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Article

Methodology, application and platform for urban security planning and management

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Abstract: With the acceleration of economic development and urban construction, urban security accidents have occurred around the world with alarming frequency, causing serious casualties and economic losses. Urban security planning and management as emerging areas of research have drawn widespread attention. For city development plans, urban security planning and management have become one of major topics. This paper first outlines the principles of urban security planning and management, combined with the construction of a digital and intelligent platform for urban emergency management. This research then analyzes the core technology and equipment support system of urban security management and its practical application. It also presents a new model based on urban security planning and management, followed by examples of its application in some mega infrastructure development for security planning and design (for example, Singapore Changi Airport and Shanghai Hongqiao Airport Transportation Hub). Additionally, a blast protection concept of urban security planning and management is provided.

Keywords: urban security planning and management; emergency technology and equipment; risk monitoring and warning; emergency science; Technology Industrial Park; digitization

1. Introduction

With the acceleration of the global economy, the scale of large and megacities has expanded rapidly. At the same time, urban vulnerabilities such as complex security environments, high disaster risks, and difficulties in rescue have become increasingly prominent. The combination of industrialization, urbanization and globalization has led to increasing complexity of risks to urban security and major infrastructure security accidents occurred from time to time. For example, the "7.20" heavy rainstorm in Henan caused secondary disasters such as subway accidents and power failures; the superposition of the flood and epidemic resulted in huge casualties and property losses. A gymnasium in Guangdong encountered frequent typhoons with extraordinary wind speed and due to design defects, the venue suffered serious damages, resulting in serious economic losses. The reoccurring instances of mass deaths and injuries caused by emergencies in urban infrastructure have exposed prominent problems such as insufficient security design of some urban infrastructure, low level of security risk identification, backward security management methods, and limited emergency response capabilities (Bardijieva, 2019; Lu and Li, 2021).

Due to the frequent occurrence of emergencies, the coexistence of multiple disaster-causing factors, and the secondary disasters that can easily lead to systemic crises, more cities have begun to pay attention to the construction of resilient cities.

Metropolises around the world such as New York, London, Tokyo, and Singapore have put forward new development concepts to enhance urban resilience in their long-term plans. In 2020, the enhancement of urban flood control and drainage capacity, the construction of sponge cities and resilient cities were included in the "14th Five-Year Plan" of China as guidance for the practice of urban waterlogging disaster management. With all these in mind, the importance of urban emergency management is becoming increasingly prominent. Research on the theory and application of scientific, professional, intelligent and lean urban emergency management is of great significance in improving the ability to prevent and deal with emergencies, reducing the associated losses and ensuring urban security (Zhu, 2020).

Urban security planning and management can provide a reliable technical platform for urban emergency management, an effective solution for the construction of a resilient city, and a safe and stable living environment for the general public. There is an ever-growing number of initiatives that address infrastructure security problems (e.g., The International Crime Prevention Through Environmental Design Association). Still, the systematic analysis of scientific and intelligent technology or equipment for emergency management needs to be improved. Technological platforms and countermeasures can be formed based on design methodology. For example, megacities have set up emergency command centers to deal with emergencies. Urban security planning and management provide the correct methodology for emergency command centers, and security design can play a role in early warning and risk aversion. When disasters occur, urban security design methodology can provide not only emergency plans but also timely and effective response measures for decision-makers in order to avoid major casualties (Yin and Zhang, 2020).

For the application of urban security planning and management, stakeholders need to first understand the elements of the concept. Second, technical support, more specifically a dedicated platform is required. Building upon this, this paper outlines first, the basic principles of urban security planning and management. Second, an intelligent digital platform-based technology and a multi-layered blast protection concept is proposed. As a reference for digital technology-supported security management improvement and resilient city construction, the model's application experience analysis regarding the Singapore Changi Airport and the Shanghai Hongqiao Airport Transportation Hub are presented.

