned at specific locations across the premises. Guards use NFC-enabled smartphones to patrol their assigned routes, registering their presence by scanning the NFC tags. The system

updates checkpoint status in real-time, transmitting data to the cloud server over the internet, which includes checkpoint names, locations, scan times, and guard IDs. In the event of a network outage, the system switches to cellular SMS to ensure data capture.

Upon scanning an NFC tag, a timer starts, displaying the remaining time on the interface. These countdowns, set by the administrator, help ensure timely scans between checkpoints. The software also tracks the guard's GPS location and sends notifications to their supervisor via email, SMS, or WhatsApp if the guard stay behind at a checkpoint longer than the allotted time.

After completing their patrol, the application displays a confirmation message. The SPT web dashboard enables administrators to monitor and retrieve all scanned data, offering customized reports on an hourly, daily, weekly, monthly, or annual basis. Additionally, guards can report hazards and incidents in real-time during their patrol, enhancing both operational efficiency and safety through the SPT system.

The safety function of SPT is a crucial component that sets off emergency alerts when guards fail to stop at checkpoints or stray from approved patrol routes. This keeps the guards safe and enables security administrators to react quickly to any anomalies. By incorporating cloud storage, the system also secures data backups, guards against data loss, and makes administrator access simple.

Devices that meet ISO/IEC 18092 and ISO/IEC 14443 standards must be NFC-compliant in order to use NFC. For a range of NFC applications, these standards guarantee security and compatibility. NFC functions in three main ways: reader/writer, peer-to-peer, and card emulation. Because it allows security officials to utilize NFC-enabled devices to communicate with NFC tags posted at checkpoints, Reader/Writer mode is crucial to the SPT system. These tags capture patrol information, which is immediately transmitted to the cloud server for monitoring and reporting in real time.

Devices can speak directly with one another in peer-to-peer mode, which may make inter-patrol communication easier in an emergency. The Card Emulation mode, which is frequently used for payments and access control, might also be modified by SPT to manage safe access to limited places. Integrating NFC technology into the SPT system streamlines security operations, reducing manual input and providing a reliable, automated method for tracking patrols.

SPT MOBILE APPLICATION AND SYSTEM DASHBOARD

The SPT management system comprises a mobile application and a dashboard management system, both of which work together to oversee and optimize the entire patrolling operation. The mobile application serves as a tool for security personnel, allowing them to carry out patrols efficiently by providing real-time tracking, checkpoint management, and incident reporting features. Meanwhile, the dashboard management system enables administrators to monitor patrol activities, manage schedules, and generate comprehensive reports, ensuring seamless oversight and decision-making.

This section provides a detailed explanation of how patrolling operations are managed through the integration of these two components. It explores the functionality of the mobile application, including its role in facilitating patrol execution and communication, and the capabilities of the dashboard system in analyzing patrol data, ensuring accountability, and enhancing overall operational efficiency. Together, these systems form a comprehensive solution for modern patrolling management.

SPT Mobile Application Management System

An important point of access for authorized users is the SPT mobile application's login page. Users are required to provide their password and registered email address in the application's relevant fields upon launch.

Fig. 2. SPT Mobile Application Login Page

As shown in Fig. 2, the users have to click the "LOG IN" button in order to authenticate and use the functions of the system after providing their login credentials. The integrity and security of the patrol data handled by the SPT platform are preserved by this authentication process, which ensures only authorized users, like security guards, can access the system.

