Smart Safety Zones Using Intelligent Surveillance Systems for Public Crime Prevention and Emergency Response

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Abstract—In this work, intelligent surveillance systems integrated to improve crime prevention and policing capability in smart safety zones of Thailand have been discussed. Specifically, the system comprises several security cameras for surveillance, emergency hotline stations for receiving local reports, and smart public announcement units. All components are then connected through a network to a main control center at the nearby police station for real-time monitoring. Afterward, the system performance was evaluated based on questionnaires surveying the satisfaction of the local population and police. It was found that the feeling of safety of residents significantly improved after the implementation, with satisfaction reported at a medium level. Meanwhile, surveyed police expressed high satisfaction with the system functionality in crime control. Overall, the surveillance system showed high effectiveness in criminal deterrence and also emergency response capability. Therefore, intelligent surveillance systems will be incorporated in future smart safety zones throughout the country.

Keywords— intelligent surveillance system, smart safety zones, crime prevention, police modernization, real-time monitoring, service satisfaction.

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1. Introduction

Crime rate is a social index signifying the trouble and peace of citizens which additionally affects the economy, safety, and quality of life. In the past decade, the crime rate in Thailand has been reported to gradually increase each year, [1] as depicted by the rising number of prisoners in Fig. 1.

Due to the presence of increasing crime perpetrators, insecurity is induced in the local population. Specifically, 38.76% of citizens living in crime-risk areas were afraid of robbery when in public, [2]. Moreover, crime perpetrators tend to be well-prepared and have modern equipment which consequently leads to intensified crimes. The less satisfaction of people with the policing procedure is also a major concern, mainly due to insufficient crime control capability. Therefore, the Royal Thai Police realizes the problem and aims to improve the crime prevention system of the country.

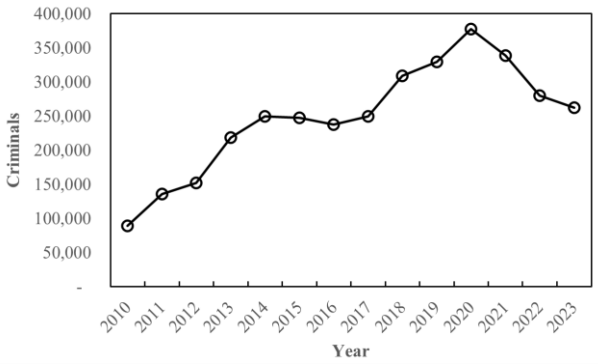

Fig. 1. Statistics of prisoners in Thailand from 2010-2023

Nowadays, technology has played an important part in our everyday society such as remote working and smart control systems. The concept of smart city is consequently proposed where technology is integrated into society to improve the quality of life

of citizens, [3]. For example, smart vehicular sensor networks based on the internet of Things (IoT) can lead to more fluid and safer traffic, [4]. Likewise, smart surveillance utilizing IoT offers assistance in locations of higher risks and hazardous environments dangerous to human operators, [5]. Here, the implementation of intelligent surveillance systems such as using closed circuit television (CCTV) has been considered in smart cities for providing highly effective crime control, [6]. The main advantage is situational crime prevention where potential criminals are deterred from committing offenses due to installed surveillance systems, [7]. An example of this can be seen in surveillance systems capable of human face recognition, which provide efficient criminal identification, thus preventing them from causing any harm in the vicinity without consequences, [8]. This approach moreover improves the policing efficiency by extending the monitoring areas instead of dispatching more staff to patrol. Furthermore, this idea is aligned with the Sustainable Development Goals (SDG), particularly on the subject of decent work and economic growth, [9]. Intelligent surveillance systems will elevate the quality of living for citizens by creating smart safety zones which inevitably lead to a better economy.

In this work, the integration of intelligent surveillance systems in pilot smart safety zones has been discussed to provide the concepts of criminal deterrence, security promotion, and emergency response through smart surveillance technology. Primarily, the surveillance systems were comprised of security cameras, emergency hotline stations, and smart public announcement systems for local crime prevention and emergency response. The system architecture and design objectives along with the satisfaction of residents and also operating police are consequently discussed to promote the country's innovative goal of "Thailand 4.0" through smart technology implementation for the population.