2. Basic principles of urban security planning and management

In recent years, it has been a trend to build sponge and resilient cities to enhance the disaster resistance of urban hardware systems, focusing on engineering disaster mitigation such as the optimization of urban infrastructure, the innovation and application of information technology, and the construction of urban lifeline systems. As an emerging research field, urban security planning and management involve various urban emergencies, including disaster prevention planning and management, public health emergencies and social security events. Among them, urban disaster prevention planning and management are generally divided into earthquake resistance, flood control, fire protection, civil air defense planning and management for natural

disasters, accidents or disasters caused by human activities. Public security planning and management is to reduce the impact of disasters, improve the ability to respond and deal with emergencies, and reduce risks by adjusting the rational distribution of disaster sources, protection targets, and emergency rescue forces in urban planning (Rong, 2019).

In order to improve security management capabilities fundamentally, the key is to move the governance threshold forward and consider security management in the urban security planning stage. Additionally, urban security risks originating from this source should be reduced, emergency response capabilities should be improved at the same time, and urban security and stability should be maintained. To do this, the following principles of urban security planning and management are proposed (**Figure 1**).

Figure 1. Principles of urban security planning and management.

(1) The principle of risk tolerance

From the perspective of human disaster reduction practice, it is difficult to eliminate risks fundamentally, but various means can be used to reduce the impact of these crisis situations on human beings, prevent the occurrence of chain and compound disasters, improve the resilience of cities, absorbing external disturbances, and keeping the original main characteristics, structure and key functions.

(2) The principle of system integration

The principle of system integration is not only reflected in the planning and management of the integration of prevention, response and recovery, but also in the prevention and rescue, comprehensive management of all disasters, multi-departmental coordination, cross-administrative area and block coordination, moreover social pluralistic collaborative governance. It refers to the integration of disaster prevention planning and management in various professional fields of the current system.

(3) The principle of sustainable development

Urban security planning and management are required to change from the traditional planning and management concept to a sustainable development model, that is, from the human domination of the environment to the interdependence between humans and the environment, from the centralized layout to the decentralized layout,

moreover from the economic cost domination decision to the social and environmental cost dominate decisions.

Urban security plans seek to detect and address identified vulnerabilities in cities' security. Urban security includes normal urban management and emergency management. Normal management is the basis for urban security improvement, and emergency management is the guarantee of urban security under abnormal conditions. It is necessary not only to quickly track disaster risks but also to ensure the normal operation of the city to the greatest extent. The realization of integrated emergency response and "lean prevention and control" of perception, diagnosis, and decision-making is not only a requirement for urban emergency management capabilities but also a requirement for the refinement of urban abnormal management (Rong, 2019). To follow the aforementioned principles of urban security planning, these urban strategies should be established in line with the following implementation measures (**Figure 2**):

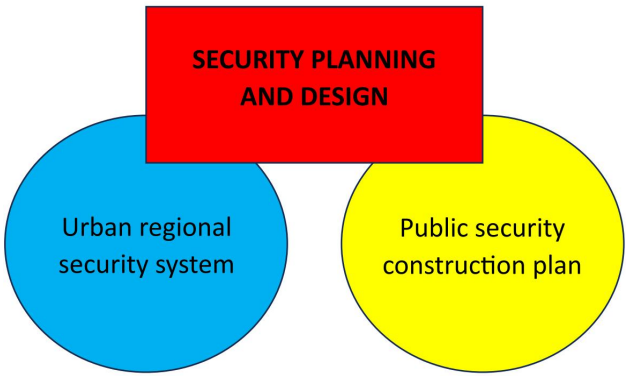

Figure 2. Security planning and design.

a) During the process of renovation, expansion and new construction of urban functional areas, public security construction planning should be designed, inspected, and implemented at the same time;

b) In the existing old urban area—considering the type and distribution structure of functional areas—the formulation of security planning should be supplemented to ensure the reasonable planning and setting of the urban regional security system;

c) In the process of urban construction and renovation, urban security planning should be one of the most important requirements of urban renovation projects;

d) In the new development zone, construction planning and security planning should be discussed, designed and implemented together. When there is a contradiction between functional area construction planning and security planning, the security planning and design should be considered as a whole, and the security calculation method should be used to optimize the measures to be taken, so as to satisfy both urban functions and urban security.