Fig. 3. SPT Mobile Application Home Screen

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume VIII Issue XIV December 2024 | Special Issue on Management

Fig. 3 shows the SPT mobile application home screen. After a successful login, users or security personnel are directed to the home screen, which serves as the central hub for patrol planning and monitoring. To ensure immediate situational awareness, the user's profile name and current location coordinates are displayed at the top of the screen. This enables security guards to be informed about their location, patrol routes, and any pertinent events or modifications while on patrol. Guards can stay updated and react to possible security threats and emergencies more skillfully thanks to their expanded knowledge. At the bottom of the interface is a visible display with the next patrol's time and date. Guards can click the "Start" button to begin a patrol when it is planned. The home screen also provides access to key functions. Users can access patrol routes and records, as well as previous and planned patrols, using the "Patrols" option. The "Report" feature, which enables users to generate and submit different types of reports straight from the SPT system, is another crucial component. These reports may include incident logs, maintenance requests, and other documentation related to patrols. The home screen is designed to centralize critical patrol management tasks, enabling security staff to navigate efficiently.

Fig. 4. Patrol screen showing real-time route, checkpoints, and action buttons.

Fig. 4 shows the active Patrol Screen, displaying real-time routes, checkpoints, and action buttons. When the "Start" button is pressed, the system switches to the active patrolling interface, providing essential information about the current patrol. The screen displays the guard's current location and patrol route on a map, with every checkpoint marked. At each checkpoint, the guard can register their presence by tapping their device to scan the NFC tags. To guide the guard along the route, the next checkpoint is highlighted.

This interface also includes action buttons to support the patrol. The guard can activate the flashlight by pressing the "Torch" button when needed. In an emergency, the "Send SOS" button is crucial, enabling guards to quickly send a help signal. The "Patrols" button provides access to a list of previous and upcoming checkpoints, offering additional details about the patrol process. Finally, the "End" button concludes the patrol once all checkpoints have been scanned or if the patrol is paused.

Fig. 5 shows the checkpoint scan results, illustrating the SPT application's workflow. When a guard successfully scans a checkpoint, the SPT application displays a "Scan Successful" message, confirming the accuracy of the checkpoint marking. If the patrol route is set up in sequential order, each checkpoint must be scanned in the correct sequence. If this order is not followed, the application shows a "Scan Error" notification, indicating that an incorrect checkpoint was scanned. The guard must then use the app's navigation instructions to locate the correct checkpoint. If a checkpoint cannot be found in the system's data, an error message, "Checkpoint Failed – Appropriate Data Not Found in Server," appears, signaling that the required data is missing from the server. Guards encountering this issue should report it to their supervisors to verify the accuracy and recording of the checkpoint's location coordinates. The SPT system also displays the error "Checkpoint Failed – You Are Away from the Checkpoint" if the guard's location is outside the designated range of the checkpoint coordinates. For a successful scan, the guard must be within a specified radius and use accurate position data. If an issue arises, the guard must approach the checkpoint and attempt the scan again to ensure proper marking and reporting within the system.