2. Related theories

2.1 Environmental components of crime prevention

In general, environments contribute to the risk of crime and other violations in society. For example, open areas are less likely to have potential criminals than dark alleys with low visibility. Thus, the concept of crime prevention through environmental design is proposed to improve safety in local areas, [10], [11]. In this aspect, 2 environmental components of crime prevention can be described in the following:

- Safe roads are frequently communed channels where lights, caution signs, and facilities such as telephones are adequately installed to provide safe travels. Furthermore, the roads should avoid cluttered or crime-risk areas in 50-100 meters of the vicinity; else, the road should be closed. The possibility of crime is then lowered by initially preventing potential danger to the travelers.

- Public surveillance is an environmental mechanism that deters crime through watchful eyes. Areas with obstructed views and fewer people present more risk of crime than open areas due to the lack of sufficient surveillance. In this way, public spaces such as bus stations and crowded parks should have more security services for crime prevention. Consequently, security can be improved by increasing the number of witnesses or surveillance equipment, removing obstacles to vision, and installing lighting systems. These implementations will deter criminals from violating the law in public areas, providing safety to the local population.

2.2 Smart cities

Owing to the emergence of the Internet of Things (IoT), urbanization using intelligent networks has been of interest. In this aspect, smart cities are applications of IoT to intelligently manage the well-being of citizens using innovative infrastructure, [12], [13]. Specifically, the components of a smart city can include the aspects of smart energy, smart mobility, smart industry, smart health, smart public services, smart buildings, and smart homes. These aforementioned aspects are, however, considered differently depending on the objectives of urbanization. In Thailand, smart city components can be categorized into 7 groups that are, [14]:

- Smart environment: cities concerning the environment and climate change where technologies are incorporated to manage water supply, air conditioning, waste disposal, disaster relief, and public involvement in nature conservation.

- Smart economy: cities integrating digital technology for improving commercial competitiveness and management.

- Smart energy: cities where energy is effectively distributed between residential and industrial areas for self-sustainability.

- Smart governance: cities that have modernized public services to accommodate the well-being of their citizens with high transparency and public relations.

- Smart living: cities that have the universal design of facilities for improving the quality of living for the local population.
- Smart mobility: cities with effective transportation systems for rapid communications between areas with various mobility choices (cars, trains, bicycles, etc.) and eco-friendliness.
- Smart people: cities where people's knowledge and skills are enhanced by supporting the environment to aid their education, creativity, innovation, and social engagement.

From this perspective, each smart city has an emphasis on general improvement to the living quality of the residents. In this paper, smart safety zones are discussed as a part of the smart governance city where surveillance systems allow for effective crime prevention in the smart city.

2.3 Theories of service satisfaction

To evaluate the effectiveness of a surveillance system, the satisfaction of the residents and also police in the area can be applied. The satisfaction, in particular, reflects the opinion of involved personnel on the surveillance system in terms of effectiveness, benefits, and suitability in local safety. In this case, the theory of customer relationship can be exploited by considering the citizens as customers, [15], [16]. Therefore, a well-satisfied service can be provided by focusing on the following:

- Reliability in service and appointment
- Quick response to customers
- Good attitude and work ethics
- Competitive employees
- Socializing

The mentioned components are examples of the fundamentals in customer service that can be adapted to increase the satisfaction of public services. In this manner, the satisfaction in the police work can include procedural justice, lawfulness, efficiency, and effectiveness in crime prevention and emergency response, [17]. Nevertheless, the job appreciation of the police should also be investigated since high satisfaction can result in high performance, [18]. In conclusion, the satisfaction of both the residents and police in the smart safety zones should be surveyed to evaluate the effectiveness of the implemented surveillance system.

3. Experimental setup

In this work, intelligent surveillance systems for smart safety cities have been discussed to promote the integration of policing technology for improving local safety through crime prevention. This section consequently explains the components of the surveillance system, its architecture, implementation in pilot safety zones, and also evaluation procedure, respectively.

3.1 Overview of surveillance systems

The objective of this research is to improve the safety of local populations through the integration of crime surveillance technology. Thus, intelligent surveillance systems have been designed and later implemented in pilot smart safety zones. Consequently, the surveillance systems mainly consist of multiple security cameras, emergency hotline stations, and public announcement speakers as shown in Fig. 2

Fig. 2. Primary components of intelligent surveillance system: (a) security camera, (b) emergency hotline station, and (c) smart public announcement speaker

Firstly, closed-circuit television (CCTV) cameras were employed to perform the surveillance in designated areas such as in crime-risk public spaces or narrow streets. The cameras served as the principal surveillance systems in the smart safety zones. Emergency hotline stations were, additionally, installed to allow immediate reports from the locals. They also promote the cooperation between the police and citizens in reducing threats. To relay specific warnings or information from the local authorities, smart public announcement speakers were set up in communities. Overall, all three components are designed to effectively offer police services to the general public and deter potential criminals from vile acts.

