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English Abstract and Keywords

This report summarizes the findings of an exploratory study on data requirements of intelligent indoor emergency evacuation systems. Here, the term *Intelligent indoor emergency Evacuation System*, or *IES* for short, refers to a core component of advanced facility management and building automation systems for large buildings. IES can respond to CAP (Common Alert Protocol) formatted alerts and alarms generated by local emergency alert systems warning of fires, gas leaks, explosions, etc. within the facility. The IES also can respond to CAP alerts from responsible government agencies warning of imminent and observed natural disasters such as earthquakes, flood and landslides threatening wider geographical areas containing or near the facility. In response to each CAP alert, the IES works automatically or semi-automatically to prevent loss of lives, reduce chance of injuries and minimize property damages. When evacuation within or from the facility is warranted, the system can dynamically re-routes people depending on their locations, extents of damages and density and distribution of people, and provide people with real-time, location-, environment-, and situation specific instructions during emergencies.

The primary focus of this study is on data requirements of intelligent indoor emergency evacuation systems (IES) for representative large public buildings/facilities in Taiwan. Its objectives include (1) to determine data requirements of IES for representative public buildings selected as targets of case studies; (2) to identify potential technical, legal and regulatory issues if any that must be addressed for the required data to be accessible by IES during emergencies of multiple severity levels and through the system released to first responders, facility managers, affected people and general public; and (3) to identify work to be done to make data on critically needed to support indoor emergency evacuation decisions and operations available to IES. The study was done in collaboration with New Taipei City Government, Public Works Department (PWD, 新北市政府工務局), Architecture and Building Research Institute, Ministry of Interior (ABRI, 內政部建築研究所) and the National Science and Technology Center for Disaster Reduction (NCDR).

The results presented in this report include (1) IES data requirements derived from analysis of emergency scenarios within four buildings selected as targets of case studies and data requirements of large public buildings in general; (2) a prototype scalable and disaster resilient indoor positioning system that is accessible via both smart and dumb mobile devices; and (3) a responsive hybrid scheme for IES to control data accesses by first responders, emergency, building managers, and so on with Break-the-Glass emergency accounts and by general public without such accounts. In addition to describing these results, this report presents a summary of existing building code and regulations related to fire, flood and earthquakes emergencies; an overview on BIM and the current state of practices; an overview of Common Alert Protocol (CAP), the international standard format for emergency alert messages; descriptions of emergency scenarios and SOP supporting emergency evacuation in buildings selected as test sites; an overview of legal and regulatory issues governing access and use of data required by IES, and proposed work to lower the barriers to wide adoption of IES and availability of data required by these systems.

Keywords – Intelligent indoor emergency evacuation, data requirements, emergency scenarios, Building Information Model, Indoor positioning, emergency data access control, legal and regulatory issues

Chinese Abstract and Keywords

公共建築緊急避難指引系統資料要求

此探究性的研究專注於智慧室內緊急避難系統(Intelligent Indoor Emergency Evacuation Systems, IES) 的資料需求。用於大型建築物內的 IES 必須能夠接收反應建築物本身的警報系統所發佈的火災、瓦斯外洩、爆炸等設施內緊急警報，也能夠接收反應政府單位 (例如中央氣象局) 所發佈有關地震，淹水和土石流等的災害預警與緊急警報。接收到警報時，IES 會自動化或半自動化地預防及響應、以降低人員傷亡和財產損失為目的。在緊急避難時刻，IES 能依據不同類型的緊急事件、造成破壞的範圍、人群密度等即時情境資訊，動態更新規劃人群的逃生路線，並能考慮所處環境的特殊性提供因人、因地特定的逃生指令。這些逃生指令通常是透過多媒體告示牌的方式公告，及個別發到受災民眾的手機或是通用的移動裝置。

此項研究側重於台灣大型建築物的智慧室內緊急避難系統的資料需求。其工作包含 (1) 選擇兩種類型的公共建築 (新北市三個新的體育中心及中央研究院資訊所大樓) 為案例研究的測試點，確定用於此類建築內的 IES 之資料需求，然後從此結論與決策過程推斷出用於一般台灣大型建築內的 IES 之資料需求; (2) 在不同的緊急級別事件中，系統資料可能被前線救難人員、設施管理員、受災群眾以及一般大眾所存取，本研究在此中探討潛在的技術、法律及監管議題; (3) 建議確保 IES 能在緊急疏散操作及決策時得到所需資料的途徑。為了促使研究成果具體落實，此工作的合作夥伴為新北市政府工務局、內政部建築研究所以及國家災害防救科技中心。

此項研究的成果包含 (1)透過分析四個測試點建築物緊急災害情境而得到的一般大型建築物中的 IES 資料需求規範；(2)一個彈性可擴充的、可與智慧型裝置以及功能型裝置互動的室內定位系統模型；(3) 一個複合式應變資料存取控制架構、可讓第一線救災人員、建築管理員及一般大眾擁有不同的資料存取權。此報告除了描述這些成果以外、其內容還包括現今的建築物在面對火災、水災以及地震災害的法規概要；建築物資訊模型現今的實務應用；共通示警協定 (CAP: Common Alert Protocol)的概要；在測試點建築物中的災害情境、緊急逃生的標準作業流程以及 IES 資料需求；與有關 IES 資料需求的法律及監管議題概要。

關鍵字: 智慧室內緊急避難、資料需求、緊急災害情境、建築物資訊模型、室內定位、緊急資料存取控制、法律及監管議題

1. Introduction

(A) Definition and Assumptions

The exploratory study reported here is concerned with the data requirements of intelligent *indoor emergency evacuation systems* (*IES*) for representative large public buildings/facilities in Taiwan. Here, the term IES of a building refers to a system that is a core component of an *active emergency response system* (*AERS*) [1] for the building. In essence, the AERS can be thought of as an advanced building management/automation system or a part of the system. It makes use of surveillance cameras, environment sensors and smart embedded devices that are used in typical state-of-the-art building management systems to support normal building operations. A difference is that in AERS, some smart embedded devices (e.g., controllers of evaluators, gas valves, air conditioner, and access controlled and isolation doors) and some mobile applications carried by people in the building can process standard-compliant alert messages from authorized senders. Moreover, in preparation for and response to the disaster/emergency forewarned by the alerts, they can respond by taking appropriate actions to prevent loss of lives, reduce chance of injuries and minimize property damages during emergencies. Figure 1 illustrates the relation between IES and other components of the AERS, which is shown in the dashed rectangle in the middle of the figure.

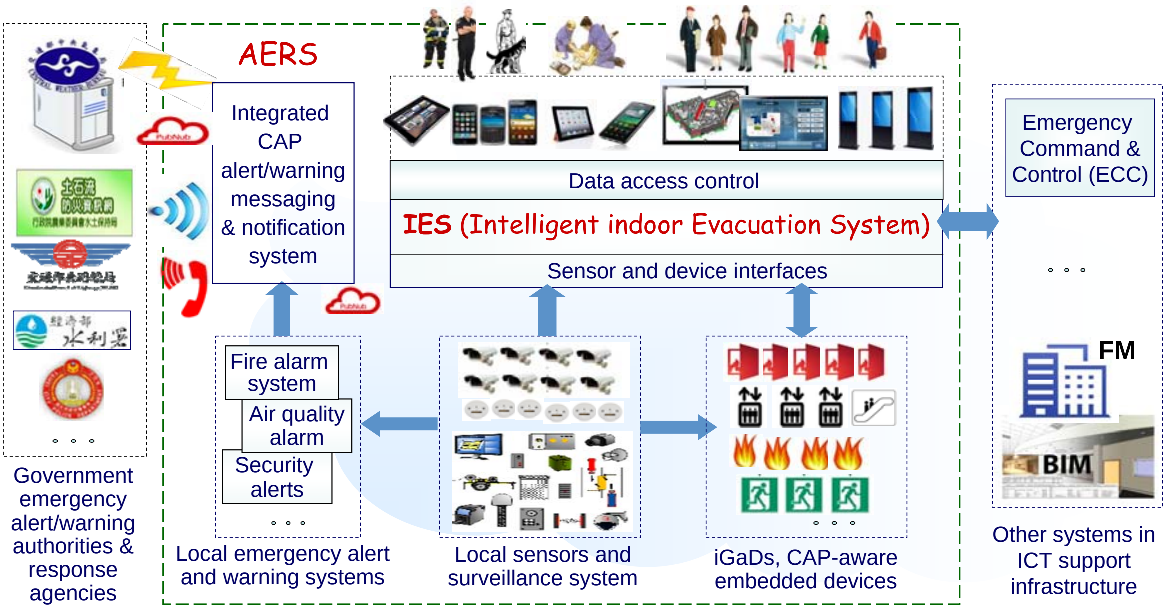


Figure 1 IES as the core of an active emergency response system

Making use of sensors, smart embedded devices, multimedia bulletin boards, digital signages, and mobile APPs in the AERS, the IES has two major attributes:

- First, the IES responds to CAP (Common Alert Protocol)[1] formatted alarms generated by building safety systems. In Figure 1, they are referred to as *local emergency alert systems*. Examples shown here include alarm systems warning of fires, gas leaks, explosions, etc. within the facility, as well as accidents, robberies, and gunshots

[1] Common Alert Protocol (CAP), v1.2, http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html. Also see Appendix III for an overview on CAP.

incidents that may affect and endanger people inside. This work assumes that the AERS, hence the IES, also responds to CAP alerts from responsible government agencies warning of imminent natural disasters such as earthquakes, flood and landslides threatening wider geographical areas containing or near the facility. Figure 1 shows an integrated messaging system as a part of the AERS that receives all CAP-formatted alerts and warnings and broadcasts them to other components of the AERS.

- Second, the IES works automatically (or semi-automatically in collaboration with facility management and security personnel) to increase the safety of people in response to each CAP alert. When evacuation within or from the facility is warranted, the system can dynamically re-routes people depending on the type of emergency, locations and extents of damages, density and distribution of people and other factors that must be considered during evacuation. Moreover, it can provide people with real-time, location-, environment-, and situation specific instructions during emergencies: to all people in different areas of the building via multi-media and digital signage displays and to people individually via CAP-aware applications on devices carried by them.

(B) Overall Goal and Immediate Objectives

The overall goal of this effort is to identify the data required by intelligent indoor evacuation systems of large public buildings/facilities in Taiwan and develop a feasible plan to make the required data accessible and readable by the systems. Through the system, some or all of the data released during the emergency are made available to first responders, facility managers and general public. For this purpose, the IES needs to provide appropriate data access control and privacy protection capabilities and ensure that the response actions recommended by the system are in compliance with relevant laws and regulations.

The overall goal is divided into several intermediate objectives. These objectives are:

(1) To develop a data requirement specification, detailing the types and accuracy levels of data required by IES for dynamic computation of evacuation routes, decision and operation supports, and other essential functions, together with metadata on other attributes of the data and data format and data exchange standards;

(2) To identify the potential technical, legal and regulatory issues if any that must be addressed for the required data to be accessible to IES and users served by them during emergencies of multiple levels of severity and extent; and

(3) To develop plans for the work needed to address the issues in order to remove possible barriers to making data on public buildings/facilities critically needed to support indoor emergency evacuation decisions and operations available to IES during emergencies.

(C) Collaborators

This work was done in collaboration with New Taipei City Government, Public Works Department (PWD, 新北市政府工務局) and Architecture and Building Research Institute, Ministry of Interior (ABRI, 內政部建築研究所). PWD is in charge of issuing building permits and constructing public works in New Taipei city. Through collaboration with the department and AEC (Architecture, Engineering and Construction) companies working with the department, we aim to fully understand and utilize potential applications of BIM

(Building Information Models)[2] that provide standard-based digital representations of new public buildings under construction, in addition to selected existing buildings.

ABRI is a research center under Minister of Interior (內政部). ABRI will share with us their experiences on BIM researches and expect us to feedback suggestions on BIM-IES standards and information and communication technologies (ICT) so that ABRI may embody the research results in building code and suggest local governments to improve their administrative process and public safety. Current and past collaborations with NCDR (National Science and Technology Center for Disaster Reduction) include the participation by several authors in the localization of CAP for Taiwan and the development of a prototype information delivery middleware for disaster management.

(D) Organization of the Report

The remainder of the report is organized as follows. Section 2 presents the tasks that were carried out in order to achieve the immediate objectives and overall goal stated above. Sections 3 - 6 present the results produced by the tasks. Section 7 summarizes the data requirements of IES and describes proposed future work. Section 8 lists references to our work cited in the report. Related work by others and references to background information are cited in footnotes. Appendices I - VI at the end of the report present, respectively, a brief summary of existing building code and regulations related to fire, flood and earthquakes emergencies; an overview on BIM and the current state of practices; an overview of CAP, factors in scenario models; emergency scenarios and standard operating procedures supporting emergency evacuation in buildings selected as test sites for case studies pursued in this effort, and legal and regulatory issues governing access of data required by IES.

2. Major Tasks and Approaches

The work reported here is divided into five tasks (分項). The tasks are

- Task 1 - Data Requirements of Intelligent Indoor Evacuation Systems,
- Task 2 - Data Requirements of Indoor Positioning/Location Services,
- Task 3 - Data Access Control for Multiple Levels of Emergencies,
- Task 4 - Legal and Policy Issues and Enabling Government Legislation, and
- Task 5 - Integration and Roadmap Development.

Generally speaking, efforts of the tasks were directed towards meeting the objectives stated in the previous section. This section presents the approaches, scope of work and anticipated results specific to each of the task.

(A) Case Studies on Selected Public Buildings

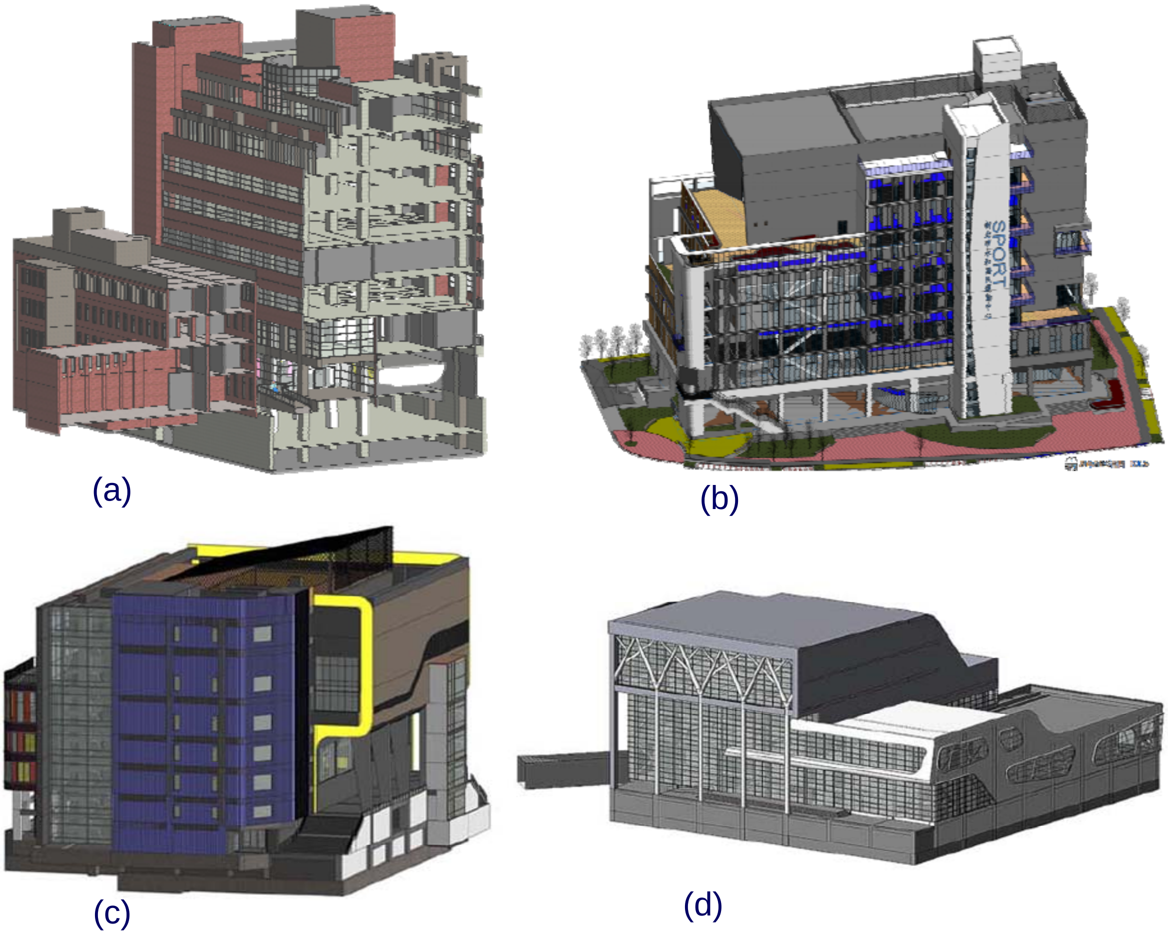
In order to ensure that our results will be concrete, with sufficient specificity and depth, and more readily applicable, this exploratory effort started by pursuing two case studies on two representative types of public buildings in Taiwan. Common characteristics of the selected target buildings (also referred to as test sites) include that they are so large and complex and

[2] Building Information Models/Modeling (BIM), http://en.wikipedia.org/wiki/Building_information_modeling. Also, see Appendix II for an overview.

their occupants and visitors so large in number as to make intelligent indoor emergency evacuation systems desirable or necessary.

In each case study, we first extract from the BIM (Building Information Model) of the building (or buildings) detailed sub-models of the building components (e.g., stairwells, elevators, and corridors) and connectivity relationship among the components. These models are needed to support the computations and decisions of the IES. Section 3 will present further details on these model elements together with other types of data extracted from BIM and facility management data of the building. We then developed a possible disaster scenario within each building and evacuation standard operating procedures (SOPs) for the building. These building-specific models and procedures enable us to identify data requirements of IES for the building. The next step is to extrapolate from the building-specific data requirements to develop a data requirement specification for public buildings in general.

The buildings selected as targets of case studies are the Institute of Information Science (IIS) Building at Academia Sinica in Nangang and Yonghe, Xizhi and Shulin Sports Centers under construction in New Taipei City. Figure 2 shows the 3D geometric models of the buildings. Hereafter, in the description of each of the tasks, by a building or facility, we mean specifically one or both of these buildings except for where it is stated otherwise.



(a) Institute of Information Science (IIS) Building, Academia Sinica, Nangang, Taipei
(b)-(d) Yonghe, Xizhi and Shulin Sports Centers, New Taipei Cities (Source: 104年新北市永和、汐止、樹林國民運動中心興建統包工程, 基本設計階段BIM成果報告書)

Figure 2 3D models of buildings selected as targets of case studies

The IIS Building is a multi-story office building. It has two parts: The 9-story part of the building includes a one-level parking garage underground. Floors above ground contain offices, a central machine room and computer labs. The 4-story part contains large meeting rooms and offices. The parts are connected at the ground level, giving this level a large and complex floor plan, complex enough that visitors can get lost in it. On some days, the building can have large crowds of visitors. IIS being built in the 90's before wide adoption of BIM, only blueprints of the building were available at the start of this effort. A sufficiently complete BIM were created as a part of the effort, however. The next step is the development of emergency scenarios and emergency response SOPs. Several team members work in the building. The fact that they are familiar with the building, can work closely with the building's maintenance and operation staffs, and have access to assistance from experts in the local fire department is a distinct advantage of this selection.

Yonghe, Xizhi and Shulin Sports Centers are new public facilities in New Taipei City. While the buildings are still under construction, BIM on their design and construction, including detailed models of stairwells and other building components are available. Moreover, models for analysis of air flows, lighting, energy consumption and so on are available. Compared with the IIS Building, the sport centers have significantly more complex structure and floor plans. Unlike people in the IIS Building, the sports centers will have people who come to the center at different frequencies to use their facilities and are unlikely to know the buildings well. An IES for the buildings are surely desirable.

(B) Task 1: Data Requirements of Intelligent Indoor Evacuation Systems

The anticipated results of Task 1 will be specifications of the building and environment data (including 2D-4D BIM, facility management, building control and observational data) required to compute evacuation routes, support emergency response operations and other essential functions of IES for the IIS Building and for Yonghe, Xizhi and Shulin Sports Centers. The task will also identify the standards governing data formats, metadata and data exchanges needed to ensure seamless flow of the data to IES.

The task focuses primarily on IES data requirements and addresses questions on how and where the data are generated and collected only to the extent to demonstrate the existence of the data and feasibility of their collection. Similarly, the task addresses the questions on how the data will be used by IES only to the extent required to justify the need for the data and data quality regardless how IES functions are implemented. A way to ensure that in-depth questions and answers specific to selected buildings can be generalized to apply to large public buildings in general is to work within the framework of an IES reference architecture[3]. The reference architecture described in the next section was developed for this purpose.

For the purpose of determining the data required to support essential IES functions, realistic scenarios of likely emergency types (e.g., fire and earthquake) and severity levels and SOPs for indoor emergency evacuation within and from the buildings are needed. The task works with scenarios and indoor evacuation SOPs that have been developed for the building and therefore are available whenever possible.

Given evacuation SOPs in different scenarios, the next step is to determine and analyze the

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[3] Reference Architecture, https://en.wikipedia.org/wiki/Reference_architecture.

data requirements of essential IES functions needed to support intelligent indoor emergency evacuation, in particular, data required for dynamic computation of evacuation routes from individual locations within the building and data required to support decisions and operations during evacuation. Data requirement specification should include only data that are available or can be made available cost effectively via current technologies. For this reason, sources of data (e.g., government agencies, non-profit organizations, building management service providers, etc.) and current state of practice in terms of whether and to what extent the required datasets are open should be identified. In case of real-time observational data (e.g., data on human densities near exits and on different floors) critical for decision and operation support, the specification should include an overview of state-of-the-art techniques that can be used to collect the data and associated cost-versus-data quality tradeoffs.

Timeliness of the input data is of critical importance in fast deteriorating scenarios. Therefore, data requirements should provide estimated relative deadlines for acquisition of time-critical data by the IES and the required timeliness of time varying data. The former specifies the maximum allowed response time incurred by IES. The latter specifies maximum data update delay. They are also part of the timing requirements of underlying database systems and the choices of authorization and access control models and policies for the data.

(C) Task 2 - Data Requirements of Indoor Positioning/Location Services

In large public buildings (e.g., transport hubs, major hospitals, and large department stores), emergency exits and direction signs are often not directly insight. An indoor positioning service/system (IPS) that can reliably help people locate themselves within a few meters using common mobile devices is useful during normal times and is essential during emergencies. This is why this effort includes IPS as an essential AERS/IES capability.

Location accuracies of modern IPS still falls short from location accuracy required during emergency[4], sometimes by as much as an order of magnitude (e.g., 50 meters)[5]. This fact is the motivation behind Task 2 that exploits accurate geometric and location data provided by BIM of a building to enable IPS with the following four attributes: First, the system must be scalable. Orders of magnitude surges in crowd density and location queries may occur daily and during holidays, special occasions and emergencies. Degradation in performance when surges occur should be small.

Second, the system must be easy to configure, deploy and maintain. Spatial, physical and functional characteristics of large public buildings and building complexes often change due to repairs, renovation and reconfiguration. It is important that updates of the IPS required to take into account the changes can be made systematically and easily. Moreover, the health of the system can be reliably monitored at low cost.

Third, graceful degradation is an essential attribute. The system should be capable of

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[4] Z. Farid, R. Nordin, and M. Ismail, "Recent advances in wireless indoor localization techniques and systems," Journal of Computer Networks and Communications, Volume 2013, 12 pages. D. Schneider, "New indoor navigation technologies work where GPS can't," IEEE Spectrum, November 2013. D. Dodge, "Leaders in indoor location positioning technology," http://dondodge.typepad.com/the_next_big_thing/2013/04/leaders-in-indoor-location-positioning-technology.html , April 2013.

[5] "Wireless E911 location accuracy requirement," FCC PS Docket No. 07-114, Feb 2015, https://www.fcc.gov/document/fcc-adopts-new-wireless-indoor-e911-location-accuracy-requirements-0 .

providing location information even when large parts of it are severely damaged. In particular, it should function when Internet, WiFi and cell phone coverage are disrupted.

Fourth, most importantly, the capabilities required of user devices to use the service should be minimal. Ideally, any cell phone usable for originating an indoor emergency call can be used to get the caller's location sufficiently accurately.

Task 2 took a practical approach to providing indoor positioning services for large public buildings and places with the above mentioned attributes. A result of the task is the prototype indoor positioning system called BeDIPS (Building/environment Data Based Indoor Positioning System) [3] presented in Section 4. As its name implies, the system uses 3D coordinates and geometric models of physical objects of interest in the building, which are typically provided by the BIM and facility management data. A performance goal of the prototype is that it can dependably provide location data with 3-5 or 5-10 meter horizontal accuracy and zero vertical error to smart phones and Bluetooth enabled feature phones.

(D) Task 3: Access Control for Multiple Levels of Emergencies

Security and privacy protection policies and mechanisms used to safeguard data are often obstacles to timely access to data vital to effective evacuation and rescue decisions and operations during emergency. Take the BIM-based FM system YouBIM for example[6]. Its advertisement says that 2D floor plans are available to occupants and visitors for navigation purposes. Virtual-reality displays can show the maintenance supervisor on duty all the broken lights, but a repairman is shown only the lights he/she is assigned to fix. A role/attribute-based access control[7] (A/RBAC) system can easily make sure that the display system does the right things. During emergencies, however, the access control mechanism may stand in the way of timely access to information by responders and affected people.