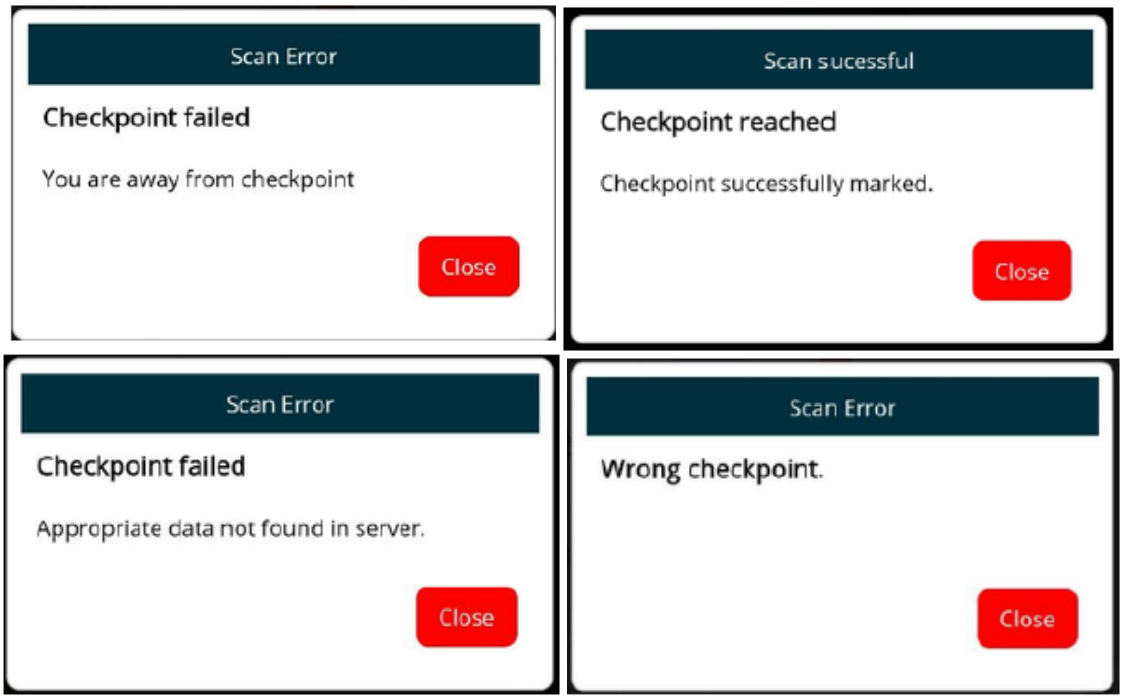

Fig. 5. Checkpoint Scan Process in the SPT Application

When the guard taps the "Patrols" button on the SPT system, a screen displaying comprehensive details about the assigned patrol route appears, as shown in Fig. 6. This includes information such as patrol times, shift details, and the route name. The interface provides two main action buttons: "Send SOS" and "Upcoming Patrols." By pressing the "Send SOS" button, the guard can signal for assistance or issue an emergency alert. The "Upcoming Patrols" option allows the guard to review scheduled patrols, including the exact time, date, and route of the next patrol, helping them plan and execute their tasks more effectively and on time. The Push-to-Talk feature of the SPT system allows security professionals to quickly interact by voice while on patrol. By pushing and holding the Push-to-Talk button, guards may transmit audio messages instantaneously, enabling efficient, in-the-moment communication. Particularly in emergency situations or when prompt updates are needed, this capability guarantees better coordinated and swift patrol activities. Its ease of use and promptness greatly improve situational awareness and field operations efficiency.

Fig. 6. Scheduled patrol views panel

SPT Dashboard Management System

Fig. 7. SPT Dashboard Login Page

As shown in Fig. 7, users can access the dashboard easily and securely via the SPT system's login page. Users, including security personnel, must visit the provided URL and enter their credentials, which include a

valid username (MyKad No.) and password. Administrators have the option to select the "Admin Dashboard" box, granting them access to administrative controls and features. Once the required information is entered, users can access the main dashboard screen by clicking the “Submit” button. This login procedure enhances the security and management of patrol operations by restricting system access to authorized individuals.