The presented equipment is consequently connected via an established network which allows remote observation, control, and crime administration. Here, the architecture of the surveillance system is illustrated in Fig. 3.

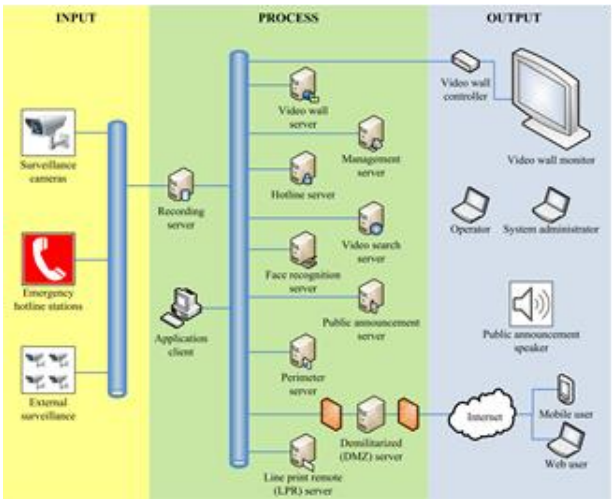

Fig. 3. Architecture of an intelligent surveillance system

The overall architecture of an intelligent surveillance system can be divided into 3 parts: input, process, and output. Initially, the system is installed with multiple security cameras, emergency stations, and smart public announcement speakers connected by a secured wire network. The network is intentionally routed to a nearby police station with a dedicated control center for administering the surveillance. In operation, the videos and emergency calls are sent to a recording server for data input. Note that video feeds from external surveillance systems can also be received if necessary. Afterward, several application servers are utilized for specific functions such as video search, face recognition, general management, hotline routing, public announcement, etc. Therefore, incoming data can be automatically sorted and distributed to appropriate personnel. For real-time monitoring, a video wall monitor is installed in the control center where operators, administrators, and also police can efficiently observe the local situation. In case an immediate announcement is required, the operators can remotely relay instructions using the public speakers. Additionally, a demilitarized (DMZ) connection is established to grant online information access to mobile and web users. This connection is consequently protected by firewalls and sensitive information can only be accessed by the authorities. This architecture ultimately allows an intelligent surveillance system to effectively communicate with all relevant personnel in crime prevention and safety provision in a smart safety area.

3.2 Implementation of surveillance system in pilot smart safety zones

After designing the intelligent surveillance systems, the projects have been launched in 3 pilot smart safety zones. These zones involve local public areas and police stations in Phasi Charoen, Lumphini, and Huai Khwang, Bangkok. Initially, the crime situation in the zones was investigated to subsequently install the surveillance components in suitable areas. For example, hidden spots, narrow alleyways, and public spaces frequently favored by delinquents were listed as potential crime risk sites, and surveillance systems were subsequently implemented to improve local safety. The aim is to reduce potential crimes in the area by installing surveillance equipment as deterrence. For this reason, the risk assessment of criminal activity in the proposed smart safety zones was first carried out before the implementation of the surveillance system for full effectiveness.

3.3 Satisfaction evaluation process

After implementing the surveillance system, its effectiveness is evaluated based on the satisfaction of the local population and operating police. To objectively evaluate their satisfaction, questionnaires were employed using score-based answer choice ratings from “1” to “5” where “1” represents the least relevant and “5” the most relevant, respectively. In the survey of the local population, at least 400 people were recruited to complete 2 main questionnaires concerning crime and safety awareness in the pilot smart safety zones and also satisfaction with the intelligent surveillance system. The first questionnaire primarily asks about the fear of crime (i.e., robbery, intrusion, assault/intimidation) of the locals as well as their feeling of security in public and private areas during daytime and nighttime. Their trust in the crime prevention scheme is, moreover, investigated. The second questionnaire, on the other hand, surveys the satisfaction of the citizens with the deployed security cameras, emergency hotline station, and smart public announcement system in terms of performance, accessibility, suitability, benefits, etc.

Furthermore, the police in charge of local crime prevention were invited to participate in the satisfaction evaluation. Here, 50 polices were asked to rate their performance using a questionnaire-based approach similar to the case of the local population. However, the main topics of the questionnaire focus

on the suitability, functionality, data security, and support service of the surveillance system in practical crime control.