3. Constructing an intelligent digital platform for urban security management

Urban security planning is to avoid accidents and disasters from the arrangement of time and space, and its essence is the security decision-making based on the

prediction of urban risks, or the security design of the city, with the purpose of controlling and reducing urban security risks to an acceptable level. Considering security management in the urban security planning stage, constructing a scientific urban security plan can reduce the occurrence of urban security incidents while it adopts emergency plans in a timely manner, and initiating emergency response procedures at corresponding levels to reduce losses caused by security incidents. Therefore, it is an urgent need to effectively and systematically improve the level of emergency management for carrying out scientific urban security planning and incorporate emergency management into urban security planning.

Urban security management provides a comfortable production, a living environment and personal security for urban residents through scientific management and regulation, so that the city has the ability to resist all kinds of unexpected security incidents, and can maintain dynamic coordination in the operation of the city's various functions. From the perspective of management processes and goals, scientific urban security management includes the main contents of risk management, emergency management and crisis management. It not only needs to improve the ability to identify, evaluate and suppress risk sources from the perspective of risk but also needs to carry out emergency treatment when triggered by risk events. Then, the crisis in the risk stage and the event stage are under control. It is an inevitable requirement to effectively improve the level of emergency management and take it into consideration at the stage of urban security management which ensures the continuous development and improvement of the urban security management system.

It is a primary prerequisite for improving urban emergency management to carry out scientific urban security planning and management. This will help to fundamentally improve the ability of urban security risk prevention and control. It is necessary to strengthen the security management of related project planning, design, construction, completion and other links, check the hidden dangers of each link, improve the full-cycle security risk assessment of urban planning, construction and operation, at the same time to tighten the management and control of the source of security risks and promote the effective reduction of security risks.

Security management based on urban security planning and management adopts the paradigms for planning-engineering and system governance as well engineering and non-engineering measures. Engineering measures are used to strengthen infrastructure construction, coordinate urban construction planning, promote urban construction hardware upgrades, and improve disaster early warning capabilities; whereas non-engineering measures are used to coordinate security and development, improve emergency response systems, promote institutional strengthening, and enhance emergency response capabilities. The construction of sponge cities must be strengthened to improve the ability to respond to high-probability conventional events such as rain and flood disasters (He and Gao, 2010; Ma, 2021). The construction of resilient cities should be enhanced to improve the ability to respond to small-probability unconventional events. It is necessary to promote and realize the organic unity of engineering projects and non-engineering measures in the practice of sponge city and resilient city construction to improve the resilience of urban systems and promote the safe development of cities. The core focus of emergency management is the application of emergency technology and equipment.

With the advancements in information technology, intelligent disaster response has become an international trend. To ensure the thorough implementation of urban security plans, it is necessary to build an intelligent multi-level security management system. Such a platform could strengthen scientific and technological support, improve the overall process of emergency management capabilities and refine risk prevention, monitoring and early warning, disposal and rescue, moreover restoration and reconstruction.

3.1. Benefits of an urban security management model

Prior to delving into the details of the urban security management concept, it is necessary to highlight the benefits of such a model. Firstly, it is unquestionable that once an urban security management model has been established at the initial phase of development, it will make the project considerably more attractive to investors. Secondly, the concept brings a remarkable decrease in security by design cost. According to our estimations, in the case of a Mega Development with total developed land of 1084 km^2, saving of security by design cost can be around 5%–7% of the total budget which is $12.5 billion–$17.5 billion out of the Mega Development total value of $250 billion (Liu and Quek, 2019). Thirdly, an established urban emergency management model substantially increases the value of the development (Liu, 2018).

3.2. Introducing the model of urban security management

3.2.1. The pillars of the concept

The new generation of information technology provides the means for intelligent emergency management. Intelligent emergency technical equipment includes a precise early warning, comprehensive diagnosis, intelligent decision-making technology and equipment system, that is, perception, diagnosis, and decision-making technology and equipment system. In the upcoming lines, these three essential pillars are presented.

(1) Perception technology and equipment system: Through machine vision, the Internet of Things (IOT) sensors, speech recognition and other technologies and equipment, a multi-based collaborative perception system should be constructed to realize the fusion of multi-source heterogeneous monitoring data, promote the extraction of evaluation feature indicators, improve the spatial dimension of monitoring, and realize all-round accurate early warning.