Two different approaches have been proposed to remove such obstacles. Break-the-glass (BTG) extensions[8] to standard role-based access control model offers a way to circumvent such obstacle during emergencies. Using these extensions, one can specify a hierarchy of emergency access control policies based on the security overriding requirements at different levels of emergency. Usually, BTG polices for more severe emergency levels allow more flexibility in overriding nominal access control decisions while imposing more extensive auditing requirements. Like the underlying access control scheme, BTG extensions works when users can be authenticated. BTG extensions are not likely to work as well for access control to data needed by IES during emergency however. For example, confidential BIM data (e.g., a 2D-3D maps of a underground tunnel normally closed to public) made available to IES for computations of evacuation routes may later be released in part or fully to thousands of evacuees and responders (e.g., when they need to go through the tunnel to escape a fire). It would be impossible to authenticate most of the people; yet, accurate data must be given to them in time in life-or-death situations.

The Trustworthy Information Brokerage Service (TIBS) [4] can offer an alternative

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[6] YouBIM, http://www.youbim.com/about-youbim.html

[7] Role-based access control, https://en.wikipedia.org/wiki/Role-based_access_control

[8] A. D. Brucker and H. Petritsch, “Extending Access control model with break-glass,” *Proceedings of SACMAT’09*, June 2009

solution. This access control and privacy protection service aims to enable responsive flow of decision and operation support data to diverse disaster/emergency preparedness and response applications, and through them to emergency responders, victims and general public. TIBS works particularly well when critical data required by emergency response applications are known a prior, and datasets containing the critical data can be filtered and desensitized and made ready for release when needed without per-access control. Task 3 aims to exploit the combined use of BTG extension and TIBS for safeguarding access of BIM and FM data by IES during emergencies. The hybrid access control scheme is described in Section 5.

(E) Task 4: Legal and Policy Issues and Enabling Government Legislation

To fully develop potential application of BIM by IES, it is not only matters of software, hardware, sensors, and communication, but also issues of legal, policy and governmental administration. In recent years, national and local governments have realized the essence of BIM applications and its industrial development. In May, 2014, Public Construction Commission (行政院公共工程委員會) invited Ministry of Interior (Construction and Planning Agency 營建署, Architecture and Building Research Institute 內政部建築研究所), Ministry of Transportation and Communications, Ministry of Economic Affairs, and many private professional and academic associations, to organize a BIM platform for sharing experiences and making suggestions to national BIM policy[9]. They identified 3 aspects, namely legal, capability building, and reward, to promote the BIM industry in Taiwan. Legal issues involve contract terms, intellectual property rights, risk and responsibility, and investment allowance, etc. Capability building is concerned with information technology, pilot study, and human resource training. Reward policy includes encouraging research and development, quality evaluation system, public works bidding and competitions.

Construction and Planning Agency (營建署) has done several pilot studies (including road and sewage, in Taipei, Taichung, Taoyuan, and Tainan) to adopt BIM in their design and construction phases[10]. Construction and Planning Agency is in charge of building codes and related regulations, which will be enforced in local government for all public and private building construction permits. New Taipei City, as a local government that will execute BIM policy and regulations, has taken 3 sport centers to study the feasibility and administrative issues for construction permits.

These activities show that national and local governments have realized the essence of applications and industrial development of BIM, but have had little or no discussions and research on the use of BIM for indoor emergency evacuation. We aim to identify potential legal and regulatory issues, if any, that may raise the barrier to BIM in Taiwan, and more importantly, barriers to accessibility of BIM data by IES during emergencies. Our findings are summarized in Section 6. Background information used to support our findings can be found in Appendix VI.

(F) Task 5: Integration and Roadmap Development

Task 5 would be the main project if this effort were a thematic project with multiple

[9] 許俊逸，徐景文，林傑 and 李文欽, "BIM 帶來的變革與政府的前瞻作為," 中國工程師學會 工程雙月刊, 2014

[10] 丁育群, "內政部營建署於營建工程導入建築資訊模型之推動與應用," 2014, http://bim.caece.net/bim_detail.php?id=71&frompage=1

subprojects. It is responsible for the coordination the efforts in selecting buildings to be studies. The task works in close collaboration with Tasks 1-4 and integrates their findings with the goal of identifying and recommending ways to lower or removal of possible technical, legal and regulatory barriers to making data on public buildings/facilities critically need to support indoor emergency evacuations decisions and operations available during emergencies to IES. For as much as possible, the results of the task include recommendations on BIM, FM and building automation datasets, data exchange standards, and emergency data access control models/policies. In this effort, we discussed with the government building administrations (政府建築管理部門) with jurisdiction over the selected buildings to ensure the feasibility of our recommendations.

3. IES Data Requirements of Representative Public Building

As stated in the previous section, Task 1 focuses on the data requirements of IES for the buildings selected as targets of case studies in order to capture the requirements in sufficient detail and depth to produce data requirement specifications of these IES. This work is guided by an IES reference architecture. Reference architecture[11] for an application domain typically provides a template for design and implementation of systems and applications in the domain, in our case, the domain of indoor emergency evacuation. We use IES reference architecture to highlight commonality of specific IES for specific buildings and help us to generalize the building specific data requirements into a general data requirement specification for all or most public buildings. This section first described an IES reference architecture. It then presents the data requirements of IES for the IIS Building and New Taipei City Sports Centers together with the process that led to the determination of the requirements.

(A) IES Reference Architecture

Figure 3 shows the IES reference architecture used for the purpose stated above. The architecture as depicted here makes three assumptions. - The assumptions are made for sake of concreteness; they should not lead to loss of generality - First, IES is structured as a feedback control loop, depicted as update view, input to controller and manipulate models. Second, it is model-based, object-oriented: Specific models of any type are specializations of the abstract model of the type. The third assumption is that evacuation route computations are done hierarchically. The computation of a new or updated route starts from updating the states (conditions) of building components (e.g., rooms, corridors, and stairwells) and computing route segments for evacuation from them. Then horizontal routes for people to move on each level to either refuge area(s) on the level or to stairwells, elevators, and escalators that connect levels are computed. This step is called *horizontal evacuation* in Figure 3. The overall routes in a multi-story building are computed by assigning people moving along horizontal route segments to stairwells, elevators, and so on to move them from level to level. This part is called *vertical evacuation*. During each step in the computation, the states of all affected models are changed (manipulated). Some of the changes are feedback to the controller, and some changes are made available to affected people and systems (e.g., EOC) under the control of data access mechanisms, which will be described in Section 5.

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[11] Reference architecture, https://en.wikipedia.org/wiki/Reference_architecture

Models depicted in the large rectangle at the bottom of Figure 3 can be viewed as check lists of required data types. (Due to space limitation, the figure shows only examples of them.) The three columns from the left list examples of building-specific data models. The IES may retrieve these types of data from the building BIM and facility management databases during initialization and update them periodically or upon receipt of change notifications from the databases. Specifically, IES will need the following types of data objects that model building components and resources and obstacles in the building:

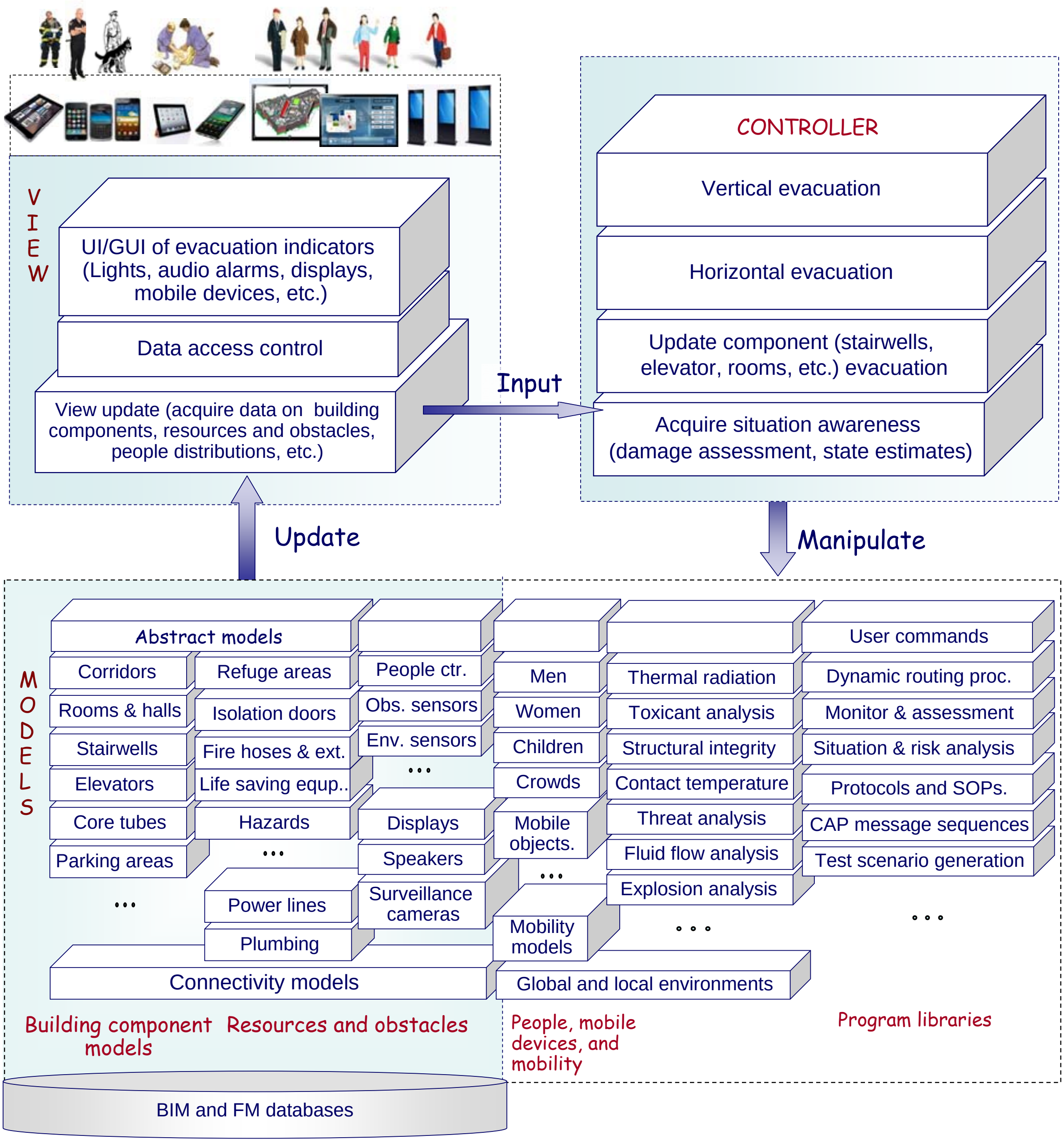

Figure 3 IES reference architecture

- *Building components* - Clearly 2D and 3D geometric models of building components (including rooms, corridors, halls, and stairwells and so on) provided by the BIM of the building are essential. The model of each building component should also provide data/information on attributes that are important to IES. Examples include fire and water resistances of the walls and floors and physical dexterity demand of stairwells. Data that describe capacities, performance, and tolerance to adverse conditions (e.g., shock, temperature extremes and water) of elevators, escalators and moving walkways are also essential. Structures and fire/temperature resistance of core tubes are important in emergencies caused by severe earthquakes and extreme explosion/fires.

- *Resources* - The term resources refers to building components, devices and equipment that can be used to aid the response to emergencies. They include refuge areas, isolation doors (e.g., for fire and water); fire hose and other fire fighting equipment; smoke control system; and defibrillators, first-aid supplies, eyewash stations, and other life-saving equipment. Their capabilities and locations are clearly needed during emergency response and evacuation. Figure 3 also lists in the third column devices that provide the IES with monitoring, assessment and notification capabilities as resources within the building. These resources include people counters for assessing crowd distributions and mobility, surveillance cameras and environment sensors, emergency lighting and evacuation indicatory systems (including digital signage displays and public speaking systems).
- *Obstacles* - Some obstacles are areas within the building that are physically blocked. Areas containing hazardous materials (e.g., flammables and harmful gases) and high voltage electrical equipments are also treated as obstacles; they should be avoided during emergency response and evacuation. Information on reasons the areas are to be avoided is critical for the IES to make decisions on how far people should be kept away from them.
- *Connectivity models* - Connectivity models provide the IES with information on reachability relationships between building components. Connectivity is often defined by a graph in which nodes represent building components (e.g., rooms and corridors) and an edge between two nodes represent a path to reach one component from other component (e.g., reaching the corridor from the room). To support route computation and other decisions of IES, data on physical distance, incline along the path, path surface, and spatial characteristics (e.g., capacities for people and objects) are also needed.

The third column from the right in the big dashed rectangle in Figure 3 lists models of people and crowds and mobile devices that are in the building but are not part of the building. The models of individual persons and mobile devices are not building specific. In contrast, the mixes of people in crowds and their mobility are. For example, as mentioned earlier, people in IIS Building work there. Most of the time, they stay in their offices or labs. Majority of them carry smart phones, and some of them laptop computers, with them while they move within the building. In contrast, visitors to the sports centers are likely to stay only for a part of the day and while they are there, move among different activity areas. Data and information that will enable the IES to model sufficiently accurately the movements of people within the building during normal times and in emergencies can be helpful.

The second column from the right lists examples of programs that IES calls upon to update the states (situations) of building components, local environments of the components and areas composed of them and the global environment of the building. It is safe to assume that every IES has an extensible library of these programs. By studying commonly used ones, we will be able to determine the types of data required by the programs used by a specific IES of a specific building (e.g., the IIS Building and Yonghe, Xizhe, and Shulin Sports Centers).

The first column from the right in bottom of Figure 3 lists major components of the IES. Examples include dynamic routing, monitoring, situation and risk analysis modules, as well as standard operating procedures. These components of IES for a building must take into accounts specific attributes and characteristics of the building. Similarly, CAP message sequences and test scenario generation needed for testing and quality assurance purposes must also be customized to a great extent to the building.

Table 1 lists examples of data types that are input to IES and output generated by the IES, including some of the data types mentioned above. Their descriptions in column 1 (i.e., the leftmost column) may help to clarify the descriptions above.

Table 1 Examples of data types and data access control

(a) Examples of BIM and Facility Management Data – Input to IES

Building and environment Data types	For general public		For auth. users	For Info. sys.
	Release conditions	Accountability requirements	BTG policy levels	Rights
2-D floor plans, attributes of building components and location specific evacuation routes	At all times	None	NA	R
Locations and use instructions of fire hoses and extinguishers and other life-saving equipment	At all times	None	NA	R
Locations & general descriptions of dangerous equipments, storage areas of dangerous materials	At all times	None	NA	R
3-D models and capacities of stairwells, elevators, escalators, corridors, etc. & connectivity graph	S &C levels	None	All levels	R
3-D models of private & security controlled areas	Level C	ID/photo	S &C levels	Sys. Specific
Specific information on dangerous equipments and materials	Level C	ID/photo	All levels	Sys. Specific

(b) Real-time data on current situation produced by IES

Real-Time Data types	For general public		For auth. users	For Info. sys.
	Release conditions	Accountability requirements	BTG policy levels	Rights
Current situation: affected areas closed and expected to be closed to public, detours, etc.	At all times	None	NA	R
Locations & wait times of aid stations	At all times	None	NA	R
Damage and situation updates to public	S & C levels	None	All levels	R
Current situation: conditions affecting decisions and actions of responders and emergency mgrs.	Not released	NA	All levels	R
Details on conditions and demands of the routes, locations and remaining capacities of safe areas	Not released	NA	S & C levels	R
Primary evacuation routes, advises and instructions related to the routes	S & C levels	None	All levels	R

The other columns in Table 1 list examples of data access control alternatives for different types of users and information systems and emergencies of different levels. Section 5 will describe the access control alternatives mentioned in the table.

In Table 1, and throughout the report, the term *emergency levels* (or *severity levels*) is used in a similar sense as *emergency severity index*[12] (ESI) defined for medical emergencies: The five-level ESI categorizes emergency room patients according to patient acuity and resources needed to care for the patient. It is a powerful tool commonly used in emergency departments

[12] Emergency Severity Index, Emergency Severity Index (ESI): A Triage Tool for Emergency Department, http://www.ahrq.gov/professionals/systems/hospital/esi/index.html

of hospitals worldwide to enhance patient safety and support operational decisions. There are no similarly well-defined and widely-adopted indexes for categorizing indoor emergency situations. The discussion in this report roughly divides emergencies into three levels: levels N, S and C. They are defined in Figure 4 in terms of color code published in 2012 for categorizing emergencies in Taiwan[13]. N stands for normal condition, i.e., no emergency within the building. The level corresponds to code green. Levels S (Severe) and C (Calamitous) roughly correspond to code yellow/orange and code red, respectively. Emergencies developing from level S to level C call of increasing more flexible and responsive data access control at the expense of vigor in privacy protection.

顏色燈號		Pantone 色號 (色彩數值)	危險等級	優先順序	管制方案	疏散撤離
紅色	●	Red 032 C (M100 Y100)	高	第一優先	禁止、封閉、強制	強制撤離
橙色	●	Orange 021 C (M50 Y100)	中	第二優先	加強注意	加強勸告撤離準備
黃色	●	Yellow 012C (Y100)	低	第三優先	注意、警戒、通知、警告	勸告、加強宣導
綠色	●	Hexachrome Green C (C100 Y100)	一般狀況、平時、整備作業			

各類災害警戒等級之顏色及燈號
依據：行政院 101 年 3 月 27 日院臺忠字第 1010126718A 號函

- Normal (color green): no emergencies
- Severity level S (color yellow and orange) : Level S emergencies include the ones for which preparedness/response SOPs and emergency data access control policies and enforcement mechanisms have been put in place in preparation, and BTG extensions are sufficiently responsive.
- Severity level C (color red or beyond) : Level C emergencies include the ones that call for mandatory and immediate evacuation midst extensive damaged building structures, disruption of network connections, dangerous conditions, etc.

Figure 4 Definition of Level S and Level C emergency levels

(B) Disaster Scenarios

Again, the public buildings selected as targets (test sites) of case studies are Yonghe, Xizhe, and Shulin Sports Centers in New Taipei City and the IIS (Institute of Information Science, Academia Sinica) building in Nangang, Taipei. Figure 2 shows their 3D models. The buildings represent two types of public buildings. The sports centers are among the most modern public buildings in Taiwan, equipped with a wide range of emergency preparedness and response resources. Most of the data and information needed by intelligent indoor evacuation systems for them are available. The IIS building, on the other hand, were built almost 20 years ago. Though well maintained and continued to be updated, it lacks many modern monitoring and automation capabilities.

- **Descriptions of Sports Centers**

  As stated in Section 2(A), Yonghe, Xizhe and Shulin Sports Centers in New Taipei City are still under construction. They are at locations described, respectively, by Figures V-1, V-7 and V-11 in Appendix V. Figures V-2, V-8 and V-12 show 2D floor plans of representative floors in the centers, respectively. The New Taipei City year 104 report on BIM of the sports centers[14] presents detailed information. The list in Table 2 intends to provide an overview of aspects relevant to the IES data requirements for these buildings and links to

[13] "各類災害緊戒顏色燈號訂定原則,"行政院 101 年 3 月 27 日院臺忠字第 1010126718A 號函, http://www.life.fcu.edu.tw/wSite/publicfile/Attachment/f1334025401890.pdf

[14] 104 年新北市永和、汐止、樹林國民運動中心興建統包工程, 基本設計階段 BIM 成果報告書

where in this report further details can be found. In this table and Table 3 presented shortly, the terms models and data mean specifically models and data needed to support the functions and decisions of IES, including BIM, facility management and sensor data for acquisition of situation awareness, computation of evacuation routes, and so on.

Table 2 Summary of information on New Taipei City sports centers

	Data and information types	Also see
1	o Building component and connectivity models - Being designed and constructed with the help of BIM and related technologies, detailed 2D-3D building components and connectivity graphs are available. o Characteristics and attributes (e.g., fire, water and shock resistances) of building components and emergency preparedness and response resources (e.g., refuge areas, life saving equipment, etc.) - BIM and facility management data of the buildings can provide these data. Some of such data can be also derived from the code and regulations complied by the buildings. - Table I-2 in Appendix I lists current code and regulations. Table I-1 in Appendix I lists disaster prevention and safety indices and benchmark scores of resources for fire, earthquake and floor emergencies. Also Figure II-2 shows E-checking of disaster prevention aspects of resources. o Characteristics and attributes of hazards (e.g., high voltage equipment, compressed gas and dangerous chemicals) - Published floor plans contain information on only a subset of these elements.	Figure 3, Table 1, and Tables I-1 and I-2 in Appendix I. Figure II-2
2	o Sensor and surveillance data - 2D floor plans of the buildings show the types, numbers and locations of environment sensors (temperature, humidity, smoke detectors) and surveillance cameras. Appendix IV Section (A) provides the types of sensing and surveillance devices in the buildings.	Table IV-2
3	o Indoor positions - Indoor positioning system tracks movements and locations of individuals via their smart watches and phones. o Models of people and crowds - Disaster scenarios assume that the command and control center and IES know the number of people in the building, their ages, locations and possible disabilities.	Table IV-2, Figures V-2, 8 and 14 Table IV-1, Figure V-3
4	o Information on devices for delivery of emergency response and evacuation instructions - The disaster scenarios assume that people are instructed by emergency responders, speakers, and multimedia displays and smart phones and watches.	Appendix IV, Sec. (A) Appendix V
5	o Models, methods and tools for analysis of air flows, lighting, energy consumption and so on - They are available. o Building specific dynamic/real-time data on speeds with which heat and smoke may spread, mobility of people, and other factors to be taken into account in computation of emergency response strategies and evacuation routes - These types of data are not yet available. Models and simulators similar to the ones used for analysis of air flows, lighting and energy consumption should be developed to get the required data and determine real-time requirements.	Table 1(b) Figure IV-1 Table IV-3

- **Descriptions of IIS building**

The case study focused on the new, 9-story part of the IIS building. As stated in Section 2(A), even the new building is nearly 20 years old. The size of research, technical and administrative staff of Information Science Institute is now near 400. Except for the director and administration offices, almost all meeting rooms, offices and research labs, and majority of the 400 people, are in the new building. Figure V-18 and Table V-4 in Section (D) of Appendix V show 2D floor plans of the first, second and 6th floors and the usage of individual floors. The list in Table 3 provides an overview of aspects relevant to the data requirements of IES for the building.

Table 3 Summary of information on IIS New Building

	Data and information types	Also See
1	o Building component and connectivity models - BIM and 2D-3D models can be generated from available blueprints of the building. Parts of the BIM are now available. o Characteristics and attributes (e.g., fire, water and shock resistances) of building components and emergency preparedness and response resources (e.g., refuge areas, fire extinguishers, life saving equipment, etc.) - In principle these types of data and information can be derived from maintenance records of the building and building code met by the building, possibly at a high cost, however. o Characteristics and attributes of hazards - Hazards include flammable materials that may speed up the spread of fire and heavy equipment that can cause serious injuries during strong earthquakes. - Data on such elements are not available.	Figure 3, Table 1
2	o Sensor and surveillance data - 2D floor plans of the buildings show the types, numbers and locations of environment sensors.	Figures V-18, and V-19
3	o Indoor positioning - There is no indoor positioning system. o Models of people and crowds - The personnel management system of the institute can provide the identities and likely locations of most of IIS staff in the building. During events such as workshops and conferences, the registration records can provide similar data on attendees of the events.	
4	o Information on means and devices for delivery of emergency response and evacuation instructions - The disaster scenarios assume that people are instructed by emergency responders, speaker system, a few multimedia displays, and emergency lights. No mobile devices and applications are assumed.	Appendix V
5	o Models, methods and tools for analysis of air flows, lighting, energy consumption and so on - They are not available. o Building specific dynamic/real-time data on speeds with which heat and smoke may spread, mobility of people, and other factors to be taken into account in computation of emergency response strategies and evacuation routes - These types of data are not available.	Table 1, Figure IV-1 Table IV-3

▪ **Disaster scenarios**

Appendix V presents four disaster scenarios, one for each of the test-site buildings. The summary below provides links to where in the appendix details can be found:

- A magnitude 6 earthquake in northern part of Taiwan causing an emergency evacuation in the Yonghe Sports Center: The scenario is described in Section (A) of Appendix V. The distribution of people on second floor where the swimming pool is and initial evacuation routes for them at the time are shown in Figures V-3 and V-4, respectively. The flow chart in Figure V-6 describes the decisions and actions of the emergency command/control center based on geometric and functional data on building components (e.g., the three stairwells) and sensor data from devices distributed as shown in Figure V-5.
- A fire/explosion emergency due to high concentration of combustible gas in Xizhe Sports Center: The scenario is described in Section (B) of Appendix V. Figure V-9 shows the initial evacuation route for the 4th floor and distributions of resources (including stairwells) and sensors. The flow chart in Figure V-10 summaries the decisions and work done by the emergency command/control center.
- A fire emergency in Shulin Sports Center: The scenario is described in Section (C) of Appendix V. Figures V-13 and V-14 describes the initial escape routes computed for people and distribution of sensors providing information needed by the command/control center. Figures V-15 and V-16 describes the decisions/actions of people in response to the emergency and the work done by the emergency command and control center.
- A fire started from a research lab in the new IIS building: The scenario is described in Section (D) of Appendix V. The lab in room 518 is one of the larger research labs. Roughly, 10-15 research assistants work there. The room is full of PC's, laptops, and large monitors. The room also contains books, empty or half-filled cardboard boxes, fabric covered chairs, etc., which can burn fast and generate smoke in a fire emergency. As shown in Figures V-18 and V-19, each room on the floor has 4 or 5 fire detectors which trigger an alarm when they sense temperature rises beyond some specified threshold[15]. Possible delay in the fire alarm and lack of automatic fire fighting resources (e.g., fire sprinklers and isolation doors) lead to the scenario described in Tables V-5 and V-6: Despite efforts, the fire could not be contained. In this case, the institute takes advantages of the fact that the people in the building know the building, its facilities and each other well to organize an emergency self-defense team of approximately 20 people and have them help others in the building to evacuate safely.