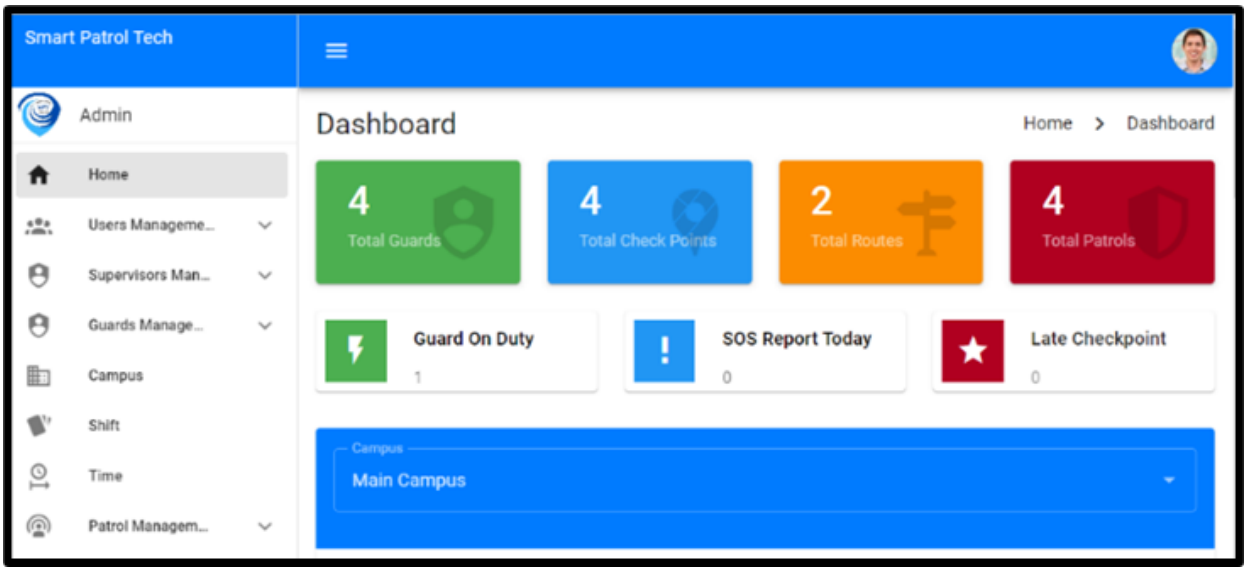

Fig. 8. SPT Dashboard

With an intuitive design, the SPT dashboard, as shown in Fig. 8, provides a comprehensive summary of key security data. The green box labeled "Total Guards" displays the total number of guards registered in the system. The blue box, "Total Checkpoints," indicates the number of checkpoints that guards are assigned to monitor. The orange box, "Total Issues," shows the number of reported issues or incidents from patrols, while the red box, "Total Panels," represents the number of active areas or panels under observation. The dashboard also includes a "Guard on Duty" feature, allowing users to instantly view the current active guard. The "SOS Report Today" section provides administrators with real-time information on emergency situations reported by guards during patrols. Finally, the "Live Checkpoints" feature enables real-time tracking of patrolling activities by displaying the number of checkpoints currently being actively monitored.