(2) Diagnosis technology and equipment system: It is used to carry out infrastructure risk assessment and early warning, implement resilient disaster prevention diagnosis, integrate complex emergency systems, and realize comprehensive network-wide diagnosis through technologies and equipment such as natural language processing, knowledge graph, intelligent interaction, and disaster simulation.

(3) Decision-making technology and equipment system: Through technologies and equipment such as an emergency command platform, emergency management platform, and intelligent decision-making system for safe operation and maintenance of urban infrastructure, a multi-based collaborative decision-making system is built to realize assisted decision-making and autonomous decision-making.

3.2.2. The characteristics of urban security management

Through the application of urban emergency management technology and equipment, intelligent emergency management in the field of urban infrastructure is realized with the following characteristics (**Figure 3**).

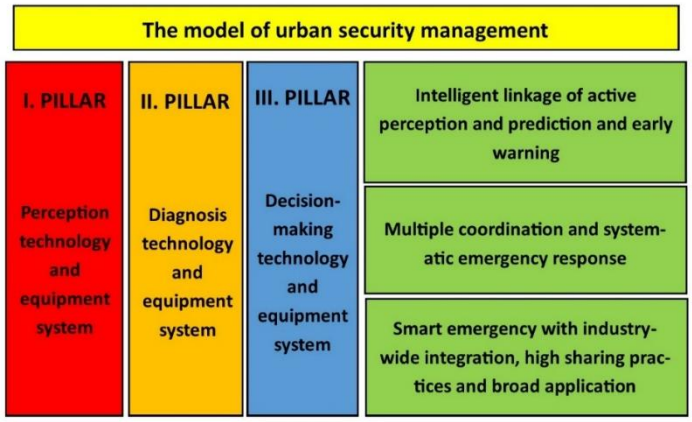

Figure 3. The model of urban security management.

(1) Intelligent linkage of active perception and prediction and early warning

Combining IOT, data analysis, and intelligent computing, the intelligent linkage of effective active perception and prediction and early warning can be realized.

(2) Multiple coordination and systematic emergency response

The traditional mode of single-line and vertical connection of the original emergency participants is broken through, and a systematic intelligent emergency management system with a high degree of coordination between the government, society, and the public, and close cooperation between individuals, communities, cities, intercity, provinces, and countries is further realized.

(3) Smart emergency with industry-wide integration, high-sharing practices and broad application

Industry resources such as meteorology, environment, fire protection, medical care, housing construction, transportation, electric power, water conservancy, communication, and people's livelihood are integrated to achieve diversified, intelligent and integrated information acquisition and sharing.

3.2.3. Urban security management support system

In accordance with the general requirements of "one case and three systems", that is, the integration of a plan, system mechanism and legal system, China has carried out the construction of a modern emergency management system. The construction of an urban emergency management system should be driven by innovation and entrepreneurship in promoting standardized management (Feng et al., 2018). With the presence of infrastructure construction, laws, regulations and expert personnel training, the urban risk prevention and control system is improved continuously to ensure a safe, orderly and stable city.

Terms of the standardized management. Through full consideration of the characteristics of the city and the situation of information construction, the standards

and specifications of monitoring and early warning data are improved. With a standardized system data reporting format, data exchange and sharing requirements, a unified standard system for urban emergency management is formed.

Terms of institutional norm system. With the combination of characteristics of urban emergency management, a set of general urban security management systems for risk monitoring and early warning, emergency response, security planning and management smart operation are formed, which closely integrates legal management requirements with urban emergency management as well clearer functions and smoother system operation.

Terms of infrastructure security system. Emergency science and technology industrial parks should be built to vigorously promote the digital transformation of urban emergency management.

Terms of talent team system. Talent team structure should be improved that gives full play to the talent advantages of universities and scientific research institutions and provides a strong talent guarantee for the development of urban emergency management work.