(C) IES Data Requirements

From the above descriptions of the test-site buildings and possible disaster scenarios in them, one can make the following observations:

▪ *Critical emergency response functions* – One can observe from the fire emergency scenario within the IIS building the critical need of an active emergency response system (AERS) with at least three capabilities: automatic activation of risk reduction actions (e.g., automatic closing of fire doors to the main stairwell in the middle of the building),

[15] The primary reason for using fire detector rather than smoke detector is that the false alarm rate of smoke detectors is too high.

automatic notification (including alerting building occupants and calling 0-119 and institutes nearby), and situation assessment and decision support (e.g., alerting the fire fighting team when the fire is burning out of control and advising evacuation at 13:32 in Table V-5). As Figure IV-1 in Appendix IV shows, a fast fire can develop fully in 1-2 minutes and a typical one in 5 minutes, giving people insufficient time to carry out manually many of the tasks stated in Tables V-4 and V-5.

In fact, flow charts in Figures V-6, V-10, and V-16 in Appendix V all include shutdown electric power and gas and close isolation doors and windows among the first tasks of emergency command and control centers in response to emergencies within the sports centers. Similarly, in cases of gas explosion and fire scenarios, the emergencies originate within the buildings. Sending notifications/alerts to emergency response agencies and the organizations with properties affected by the emergency is also one of the first tasks.

Situation assessment and decision function can be divided into two parts. The first part can be called disaster/emergency surveillance and prediction/detection. It involves the determination from sensor data whether and when an emergency alert should be issued. In cases such as earthquake and flood, this work is done by responsible government agencies (e.g., Central Weather Bureau). Flow charts in Figure V-10 and V-16 include locating the source of fire and estimating immediately affected area within the building. A result of this work is the declaration of an emergency which triggers the necessary preparedness and response actions, including possible evacuation from the building. The focus of this effort is on situation assessment and decision support after an emergency is declared.

- *Functional Partition Between IES and Other Components of AERS* – For sake of concreteness and clarity, our work assumes the partition of critical functions of AERS [1, 2] as shown in Figure 1. The surveillance and prediction/detection functions for emergencies originating within the building are done by one or more local emergency alerts/warning systems. The alert/notification function is done by an integrated messaging system: It routes CAP formatted alerts from government authorities and local alert systems to a system of smart embedded devices and applications; they process the alerts and carried out appropriate risk reduction actions such as close/open door and windows, turn off power, etc. [5]. The messaging system can also make emergency calls automatically. Most important of all for our discussion here, the message system also sends alerts to the intelligent emergency response system (IES), the core component of the building's AERS.

  Upon receiving an emergency alert, IES works as illustrated by Figure 3 in general: It acquires situation awareness, updates the states of affected building and environment components and people/crowd, and computes and communicates decisions to change the states. In flow charts in Figures V-6, V-10 and V-16 in Appendix V, emergency evacuation functions include the processes starting from and below the ones in second row. If there were an IES in the IIS building, it would provide information on the development of the fire and provide directives and advises during the exercise described in Table V-7.

- *Data Requirements of IES* – From Figure 3 and Tables 1, 2, and 3, one can conclude that an IES requires the following groups of data to carry out its functions. The first five groups are numbered as they are in Tables 2 and 3, which provide further details on the data types within each group. The list below includes data on likely scenarios as the sixth group.

  - Group 1, spatial and attribute data on the building – This group of data is an essential input to computation of evacuation routes. Detailed building components and connectivity models can be found from BIM of the building. Sources for data on characteristics and attributes of building components, resources and hazards include the buildings BIM and facility management databases and building code and regulations complied by the building.

- Group 2, sensor and surveillance data – The BIM and facility management databases of the building usually has sufficiently detailed data on environment sensors, surveillance cameras, and other sensors.
- Group 3, indoor positioning and models of people and crowd – Ballpark estimate of the total number of people within a building can be made available easily. In all the test-site buildings, spatial distributions of people can also be estimated. Data of this type are acquired by an indoor positioning system in the sports centers[16] and from personnel management system in the IIS building. Attributes (e.g., body types, ages, functional disabilities) of individuals needed to compute individualized evacuation decisions include the ones listed in Table IV-3. Such data require tracking and identifying individuals and their movements to some extent.
- Group 4, data on output devices, in other words, types, capabilities and locations of devices and applications which the IES can use to deliver location-specific instructions and directives to affected people and smart risk reduction devices – Parts of this data are provided by the BIM and facility management databases. Delivery of individualized instructions requires data on the types and locations of mobile devices and applications.
- Group 5, building-specific real-time and dynamic data on the building and environment, development of the emergencies, and mobility of people – Only limited types of such data are available even for recently-built buildings such as the sports centers.
- Group 6, results of scenarios analysis for common emergency types – Data obtained from analysis of likely scenarios of common emergency types and assessment of preparedness and response actions can be used by IES algorithms and tools to make better decisions in shorter time. Consulting scenario database is indeed done by emergency command and control center according to the flow charts presented in Appendix V.

4. BeDIPS - Building/environment Data-Based Indoor Positioning System

The goal of Task 2 stated in the proposal is to identify the BIM data required to support indoor positioning system that can provide 3-5 meter, 5-10 meter, or room-level accuracy in large complex buildings. Rather than this relatively easy-to-reach goal, we have designed and partially prototyped a system called *Building/environment Data-Based Indoor Positioning System* (*BeDIPS*) to provide this capability.

(A) Capabilities, Design and Implementation of BeDIPS

As stated in Section 2(C), despite years of efforts of research communities on indoor position/location technologies and many big players and numerous startups racing to be leaders in the growing market of IPS, there is still no clear winner and no common standard today. A reason is that existing IPS typically do not have the four attributed stated in earlier in

[16] The indoor positioning systems in New Taipei City sports centers monitor the movements of people by monitoring smart devices (smart phones, watches and bracelets) carried by them.

Section 2(C): The IPS must be scalable and easy to deploy and maintain; moreover, it degrades gracefully and requires minimal user device capabilities[17]. BeDIPS is designed to have these attributes. This section presents an overview of the system. Further details on its design, implementation and performance can be found in [3].

As its name implies, BeDIPS relies on a *building and environment data/information cloud* (*BeDIC*), which among other types of data about the building and its interior, contains the 3D coordinates and geometric model of every physical object of interest. In particular, it contains the coordinates of location beacons, hereafter referred to as *LBeacons*. Basically, Lbeacons are low-cost Bluetooth transmitters. Each Lbeacon stores locally its own 3D coordinates together with a short text message containing a brief description of its location and a one-step navigation instruction to the nearest exit. LBeacons are installed pervasively throughout the building to provide the desired coverage and networked together with a server. At deployment/initialization and maintenance times, the BeDIPS server retrieves the 3D coordinates and text message of every Lbeacon from BeDIC and loads the coordinates on the beacon. Once initialized, the server steps out of the way. Each Lbeacon broadcasts periodically its coordinates and a text message. On smart phones with indoor maps, a simple application *HereUAre* can easily generate screenshots illustrated by the leftmost one in Figure 5. The inclusion of the text message from each Lbeacon eliminates the need for the application and indoor maps as illustrated by the screenshots also shown in Figure 5.

Screenshot similar to this Google ad can be generated by HereUAre on a smart phone with indoor maps

Screenshots produced from broadcast from a Lbeacon on phones without indoor map and HereUAre application

Figure 5 Screenshots on phones with and without indoor maps and HereUAre

Figure 6 shows the structure and components of BeDIPS. Again, the workhorse of the system is the network of Lbeacons installed throughout the building. The other major component is the BeDIPS server. Like smoke detectors in modern buildings, Lbeacons are AC powered. Beacons serving each area in the building are connected by a powerline sub-network and all sub-networks are connected via gateways to the building's wide area network and the BeDIPS server. The functions of the server are limited to installation, initialization and maintenance. Once installed and initialized, the server steps out of the way, letting each Lbeacon function independently of each other.

[17] From Appendix V and the previous section, the indoor positioning system use in New Taipei City sports centers does not meet this requirement.

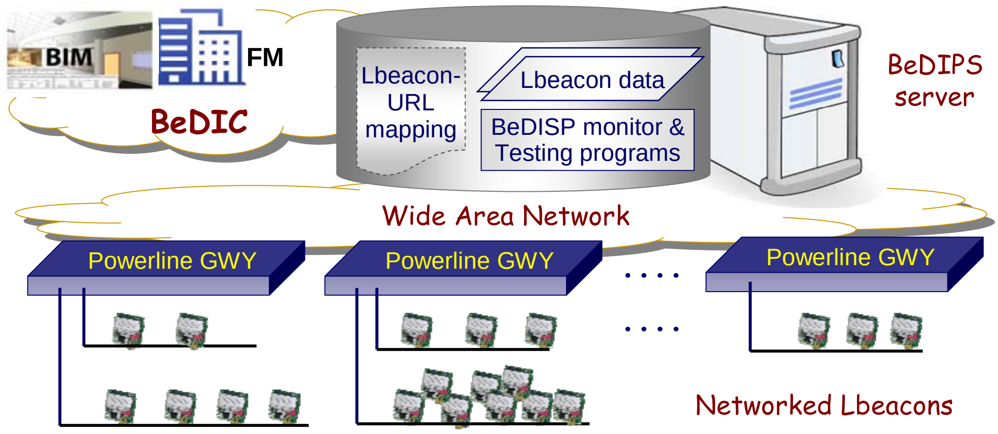

Figure 6 Structure and components of BeDIPS

Figure 7 shows the structure of the Lbeacons. The primary function of Lbeacon is provided by the Bluetooth Smart Ready (i.e., dual mode) module. Specifically, Bluetooth LE stack is used for broadcasting to modern smart devices. Today, a large number of mobile phones remain to be legacy devices, however. Being required to serve them as well, Lbeacon also has the basic rate/enhanced data rate (BR/EDR) protocol path as shown.

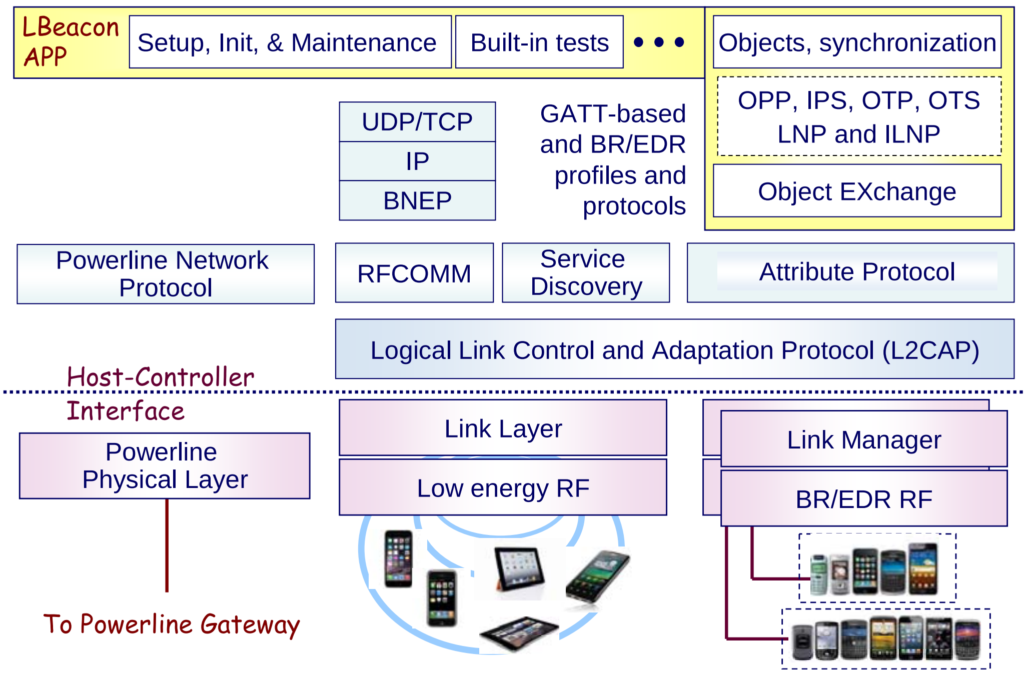

Figure 7 Structure of Lbeacons

(B) BeDIPS Development Environment

The primary reason that BeDIPS is easy to install, configure and maintain is its use of data and information in the Building/environment Data/Information Cloud (BeDIC) of the building for configuration, installation and maintenance purposes. This virtual repository contains selected parts of the BIM and facility management databases. The fact that it can provide the data for the indoor positioning purpose in general and support BeDIPS specifically is a benefit gained at negligible additional cost. Figure 8 illustrates the key role of BeDIC within a development environment that supports the design, deployment and maintenance of a BeDIPS for a large public building complex. Specifically, the lower part of

Figure 8 shows the usage of 2D and 3D geometric models of the building interior provided by the cloud and digital exchange standards supported by it.

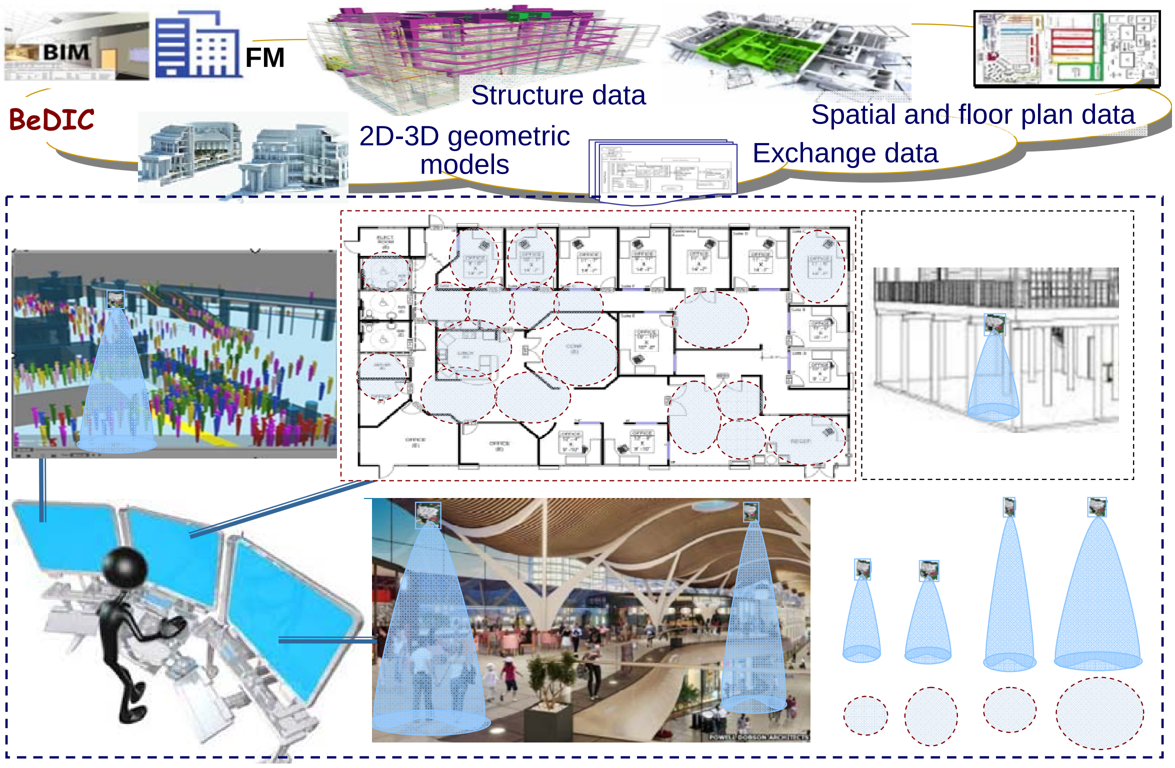

Figure 8 BeDIPS development environment

With rare exception, Lbeacons are installed on the ceilings. Different types of Lbeacons differ in their ranges and antenna radiation patterns. The lower right corner of the figure shows four types as examples. Each dashed circle or oval represents the coverage area of a beacon. A building such as large shopping malls, transport hubs and Sports Centers is likely to require several types as illustrated by Figure 8. While Lbeacons with range around 3 meters are suitable for typical rooms, beacons with range 20 meters or more may be needed for multi-level halls. All of them have directional antennas with conical beams. For 3-meter location accuracy, beacons with 3-meter range have 60-degree coverage, while beacons with larger ranges need to have antennas with narrower radiation patterns.

The process of design and deployment of a positioning system in a building starts from the selection of the types of Lbeacon for each area in the building from available types. Graphical and visualization tools built on the 2D-3D geometric models of the building such as the ones shown in the lower half of the Figure 8 aims to help the developer to select the right type of Lbeacon for each location, experiment with the placements and orientations of the selected beacons, and visualize and assess the coverage provided by them. Upon finding a satisfactory design for an area (e.g., a room, a corridor, and a large hall), the developer can have the tool generate, for each beacon in the area, its 2D barcode, type and coordinates. In addition, the tool also generates the coordinates of a reference point for the area. The reference point is a location in the area that can be easily pinpointed by the installer. Examples include the south-west corner of the room or the left inside frame of a specified door. This information will help the installer locate the position of each Lbeacon in the area accurately with the help of the installation tool described in [3]. Figure 8 BeDIPS development environment

(C) Current Status and Future Plan

We have been experimenting with prototype Lbeacons, focusing primarily on their functionality. The BR/EDR module of the prototype uses only one dongle. The coordinates and textual location description are sent in vMessage format according to the Bluetooth Object Push Profile (OPP) and Object Exchange (OBEX) protocol[18]. OPP being widely supported, all of the feature phones we experimented with can display location descriptions such as the one illustrated by Figure 5. As expected, the implementations of the LE (Low Energy) module and HereUAre on smart phones are straightforward. In addition to prototype LBeacons, we built a BeDIPS development environment as an extension (i.e., a plugin) of Autodesk Revit[19]. We demonstrated Lbeacons within the Institute of Information Science Building during Academia Sinica Open House day on October 30, 2015.

The contribution of this work is a practical approach to providing indoor positioning services for large public buildings and places. An enabler of BeDIPS is BIM. BeDIPS is made possible by using the data innovatively. To illustrate, it is known that Frankfurt Airport has approximately 50,000 smoke detectors. It will need two or three times more Lbeacons to provide 3-5 meter or room-level location accuracy. The tasks of selecting the location of each beacon, determining it coordinates and place the beacon at the chosen location would be prohibitive without the BeDIPS development tools described in [3]. With the tools, however, the tasks are only slightly more demanding than the task of deploying smoke detectors throughout the facility.

In the near future, we will evaluate the effectiveness and performance Lbeacons experimentally in terms of responsiveness and scalability. The next step is to build and evaluate parts of prototype BeDIPS in IIS building and Yonghe Sports Center.

In current prototype, each Lbeacon provides only a one-step navigation instruction to the nearest building exit. Another extension is to use Lbeacons to deliver fine-grain location-specific emergency response and evacuation instructions to people via their mobile devices. Such instructions can be loaded on each Lbeacon in the disaster preparedness phase. Lbeacons are networked with the BeDIPS server, and the server can be an information system served by the IES. During emergency, the IES can instruct the server to notified Lbeacons in emergency affected areas in the building and have them broadcast specified emergency alerts and response/evacuation instructions specific to their locations. An advantage of this scheme is that there is no need to identify the individuals and track their movements.

5. Emergency Data Access Control

As stated in Section 2(D), Task 3 proposes to exploit the combined use of BTG (Break-the-Glass) extension and TIBS (Trustworthy Information Brokerage Service) for safeguarding access to data required by IES during emergencies of different levels. Both alternatives were described briefly in Section 2(D). This section describes the hybrid scheme and presents examples to illustrate its application.

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[18] Object Exchange Protocol (OBEX) and Object Push Profile (OPP), https://developer.bluetooth.org/TechnologyOverview/Pages/OBEX.aspx

[19] Autodesk Revit, https://en.wikipedia.org/wiki/Autodesk_Revit

(A) Complementary Capabilities of BTG Extensions and TIBS

Again, BTG (Break-the-Glass) extensions of standard role based access control models specify a hierarchy of emergency access control policies based on security overriding requirements at different levels of emergency and thus enable the circumvention of data access control obstacles during emergencies. For example, the BTG extension adopted by a hospital's electronic patient record system may work as follows: Under normal conditions, the medical record of a patient is accessible only by his/her physician(s). During a (ESI, Emergency Severity Index) level-2 medical emergency (i.e., when the patient exhibits a time-critical problem), the patient record system overrides the normal access control policy and allows all physicians in the emergency room to access the patient's record. However, at a level-1 medical emergency (i.e., the patient is triaged as requiring immediate, life-saving intervention), the system may provide access of his/her record to any physician who by previous arrangement has an emergency account and can be authenticated by the system. In each case, the override of normal access control decisions is accomplished by specified obligations (i.e., mandatory auditing actions). In this example, the action may be sending notifications of the emergency accesses to the patient, or/and his/her physicians and the patient privacy monitoring system. As stated in Section 2(D), BTG extensions are typically defined to provide more flexibility in overriding data access decisions at more severe levels of emergency while imposing more extensive obligated auditing actions. Figure 9(a) shows a general architecture of BTG extension.

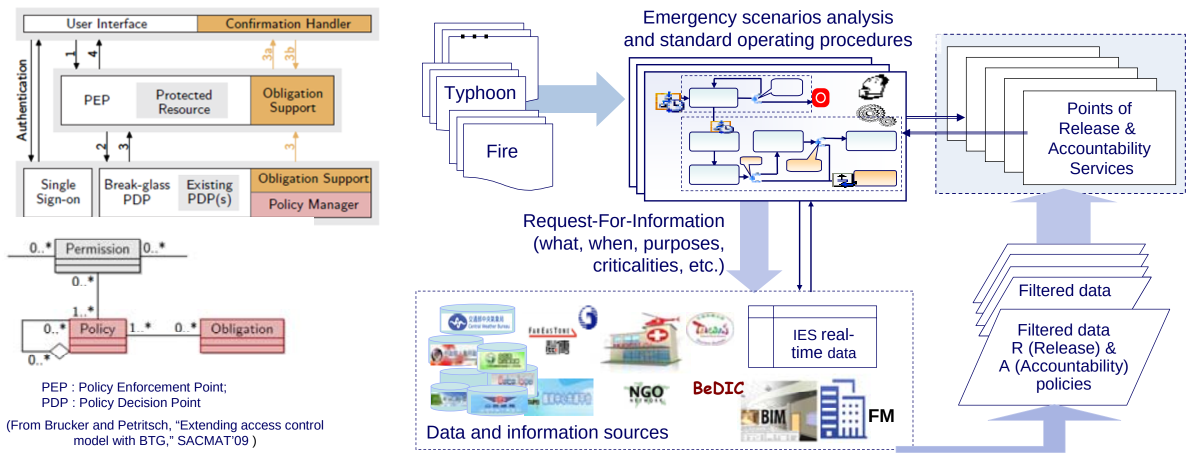

Figure 9 (a) Left, BTG architecture and (b) Right, TIBS assumption and usage

Developed to facility accesses to healthcare information during medical emergencies, BTG extensions are quite capable of handling the emergency access control to electronic patient health record systems. In this case, the user groups (of healthcare professionals) are relative small and can be authenticated by a functioning hospital information system. In Figure 9(a), single sign-on allows a user to access multiple data/information sources. To a great extension, this is also true for access of BIM-FM data and real-time data produced by the IES system by emergency responders, policemen, medical personals and so on. It is possible to set up BTG accounts for these groups of users a priori. During emergencies, these users and their mobile devices can be identified and authenticated, allowing the override of normal access control decisions when necessary in adherence to BTG policies.

The same thing about users of BTG extensions cannot be said about general public within a public building: TIBS (Trustworthy Information Brokerage Service) [4] is an alternative access control approach for them. This access control and privacy protection service aims to enable responsive flow of decision and operation support data to diverse disaster/emergency preparedness and response applications, and through them to emergency responders, victims and general public. TIBS achieves responsiveness by eliminating per-access control: The service divides information access control into two phases, which are managed by prospective sub-service (PTIBS) and retrospective sub-service (RTIBS). Specifically, PTIBS manages the release of the data critical to disaster preparedness and emergency response and makes them available to specified subscriber applications, and through them to users, when needed according to specified policies. The policies are defined in terms of release and accountability clauses, which specify the conditions under which the information may be released and the traceability/accountability requirements for releasing the data, respectively. The policies are enforced by RTIBS. As stated in Section 2(D) and shown in Figure 9(b) TIBS works well when data required by emergency response applications for likely emergency scenarios and SOPs in response to likely conditions can be determined. For these applications, datasets containing the required data are filtered and desensitized and their releases conditions and accountability requirement determined. IES is such an application.

Figure 10 illustrates how a hybrid access control scheme may be used to facilitate access of data in a BeDIC (Building and environment Data and Information Cloud) during emergencies. Without loss of generality, the scheme assumes that access to and release of data within BeDIC and data produced by other components of AERS are done via the IES.