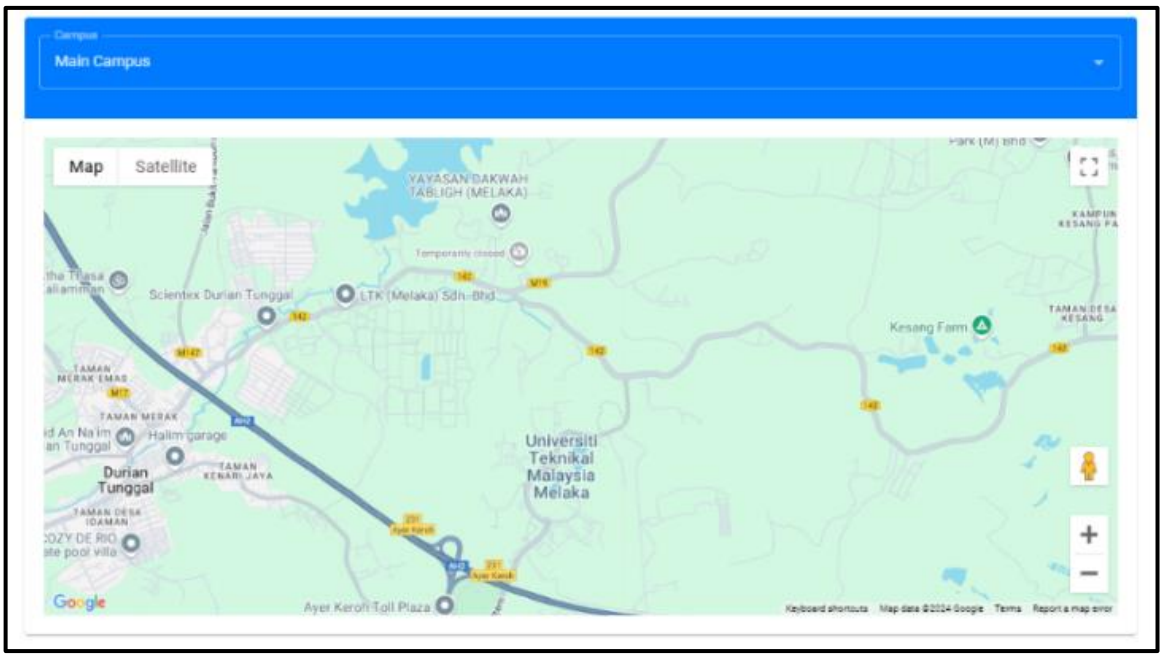

Fig. 9. Real-Time Map Interface of the SPT Dashboard

Security activities are tracked in real time using the SPT dashboard's map component, as shown in Fig. 9. It features an interactive map interface that displays the current locations of security personnel, patrol routes, and checkpoints. This function enables administrators to monitor the precise locations of guards during their shifts, and ensures that patrols are conducted as planned. It is also possible to examine the status of checkpoints along the patrol route, which allows for prompt confirmation of whether checkpoints are visited and monitored in accordance with the schedule. By enhancing situational awareness and providing a visual overview of patrol coverage, the map simplifies security management.

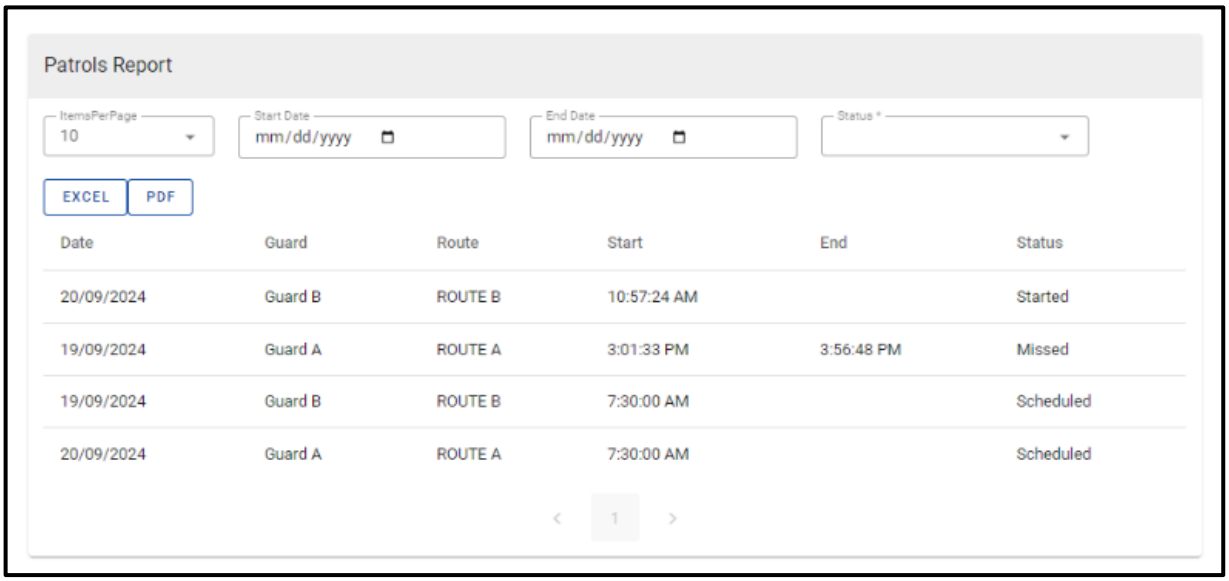

Fig. 10. Patrol Report Table for Detailed Log of Patrol Activities

The SPT dashboard's Patrol Report Table as shown in Fig. 10 provides a thorough record of recent patrol operations. To efficiently filter reports within a certain time window, users in this system may choose exact start and end dates using the Date Range Filter. Furthermore, the system has export functionality, which allows reports to be saved in PDF or Excel formats for further analysis or record keeping. Each patrol specifics are recorded in the Patrol Logs, which include the date of the patrol, the name of the guard in charge, the location of the patrol, and the start and finish timings. Every patrol's status is prominently shown whether it was completed or missed. Administrators can effectively monitor and evaluate patrol activities in this well-organized style.