3.3. Building an integrated security management platform (Figure 4)

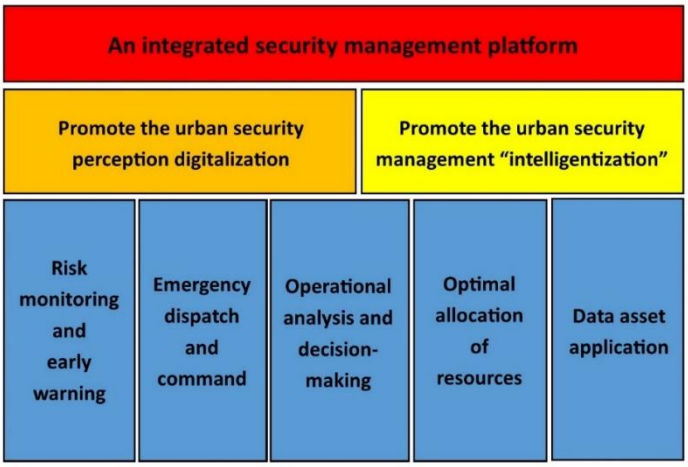

Figure 4. An integrated security management platform.

Data center station is a solution and a methodology. As an important support for the construction of emergency management information, it can be used to improve the applicability of data and knowledge. An emergency management platform takes the emergency smart operation center as the core and the emergency science and technology industrial park as the carrier. It makes full use of early warning systems and monitoring resources built in various fields and industries, strengthens intensive construction and realizes urban infrastructure projects and other emergency perception systems connected and coordinated with each other. The perception data of each smart operating system is aggregated into the data center, and the emergency smart operation center can realize the convergence, integration, diagnosis and sharing of perception data through data mining and analysis, and carry out five functions such as risk monitoring, early warning, the emergency response of dispatch and command,

operation analysis and decision-making, resource optimization allocation, and data asset application to ensure the safe and stable development of the city.

3.3.1. Initial Development Phases of the Platform

Focusing on the construction of an emergency management system in the field of urban infrastructure, it is necessary to first fully integrate the housing and urban-rural construction, urban management, transportation and other industry authorities, as well as the urban security risk perception systems that have been built by social enterprises such as gas and water supply companies. Secondly, it is advisable to promote urban infrastructure projects and other emergencies to perceive digital transformation and realize an all-round perception of digital operations.

3.3.2. Promote the urban emergency management "intelligentization"

Relying on a unified data center, it can gather internal and external full-sensing data resources, deepen the five functions as risk monitoring and early warning, emergency dispatch and command, operation analysis and decision-making, resource optimization and allocation, and data asset application, to create an urban emergency "management center" and promote the development of emergency management data as assets.

3.3.3. Risk monitoring and early warning

A multi-level monitoring and early warning platform should be established which uses data and technical means to conduct online monitoring and is responsible for the early warning of urban security perception data. It also realizes correction and closed-loop diagnosis of urban security incidents, and ensures that urban security risks at all levels are controllable.

3.3.4. Emergency dispatch and command

Through the information from an urban emergency smart operation center and an integrated security supervision platform, a unified command of the emergency state can be realized, in parallel, the emergency response is faster, and the emergency support is more efficient. Establishing a complete emergency support system—in accordance with the principle of "service in peacetime and emergency response during disasters"—strengthens organizational guarantee, resource guarantee, procedural guarantee, and supports guarantee mechanism in daily work to ensure the reliable guarantee of emergency materials.

3.3.5. Operational analysis and decision-making

From the five dimensions of "security and stability, openness and collaboration, standardization and compliance, efficiency and benefit, and innovation and development", it builds an operation evaluation index system, and carries out data analysis, prediction, decision-making and optimizes work through the system of "automatic fetching and automatic calculation".

3.3.6. Optimal allocation of resources

It brings physical resources, testing resources, transport capacity resources, and expert resources together to the urban emergency smart operation center, and builds a cross-regional and cross-professional physical "digital resource pool", realizing cross-regional platform interconnection and interoperability, and promoting the optimal

allocation and overall planning of resources deployment to ensure the security and stability of the city.

3.3.7. Data asset application

It establishes urban emergency management data asset files, clarifies the responsible person for data assets, and continuously enriches the data content of urban emergency management data in the data center. Combined with modern service industries such as e-commerce, credit services, government development planning/supervision, and industrial development, it uses data to develop new businesses, forms supply chain profit growth points, and achieves value creation.