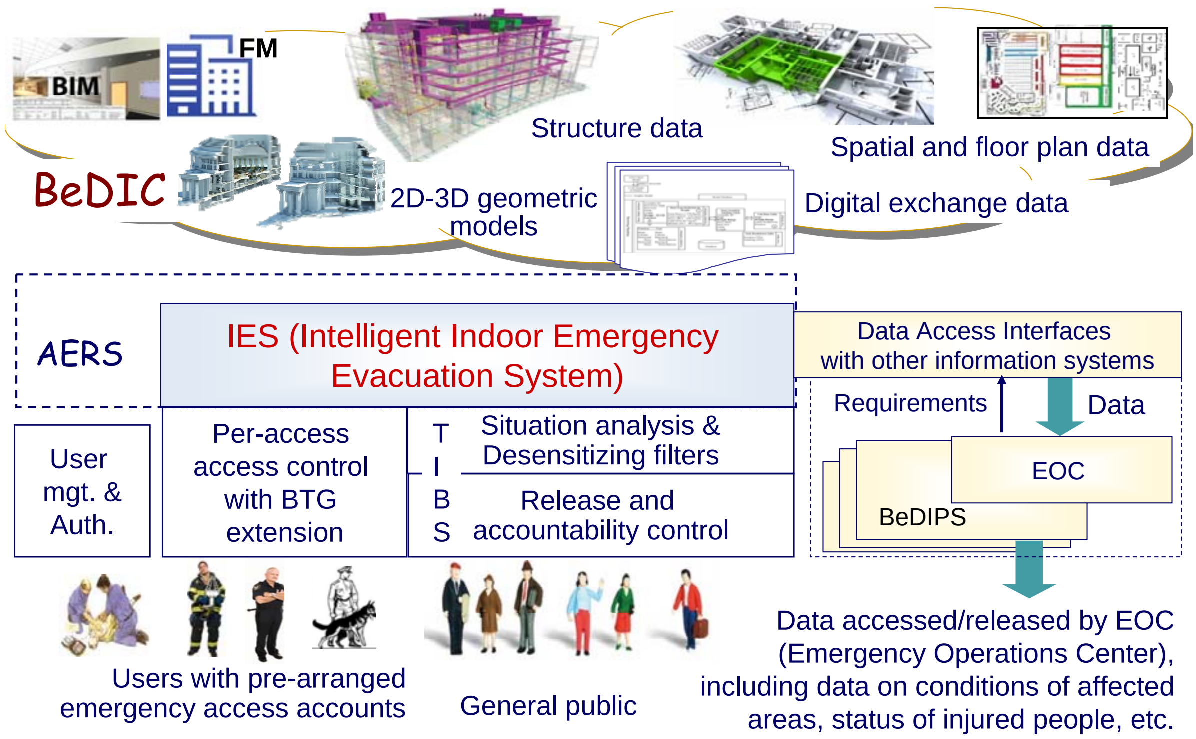

Figure 10 Use of hybrid BTG-TIBS access control to building and environment data

Specifically, Figure 10 assumes that during normal times, a per-access access control scheme (e.g., a role-based access control scheme) is used to control access to data within BeDIC by people and systems. Furthermore, emergency access accounts and BTG extension emergency access control policies have been set up for specified groups of users. (Examples include firemen, police, medics and other first responders, as well as selected people who manage and maintain the building.) A user management and authentication system (UMAS) is a part of the access control system. During emergencies, each of these users and the mobile device used by the user is authenticated by the UMAS and the BTG extension overrides normal access control decisions on behalf of the user. In contrast, the hybrid scheme makes selected data available to the general public via multi-media displays, public speakers, etc. and/or have the data delivered to the people via their mobile devices under the control of the TIBS part of the system. Again, the PTIBS part is responsible for releasing the data, while the RTIBS part enforces accountability requirements at the point where the data are released.

The scheme shown in Figure 10 also assumes that during emergencies when the IES of the building is in operation, all data and information on the building required by other information systems used to support response decisions and operations are made available via the data access interfaces of the IES. (For example, the Emergency Command and Control (ECC) Center gets all data and information from IES.) This is a reasonable design choice. As Figure 1 shows, the IES must have access to all sensor data needed to support its own situation awareness and decisions and has control of all active devices in the building.

(B) Examples of BTG Extensions and Release/Accountability Conditions

We use the examples listed in Table 1 to help explain the proposed hybrid BTG-TIBS scheme further. The first column from the left in parts (a) and (b) of the table lists descriptions of data that are used by IES as input and data produced by the IES, respectively. Some types of data are also provided to emergency responders, building management, general public, and so on. Entries in the second and third column from the left in Table 1 state the access control options for different data types for general public and authenticated users, respectively.

The first three rows in part (a) of Table 1 lists information on building floor plans, location specific evacuation routes, locations and information of resources (e.g., fire extinguishers, first aid kits, eyewash stations) and hazards (e.g., high voltage equipment, stored compressed gas and stored swimming pool chemicals). Figure 11 shows examples of these types of data commonly posted in buildings: As first three rows in Table 1 part (a) indicate, these data types are public information at all times and no data access control is required. All information systems connected to IES via its system interfaces are provided R(ead) access as indicated by the entry "R" in the rightmost column.

While part (a) of Table lists examples of relatively static BIM and facility management data from BeDIC, part (b) of the table lists real-time data generated or updated by the IES. The first two rows of part (b) list closed areas, detours, locations and waiting times of aid stations, and so on. Similar to examples of published data exemplified by the ones in Figure 11, they are made available to all people and readable by systems during emergencies.

In contrast, 3D models of building components (e.g., stairwells and corridors) in row 4 of part (a) and desensitized damage and situation updates and current primary evacuation routes in rows 3 and 6 of part (b), respectively, are released to public only when an emergency in the building is declared. These types of data are accessible by users with normal and emergency accounts at all times, however. Some types of data are released to public only during extreme calamitous conditions (level C and beyond). Examples include when only safe evacuation routes are through private and security controlled areas and when volunteers must be recruited from people in the building to deal with dangerous equipment and materials. The types of data released to public are described in the last two rows of Table 1 part (a). Such data may still need to be desensitized (e.g., with most parts of private areas, identities of the owners, etc. covered) before releasing during a Level-C emergency. In most cases, some accountability conditions, specified by minimum identity and traceability requirement for releasing the information, may be imposed. (For example, the system may require people accessing the information to provide their cell numbers, allow photos of them taken while they pass through the private areas, etc.) Later, in the recovery phase, these people can be tracked down based on their cell phone numbers and photos and held accountable for actions enabled by the information provided to them during the emergency. Table 1 part (a) states that such types of data are likely to be available to users with normal and emergency accounts during emergencies.

Similarly, rows 4 and 5 give examples of types of data that are likely never released to general public for one reason or the other. Again, they can be made accessible to users with emergency accounts via BTG extensions.

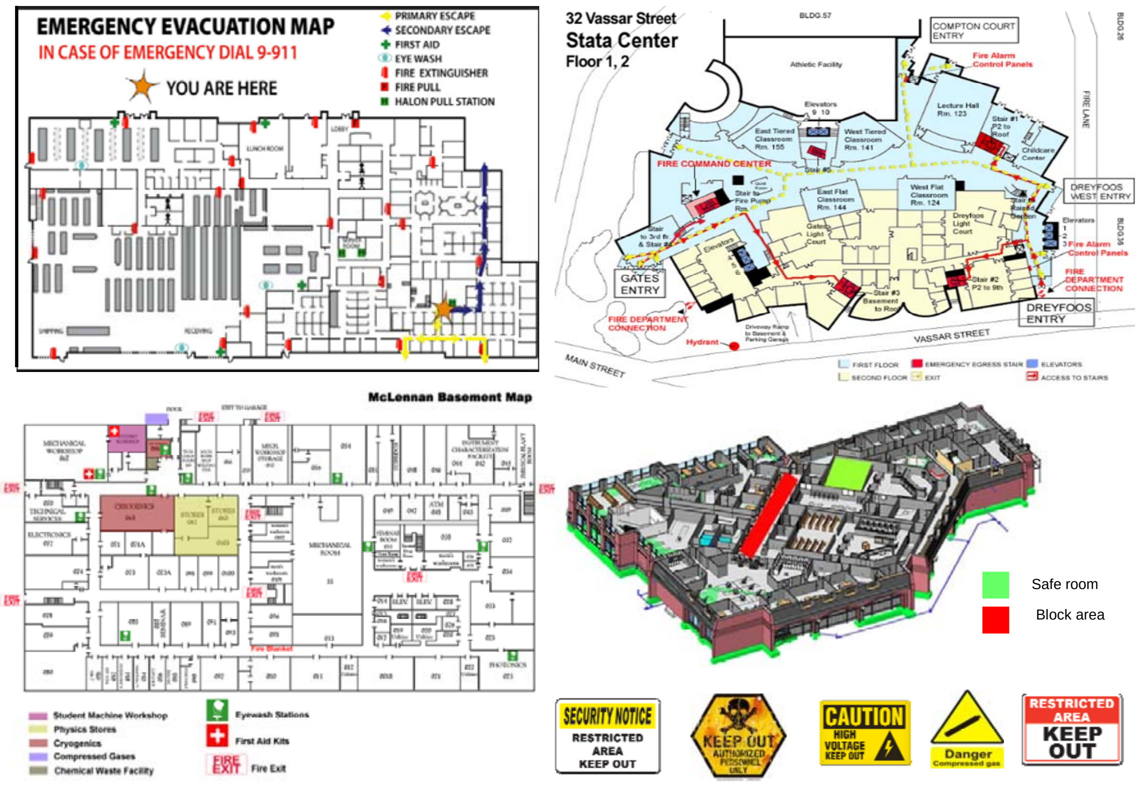

Figure 11 Examples of building and facility data released to public at all times

6. Legal and Regulatory Issues

Issues that must be addressed to make IES for large public buildings in Taiwan feasible and effective include not only technical ones related to their functionalities and design, critical technologies and support information and communication infrastructures. Many legal, policy and government administration issues may need to be addressed and resolved in order to pave the way to their wide deployment and use in buildings of some specified sizes and complexity. This fact motivated us to study Taiwan laws and regulations related to the use of disaster risk reduction technologies and tools, intellectual property rights, collection and usage of personal data, and safeguards of privacy and security which may restrict IES functionalities and constrain their design and implementation. Laws and regulations studied by this effort include the legal basis for governments at all levels to promote the use of disaster risk reduction technologies such as IES and emergency response decisions and operations supported by such systems; laws related to intellectual property and copyright that may affect the use of BIM, and personal privacy protection law. Details on our findings can be found in Appendix VI. This section first presents a summary of the appendix. It then presents proposed ways to refine and strengthen the legal and regulatory basis of IES.

(A) Summary of Laws and Regulations Related to IES

Specifically, Appendix VI first presents laws and regulations relating to the use of IES and related technologies in Taiwan. It then summarizes our findings on intellectual property rights, collection and use of personal data and privacy protection.

- Section VI(A) presents an overview of existing laws and regulations related to disaster prevention, preparedness and response, including Disaster Prevention and Relief Law (災害防救法, DPRL). The law is the basis of Taiwan's laws and regulations related to disaster prevention and response. The implementation and use of indoor emergency evacuation systems fit in Regional Disaster Prevention and Relief Program (各級政府災害防救會之災害防救計畫), which was approved by governments of all levels. Article 10 of DPRL states the local responsibilities in disaster prevention and response, including decision on the adoption of IES and the capabilities of such systems. Another example is Article 24 of 中華民國刑法: The article provides the underlying principles on the range of actions which affected persons can take during emergencies of different severities. Response and evacuation actions recommended by the IES should guided by the principles.
- Section VI(B) presents copyright laws applicable to data in building information models (BIM) and facility management data by IES and the dissemination of the data during emergencies. (An example is the 2D emergency evacuation maps such as the ones shown in Figure 11.) The section presents alternative solutions for removing or loosening the restrictions on the use of copyrighted data and law basis of the solutions.
- Section VI(C) presents laws for personal data protection and collection of personal data. From Section 3 and Table IV-3 on IES data requirements, one can see that data on many attributes of individuals (e.g., body type, physical disabilities, and heart/lung conditions) are needed by the system to compute personalized evacuation plans for all affected people or people at high risks. Existing laws typically restrict the collection and use (disclosure) of such personal information. On the other hand, IES that do not attempt to offer personalized evacuation plans require only locations of people and density distributions of crowds. Such systems can easily work with the restrictions imposed by the laws described here.

(B) Recommended Refinements and Enhancements

Modern urban development strategies call for more and more large multi-function public buildings as a means to improve land and space usage. One expects to see more and more large, complex public buildings in Taiwan in the future. Taiwan being a country with high risk of natural disasters, disaster resiliency and risk deduction are important factors to consider in their development. (For example, as Section (C) argued, facility management and building safety systems of all large public buildings of specified sizes and usages should have three essential IES functionalities: automatic risk reduction actions, automatic notifications and situation awareness and response decisions and operations support during emergencies.) This fact motivated us to make the recommendations listed below:

- Generally speaking, we recommend that regulations governing data and information access, usage and dissemination by IES of large public buildings during emergencies to be fully developed based on the rationales behind the regulations defined by 「傳染病防治法」, that is, regulations and laws for prevention and control of infectious diseases. Doing so can help to make data and information required to provide essential IES capabilities available, readily accessible and usable in preparedness and response for common types of indoor emergencies of different severity levels.
- Many issues related to the use of IES specifically, and technologies for disaster risk reduction in general, should be addressed though Disaster Prevention and Protection Law. While Regional Disaster Prevention and Relief Program can provide some support for the adoption of IES and related disaster information systems and applications, organizations who want to promote the use of IES and related disaster risk reduction technologies might have to persuade each government agency.
- We recommend that related laws and regulations to describe clearly the government's obligation in disaster prevention and responses, specifically regarding the adoption of new technologies for these purpose. It will be speed up the construction and use of IES when further regulations, such as regulations related to BIM and collection and information usage, are taken into account.
- Many issues that are likely to arise through the use of IES and other disaster risk reduction technologies are not addressed by existing regulations. For examples, existing laws/regulations for copyrights and personal information protection makes no mention of exceptional rules. Unlike Article 24 of 中華民國刑法 mentioned earlier, existing personal information protection law does not state conditions under which specified exceptions are allowed. Consequently, the use of IES that make use of personal data to provide individuals with special needs with personalized emergency response directives would run into complicated processes due to legality. For this reason, we recommend that regulations and laws relevant to disaster/emergency risk deduction include exception rules as law for prevention and control of infectious diseases does. The inclusion of exception rules is also essential to guide emergency data security and personal privacy protection schemes such as the hybrid BTG-TIBS scheme described in Section 5 in tradeoff between availability of data and rigor in data access control.

7. Summary and Proposed Work

This exploratory study is on a family of smart systems for indoor emergency evacuation from large public buildings. The systems are referred to throughout this report by the abbreviation IES (Indoor Evacuation System). An IES can respond to alerts and alarms generated by local emergency alert systems warning of fires, gas leaks, explosions, etc. within the facility, as well as alerts from responsible government agencies warning of imminent or observed natural disasters such as earthquakes, flood and landslides threatening the areas containing or near the facility. In response to each alert, the IES works to prevent loss of lives, reduce chance of injuries and minimize property damages.

An observation drawn from case studies carried out by this exploratory work is that all IES in large public buildings should have at least three capabilities. They are automatic activation of risk reduction actions, automatic notification of affected people, and provide emergency manager and responders with sufficient situation assessment and decision support during emergencies. (Section 3(C) provides illustrative examples and justifications for this requirement.) An advanced IES can dynamically and automatically or semi-automatically re-routes people depending on their locations, extents of damages and density and distribution of people, and can provide people with real-time, location-, environment-, and situation specific instructions during emergencies.

The main focus of this work is on data requirements of IES for representative large public buildings/facilities in Taiwan. In addition to determining the data types required by IES for the four buildings selected as targets of case studies and large public buildings in general, this work also investigated technical, legal and regulatory issues that may raise barriers to accessibility of the required data by IES and identified possible steps to lower or remove the barriers. This work is not concerned with the structures and implementation of IES, however. The design and implementation of IES are addressed only to the extent needed to ensure that all data types identified as required are indeed needed for such systems to work regardless the specific methods and algorithms used to implement the essential IES functions.

The remainder of this section first presents an overview of IES data requirements based on the discussions in Section 3. It then briefly describes the proposed technical solutions to indoor positioning and emergency data access issues. Legal and regulatory issues were presented at the end of the previous sections, and hence, are skipped here. The section then concludes the report by presenting a list of proposed work to address the issues with the goal of speeding up the development and deployment of next generation IES and building safety systems for large public buildings in Taiwan.

(A) Summary of IES Data Requirements

Figure 12 presents a simplified architectural model of IES. We use the model to help us present the data requirements of IES of large public buildings in general. The numbers labeling the edges are in accordance with the numbers that identify the types of data in Tables 2 and 3 and the list in Section 3(C). To make this section more self-contained, the list and explanation are duplicated in part below:

- Group 1, building-specific spatial and attribute data – This group of data include geometric models and attributes of building components and resources and hazards in the building. These types of data are an essential input to computation of evacuation routes. Detailed building components and connectivity models can be found from BIM of the building. Sources of data on characteristics and attributes of building components, resources and hazards include the BIM and facility management databases of the building and building code and regulations complied by the building. Sufficiently detailed data and attributes of data on resources (e.g., fire distinguishers, eyewash stations, etc. and use instructions) are available for most buildings, include the sports centers and IIS building. In contrast, data on hazards are often too sketchy for decision support purposes. It is understandable that details on hazards are kept hidden during normal conditions. Data on them should be available to IES during emergencies, as they surely are available to emergency control centers now.

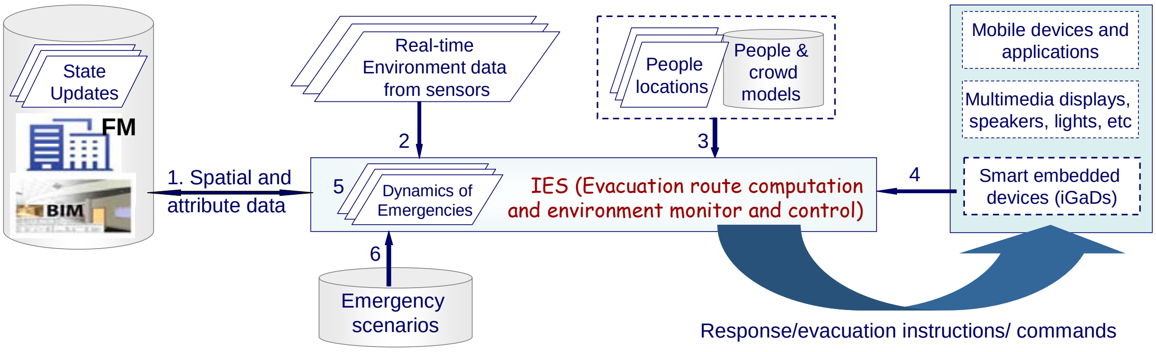

Figure 12 A simplified IES model showing different groups (types) on data

- Group 2, real-time environment data from sensors and surveillance devices – The BIM and facility management databases of the building usually has sufficiently detailed data on number and types of environment sensors (e.g., temperature, humidity and air quality sensors), surveillance cameras, and other sensors at fixed locations.
- Group 3, locations and models of people and crowd – Data of this type include ballpark estimates of the total number of people and spatial distributions of people within the building. How data of this type are acquired differs greatly from building to building, as exemplified by the four test-site buildings. People counters [20] based a variety of technologies can be used to collect such data without tracking movements and exploiting attributes of individuals. Attributes (e.g., body types, ages, functional disabilities) and locations of individuals needed to compute individualized evacuation decisions include the ones listed in Table IV-3. Acquiring such data require identifying individuals and tracking their movements within the building to some extent. There are laws preventing the collection of such data. (Examples can be found in Section VI(C) in Appendix VI.)
- Group 4, data on output devices, i.e., data on types, capabilities and locations of devices and applications which the IES can use to deliver location-specific instructions and directives to affected people and smart risk reduction devices. Data on devices at fixed locations are provided in part by the BIM and facility management databases. Delivery of individualized response instructions requires data on the types and locations of mobile devices and applications. This kind of information requires the system to monitor and track mobile devices and applications on them.
- Group 5, building-specific real-time and dynamic data on the building and environment (e.g., the length of time the building core can stay intact in a fire as a function of temperature), development of the emergencies (e.g. the spread of smoke and heat), and mobility of people (e.g., the speed people can move in a crowd). – Only limited types of such data are available even for recently-built buildings such as the sports centers. Figure 12 assumes that the IES has simulation and analysis tools to generate such data.
- Group 6, results of scenarios analysis for common emergency types – Data obtained from

[20] People counters: https://en.wikipedia.org/wiki/People_counter

analysis of likely scenarios of common emergency types in similar buildings and assessment of preparedness and response actions can be used by IES algorithms and tools to make better decisions in shorter time. Consulting scenario database is indeed done by emergency command and control center of test-site buildings according to the flow charts presented in Appendix V.

(B) Solutions to Indoor Positioning and Emergency Data Access

Sections 4 and 5 presented two technical solutions to provision, collection and use of data by IES. The indoor positioning system BeDIPS is scalable, disaster resilient and easy to maintain. Unlike existing approaches to providing people with indoor positioning information, including the system used in New Taipei City sports centers, BeDIPS requires only that the receiving mobile devices are Bluetooth enabled. Moreover, the location beacons provided by the system can deliver location-specific instructions to people during emergencies. An advantage of the system is that each beacon can provide an estimate of number of people under its coverage without tracking the movements or identities of people.

The hybrid BTG-TIBS data access control scheme described in Section 5 can be used by IES to protect data security and privacy during emergencies in ways defined by emergency data access policies. The scheme divides all people in the building into general public and separate them from groups of users (such as firemen, medics, etc.) who by prior arrangement are giving accounts for emergency access to data. Users (or devices used by them) with accounts can be identified and authenticated during emergencies. A hierarchy of Break-the-Glass emergency data access policies governs per-access overrides of normal access control decisions for read/write requests from them. It is impossible for the system to authenticate general public, however. The system uses an accountability-based scheme to release desensitized data to them. The use of such as hybrid scheme can help the system to control release of data according to the privacy protection laws.

(C) Proposed Future Work

In addition to recommendations/proposals related to laws and regulations presented in Section 6(C), this work has led to the recommendations summarized below. They all are motivated by the observations and insights gained from the work done as a part of this exploratory study and aim to enhance the availability of data for IES direct or indirectly and speed up the process of the adoption of IES in public buildings.

- **Extensions and adoptions of standards**

  We suggest the adoption of two standards related to emergency preparedness and response: They are emergency severity index and CAP (Common Alert Protocol).

  - Standard severity index for indoor emergencies - As stated in Section 3(A), there is no well defined, standardized indexes for categorizing indoor emergencies according to their severities similar to medical emergency severity index (ESI). From the definition of ESI, it is possible to define medication data requirements and put in place data access policies for emergencies of different severities. In contrast, the definition of the color codes for emergency severity levels (See Figure 4) does not go far enough regarding the thresholds between different levels. The definition also does not address how data access and usage policies and allowed response actions/operations depend on the severity levels.

- Extension of CAP for indoor emergencies - The OASIS Common Alert Protocol (http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html) is an international XML-based standard for encoding alert messages. It is widely adopted worldwide, including Taiwan and Australia, for messages alerting of typhoons and severe weather, earthquakes, floods and debris flows, in US, even amber alerts about lost children. CAP compliant messages are machine readable and hence can be processed automatically by systems like IES, as well as smart disaster risk deduction devices (e.g., automatic fire doors and gas valves) and CAP-aware disaster risk reduction applications. CAP is also intended as a standard for messages exchanged between emergency information systems, aggregation and correlation of warnings from multiple sources, and automatic reports by sensor systems to analysis centers. This work assumes that CAP format is used for all alerts messages, including not only alerts issues by government agencies (e.g., Central Weather Bureau) but also alerts from building safety systems (e.g., fire alarm system). We proposed the make the use of CAP format a standard for all indoor emergency alerts within public building. The increase in the application scope of CAP will require extension of the protocol. Taiwan has recently developed CAP-TWP (CAP Taiwan Profile), which is a localized version of CAP for use in Taiwan. This is good time to extend the protocol for use of alerts/warnings of indoor emergencies.

- ***Development of emergency scenarios and SOPs for representative large pubic buildings***

  Realistic emergency scenarios for common types and likely severity levels of emergencies are effective tools for the development of standard operation procedures for emergency preparedness and response. As Section 3 and Appendix V show, likely scenarios are also the basis for the identification of data and information required to support emergency preparedness and response decisions and operations within the building. Accountability-based schemes such as the proposed BTG-TIBS schemes works well when data required in likely scenarios can be desensitized before they are released. We propose that likely emergency scenarios in several representative public buildings to be either developed from the start or built on existing ones. The scenarios can be used by projects such as this one as benchmarks for experimentation and evaluation purposes in the future as well.

- ***Development of emergency data access control policies and identify changes in laws and regulations to allow the policies***.

  Many issues are likely to arise through the use of IES and other disaster risk reduction technologies, and they are not addressed by existing laws and regulations. For example, an advanced indoor emergency evacuation system that has data on physical conditions, ages, body shapes of individuals in affected areas can make individualize decisions to keep them safer, but collections of such data by the system may not be allowed by laws. Section 6(C) suggested the inclusion of exception rules in related regulations and laws and thus in part enable the implementation of this and other advanced disaster risk reduction capabilities that require data and actions not allowed by laws and regulations during normal times. We also recommend that development of emergency data access control and accountability policies for selected large public buildings in Taiwan based on like emergency scenarios. This work will identify the types and extents of exceptions which unless allowed by laws during emergencies will make some emergency response decision and operation support capabilities infeasible.