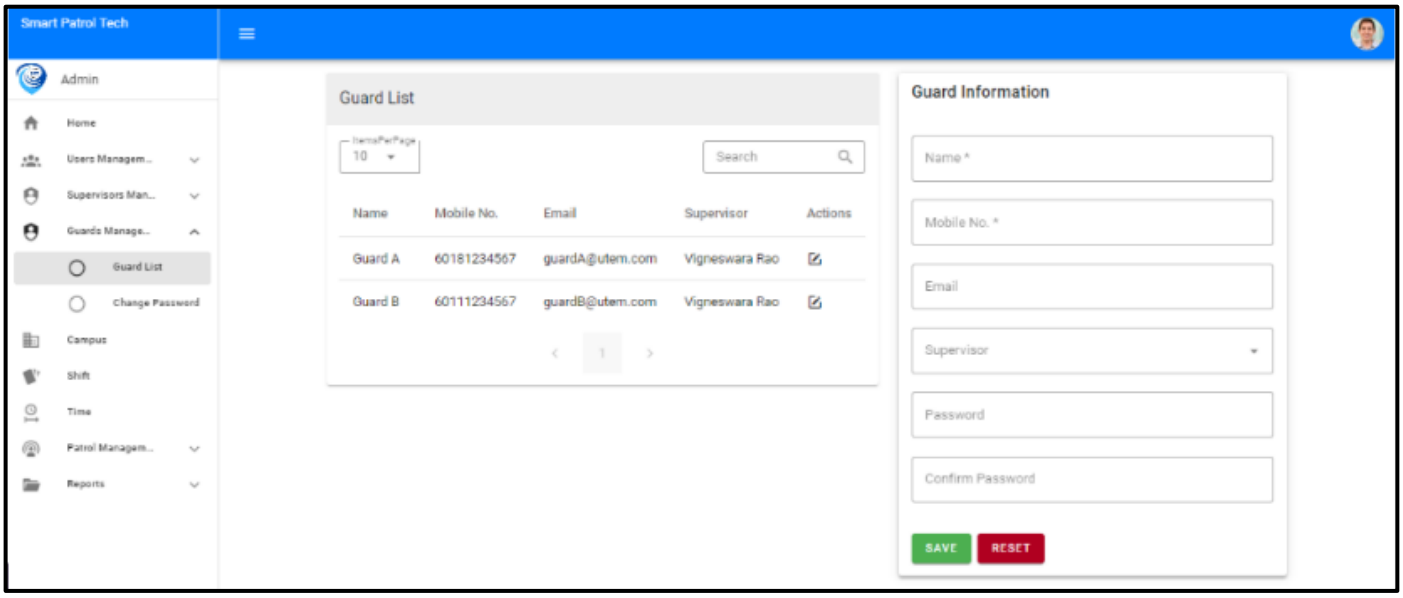

Fig. 11. Guards Management Interface

The SPT dashboard's Guards Management section as shown in Fig. 11 provides administrators with a well-structured interface for managing their security staff. All registered guards are included in the Guards List, along with important details including their complete name, email address, and cellphone number, as well as the supervisor in charge of managing them. By entering the guard's information into an editable form, administrators may alter the guard's data using the Edit Icon. Contact data and supervisor assignment are among the details that may be added or updated using this guard information page. Administrators may choose Reset to make room for new entries or save the revised data once changes or additions have been made. Adding a new guard is a simple procedure that involves administrators creating a password for the guard, assigning a supervisor, and completing the necessary fields before saving the new entry into the system. This user-friendly management feature ensures that the guard roster is kept up-to-date and easily accessible.