Through the above analysis, the construction of an emerging science and technology industrial park can promote the improvement of urban security planning and management. It realizes the digitization, intelligence and platformization of urban security management, drives the development of emergency industry, and promotes the improvement of urban emergency management. It also helps to reduce the occurrence of emergencies, and even if they happen, emergency plans can be taken in time. At the same time, the in-depth development of monitoring methods and applications of Internet of Things, Big Data and other similar technologies, will accelerate the transformation and upgrading of emergency enterprises, drive the continuous expansion of the emergency industry, expand the application space of the emergency field, help the emergency management system and governance capabilities to be greatly improved, and ultimately enhance the resilience of the city.

3.4. Multi-layered blast protection concept

A multi-layered security concept for blast protection involves a holistic approach to mitigating the impact of an explosion or blast effects. Each layer serves a specific purpose and works in conjunction with the others to enhance protection and minimize impacts. Here's a description of a typical four-layered security concept for blast protection (**Figure 5**).

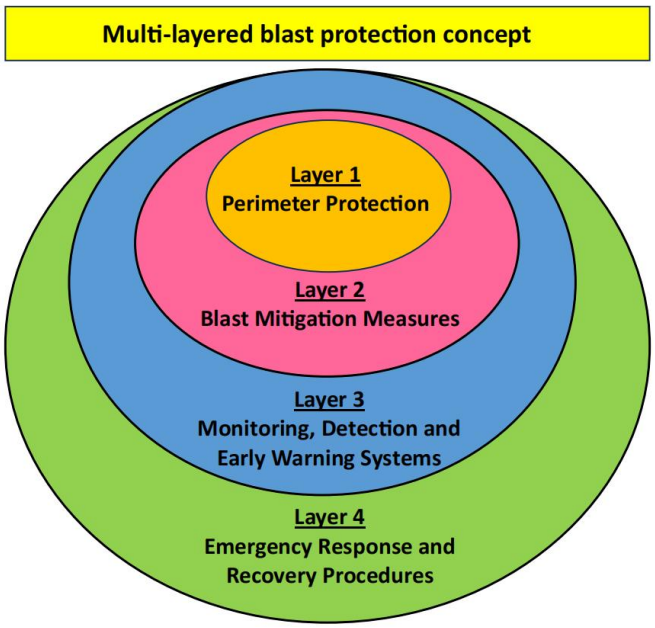

Figure 5. Multi-layered blast protection concept.

Layer 1 (Perimeter Protection)

The first layer focuses on protecting the perimeter of the facility to prevent unauthorized access and control the flow of people and vehicles. Security measures may include perimeter fencing, access control, video surveillance, and security personnel. The goal is to create a controlled environment and prevent potential attackers from reaching critical assets.

Layer 2 (Blast Mitigation Measures)

The second layer aims to reduce the impact of a blast by implementing countermeasures to absorb, redirect, or dissipate the energy generated by an explosion. This may include installing blast-resistant windows, reinforcing structures with blast-resistant materials, using blast curtains or blast shields, and incorporating blast-resistant design principles in building construction. The objective is to minimize structural damage, mitigate the effects of shockwaves, and protect occupants.

Layer 3 (Monitoring, Detection and Early Warning Systems)

The third layer involves deploying advanced monitoring, detection and early warning systems to identify potential threats and provide timely alerts. These systems may include surveillance cameras, intrusion detection sensors, motion detectors, and acoustic sensors that can detect explosions or abnormal activities. When an impending blast is detected, an alarm is triggered, allowing for an immediate response and evacuation if necessary.

Layer 4 (Emergency Response and Recovery Procedures)

The fourth layer focuses on response and recovery in the event of a blast attack. This includes establishing emergency response plans, evacuation procedures, and training programs. The plans should outline evacuation routes, assembly points, communication protocols, and responsibilities during an emergency. Regular drills and exercises help ensure that individuals are familiar with the procedures and can respond effectively during a crisis.

It should be noted that the specific measures implemented at each layer depend on the nature of the facility, prioritized assets, prioritized risks, and exploitable vulnerabilities.