8. References

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Appendix I 現行建築技術規則（Existing Building Code and Regulations)

現行建築法規已有建築物防災相關的規定，例如建築技術規則「建築設計施工篇」以及「建築設備篇」皆有相關條文，對於建築材料之防火係數、材質、面積等加以規範。目前的 BIM 圖檔可以協助處理法規審查中的「實體元件」，例如建築元件的材料、防火係數或一些基本屬性等等，也可以透過電腦計算面積來檢核是否有達到法規中規定之面積。智慧建築標章中關於防災的評分基準(如表 I-1 所示)，主要也是指認建築是否有表列的實體元件來作評分。表 I-2 為建築技術規則防災相關資料項目。

然而，目前 BIM 圖資元件尚不包括一些「抽象元件」，如圖 I-1 所示，而這些抽象元件往往又是左右避難路徑之重要資訊。抽象元件之處理需要再透過如語意或是知識本體等方式加以指認、分類，在進一步配合軟體進行分析，方能達到法規審查自動化之效益。

元件	屬性(值)	法規
街廓	防火區	第63條
所有建築元件	材料(是否為不燃材料、耐燃材料級數)	第68條、第79-2條
柱、樑、承重牆壁、非承重外牆、樓地板、屋頂、樓梯、屋頂突出物	防火時效(無、半小時以上、1小時以上、2小時以上、3小時以上)	第70-74條
門窗	是否為防火門窗?常時關閉式? 防火捲門? 朝避難方向開啟?	第75、76條

無法處理抽象概念

避難通路	寬度、長度	第90條
避難層	面積	第90-1條
屋頂避難平台		第99條

圖 I-1 建築技術規則中實體元件與概念元件示意圖

表 I-1 防災安全指標之「建築物防災」指標基準評分原則表

(資料來源: 智慧建築解說與評估手冊 2011 年版)

項次	指標項目	評估項目	評估基準	配分	配分原則
一	防火系統	設置防災中心或中央監控室	防災中心(或中央監控室)內設置系統主機、監控主機、火警廣播設備控制裝置及消防專用通信設備。(基本性)	2	符合各類場所消防安全設置標準規定之各子系統。
		火警自動警報設備可自動探測各種火災徵兆並自動確認火災警報之正確性並通報。	系統設置火警自動探測設備，以探測煙霧濃度、溫度差、光電或其他可燃性氣體濃度等。(基本性)	2	經查核火警自動警報設備具有檢知之性能。
			系統設置火警警鈴、緊急廣播等警報避難系統。(基本性)	2	該避難系統必須由防災中心直接分層監控。
			系統能檢測火警自動探測設備之警報正確性。(基本性)	2	經查核系統能檢測火警自動探測設備之警報正確性。
			系統對火警自動探測設備提供可靠的監測數據和警報資訊。(基本性)	2	對火警自動探測設備提供可靠的監測數據和警報資訊。
		可顯示火災處所相關室內位址	系統能顯示火警區域或火警點的狀態信號及其平面位置。(必要性)	2	**1 分**：能定址出火警之區域所在。 **2 分**：符合上述，並以圖控方式詳細顯示火警區域/位置/火災程度和疏散等資訊。
			建築物各區域或樓層設置識別火警位置的聲光顯示裝置。(鼓勵性)	2	**1 分**：在各區域或樓層裝有聲光顯示裝置。 **2 分**：在各區或樓層裝有圖控軟體等聲光顯示裝置。
		通過依據消防法規規定之消防設備檢查	通過依據消防法規規定之消防設備安全檢查。(必要性)	2	**1 分**：委託專業單位每 12 個月定期性之消防設備檢查。 **2 分**：委託專業單位每 6 個月定期性之消防設備檢查。

項次	指標項目	評估項目	評估基準	配分	配分原則
一	防火系統	防火系統故障之自動回報及記錄系統	系統平時與各子系統動作迴路自動檢測並記錄其檢查結果，故障時即發出信號警報。(必要性)	2	**1 分**：系統保持檢測狀態，電路故障隨即發出警報。 **2 分**：符合上述，且系統與各子系統動作迴路自動檢測並記錄其檢查結果，故障時即發出信號警報並標示出故障位置。
		可自動啟動滅火設備及防止火災擴大	系統能顯示所有消防設備之狀態。(必要性)	2	**1 分**：系統以 LCD 中文顯示幕監測消防設備之狀態。 **2 分**：系統以圖控軟體之顯示監測消防設備之狀態。
			系統能擔負整體滅火的聯絡與調度功能。(必要性)	1	經查核確實裝設。
			系統能監控排煙設備。(必要性)	1	經查核確實裝設。
			系統能監控防火門及防火鐵捲門。(必要性)	2	**1 分**：經查核確實裝設。 **2 分**：符合上述，並且為「住宿類」、「衛生福利更生類」或「商業類-旅館」者。
			二段式下降防火鐵捲門(鼓勵性)	1	為「住宿類」、「衛生福利更生類」或「商業類-旅館」者。
		火災發生後能自動並即時有效引導人員避難	設置符合需求之緊急廣播系統。(基本性)	4	**2 分**：緊急廣播內容能符合安裝場所使用特徵與災害境況。 **3 分**：符合上述，並且為「商業類-旅館」及「商業類」者。 **4 分**：符合上述，且採分區廣播，並為「公共集會類」或「衛生福利更生類」者。

項次	指標項目	評估項目	評估基準	配分	配分原則
一	防火系統	火災發生後能自動並即時有效引導人員避難	系統採用具有聲響的避難方向指示燈。(鼓勵性)	2	**<u>1 分</u>**：系統採用具有聲響的避難方向指示燈。 **<u>2 分</u>**：符合上述，並且可視情況調整指示方向。
			火災發生時，系統能以自動或手動方式控制昇降機依次迫降於避難層，並使一般昇降機停止運轉，而緊急升降機待命。(必要性)	1	系統能以自動或手動方式控制升降機，並顯示升降梯目前狀態。
		其他	其他可達實質成效且視需求採用之創新技術與工法。(鼓勵性)	2	依需求及其達實質成效之相關佐證斟酌給分。
二	防震抗風系統	設置建築物結構安全狀態監視系統或地震記錄儀	建築物設置監控裝置以監控重要結構桿件或部位之結構變化狀況，以便進行結構桿件補強或更新以確保建築物結構系統安全。(鼓勵性)	1	設置建築物結構體控制系統，採用圖控軟體，隨時監控結構體安全性。
			建築物設置地震紀錄儀，以記錄地震反應。(鼓勵性)	1	經查核確實裝設。
		設置隔震系統或被動、主動制震或抗風系統	建築物採用基礎隔震、阻尼消能裝置或主動控制等減震技術以降低建築物所受地震力。(鼓勵性)	2	經查核確實採用減震技術。
			建築物設置抗風系統，以降低風力對建築物之搖晃程度。(鼓勵性)	1	經查核確實裝設。
		建築物內設置避震裝置及管線耐震設計	建築物地板設置避震裝置，以防止重要設備或物品遭地震破壞。(鼓勵性)	2	經查核確實裝設。
			建築物各種管線具有足夠耐震能力或韌性以防止其因地震力作用而斷裂。(鼓勵性)	2	建築物各種管線具有建築物耐震設計規範與解說規定以上之耐震能力或韌性以防止其因地震力作用而斷裂。
		其他	其他可達實質成效且視需求採用之創新技術與工法。(鼓勵性)	2	依需求及其達實質成效之相關佐證斟酌給分。

項次	指標項目	評估項目	評估基準	配分	配分原則
三	防水系統	設置漏水警告設備	於建築物需要嚴密控管溼度或水氣之空間設置感應器。(鼓勵性)	1	經查核確實裝設。
			於機電設備空間等相關場所偵測漏水現象並自動發佈警告信號。(鼓勵性)	1	經查核確實裝設。
		設置淹水偵測設備	建築物之地下或低窪地區設置淹水偵測設備。(鼓勵性)	1	設有淹水偵測裝置並可顯示水位高低，發出不同警報。
		設置防水閘門	建築物之地下入口設置防水閘門並與監控設備連動。(鼓勵性)	3	<u>**1 分**</u>：建築物之地下入口設置手動防水閘門。 <u>**2 分**</u>：防水閘門連接監控設備並且可自動(手動裝置為輔)開啟與關閉。 <u>**3 分**</u>：符合上述之一，並且為「住宅類」或「衛生福利更生類」者，予以加分(一分為限)。
		設置抽排水設施	建築物之地下室或低窪地區依據該區域之災害潛勢分析，設置抽排水設施。(鼓勵性)	3	<u>**1 分**</u>：建築物之地下室或低窪地區依據該區域之災害潛勢分析，設置抽水幫浦。 <u>**2 分**</u>：符合上述設置之抽排水設施可與淹水偵測設備連動。 <u>**3 分**</u>：符合上述之一，並且為「住宿類」或「衛生福利更生類」者，予以加分(一分為限)。
		其他	其他可達實質成效且視需求採用之創新技術與工法。(鼓勵性)	2	依需求及其達實質成效之相關佐證斟酌給分。

表 I-2 建築技術規則防災相關資料項目

元件	屬性(值)	法規
建築設計施工篇		
街廓	防火區	第 63 條
所有建築元件	材料(是否為不燃材料、耐燃材料級數)	第 68 條、第 79-2 條
柱、樑、承重牆壁、非承重外牆、樓地板、屋頂、樓梯、屋頂突出物	防火時效(無、半小時以上、1 小時以上、2 小時以上、3 小時以上)	第 70-74 條
門窗	是否為防火門窗?常時關閉式? 防火捲門? 朝避難方向開啟?	第 75、76 條
撒水幕		第 75 條
其它防火設備	性質(是否遮煙?)	第 75、99-1 條
防火區劃		第 79 條
自動滅火設備		第 88 條
排煙設備		第 88 條
避難通路	寬度、長度	第 90 條
避難層	面積	第 90-1 條
屋頂避難平台		第 99 條
安全梯	戶外安全梯、特別安全梯、 一般安全梯	第 96 條
緊急電源之照明設備		第 97 條
緊急照明設備		第 104 條
管道間之維修孔		第 97 條
排煙室		第 97 條
陽台		第 97-1 條
排煙設備	是否需要電源	第 100 條
防煙壁		第 100 條
排煙口	不燃材料	第 101 條
排煙風道（管）	手搖式、自動開關、遙控式 不燃材料	第 101 條
排風機	排風量	第 101 條

中央管理室		第 101 條
進風排煙設備		第 102 條
緊急用昇降機	活載重、最大容許乘座人數	第 106 條
緊急電源插座		第 107 條
消防栓	室內,室外	第 107、114 條
出水口		第 107 條
緊急進口		第 108 條
滅火設備	自動撒水設備、水霧自動撒水設備、自動泡沫滅火設備、自動乾粉滅火設備、自動二氧化碳設備或自動揮發性液體設備	第 113、114 條
警報設備		第 113 條
標示設備	出口標示燈、避難方向指標	第 113 條
危險物品貯藏庫		第 114 條
手動報警設備		第 114 條
廣播設備		第 114 條
安全維護照明裝置		第 116-2 條
監視攝影裝置		第 116-2 條
緊急求救裝置		第 116-2 條
警戒探測裝置		第 116-2 條
無障礙通路		第 167 條
無障礙樓梯		第 167-2 條
無障礙廁所盥洗室		第 167-3 條
地下水位觀測站		第 199 條
燃氣設備		第 201 條
鍋爐設備		第 201 條
給水管	不燃材料	第 205 條
瓦斯管	不燃材料	第 205 條
配電管	不燃材料	第 205 條
其它管路	不燃材料	第 205 條
自動撒水設備	密閉濕式、密閉乾式、開放式	第 207 條、建築設備 54 條
消防隊專用出水口設備		第 209 條

漏電自動警報設備		第 210 條
瓦斯漏氣自動警報設備		第 211 條
自動消防設備	自動撒水、自動泡沫滅火、水霧自動撒水、自動乾粉滅火、自動二氧化碳、自動揮發性液體等消防設備	第 213 條
緊急用電源插座		第 213 條
空氣調節設備		第 218 條
機械通風系統		第 219 條
新鮮空氣進氣口		第 222 條
緊急進口		第 233 條
偵煙型探測器		第 257 條
老人住宅(空間範圍)		第 293 條
專供行動不便者使用之昇降設備		第 297 條
消防車輛救災活動空間		第 299 條
建築設備篇		
消防幫浦		第 7 條
X 光機或放射線設備		第 15 條
游泳池		第 16 條
消防栓箱		第 47 條
重力水箱		第 48 條
地下水池		第 48 條
消防水泵		第 48 條
壓力水箱		第 48 條
加壓水泵		第 48 條
送水口		第 49 條
屋頂消防栓		第 50 條
自動警報逆止閥		第 60 條
自動火警探測設備	定溫型、差動型、偵煙型	第 67 條
火警警鈴		第 73 條
火警受信總機		第 75 條

Appendix II 建築資訊模型（Background on BIM）

建築資訊模型 (Building Information Modeling,以下簡稱 BIM) 的概念係起源於 1970 年代，美國喬治亞理工學院之查爾斯伊士曼(Charles Eastman)教授 1999 年出版的書[21,22]進一步的幫助促進此概念和應用。Autodesk[23]公司在 2002 年，開始將 BIM 納入該公司的 AEC（Architecture, Engineering, and Construction）相關產品。隨著相關產品及工具接連的開發與技術的成熟，近年來 BIM 的應用大幅增加[24]。

BIM 用於營建設施 (例如建築物、道路、橋梁等) 之生命週期內，建構維護營建設施之數位資訊及工程應用技術，強調相關生命週期之資料的收集 (例如建築、土木、水利、河海等各類工程等)，以永續應用為概念，透過跨領域的整合與 3D 視覺化的呈現方式、靜態與動態資訊的即時掌握，將幾何與非幾何資訊連結、整合巨觀及微觀的空間資訊。達到公共工程品質提升、跨領域的專業整合、溝通交流介面的有效管理、減少修正錯誤的成本浪費、縮短工程期程。

當利用電腦模擬建築之三維空間之模型時，模型中每一構件具有立體化、參數化、同步性，可成 BIM 之條件，BIM 具有完整的連動性，當部分構建建立平面資訊時，可立即產生立面資訊，使建築資訊連貫並具有一致性，更可以直觀的了解建築的配置，強化工程師的空間組合能力，因此 BIM 可有效的導入施工分析。

BIM 在不同使用中，因為時機及目的的差異，可以包含以下三種意義，當用來描述建築數位化的 3D 模型時，強調其型與意，作為結構化的資料集，此時稱為「建築資訊模型」，被當成一個「產品」，此外，當用以建置及管理建築資訊模型時，此時稱為「建築資訊建模」，被認定為一項「活動」，再者當用營建業導入 BIM 時，運用 BIM 本身系統化集體運作的特性，類似在新的商務系統，此時稱為「建築資訊管理」，被稱為一套「系統」。

(A) BIM 之相關特性

直到最近為止，工程設施的交付過程，通常以書面的溝通模式為主，由於此過程太過零碎，經常發生遺漏與錯誤，已致於必要的成本浪費於工程延遲，甚至引發契約官司與團體糾紛等相關問題，即使利用 3D CAD 的工具，雖化簡化了冗長的資訊交化過程，但並無法有效且正確的掌握時間與成本，這類非空間領域的資料。

如今，6D BIM 已是一個廣泛應用的概念，BIM 模型不只有空間元素的長寬高三個維度之 3D， 也加入施作工程的「時程」作為第 4D，以及工程「費用」為第 5D，使在工程進行中能夠更精準的掌控成本的運用，此外為了後續更有效的利用，以及替代傳統難以保存且佔用空間的紙本書面溝通方式，納入「設施管理工具」，為第 6D。

BIM 透過參數物件的概念，使其與傳統的 3D 物件相異，包和幾何定義、關聯的資料和規則，當利用 3D 顯示時，其形狀內的平面與立面必須一致，不能有多餘的贅

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[21] Eastman, Charles, *Building Product Models, Computing Environments, Support Design and Construction*, CRC Press, 1999.

[22] 賴朝俊、蔡志敏(譯) (2013)，「BIM 建築資訊建模手冊」(原作者:Chuck Eastman & Paul Teicholz & Rafael Sacks & Kathleen Listin)，臺北:松岡資產管理股份有限公司

[23] Autodesk Company and Autodesk Revit, http://www.autodesk.com/products/revit-family/overview

[24] BIM for Facility Managers, Paul Teicholz, Ed.,Wiley, March 2013; YouBIM, http://www.youbim.com/about-youbim.html; FM: Systems, http://www.fmsystems.com/company-overview/; "Integrating BIM with Building Automation Systems," http://www.tradelineinc.com/reports/2012-4/whitepaper-integrating-bim-building-automation-systems, April 2012

加，尺寸也必須統一，建入一個建築模型時，當其相關聯的物件有任何修改，物件的參數化規則，使其可以自動修改相關的幾何形狀，此外，物件也可以被定義為不同層級的集合，所以可以定義一個物件及其相關元件，因此由物件的規則可辨別出特定變更是否違反物件的可行性，因為此種特性物件可以連結或接收、廣播、或輸出屬性集到其他的應用程式和模型。

BIM 提供專業團隊的協同作業，將專案及書面的工作流程自動化，將相關資料(3D、CAD、資料庫、動畫、電子表格等)，整合到一個可交流的工作流程中，各項任務被整合成一個可以協調與合作的過程，將資料整合成資訊及知識，以實際狀況為基礎，將重複的、可核查的決策過程，作為可用來模擬及操作實際模型，以利於降低風險，並提高整體工程之品質。

建築的設計和建造工程是一個團隊合作的活動，每種專業類型和活動都有自己的應用程式，不但可應用於幾何體與材料配置的功能，也支援建築性能相關的結構和能源應用。由於施工進度非幾何體的表現，以及每個子系統(混凝土、鋼筋、管線、水電等)的構建都有其專門的細部表現方式。

交換性可以使在另一個應用程式的資料，不用人工複製，此資料運算可以解決更複雜問題的最佳解決方案，如結構或是能源設計，也可以避免人工複製的錯誤，交換性開闢了自動化的新路徑。

BIM 可呈現多種幾何形體的關係、屬性，和不同的行為屬性，利用開放的介面，匯入相對應的資料及匯出各種類型的資料，透過使用相同軟體供應商的產品，或是不同應商的軟體，但這些軟體是可以適用業界支援的標準，使得資料交換。

(B) BIM 應用領域

BIM 的技術在建築領域的利用能夠支援與改善許多業務上的實務問題，整體上可以建築設計與施工更高複雜度及更快發展，並增進其永續性、減少建築物的使用與管理成本，在不同階段 BIM 給予了不同的幫助[25]，主要可以分為設計階段、施工階段及完工後的營運管理階段。

- **設計階段**: BIM 的建築設計，是透過 3D 模型的軟體，而非多個 2D 視圖，圖面資料的統合，使得尺寸統一，任何物件與專案的特定專業圖面，可以確保物件都是對齊且正確的，可以減少空間協調上的錯誤，更可以做低階的自動更正，當需要修改設計時，可以產上一致的繪圖過程，也因如此，可以加速多個專業同時作業，縮短設計時間，漸少錯誤與遺漏，在做完重大的設計決策後，再進行價值工程的分析與成本的預算，讓過程更符合成本與經濟的效益。

  透過 3D 的視覺化，將空間面積與其材料數量化，可以更早及更精準的預估成本，對於技術性的建築(實驗室、醫院及類似的公共建築)，設計的元件與意向透過量化的定義，能夠裡用 BIM 來檢查一個建築模型是否滿足這些需求，3D 模型也可以自動評估，做簡單的驗證。

  BIM 的技術可以預估正確的數量與空間清單，根據數輸入專案重要數量的公式，可以預估成本，在設計進展到施工前需要的詳細程度，透過 BIM 可以讓各專業知道與設計相關的費用，在設計最後的階段，一具模型中包含的物件數量為基礎，能夠精確的預估最終的成本，BIM 以此為基礎，可以提供更明智的設計決策。

[25] 游澄發、李昀隆、 正岡顯宏(2012),「BIM 在營造業運用經驗分享」,捷運技術半年刊 第 47 期; 郭榮欽、謝尚賢(2011)，BIM 技術與公共工程，100 年公共工程電子報，第 38 期

- **施工階段** 設計模型被轉移至 BIM 的複製工具中，複製模型的精確呈現建築物件，使用數值控制機器進行自動化的製作，目前以成功被運用到預製元件、開窗、和玻璃製造，使得異地製作更為便捷，更降低成本與施工時間。這樣的特性，能夠因應依據施工現場的變更或是需要等到其他項目施工後才能得到精確尺寸的情況，以利於快速的反應設計的變更。BIM 也使所有專業領域的模型可以集合一起比較，多個系統可以在同一系統上及視覺上做檢查，使得衝突與施工的問題，可以在現場檢測前就被發現，強化設計者與包商之間的溝通協調，加快建造的時間及減少成本的浪費，這些數量、規格及屬性物件，可以作為採購的依據，讓設計、施工及採購同步化。進行 4D CAD 的建設規劃，加入時程的概念，在任何時間點顯示建築物與基地的圖形模擬，可以了解建築每天如何被建造，發現潛在的問題與需要改進的地方，例如人員、設備、空間衝突、安全問題等等，更可以反應臨時建築物件的現況 (防護牆、鷹架、起重機等)，提供附加的價值，連結工期的活動，使施工過程能夠有效的控管，減少精力與材料的浪費，降低成本。
- **營運管理階段** 根據設計與施工階段所建立的資料，集合已安裝的材料及建築物系統相關維修資訊，這些資訊可以作為業主設施管理的基礎，提供更好的設施管理和營運。建築模型可以支援即時監控的系統，作為感應器自然的介面，和施設的遠端管理、BIM 提供的理想平台，當設備出現問題，使用人的通報或是整合的儀控系統，判斷其嚴重性，產生不同的處理方法，並記錄設施障礙或是維修紀錄，有無其他相關聯的系統受到影響，即時了解與排除問題，提供複合性的解決方法與避難系統。

(C) 在國際間 BIM 作法的比較

因資料整合的困難，各國目前仍大多致力於資料轉換與整合的工作，以提高不同專業間之工作效率。表 II-1 比較四個國家應用 BIM 的現狀:

表 II-1 國際間 BIM 應用比較

國家	主要應用	特色
美國[26]	核心標準（Core Standards) 如 ISO 標準、資訊交換標準等 技術文獻、如參考流程、範例等 實施布署資源 (Deployment Resources）如契約範本、最佳實務指南等	2003 年、總務管理局（GSA），通過其公共建築總設計師服務辦公室，建立全國 3D-4D-BIM 計劃。 2006 年、GSA 規定通過其公共建築服務設計的新建建築必須使用 BIM。 2007 年、建置 NBIMS-US[27] (National BIM Standard) 、為偏重於電腦資訊技術性質的指導文件，內容在於建立 BIM 資訊交換需求的流程，工程團隊個專業在各階段中，約定在何時建立何種程度的模型，確保模型中具有正確且充足的資源，可分享與利用。

[26] 全球 BIM 新聞(2011)，美國營造廠商：「BIM 炙手可熱。」，2011/10/21
[27] National BIM Standards – United States, http://www.nationalbimstandard.org/

英國	除了常見的 2-3D 應用，2016 年之策略目標，是希望個專業都有能力建置 BIM 模型，進行整合應用[28]。由中央政府組織 BIM Task Group，結合英國皇家建築師學會、英國營造業協會、英國標準協會等，合作進行研究。	不專注於建築資訊建模的技術，而是重整體的供應鏈，將客戶端納入考量，透過「推力與拉力」的策略，訂定相關建模指示、資料格式及人才培訓為推力，公部門明確說明 BIM 須交付之事項為拉力，兩者建置的規範相互連結。
中國大陸	「底層標準」：包括「數據庫標準」、「存儲標準」及「信息分類標準」。 交付標準：指配合政府機關、業主商務需求或契約規定對於模型的相關規範。	因缺少資訊整合的標準，無法分享建檔資訊，因此中國大陸以設定 BIM 共通技術為目標，將現有的軟體產品、建模技術及資訊標準整合。
新加坡	CORENET 計畫，要讓相關業者在建築及房地產部門高效率進行溝通及資訊交換。建置 e-Submission（電子送審)平台、e-Plan Check（建照電子審批)系統及 e-Info（建築和房地產資訊整合)平台	由民間推動運用 BIM 作為基礎，銜接政府的 CORENET 計畫，由政府來培訓業界人才，結合 RFID、GIS 等技術。

(D)在台灣的 BIM 實際應用

表 II-2 列出五個在台灣 BIM 實際應用的案例[29]:

表 II-2 台灣 BIM 案例比較

名稱	特點說明	管理層面
富邦 A10 商旅大樓興建案	在衝突檢查階段納入空間優化流程，提升空間價值。	
國家運動選手訓練中心整建計畫	利用 BIM 模型提高叫修採購的時效性	
BIM 應用於建築物消防安全	針對模型細緻度的要求	設施管理
以 BIM 模型為基礎之防災管理案例探討	結合火災模擬軟體 FDS 協助 BIM 繪製避難路線。	設施管理
BIM 應用於專案管理－以新北市三重、蘆洲、淡水運動中心為例	在施工前納入 BIM，結合專案管理，使工程案能順利接軌設計與施工部分。	專案管理

- **富邦 A10 商旅大樓興建案**[30]:富邦建設於本案營建發包契約中納入 BIM 技術服務，委託台灣世曦工程顧問公司 BIM 整合中心執行。

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[28] AEC (UK) CAD & BIM Standards Site, https://aecuk.wordpress.com/downloads/