4. Experimental results and discussion

Initially, the risk assessment of the smart safety zones was conducted with an example of the crime risk assessment in the Phasi Charoen smart safety zone depicted in Fig. 4.

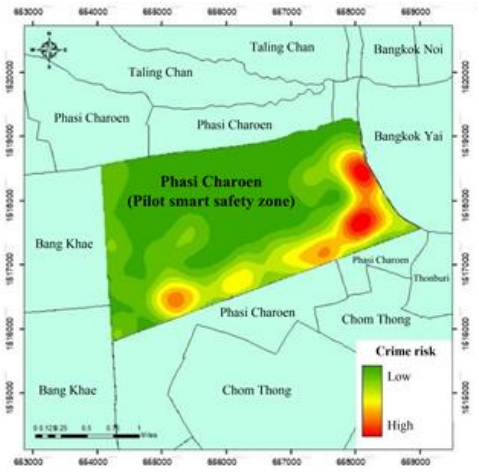

Fig. 4. Crime risk assessment of pilot smart safety zone in Phasi Charoen, Bangkok

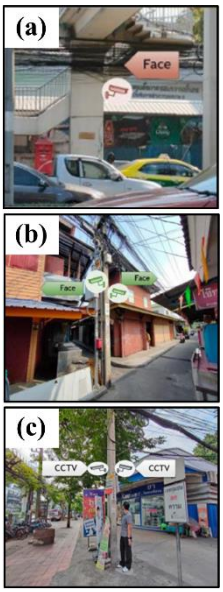

Fig. 5. Security camera installations for crime preventions: (a) overpass, (b) isolated alley, and (c) public zone

From the figure, the crime risk assessment in Phasi Charoen primarily concerned the pilot smart safety zone where the risk of crime was concentrated in residential areas. It was found to be due to poor visibility and less people circulation which reduces crime vigilance in the area. This problem was also observed in the Lumphini and Huai Khwang pilot zones.

After consideration, it was decided that the surveillance system must cover all potential crime areas. In this case, security cameras were installed under overpass walkways, isolated alleys, and public parks often reported to have delinquents, as exemplified in Fig. 5(a)-(c), respectively. With the implemented security cameras in low visibility and circulation places, more effective crime prevention schemes can then be carried out by local police. In particular, the installed cameras will provide deterrence to potential criminals as they will be more aware of law enforcement by the police. The peace of mind of the local population will, further, be elevated due to the presence of the policing system which can quickly react to emergencies in the vicinity.

Therefore, all three pilot smart safety zones have been integrated with the intelligent surveillance system. A system control center has, consequently, been successfully set up at a local police station in each safety zone as displayed in Fig. 6.

Fig. 6. Surveillance system control center at a local police station

In the control center, the video wall monitor displays real-time situations captured by the installed security cameras. Emergency calls from the residents are, furthermore, relayed to the operators who can initiate the public announcement speaker to immediately notify the residents. Here, the on-standby police can respond to the emergency with additional guidance from the operators. Thus, the control center provides highly efficient and effective crime prevention and emergency response in the smart safety zone.

From the survey of the local population, it was revealed that the surveillance system significantly affected the opinions of the population in the smart safety zones. For instance, the crime and safety awareness of the local population were improved after the implementation of the surveillance system as summarized in Fig. 7.

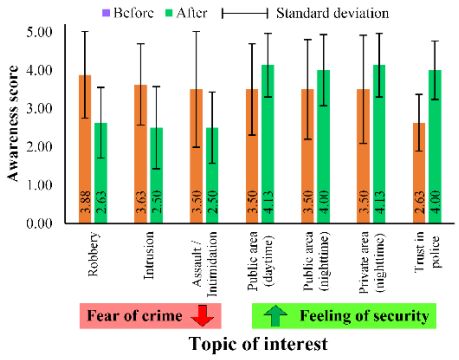

Fig. 7. Crime and safety awareness of local population in pilot smart safety zones

The analysis showed that the fear of crime significantly reduced after the installation of the surveillance system while the feeling of security increased instead. Note that lower awareness score in the fear of crime reflects higher safety for the local population and vice versa for the feeling of security. Overall, the average ± standard deviation (S.D.) of awareness score in the fear of crime after the installation is 2.54 ± 0.97 compared to the previous score of 3.67 ± 1.23, respectively. Meanwhile, the feeling of security rises from 3.28 ± 1.16 before the system implementation to 4.07 ± 0.84 in mean and S.D. score. This means that the residents appreciated the intelligent surveillance system in crime control with a high level of satisfaction.