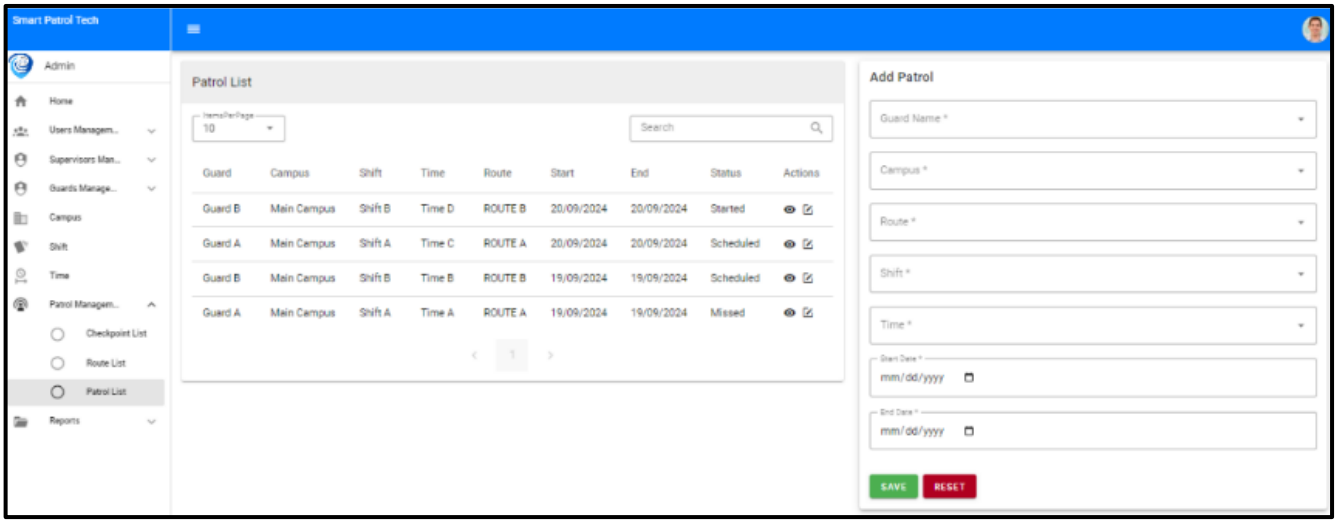

Fig. 12. Patrol List Interface

Administrators can effectively manage and keep an eye on patrol schedules with the help of the SPT dashboard's Patrol List component as shown in Fig. 12. The name of the guard, the campus or area to which they are assigned, their allocated shift, and the patrol time are among the important details that are shown in columns. It also displays the patrol's current state (e.g., Scheduled), start and finish hours, and the assigned patrol route. The “ItemsPerPage” Dropdown lets administrators choose how many patrol entries are shown at once, and the Edit Icon lets them alter patrol data via the patrol information panel. By completing the necessary elements on the Patrol Information Form, administrators may add or edit patrol entries. While “Reset” makes the page available for fresh submissions, Save guarantees that patrol information is updated in the system. This interface is very effective for scheduling and managing patrols since adding a new patrol requires choosing the guard, location, route, shift, and time before entering the patrol information into the system.

SPT ADVANTAGES

Even though the SPT system requires an initial investment in NFC tags, GPS-enabled smartphones, and cloud infrastructure but it delivers substantial long-term cost savings compared to traditional systems. Traditional methods, such as Digital RFID-based systems, require periodic battery replacements and are limited in scalability. It also incurs high maintenance and labor costs. The SPT system minimizes these recurring expenses by using NFC-enabled smartphones and cloud-based storage, which are cost-effective and scalable over time. By eliminating manual data collection and enabling efficient incident reporting, SPT streamlines workflows, resulting in up to 40% reduction in operational costs over time. Moreover, the enhanced functionality of SPT, including real-time alerts and GPS tracking, justifies the initial investment by offering higher security standards and reduced risks. These long-term benefits make the SPT system a financially viable solution for organizations seeking to modernize their security operations.