[29] 鄭元良、張寬勇(2011)，建築資訊模型(BIM)於建築物，（內政部建研所研究計畫); 何明錦、 劉青峰(2014)，借鏡國際作法、構思臺灣 BIM 策略，中國工程師學會 工程雙月刊，第 87 卷 05 期：頁 18-25

[30] 江英二、李萬利、蘇瑞育(2011)，BIM 於商旅大樓興建工程之施工應用實務與效益，中華技術季刊，91，第 80-91 頁

總流程共分為 BIM 模型建置與衝突檢查流程，BIM 模型建置中有檔案架構、基礎模型建置與機電模型建置，架構分為建築、結構與機電，機電中又含括電力、空調排煙、消防與排水等子系統，便於分工執行專案，並利用 BIM 作業標準使檔案間品質達標與能夠互相連結；基礎模型建置之目的為衝突檢查之基礎；機電模型則透過建置過程檢討管線配置之合理性與衝突。

衝突檢查階段有衝突檢查與空間優化等流程。在衝突檢查中首先必須檢查建築與結構之間的衝突，接下來才是機電管線。機電管線中可能產生的問題有管線硬碰撞、空間使用機能與視覺衝突，在施工前便解決衝突、提升建設效率與品質。空間優化則是可利用來提升空間價值與減少視覺壓迫等附加的階段。

透過 BIM 模型達到視覺化溝通、節省工程造價與變更設計次數。後續可實行於營運管理，分為維護計畫、資產管理及空間管理，利用 BIM 可即時更新資料庫與瀏覽歷史紀錄、報修設備便於追蹤管線甚至於商場與旅館之空間管理皆能應用。

- **國家運動選手訓練中心整建計畫[31]:** 國家運動選手訓練中心為內政部營建署之公共工程，利用 BIM 技術使相異的施工者之間工作得以配合協調，並在施工前預估並修正衝突情形，減少現場加工的成本。建置項目包含整棟土建模型與機電建置模型，應用於衝突檢查以及後續保固維護、叫修採購時效性。

- **BIM 應用於建築物消防安全:** 此研究為一內政部建築研究所之計畫，研究成果擬將 BIM 應用於消防安全檢修，將模式定為準備、執行與內業階段。準備階段中可提供 BIM 模型資訊庫，查看消防設備資料，方便了解設備種類、位置與歷史紀錄等等；檢修階段時可以定位設備狀況，更新資訊同時透過顏色區別完成與未完成檢修的設備，方便管理進度；在內業階段，系統會自動分析以產出相關報表。

  在 BIM 模型細緻程度上，結構體與建築裝修之細緻度僅需達 LOD200，而消防設備外觀規劃為中等程度 LOD300，元件參數則為 LOD500，提供正確位置與檢修需求。此研究另提出中長期建議，整合各建築 BIM 模型於消防監控系統，當 BIM 有標準格式時，平日可整合於消防署的相關監控系統與檢修申報系統，災害來臨時可迅速調出所需資料，即時調派車輛等。

- **以 BIM 模型為基礎之防災管理案例探討[32]:** 此本研究以新竹某環形公用高科技廠房為例，竣工時於 BIM 模型內加入火災模擬軟體 FDS (Fire Dynamics Simulator)，評估逃生安全性、並規劃避難路線，同時可以檢討公共空間之防災設備配置。

- **BIM 應用於專案管理[33]**:以新北市三重、蘆洲、淡水運動中心為例、此研究探討建築設計與施工介面整合，以專案管理 (Project Construction Management, PCM) 為主軸，利用建築資訊模型(BIM)，彙整出一作業管理架構，提升 BIM 作業成效。除此之外，另檢討生命週期各階段 BIM 作業內容應符合哪些要求。

(E) 國內 BIM 之應用與公共避難相關內容和結論

在各項整合工作中，有關於避難防災部分，目前沒有特別說明，大多在法規的契合與檢驗，以台灣目前的建照 E-checking 為例，有部分相關，但尚未健全，主要以面積及

[31] 丁育群(2014)，內政部營建署於營建工程導入建築資訊模型之推動與應用，中國工程師學會工程雙月刊，87(05)，第 10-17 頁

[32]石世祐(2013)，以 BIM 模型為基礎之防災管理案例探討，國立交通大學 土木工程系所碩士論文

[33] 林星岳(2014)，建築資訊模型(BIM)於專案管理之應用-以新北市三重、蘆洲、淡水運動中心為例，國立台灣科技大學 建築研究所碩士論文

尺寸的 2D 資料為主，對於動線、指引方面的動態資訊是缺少的、如圖 II-2 所示。

綜上所述、目前公共建築避難資訊系統圖資內容以設備及空間數量為主。對於避難的指示與模擬，雖有部分資訊與程式提及相關資料，但仍缺乏完整及多種災難整合的系統與架構。本計畫將針對公共建築緊急避難指引系統，提出相關探討。

檢測分類	檢測項目			
土地使用管制	建蔽率	建築面積	空地面積	綠化面積
容積面積	總樓地板面積	各層樓地板面積	機電設備面積	
	總容積	各層容積	地下室免計容積	地下開挖率
建築基地	退縮建築	防火間隔	車道防水閘門	
建築高度	建築物高度	樓層高度		
構造尺寸	樓梯	欄杆	扶手	
建築設備	衛生設備數量	避雷設備	昇降機	
防火避難	防火門窗	防火區劃	出入口 走廊	
停車空間	汽車位數量	車前垂直距離	機電維修通道	汽機車坡度
	機車停車數量	機車坡道	機車專用坡道	

與公共避難相關內容

圖 II-2 E-checking 與公共避難之關係

Appendix III 共用示警協定 (Common Alerting Protocol, CAP)

因人類社會受災害的影響愈趨頻繁，災害的示警 (alerting) 技術愈受重視。相較於一般訊息，示警訊息的發佈對即時性、有效性、穩定性、正確性等有更特殊的需求，因此為了提升示警訊息傳遞的效率，結構化資訊標準促進組織 (Advancing open standards for the information society, OASIS) 建置了共用示警協定 (Common Alerting Protocol, CAP) ，作為示警訊息的標準。訊息格式標準化後，除了能表達多種示警類型外，也能讓更多種設施所接收，亦作為未來示警技術的開發基礎。

(A) CAP 基本介紹

CAP 是以 XML 為基礎的格式，結構主要有四部分：<alert>、<info>、<resource>、和<area>，其關係如圖 III-1 所示，並列出各部份的內容項目。每個 CAP 檔含唯一<alert>，可包含多個<info>，每個<info>可含有多個<resource>或<area>，作更詳盡的輔助說明。表Ⅲ-1 說明有關 CAP 四個主要結構內之元素。

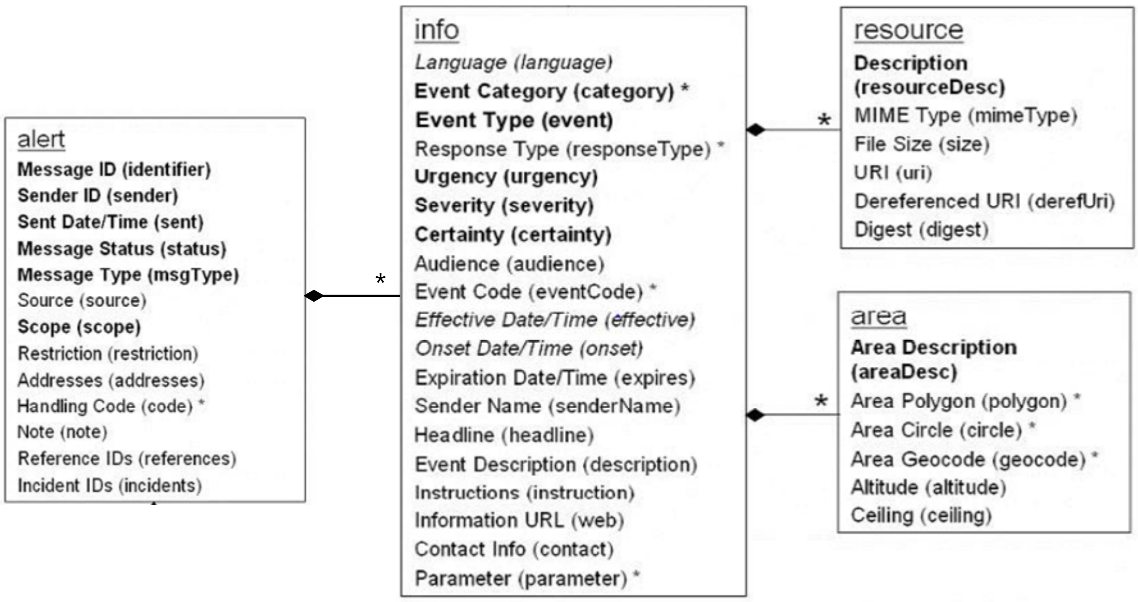


圖 III-1 CAP 架構

(圖片來源：OASIS CAP v2.1, http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html)

表Ⅲ-1CAP 元素說明[34]

<alert>

元素	定義	說明
identifier	警報識別碼	警報唯一識別碼
sender	原始來源者識別碼	資料來源單位
sent	發送日期與時間	發送日期與時間
status	類別狀態碼	"Actual" – 實際發送給所有接收者 "Exercise" – 只發送給演習的參與者;演習參與者須列於<note>內

[34] CAP-TWP, draft CAP-Taiwan Profile, 共通示警協議標準(草案) 文件編號：NGISTD-DRF-001-2014.05, https://alerts.ncdr.nat.gov.tw/Document/CAP%20Taiwan%20Profile(%E8%8D%89%E6%A1%88).pdf

		"System" – 系統內部訊息 "Test" – 技術測試完全不會發送給任何接收者 "Draft" – 草案不能發送
msgType	指令類別碼	"Alert" – 新警報 "Update" – 更新或取代先前的警報，須於<reference>內註記先前之警報 "Cancel" – 取消先前的警報，須於 <reference>內註記先前之警報 "Ack" – 收到且接收警報，須於<reference>內註記先前之警報 "Error" – 拒絕接收警報，須於<reference>內註記拒絕原因
source	來源簡述	特定的警報來源; 例如某單位人員或 裝置
scope	接收者範圍	"Public" – 不受限的一般大眾 "Restricted" – 受限的機關團體須於<reference>內註明 "Private" – 特定人士須於<reference>內註明
restriction	說明接受條件	當<scope>為"Restricted"須填寫
addresses	接收者列表	當<scope>是"Private"須填寫
code	特殊處理代碼	當<msgTypw>是"Update"時，<code>可為 pause：暫停 resume：繼續 progress：進行 finish：完成 confirm：確認 report：結果 當<status>是"System"且<msgType>是 "Alert"時，<code>可為 Ping
note	描述說明	用於<status>是 "Exercise" 和<msgType>是"Error"時之註記說明
references	相關的識別碼	<msgType>是"Update"、"Cancel"、 "Ack"與"Error"時必要註記
incidents	相關資訊列表	

<info>

元素	定義	說明
language	語言代碼	台灣使用"zh-TW"
category	訊息種類	"Geo" – 地球物理(如土石流) "Met" – 氣象(如颱風) "Safety" – 一般警報和公眾安全 "Security" - 執法，軍事，國土和本地 /私人安全 "Rescue" – 救援與恢復 "Fire" - 消防滅火和救援 "Health" - 醫學和公共健康 "Env" – 環境污染 "Transport" - 公共和私人交通運輸 "Infra" - 公用設施，電信，其他非交通運輸基礎設施 "CBRNE" –化學，生物，放射性，核或爆炸威脅與攻擊

		“Other” – 其他
event	事件主題類型描述	
response type	應變代碼	“Shelter” – 根據<instruction>至避難所 “Evacuate” – 根據<instruction>疏散 “Prepare” – 根據<instruction>預做準 備 “Execute” –執行<instruction>內的預先規劃計畫 “Avoid” –根據<instruction>避免 “Monitor” –根據<instruction>注意 “Assess” –根據<instruction>評估資訊 “AllClear” – 已無威脅或危害 “None” – 無建議應變方案
urgency	緊急代碼	“Immediate” -應立即採取應變 “Expected” - 應該於一小時內盡快採取應變 “Future” – 應採取應變 “Past” – 已不須採取應變 “Unknown” – 未知
severity	嚴重代碼	“Extreme” – 非常嚴重的威脅 “Severe” – 嚴重的威脅 “Moderate” – 有威脅 “Minor” – 很小的威脅 “Unknown” – 未知
certainty	確定代碼	“Observed” – 確定已發生或將發生 “Likely” – 超過一半的機率會發生 “Possible” – 可能會發生 “Unlikely” – 可能不會發生 “Unknown” – 未知
audience	描述可能對象	
event code	系統定義之事件代碼	系統定義之事件代碼，格式如下： <eventCode> <valueName>valueName</valueName> <value>value</value> </eventCode> “valueName”是自行定義 “value”為相對應的參數值
effective	生效日期與時間	
onset	預期影響日期與時間	
expires	到期日期與時間	
Sender name	發送者名稱	
headline	標題	
description	描述	
instruction	描述建議採取應變	

	方案	
web	其他資訊連結	參考網址
contact	聯絡資訊	可連絡相關人士進行確認或了解其他資訊
parameter	系統用參數傳遞	格式如下： <parameter> <valueName>valueName</valueName> <value>value</value> </parameter> “valueName”是自行定義 “value”為相對應的參數值

<resource>

元素	定義	說明
resourceDesc	資源類型	可閱讀的資源描述類型
mimeType	MIME	[RFC 2046] (http://www.iana.org/assignments/media -types/)
size	資源檔案大小	資源檔案約略的 bytes 數，有<uri>時若有資料應提供資源檔案大小
uri	資源檔案 URL	絕對的 URL 或相對的<derefUri>URI
derefUri	資源檔案 base64 編碼	
digest	資源檔案 hash 碼	使用 Secure Hash Algorithm (SHA-1)計算[FIPS 180-2].

<area >

元素	定義	說明
areaDesc	區域描述	影響區域說明
polygon	多邊形各點的座標	座標使用 WGS84
circle	中心點座標及半徑	中心點座標使用 WGS84
geocode	事先定義之區域代碼	格式如下： <geocode> <valueName>Taiwan_Geocode_100</valueName> <value>value</value> </geocode> 採用行政院主計總處(DGBAS)公告之「中華民國行政區域及村里代碼」
altitude	高度	
ceiling	區域的最高高度值	

民國 101 年行政院為提升政府施政透明度，推動「政府開放資料」計畫，在此計畫之下，國家災害防救科技中心 (NCDR) 推動「災害示警公開資料平台 」的建置計畫，藉此整合災害相關之公家機關，包括水利署、水保局、中央氣象局、公路總局、台鐵、高鐵、行政院人事行政局等，透過共通平台發佈 CAP 訊息，表 III-2 為該平台的

警報類型、CAP 檔名、及發佈單位，該平台為完全開放的，從該平台可取得所有發佈過的 CAP 檔。

表 II-2 NCDR 災害示警公開資料平台警報類型

Event	Src	senderName
地震	CWB-EQ	中央氣象局
海嘯	CWB-TSU	中央氣象局
降雨	fifows_extremely-rain	中央氣象局
颱風	fifows_typhoon-warning	中央氣象局
土石流	debrisFlow	水土保持局
道路封閉	THB-Bobe	交通部公路總局
淹水	WRA_floodwarm	水利署
水庫洩洪	WRA_ReservoirWarm	水利署
河川水位	WRA_WaterLevelWarm	水利署
停班停課	dgpa.gov.tw_workSchlClos	行政院人事行政總處
鐵路事故(高鐵)	thsrc.com.tw_railIncident	台灣高速鐵路股份有限公司
鐵路事故(台鐵)	tra.gov.tw_railAccident	臺灣鐵路管理局

圖 III-1 以中央氣象局所發佈降雨事件的 CAP 為例，說明 CAP 格式與我國災害示警的使用方式。該訊息是 2015 年 9 月 7 日發佈的一條 CAP 訊息，<alert>先紀錄發佈者<sender>、發佈時間(<sent>)、訊息狀態<status>、訊息類型<msgType>，接著在<info>中詳細說明示警訊息的傳遞內容，包括事件<event>、發佈者名稱<senderName>、標題<headline>、描述內容<description>等，另外，因不同災害在負責單位中有特殊定義與分類，因此使用參數<parameter>來描述，例如本例發佈的是中央氣象局定義 之「大雨特報」與「黃色警戒」；<info>下有多項<area>，說明本次大雨特報將影響的地區，包括基隆市安樂區和基隆市信義區等。<info>所夾帶的資訊才是接收者(一般民眾)需要看到的內容。

災害示警公開資料平台除了整合相關單位的示警發佈行為外，亦提供「介接」功能，開放民間私有單位擷取 CAP 資訊予以加值應用，另外也提供 CAP 開發工具，鼓勵民間團體遵循 CAP 格式開發相關技術，提升各類示警資訊的共享性。例如 Google 與 NCDR 合作開發之「Google 臺灣災害應變資訊平台 」，利用 Google 廣為大眾使用的通路，整合 Google Map 發佈示警訊息，民眾可直接透過 Google 獲取災害資訊，無須另外安裝 APP，且結合 Google Map 本身已開發的工具，讓災害訊息更有效得被傳達與利用。

(B) CAP 應用於智慧建築

除了將 CAP 標準化示警資訊應用在各種資訊發布之平台上外，本計畫先期研究 也提出可用 CAP 示警訊啟動之建築內部的避災系統，稱作 AERS 系統(Active Emergency Response System) [3]，是智慧建築的面向之一。AERS 系統發展的動機是即便民眾可透過手機即時接受災害訊息，但人為反應能力上仍可能緩不應急，因此透過 AERS 讀取

政府所發布的自然災害 CAP 訊息，例如地震，藉以啟動建築內部設施的控制行為。


```
<?xml version="1.0" encoding="UTF-8"?>
<alert xmlns="urn:oasis:names:tc:emergency:cap:1.2">

  <identifier>CWB-Weather_extremely-rain_201509070355001</identifier>
  <sender>weather@cwb.gov.tw</sender>
  <sent>2015-09-07T04:07:28+08:00</sent>
  <status>Actual</status>
  <msgType>Update</msgType>
  <info>
    <language>zh-TW</language>
    <category>Met</category>
    <event>降雨</event>
    ….
    <senderName>中央氣象局</senderName>
    <headline>大雨特報</headline>
    <description>
          鋒面影響，今（７）日新竹以北及宜蘭地區有局部大雨發生的機率，請注意
          瞬間大雨、雷擊及強陣風。
    </description>
    <web>http://www.cwb.gov.tw/V7/prevent/warning.htm</web>
    <parameter>
      <valueName>alert_title</valueName>
      <value>大雨特報</value>
    </parameter>
    <parameter>
      <valueName>severity_level</valueName>
      <value>大雨</value>
    </parameter>
    <parameter>
      <valueName>alert_color</valueName>
      <value>黃色</value>
    </parameter>
    <area>
      <areaDesc>基隆市安樂區</areaDesc>
      <geocode>
        <valueName>Taiwan_Geocode_103</valueName>
        <value>1001706</value>
      </geocode>
    </area>
         <area>
      <areaDesc>基隆市信義區</areaDesc>
      <geocode>
        <valueName>Taiwan_Geocode_103</valueName>
        <value>1001707</value>
      </geocode>
    </area>

  </info>

</alert>
```


圖 III-1 中央氣象局所發佈降雨事件的 CAP

AERS 接收 CAP 訊息的過程主要有兩機器--解析 (parser) 和執行 (actuator)，解析機制可從 CAP 訊息中讀取災害的來源、類型、緊急程度、影響地區，做出執行判斷後傳至執行機制，執行機制即根據各種災害避難之標準作業流程(SOP)採取作為，可能為主動控制建築系統或是通知民眾避難，例如自動關閉瓦斯和發佈避難廣播。在 AERS 解析與執行 CAP 訊息的過程中，「安全性」是非常重要的課題以避免錯誤警訊或惡意行為，包括三項缺一不可的重要步驟：(一) 確認 CAP 發布者是可靠的、負責的；(二) CAP 接收必須確認傳送過程是安全的、隱蔽的、可靠的，例如透過 SIP 保護雙邊的溝通管道；(三) CAP 訊息內容本身也應被安全性保護。

Appendix IV 情境模擬組成因子

情境模擬主要由六個因子組成：時間、空間、使用者、事件、設備與感測器 (sensors)。 因子依照不同情形，可以有多個設定值。情境模擬即是在時間、空間與事件中各挑選一項設定值加以組合，並搭配不同的使用者與設備進行模擬推演可能發生的情況。透過各種不同的模擬建置資料庫，可以協助民眾避難與相關單位救災。本附件首先列出模擬新北市運動中心緊急事件情境的組成因子與常見之感測器與其應用，然後介紹幾種與火災緊急情況相關的資料。

(A) 模擬新北市國民運動中心緊急事件情境的組成因子

表 IV-1 列出模擬新北市永、汐止與樹林國民運動中心緊急事件情境的組成因子。

表 IV-1 情境模擬組成因子

組成因子	情境設定	說明
時間	平日白天	一般民眾上班時間，人數較少。
	平日晚上	一般民眾下班時間，上班族使用者增加。
	寒暑假	學生增加。
	樂齡日	每周二為樂齡日，提供高齡者不同的活動參與，因此當天高齡使用者增加。
	非營業時間	晚上十點到早上六點與國定假日。
空間	運動設施	如游泳池、桌球室、羽球場、韻律教室等，為一般民眾主要運動休閒的空間。
	附屬設施	如淋浴間、醫護室、販賣區等，附屬於運動休閒的相關設施。
	樓梯電梯廁所	民眾較常使用的空間。
	行政設施	如辦公室、會議室、器材室等，為運動中心工作人員辦公之處。
	機房設備	如變電室、發電機、配電室等，除專業人員外，一般民眾不會停留於此。
事件	火災、爆炸	為室內最常見的災害，發生時需放下防火閘門，關閉瓦斯管線，並指示民眾遠離起火點並逃生。
	瓦斯外洩	需透過控制門窗系統在不引起火花的情況下慢慢開啟窗戶，使空氣流通。
	地震	依當時震度大小判斷民眾避難方式。
	水災	淹水為台灣水災最常見的災害，須注意地下室與機房是否有淹水情形。
使用者	一般使用者	災害發生時能依照災害指示迅速避難。

	行動不便者	如老人、小孩與身障者，行動能力較差，所需的避難時間較長。
	員工	災害發生時需先指引民眾逃生，而後再避難。
	救災人員	須了解災害情形，依循救災動線進行救災。
設備	固定設備	管線、機電設備、逃生閘門、升降梯等。
	感測器	隨時偵測災害是否發生與回報災害情況。
	中央控制室	中控系統需接收感測器傳送資料、計算最短路徑、偵測人群分布、判別災害位置、發佈指示等功能。
	停車場	停放汽車數量多且密度高，是災害發生時需注意其造成更嚴重傷亡之可能性。

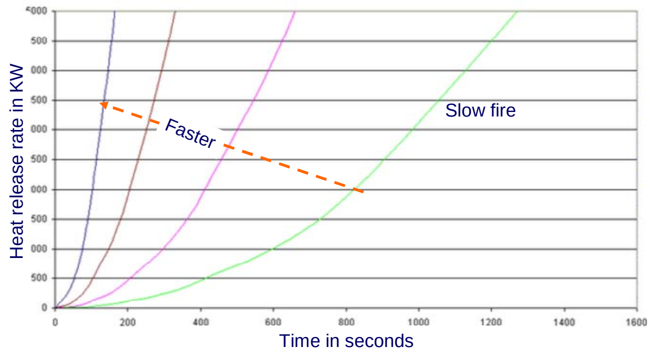
感測器監測是否發生災害，並蒐集避難所需之資訊。常見之感測器與應用如表 IV-2 所示。感測器的配置原則通常以選用可偵測的空間範圍來設定，基本以 5-6 公尺配置一台，且每隔間也必須至少有一台。較需注意的是淋浴間、蒸氣室、烤箱不設置監視器與火災感測器，而所有廁所不設置監視器。

表 IV-2 感測器說明

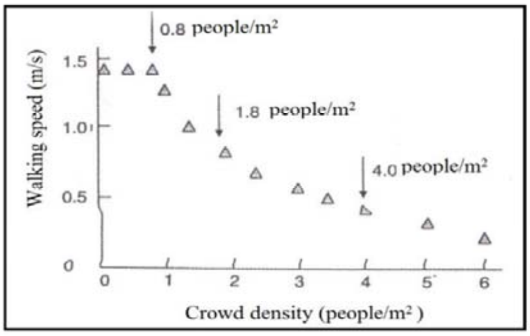
感測項目	應用災害與情況	感測器名稱
溫度	火災、爆炸	熱電偶、白金電阻式溫度計(RTD)、熱敏電阻
濕度	火災、爆炸	溼度電子感測器、乾溼球溼度計
煙霧濃度	火災	煙霧探測器(光電式、離子式)、複合型熱煙式探測器
粉塵濃度	火災	
地震震度	地震	地震警報器
地面水深	水災	水分感測器
影像	分析起火點或群眾避難情形	監視器
室內定位	顯示室內平面圖，並追蹤每個人位置。中控系統藉由輸入之年齡資料發布個人化的動態路線指示。	智能手環或手機 APP
門窗開關	偵測門窗開啟或關閉情形了解封閉或開放路線，以決策逃生路線。	門窗監控系統

(B) 火災緊急響應性能的關鍵因素

圖 IV-1 顯示(a) 火災蔓延的速度與 (b) 人群密度對個人流動性的影響，表 IV-3 列出計算個人疏散指示逃生路線理應考慮的因素。



(Source: USA National Fire Protection Association, National Fire Codes, NFPA 92B.)