3.5. The application of urban security model

3.5.1. Singapore Changi Airport

Learning the development experience of the benchmark city Singapore, it has always regarded security as the core element of its urban development strategy, and has always implemented the core concept of “safe city” both in urban planning/design and in urban construction/management. A mature and smooth urban security system has been formed aligned with appropriate urban security laws and regulations systems. Urban infrastructure has been integrated into security design and digital information security management systems. Systematic security publicity and education characterizes Singapore with an emphasis on professional security personnel training. In October 2017, the Singapore Parliament passed the *Infrastructure Protection Act*, which stipulates that building security measures must be taken into account at the design stage prior to the future construction and renovation of designated new developments and existing buildings. This decree has real significance for the design

and management of urban building security in Singapore, as well as for urban security and anti-terrorism protection worldwide. The construction of its urban security system not only escorts Singapore's economic development, but also enhances its city image, attractiveness, and makes Singapore an important economic, financial and transportation center in the world. At the same time, it has also increased government and enterprise investments in the field of security and promoted the development of the security industry. Singapore is also making full use of its mature experience and advantages in security system construction to export advanced technology, experience and research results.

Based on the past experience of K&C Protective Technologies Pte Ltd (KCPT) with Singapore Changi Airport since 2005, we understand how the urban security planning and management concept has been applied to the project. We can detect all the previously proposed principles considering that Changi Airport included anti-terrorism and explosion-proof security at the design stage, and has set up multiple security levels. First, these applied security design measures take into account the means how to reduce the impact of crisis situations and how to improve the level of resilience. Accordingly, the principle of risk tolerance has been addressed in the security concept of the airport. Second, system integration is covered at each stage of the cycle of prevention, response and recovery. Third, a sustainable development model is implemented where there is a mutual dependence between humans and the environment. Additionally, considering the function of the airport, there was an elevated need for a multi-layered blast protection system. All the four layers of the proposed blast protection security concept can be identified at Changi Airport. More specifically, there are designated installations to protect the perimeter of the complexum addressing unauthorized access. Security design incorporates blast-resistant solutions to reduce the impact of a blast incident. An early warning system ensures that threats are detected and managed in a timely manner. With regard to the fourth layer in the blast protection concept, emergency response protocols and their meticulous application guarantee prompt response to and recovery from a blast attack.

3.5.2. Shanghai Hongqiao Transportation Hub

The Shanghai Hongqiao Transportation Hub is the first major infrastructure project in China that introduces the concept of security planning and design. K&C Protective Technologies Pte Ltd is responsible for its evaluation and design, and participates in its construction and maintenance stage during 2008 and 2019. The project is an excellent example considering that security management has been set as a priority in the urban security planning stage. In line with this, the principles of risk tolerance, system integration and sustainable development have all been applied in the security concept of Shanghai Hongqiao Transportation Hub. The project is equipped with an anti-collision pier system, an explosion-proof glass curtain wall system, and a security monitoring and access control system, which greatly enhance the security performance of the building. Among them, the anti-collision pier system refers to the setting of cylindrical piers on the periphery of important buildings to prevent vehicles from intruding. This serves the protection of the building's perimeter as the first layer of the complex blast protection security concept. Moreover, once the unauthorized access to the building has been addressed, as a second layer in the blast protection

concept, blast-resistance installations seek to mitigate the impact of a blast incident. An advanced early warning system with sensor-based infrastructure aims to detect and respond to potential threats in a timely manner. Emergency response and recovery are covered in emergency response plans that include detailed protocols for evacuation and the extensive training of these measures.

4. Conclusion

Urban security management research is a continuously developing field with real practical value. This research has proposed a new application model of urban security technology and equipment based on the concept of urban security planning and management. In line with this, first, the principles and then specific measures of urban security planning and management have been elaborated. Second, the necessary technical background, more specifically digital, intelligent and platform-based technology has been detailed. In the final part, reference works for the application of the concept have been cited. Application experience analysis and reference in projects and practices such as Singapore Changi Airport and Shanghai Hongqiao Airport Transportation Hub, can fill the theoretical deficiency of systematic research on urban emergency management in the infrastructure field to a certain extent. It provides a reference for the implementation of domestic urban security management, which is conducive to realizing the modernization of urban emergency management, promoting the development of the emergency industry, and ensuring the stability and security of the city (Wang and Yang, 2019).

Conflict of interest: The author declares no conflict of interest.

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