The SPT system is designed to be highly adaptable across diverse operational environments, making it suitable for both small-scale and large-scale deployments. Its scalability is enabled by the use of NFC and cloud-based technologies, which allow seamless integration with varying infrastructure sizes. In urban environments, the system can efficiently handle dense networks of checkpoints and real-time data synchronization. Conversely, in remote areas with limited connectivity, the system's ability to switch to cellular networks or SMS ensures continuous operation. Additionally, the modular design of the SPT system supports the addition of new features or the expansion of checkpoint coverage without significant modifications to existing infrastructure. This adaptability makes it a practical solution for a wide range of applications, from university campuses to industrial facilities and large commercial complexes. By offering flexible deployment options, the SPT system ensures its functionality and effectiveness in diverse operational contexts, providing a robust and future-ready security solution.

The integration of real-time GPS tracking and automated alerts provides a level of responsiveness unmatched by older systems. For example, while traditional systems like watchclocks require manual oversight and lack real-time reporting, SPT offers immediate access to patrol logs and incident updates, enabling faster decision-making. Comparisons with other modern systems, reveal that SPT excels in addressing user safety concerns by incorporating emergency alerts and GPS-based location tracking. These real-world applications highlight the adaptability and efficiency of SPT across different environments, making it a robust solution for modern security challenges.

SPT CHALLENGES AND LIMITATION

While the SPT system offers numerous advantages, addressing potential challenges is crucial for its successful implementation. One major concern is NFC compatibility, as some older smartphones or devices may lack the necessary hardware to scan NFC tags. This can be mitigated by ensuring that all devices used for patrolling meet the ISO/IEC standards for NFC compatibility and upgrading outdated hardware where necessary. Another challenge is GPS inaccuracy, particularly in areas with weak satellite signals, such as indoors, underground facilities, or densely built urban environments. The SPT system could integrate alternative location-tracking methods, such as Wi-Fi triangulation or Bluetooth beacons, to ensure accurate location reporting. User training is also a critical factor, as transitioning from traditional systems to SPT requires guards and administrators to adapt to the new technology. A phased implementation approach, starting with smaller deployments before scaling up, can help organizations gradually address these challenges while maintaining operational continuity. By proactively tackling these challenges, the SPT system can enhance its reliability and user acceptance, ensuring smooth implementation and long-term success.

CONCLUSION

The SPT system is a significant advancement in modern security patrol since it addresses the drawbacks of both digital and conventional guard tour systems. By combining NFC technology, GPS, and cloud-based storage, SPT enables automated, real-time patrol monitoring, increasing operating efficiency. The ability to track the whereabouts of security staff, receive real-time notifications during incidents, and generate thorough reports makes security operations more visible and accountable. By reducing human error, this technological development ensures a reliable method of ensuring the security of the property and the guards doing their patrol duties. The system's user-friendly mobile app and web interface streamline the entire process, from guard registration to report creation. Furthermore, SPT's ability to operate under both continuous and intermittent internet access ensures its adaptability to many conditions. The SPT system provides a complete solution that significantly raises the efficacy, dependability, and safety of security patrolling. It is a helpful tool for rapidly and simply safeguarding large areas since it addresses the problems of manual data entry, delayed reporting, and costly maintenance that existed in previous systems.

The SPT system can be enhanced by integrating emerging technologies, such as artificial intelligence (AI) for predictive security analysis, enabling proactive resource allocation based on patterns in patrol data.

Incorporating IoT devices, such as environmental sensors or cameras, can expand monitoring capabilities by detecting anomalies like unauthorized access or fire hazards. Additionally, augmented reality (AR) could provide guards with visual overlays of patrol routes, improving situational awareness. By integrating these emerging technologies, the SPT system can evolve into a comprehensive and future-proof solution, capable of meeting the dynamic demands of modern security operations.

ACKNOWLEDGMENT

The authors wish to express their gratitude to the Centre for Research and Innovation Management (CRIM) at Universiti Teknikal Malaysia Melaka (UTeM) for the financial support provided for this article.

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