(Source: Chitty, R., Mitchell, J.F., 2003. Fire Safety Engineering A Reference Guide. Building Research Establishment, London)

圖 IV-1 顯示(左) 火災蔓延的速度, (右) 人群密度對個人流動性的影響

表 IV-3 計算個人逃生路線理應考慮的因素

Physiological Effects	Temperature (℃)
Possible heat stroke	60
Able to tolerate temperature for 49 minutes	82
Very rapid skin burns in humid air	100
20 minutes tolerance	115
Difficulty breathing through nose	126
Difficulty breathing through mouth	148
Temperature limit for escape	148
Rapid, unbearable pain to dry skin	160
Ability to tolerate temperature drops to less than 4 minutes	198
Respiratory system threshold	198

Priority Order	Factor Name	Priority Weight
1	Physical Disability	1597
2	Respiratory Disease	987
3	Visibility	610
4	Fire Growth Rate	377
5	Temperature	233
6	Gas Mask	144
7	Carbon monoxide concentration	89
8	Population	55
9	Fire Protection Wear	34
10	Link Length	21
11	Familiarity with Building Geometry	13
12	Joint-Muscle Disease	8
13	Body Type	5
14	Age	3
15	Heart Disease	2
16	Sex	1

Num	Factor name	Real values	Transformed risk values
1	Temperature C°	0-45, 45-75, 75-150, over 150	1,2,3,4
2	Fire Growth Rate (kW/m²)	0, 0.0001-0.0058, 0.0058-0.024, 0.024-0.094, over 0.094	1,2,3,4,5
3	Visibility (meter)	0-10, 10-30, over 30	3,2,1
4	Carbon monoxide concentration (ppm- particle per million)	0, 0-100, 100-6400, 6400-12600, over 12600	1,2,3,4,5
5	Population (human/m²)	0-0.8, 0.8-1.8, 1.8-4, over 4	1,2,3,4
6	Alternative Ramp for Disabled People	No / Yes	0,1
7	Link Type	Corridor- Stair-Elevator	1,2,3
8	Link Length (meter)	0-10, 10-30, over 30	3,2,1
9	Age	18-40, 40-60, over 60	1,2,3
10	Sex	Male / Female	1,2
11	Body Type	Athletic, Normal, Fat	1,2,3
12	Hearth Disease	None / Has	1,2
13	Respiratory Disease	None / Has	1,2
14	Joint-Muscle Disease	None / Has	1,2
15	Physical Disability	None / Has	1,2
16	Familiarity with Building Geometry	None / Has	2,1
17	Fire Protection Wear	None / Has	2,1
18	Gas Mask	None / Has	2,1

Sources - John Jay College of Criminal Justice, (2001). Introduction to Fire Science, Human Behavior and Fire, Flannery Associates; U. U. Atila, *et al.,* "Design of an Intelligent Individual Evacuation Model for High-Rise Building Fire," Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume II-2/W1,

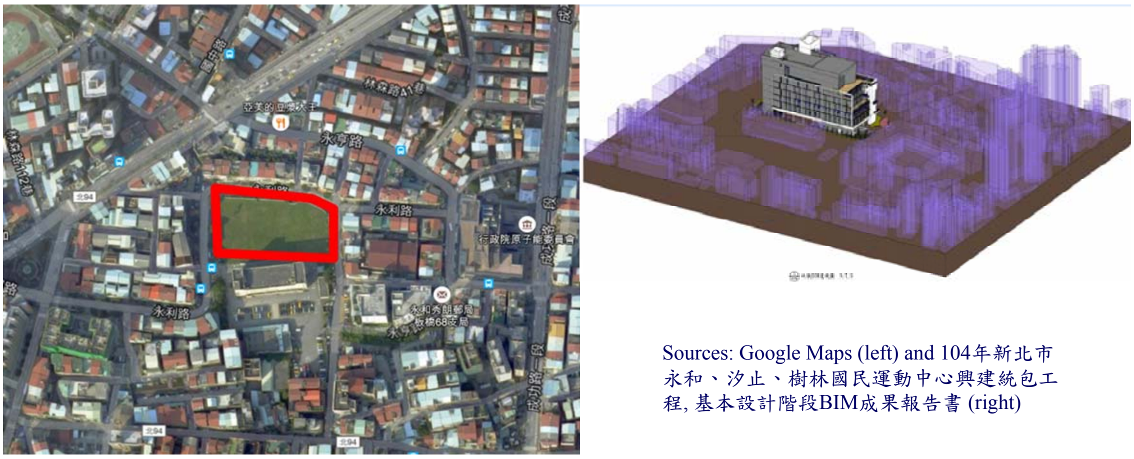
Appendix V 案例介紹

本附件简单描述新北市永和、汐止與樹林國民運動中心與中央研究院資訊科學研究所新大樓的建築資訊模型，並描述其內部可能發生的緊急情境。

(A) 新北市永和運動中心

- **基地與空間配置概述**

永和運動中心位於新北市永和區，北臨永利路，南側為秀朗福利站，附近中小學林立，如福和國中、永和國中與秀朗國小，東側距八百公尺為新店溪。營運廠商為中國青年救國團。總面積約 0.6 公頃，建築面積約三千平方公尺。圖 V-1 顯示其位置與地貌 BIM 透視圖。



Sources: Google Maps (left) and 104年新北市永和、汐止、樹林國民運動中心興建統包工程, 基本設計階段BIM成果報告書 (right)

圖 V-1 永和國民運動中心位置與地貌 BIM 透視圖

表 V-1 列出永和國民運動中心各樓層之空間配置。圖 V-2 顯示三層樓的平面圖。廁所、樓梯、走廊、茶水間與天台等等屬於一般皆會使用的空間，因此不詳列。

表 V-1 永和國民運動中心各樓層之空間配置

樓層	空間內容
地下 123 樓	停車空間兼防空避難室(汽車 288 輛、機車 90 輛)
1 樓	販賣部、入口大廳、辦公室、教室、機房
2 樓	室內游泳池(50M*8 道)
3 樓	兒童遊戲室、棋藝閱覽室、親子閱覽室、體適能中心
4 樓	羽球場(6 面)、桌球室(6 桌)、韻律教室(2 間)
5 樓	壁球室(2 間)、飛輪教室、辦公室
6 樓	綜合球場(籃球 1 面、羽球 4 面及排球 1 面)、攀岩區
7 樓	漆彈場

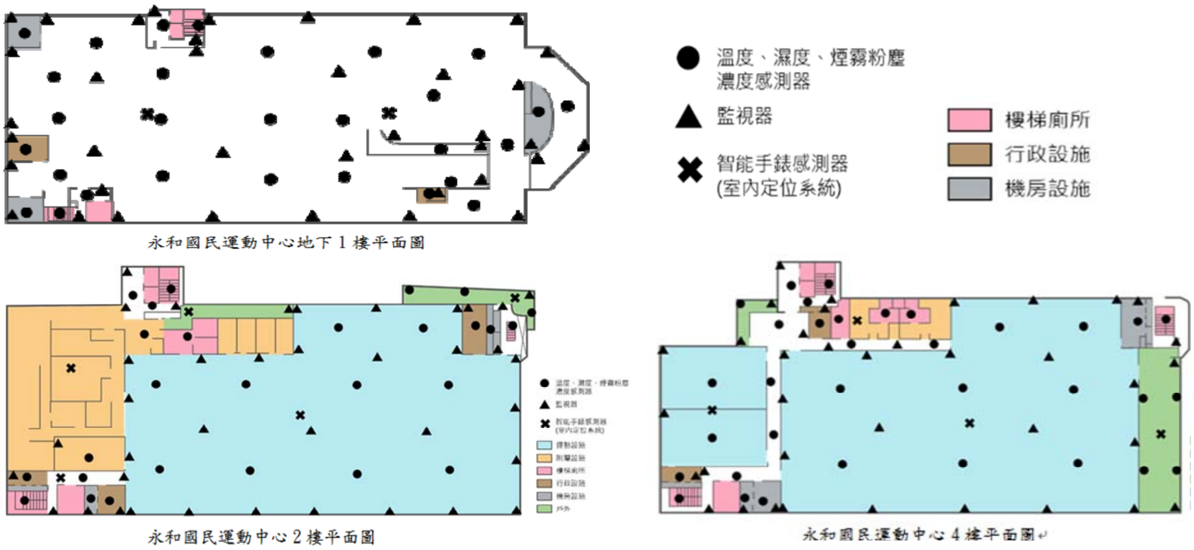


圖 V-2 永和國民運動中心示例平面圖

- **地震情境模擬**

(i) 時間：樂齡日

(ii)事件：台北地區發生六級強震

(iii) 避難路線

中央氣象局傳來地震相關資訊，監控中心第一時間播放廣播通知民眾，並切斷所有管線避免衍生災害，再打開所有門窗。靠近室內樓梯 A 與戶外樓梯 B 之顯示器顯示最佳逃生路境，雙向指示燈也亮起特定方向。 圖 V-3 為地震情境民眾分布模擬二樓平面圖。

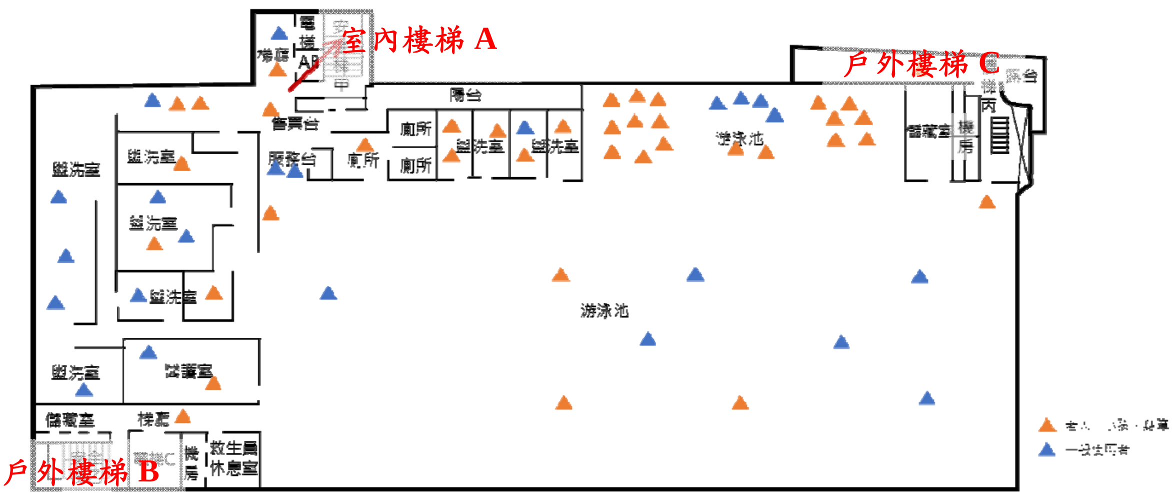


圖 V-3 二樓地震情境模擬平面圖

一樓民眾聽從指示由西北側入口逃生到戶外廣場，如圖 V-4 之初步逃生出口涵蓋之範圍圖。或由戶外樓梯 B 向外逃生；廣播持續說明如何保護自身安全，二樓顯示室內樓梯 A、戶外樓梯 B 與 C 之資訊，且提醒游泳池內民眾上岸；地下室、三、四、五和七樓若離出口較遠則就近尋找柱子、穩固的家具，並注意周遭的環境，等

待第一波震幅過後迅速離最近的出口逃生；六樓觀眾區先躲在椅子下，等第一波過後往室內樓梯 A 與戶外樓梯 B 迅速離開，北側民眾則往東側露臺避難，由戶外樓梯 C 離開建築物。每一層的民眾會收到語音訊息，由定位與所在樓層分別發出不同指令，提醒民眾往特定方向避難，若受困則以定位裝置聯絡監控中心與救災單位。室內人員多寡也會影響判定，須同時計算逃生口容流比，將過多的人疏散，通知以就地避難為主，再逃往可負擔的逃生梯。

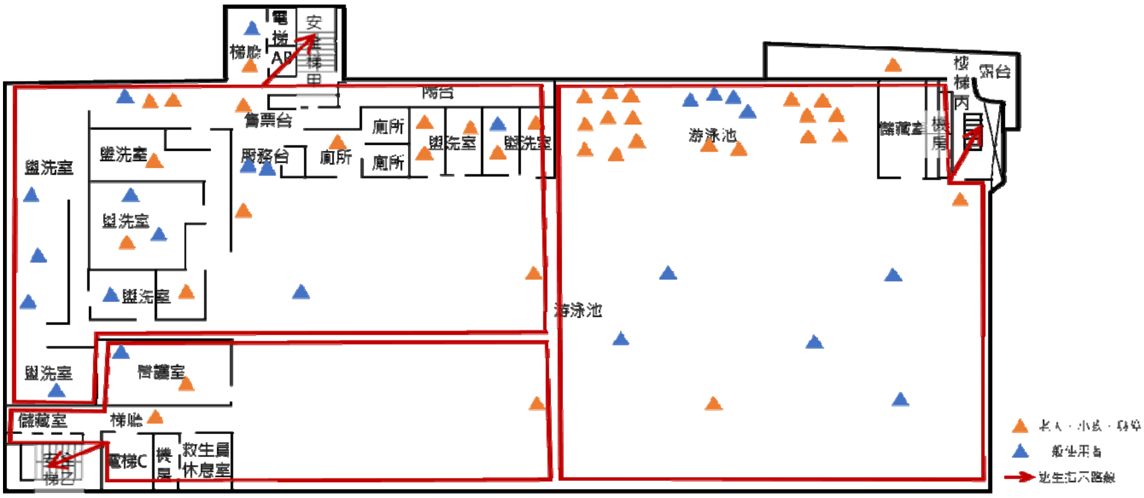


圖 V-4 初步逃生出口涵蓋之範圍圖

(iv)監控中心接收/傳送/處理資訊/執行動作

監控中心收到中央氣象局傳來地震資訊，確認地震震央臨近新北市且規模達六級，監控中心下令關閉所有可能引起衍生性災害的管線。利用定位裝置確認人員分布與每層樓總人數，如圖 V-5 所示，

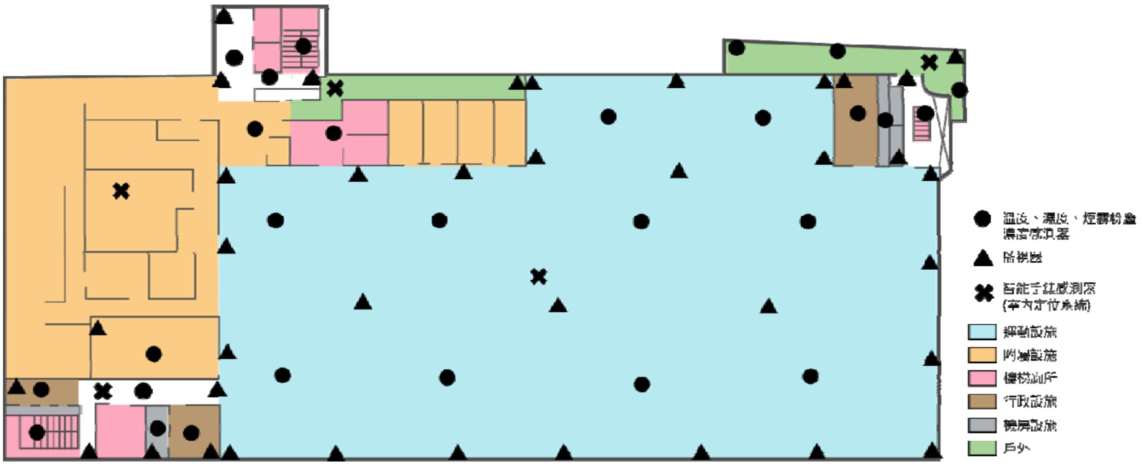


圖 V-5 二樓設施機能與感測器分布圖

依據每個定位裝置計算最接近且容量足夠的逃生出口，若在人潮多時發生地震，須先提醒民眾就地避難，不能逃向最近的安全出口，等到震波結束再迅速朝向最短路徑避難。並發布個別的動態指引避難路線，廣播與螢幕同時顯示資訊準備疏散，並自動偵測尚未逃離的人員，通知救災單位前往。圖 V-6 為監控中心處理避難之流程圖。

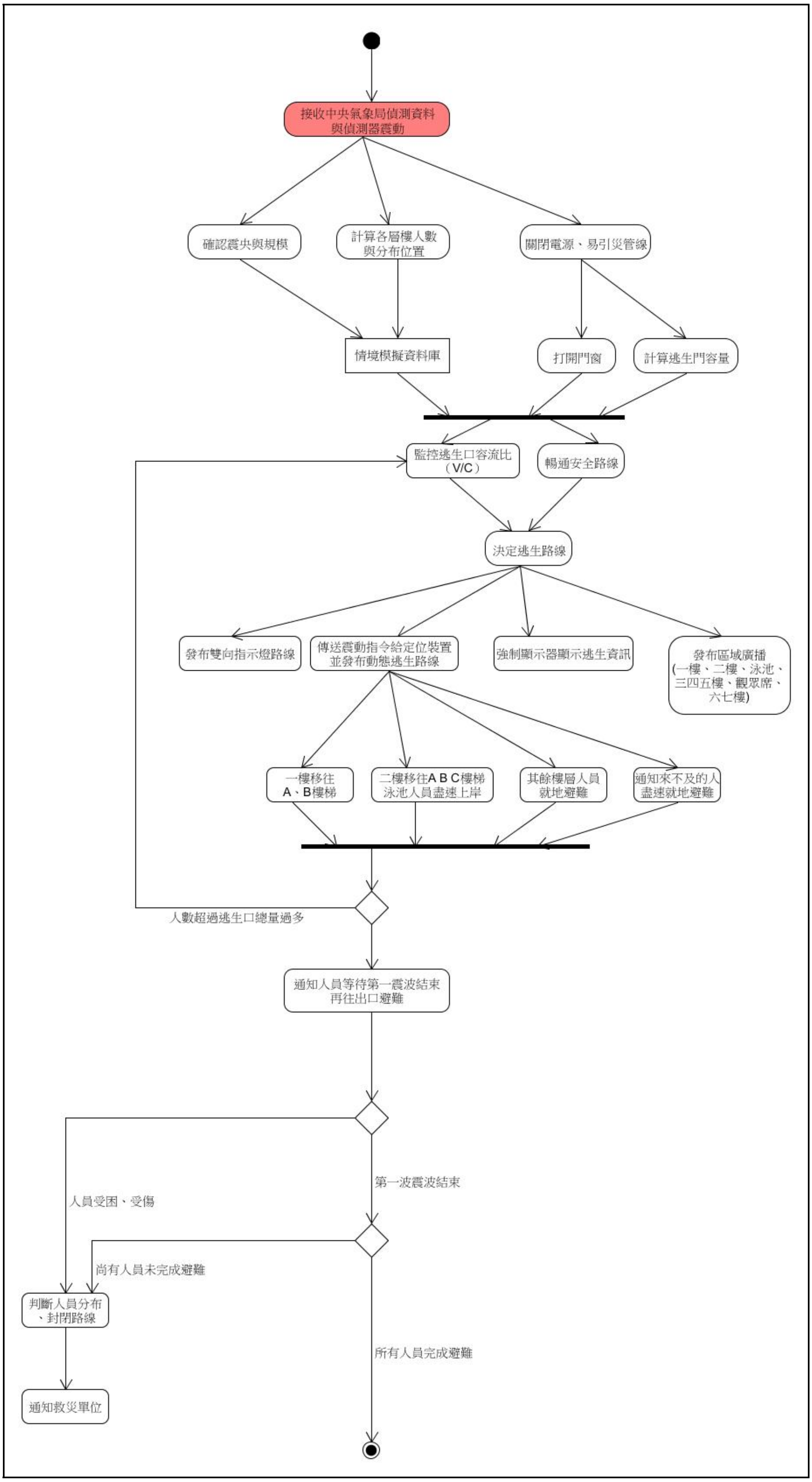


圖 V-6 永和國民運動中心六級強震情境模擬_監控中心流程圖

(B) 新北市汐止運動中心

- **基地與空間配置概述**

汐止國民運動中心位於汐止區綜合運動場內，臨接新台五路一段及新興路，距離汐止火車站步行約 10 分鐘，為一座地上 8 層的建築物，占地約 2000 平方公尺。地上 1、2 樓規劃有室內汽、機車停車場，設施規劃以滿足老、中、青、幼各年齡層為目標，包括體適能中心、韻律教室、綜合球場、羽球場、網球場、桌球室、壁球室、棒球練習場等多元運動設施。汐止國民運動中心是新北市第 10 座動工的運動中心，也是汐止區第一座國民運動中心。

圖 V-7 顯示汐止國民運動中心的地點與地貌 BIM 透視圖，表 V-2 為汐止國民運動中心各樓層之空間配置，圖 V-8 顯示四層樓的平面圖 (從左上角開始、順時針方向、為一，三，六和七樓的平面圖)。

Sources: Google Maps (left) and 104年新北市永和、汐止、樹林國民運動中心興建統包工程, 基本設計階段BIM成果報告書(right)

圖 V-7 汐止國民運動中心位置與地貌 BIM 透視圖

表 V-2 汐止國民運動中心各樓層之空間配置

樓層	空間內容
1 樓	停車場
2 樓	中央監控室、電氣、停車場、服務台、棋藝閱覽區、行政辦公室、垃圾暫存室
3 樓	兒童遊戲室、兒童閱覽室、冰火主機房、哺乳室、多功能運動區、男/女更衣室、男/女沐浴區、羽球場*3、網球場*1、親子廁所、電氣機房
4 樓	器材儲藏室、男/女更衣室、男/女沐浴區、會議室、韻律教室、電氣機房
5 樓	男/女更衣室、男/女沐浴區、運動傷害防護室、體適能中心、器材儲藏室、電氣機房

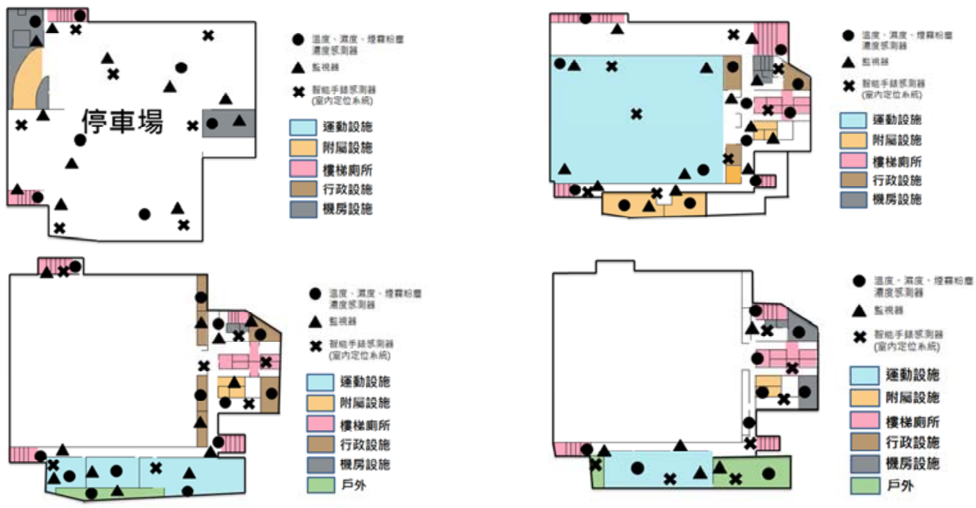


圖 V-8 汐止國民運動中心一，三，六和七樓的平面圖

- **情境模擬**

(i) 時間與地點：樂齡日, 四樓空調機房

(ii)事件：可燃氣體濃度增加到危險值，可能隨時起火爆炸

(iii) 避難路線：

四樓情況發生，接受廣播聽從指示。圖 V-9 顯示四樓初步逃生出口涵蓋之範圍和四樓設施機能與感測器的分布，會議廳、廁所、淋浴區、更衣室及茶水間的人首先聽從個別區域廣播，由 D 樓梯向下逃生，此時會看見逃生雙向指示燈皆會指向 D 樓梯，四樓其餘使用者由 A 樓梯疏散。五樓以上的民眾會藉由各廣播器傳達避難資訊，其螢幕與行動定位裝置都會分別顯示簡易平面圖與現在位置，避開使用離災害地點最近的 C 樓梯。三樓以下的顧客可使用各個樓梯逃生，但優先使用 C 樓梯以分散逃生人潮。行動不便者可藉由行動定位裝置呼叫 119 與監控中心，各場館的螢幕也會顯示現在地點與逃生口的位置。靠近 A 樓梯的螢幕顯示 A 樓梯位置與下樓後的平面圖，D 樓梯周圍的顯示器顯示 D 位置。