Aside from the criminal prevention scheme, a satisfaction survey on the locals was carried out with the results concluded in Fig. 8.

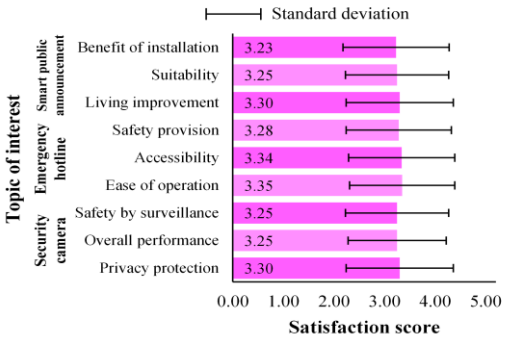

Fig. 8. Satisfaction of local residents in surveillance system

It was found that the satisfaction in the applied intelligent surveillance system of the residents has an average ±S.D. of 3.28 ± 1.03, respectively. This score is, consequently, higher than "3", which means the residents are satisfied with the surveillance equipment at a medium level.

Moreover, the satisfaction of the police in operating the surveillance system in the pilot smart safety zones can be summarized in Fig. 9.

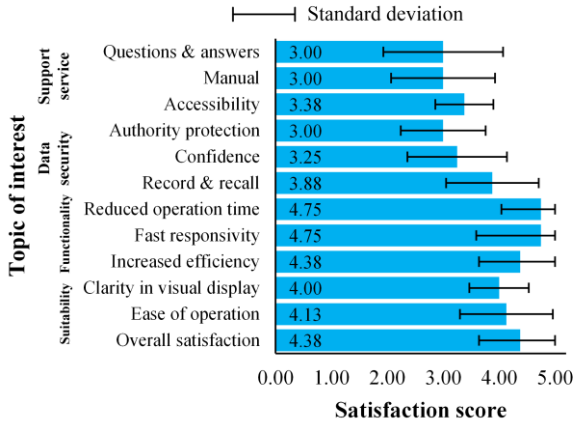

Fig. 9. Satisfaction of police operating surveillance system

The survey subsequently revealed a medium satisfaction level with an average ± S.D. of 3.83 ± 0.81, respectively. However, satisfaction with the suitability and functionality of the surveillance system was averaged at 4.40 ± 0.79 in satisfaction score, suggesting that the police are more concerned with the technical aspects of the system at a high level. Regardless, the overall feedback from the users tends to be the usefulness of the surveillance system in crime control and emergency response.

After the satisfaction surveys, it can be concluded that the performance of the implemented intelligent surveillance system is highly regarded by both the local population and police in the pilot smart safety zones. It is mostly due to the deterrence effect of the security cameras which discourage misbehavior in the area, effectively reducing the possibility of crime. Nonetheless, the local population is impressed by the emergency hotline stations which provide immediate reports of danger to the local authority. This ultimately showed the prospects of the presented surveillance system as effective crime prevention, security provision, and emergency response smart policing installation for the local population. Consequently, future applications of the surveillance system will be explored in new smart safety zones throughout Thailand.

5. Conclusion

In this work, the integration of intelligent surveillance systems comprising networks of security cameras, emergency hotline stations, and smart public announcement equipment has been discussed to improve the effectiveness of crime control for the local population. Here, the work investigates the implementation of the surveillance system in 3 pilot smart safety zones at Phasi Charoen, Lumphini, and Huai Khwang, Bangkok. The surveillance components have, consequently, been installed in potential crime risk areas such as overpass walkways, isolated alleys, and public spaces with the video feed of the areas relayed to the control center in the nearby police station. To evaluate the effectiveness of the applied surveillance system, questionnaire-based surveys concerning crime and safety awareness, satisfaction of the residents, and also satisfaction in usage from the police were carried out. It was later found that the fear of crime in the locals was significantly reduced while their feeling of safety improved after installing the surveillance system. Likewise, the satisfaction of the local population with the deployed security equipment was at a medium level. On the other hand, the police have reported an overall medium level of satisfaction in using the surveillance system. They, however, expressed high satisfaction with the technical aspects of the system such as the suitability and functionality in crime prevention. This consequently implies that the integrated surveillance systems provide high effectiveness owing to the criminal deterrence effect and emergency response capability. Therefore, the discussed intelligent surveillance system will be implemented throughout Thailand to promote smart safety zones across the country.

Acknowledgment

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