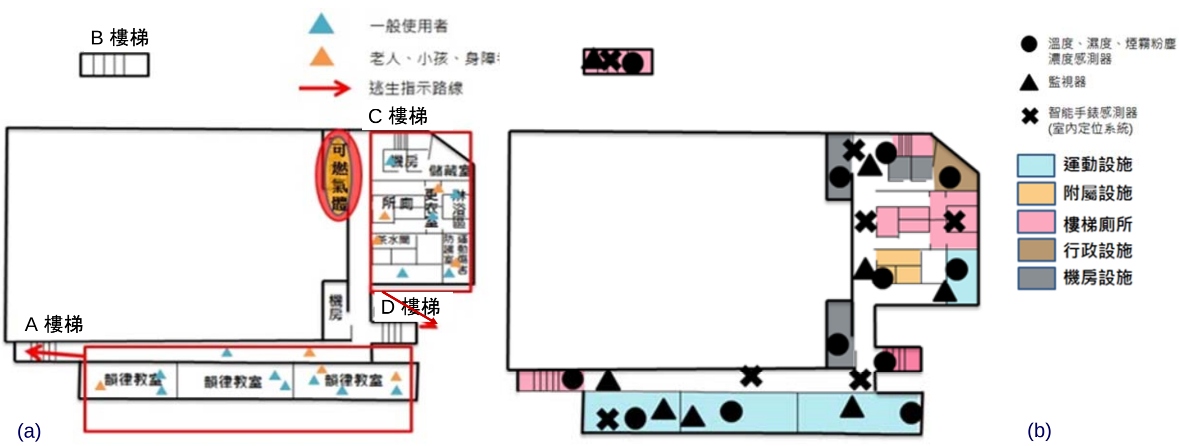


圖 V-9 (a) 初步逃生出口涵蓋之範圍, (b) 四樓設施機能與感測器分布圖

(iv) 監控中心如何接收/傳送/處理資訊/執行動作:

圖 V-10 為監控中心處理避難之流程圖，溫度、濕度、煙霧氣體探測器與影像數據傳給監控中心，確認災害類型與範圍為機電相關，監控中心下令關閉周圍防火門與

機電電源，並傳送可能火災訊息給消防局。利用定位系統確認周遭人數與每層樓總人數，如圖 V-9 (b) 所示，依據每個行動定位位置，計算最接近且與災害地點方向不同的逃生出口，並發布個別的動態指引避難路線，同時廣播準備疏散。並繼續接收溫度、濕度、氣體探測器與影像數據，持續監測氣體濃度、蔓延路線與安全範圍並傳送給消防局。

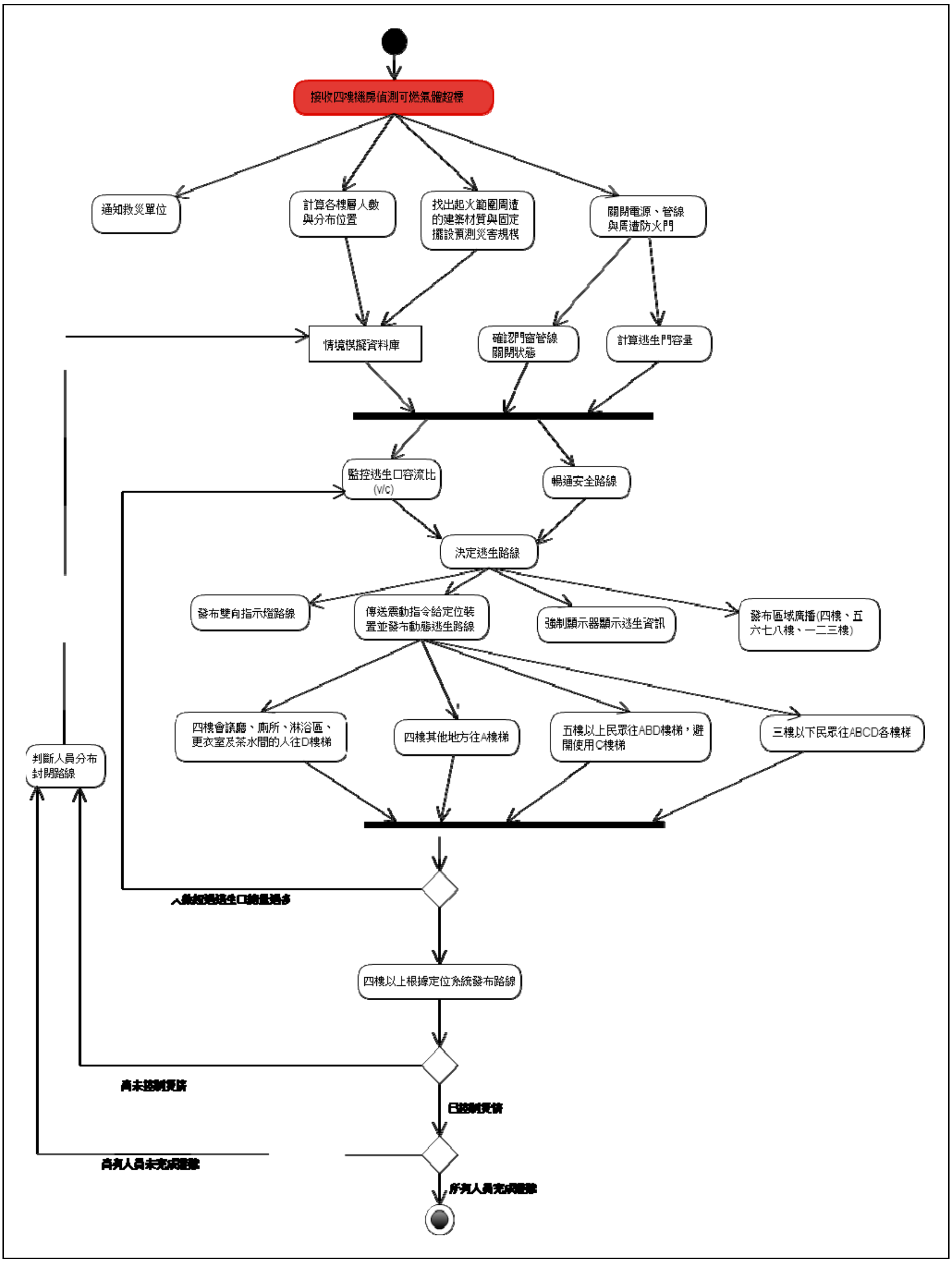


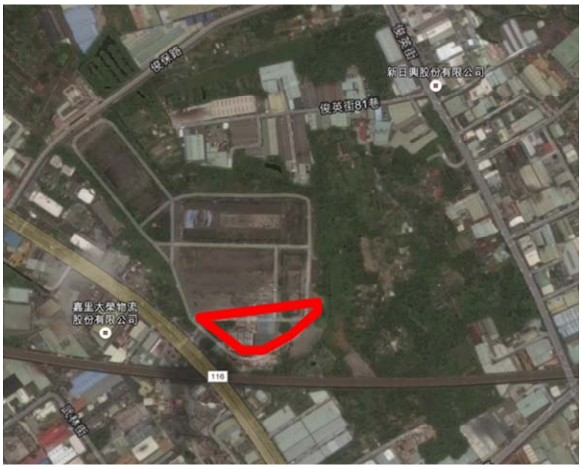
圖 V-10 汐止國民動中心可燃氣體情境模擬_監控中心流程圖

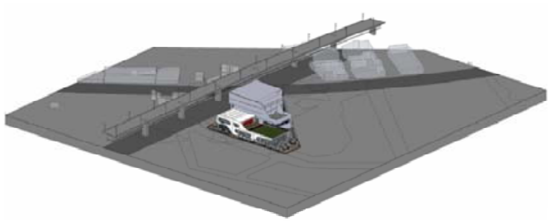
(C) 新北市樹林運動中心

▪ **基地與空間配置概述**

樹林運動中心位於新北市樹林區北側，臨近縣道 116，南側有高架高鐵路線經過。總面積約 0.5 公頃，建築面積約三千五百平方公尺。

圖 V-11 顯示樹林國民運動中心的地點與地貌 BIM 透視圖，圖 V-12 顯示四層樓的平面圖。表 V-3 為樹林運動中心各樓層之空間配置，





Sources: Google Maps (left) and 104年新北市永和、汐止、樹林國民運動中心興建統包工程, 基本設計階段BIM成果報告書(right)

圖 V-11 樹林國民運動中心位置與地貌 BIM 透視圖

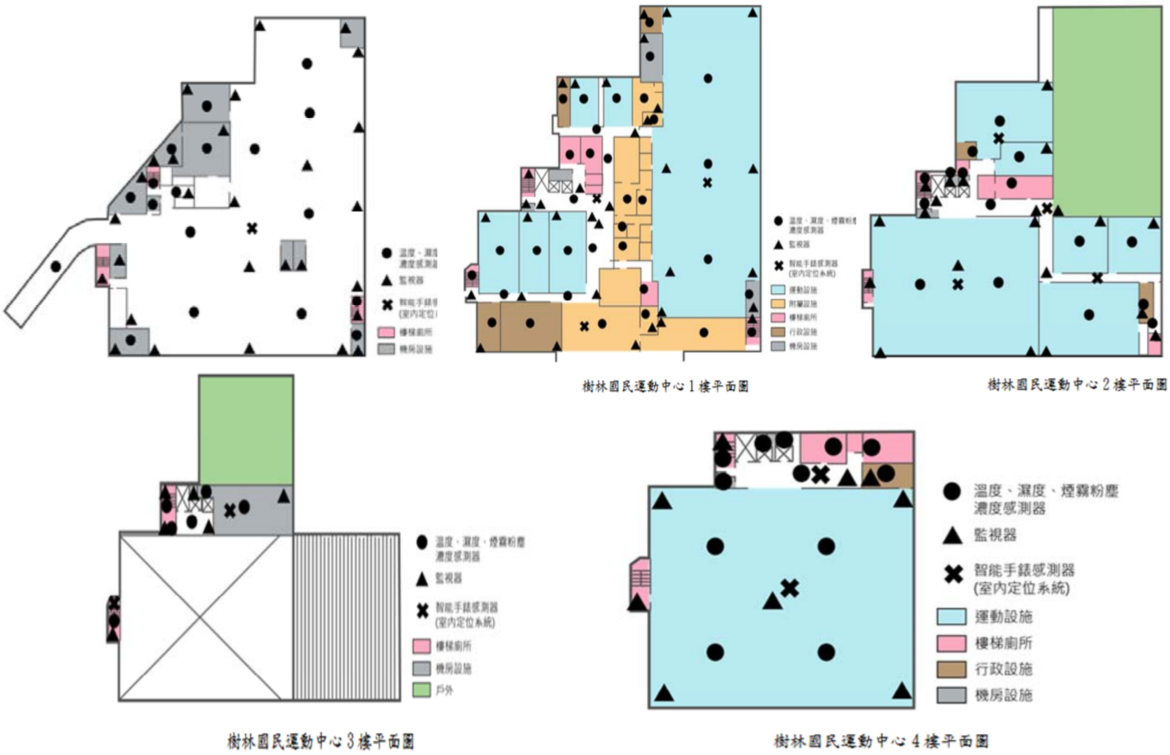


圖 V-12 樹林國民運動中心示例平面圖
(從左上角開始、順時針方向、為一，三，六和七樓的平面圖)

表 V-3 樹林國民運動中心各樓層之空間配置

樓層	空間內容
地下 1 樓	停車場兼防空避難室(汽車 86 位、機車 76 位)
1 樓	大廳、行政辦公室、游泳池(50M*8 道)、撞球室(5 桌)、桌球室(4 桌)、販賣區、兒童遊戲區、壁球室
2 樓	韻律教室(2 間)、體適能中心、跆拳道教室、羽球場(6 面)、戶外攀岩區(含槌球場 1 面)、戶外多功能運動場
3 樓	露臺
4 樓	綜合球場(籃球 2 面、排球 2 面)
5 樓	機房

- **情境模擬**

(i) 時間與地點：樂齡日(老人避難時間延長), 一樓電器機房

(ii) 事件：火災

(iii) 避難路線：

圖 V-13 為初步逃生出口涵蓋之範圍圖。火災發生，接受廣播聽從指示，員工依情況指示民眾逃生。游泳池部分與販賣區的人首先聽從個別區域廣播由 C 樓梯逃生後由入口向外避難，此時會看見逃生雙向指示燈皆會指向 C 樓梯，一樓其餘使用者由 B 樓梯疏散。二三四樓的民眾會藉由各廣播器傳達避難資訊，其螢幕與手環都會分別顯示簡易平面圖與現在位置，有突然行動不便者可藉由手環呼叫 119 與監控中心，各場館的螢幕也會顯示現在地點與逃生口的位置。靠近 A 樓梯的螢幕顯示 A 樓梯位置與下樓後的平面圖，B 樓梯周圍的顯示器顯示 B 位置。

圖 V-13 初步逃生出口涵蓋之範圍圖

(iv) 監控中心如何接收/傳送/處理資訊/執行動作：圖 V-14 為災害發生樓層感測器分布圖，溫度、濕度、煙霧探測器與影像數據傳給監控中心，確認火災類型與範圍為機電相關，監控中心下令關閉周圍防火門與機電電源，並傳送火災訊息給消防局。利用紅外線熱像儀與 GPS 定位裝置確認周遭人數與每層樓總人數，依據每個定位裝置計算最接近且與火源方向不同的逃生出口，若在人潮多時發生災害，可能須分散逃生路線，計算容流比，不能同時逃向最近的安全出口。並發布個別的動態指引避難路線，同時廣播準備疏散，繼續接收溫度、濕度、煙霧探測器與影像數據，持續監測火災規模、蔓延路線與安全範圍並傳送給消防員，圖 V-15 顯示避難人員之流程，圖 V-16 顯示監控中心處理避難之流程。

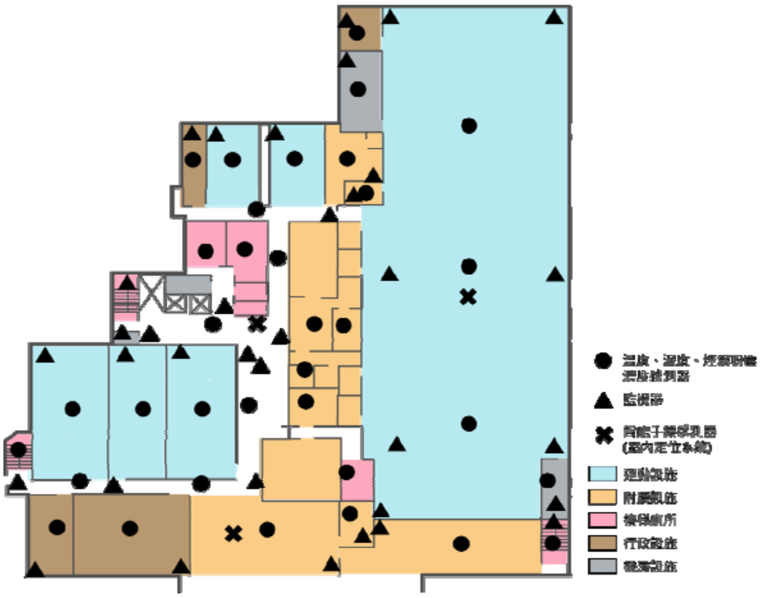


圖 V-14 災害發生樓層感測器分布圖

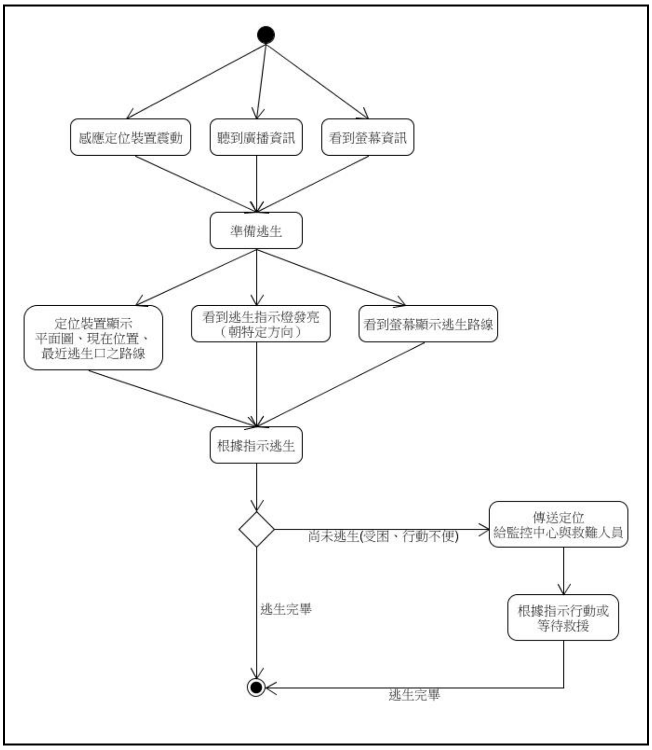


圖 V-15 樹林國民運動中心火災情境模擬_避難人員流程圖

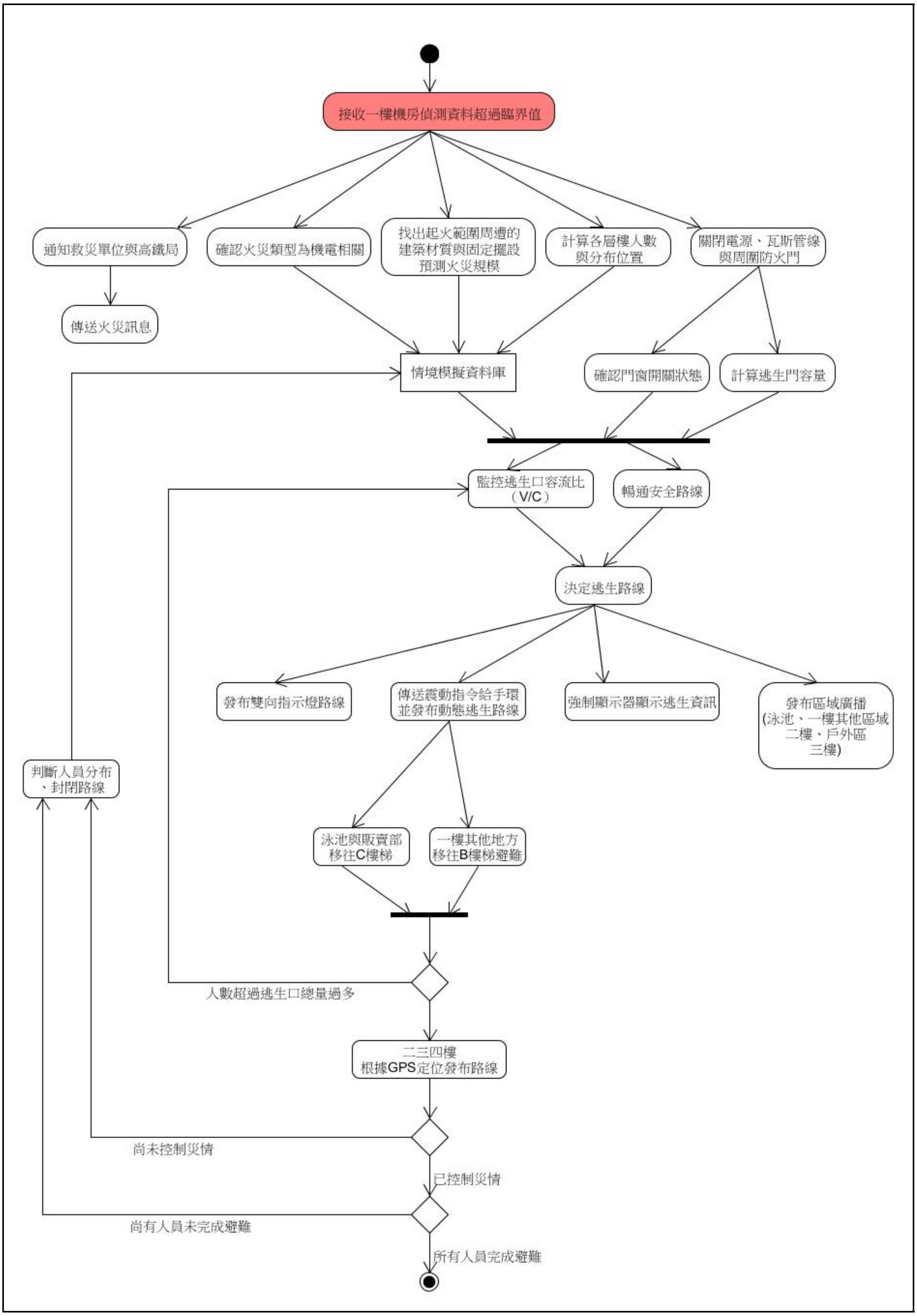


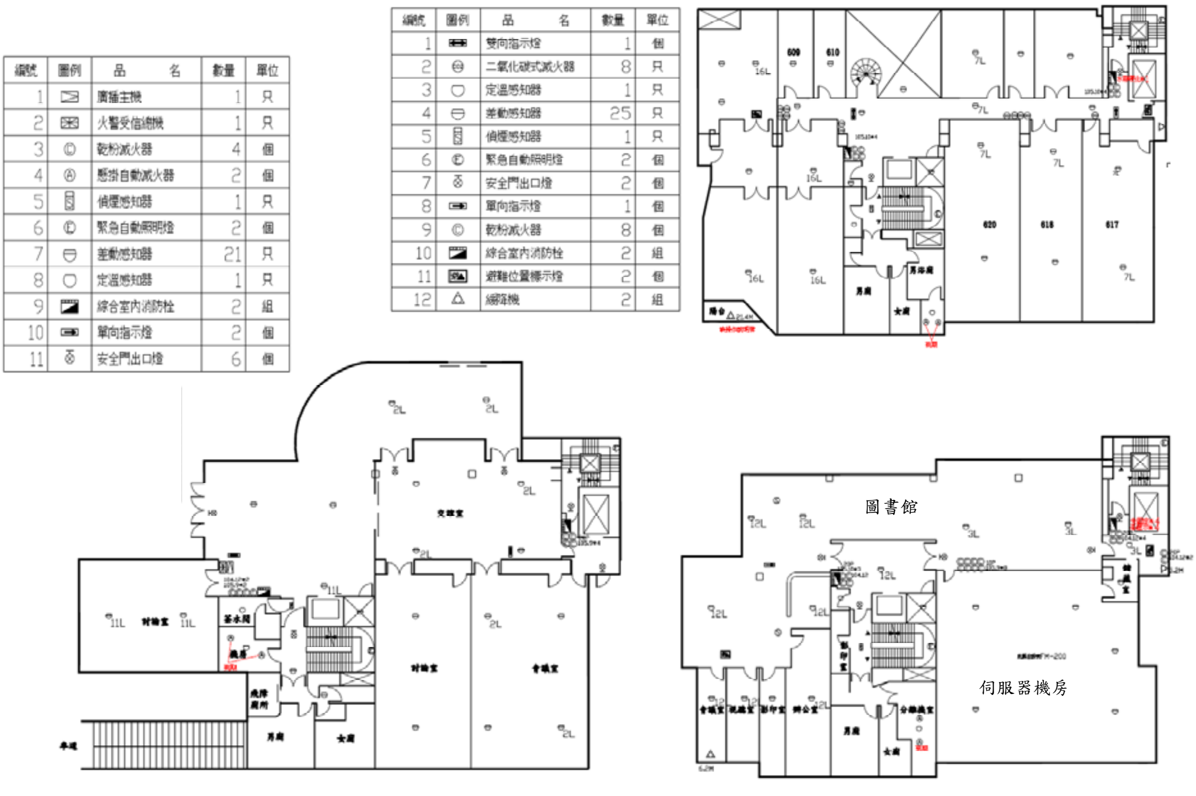
圖 V-16 樹林國民動中心火災情境模擬_控制中心流程圖

(D) 中央研究院 資訊科學研究所大樓

▪ 基地概述

資訊科學研究所是中央研究院數理組十一個單位之一，圖 V-17 顯示資訊所大樓的地點與外觀，此大樓有兩部分: 四層高的舊大樓，連到九層高的新大樓，甚至新大樓已近 20 歲。目前資訊所有將近 400 位研究人員、博士後研究學者、資訊技術人員、研究助理與行政人員，他們大多數在新大樓工作。圖 V-18 示出新大樓三層樓的平面圖，表 V-4 為資訊所新大樓各樓層之空間配置。

圖 V-17 中央研究院 資訊科學研究所大樓位置與外貌



編號	圖例	品名	數量	單位
1		廣播主機	1	只
2		火警受信總機	1	只
3	©	乾粉滅火器	4	個
4	Ⓐ	懸掛自動滅火器	2	個
5		偵煙感知器	1	只
6	Ⓔ	緊急自動照明燈	2	個
7		差動感知器	21	只
8		定溫感知器	1	只
9		綜合室內消防栓	2	組
10		單向指示燈	2	個
11		安全門出口燈	6	個

編號	圖例	品名	數量	單位
1		雙向指示燈	1	個
2		二氧化碳式滅火器	8	只
3		定溫感知器	1	只
4		差動感知器	25	只
5		偵煙感知器	1	只
6	Ⓔ	緊急自動照明燈	2	個
7		安全門出口燈	2	個
8		單向指示燈	1	個
9	©	乾粉滅火器	8	個
10		綜合室內消防栓	2	組
11		避難位置標示燈	2	個
12		緩降機	2	組

圖 V-18 新大樓三層樓的平面圖
(從右上角，順時針六、二、一樓)

表 V-4 資訊所新大樓各樓層之空間配置

樓層	空間內容
地下 1 樓	停車場
1 樓	大廳、大型會議室、空調機房
2 樓	圖書館、伺服器機房、空調機房
3－8 樓	辦公室、實驗室、小型會議室、空調機房

- 情境模擬

(i) 時間與地點：上班時間、資訊所新大樓 518 實驗室

(ii) 事件：火災

(iii) 避難演練流程：

資訊所組織了一個自衛消防隊，表 V-5 介紹其組織及任務，表 V-6 描述一次(103 年 9 月 3 日)火災演練流程，起火點為五樓的 518 室。圖 V-19 示出新大樓五樓的平面圖與初步逃生出口。518 室是資訊科學研究所新大樓中較大的研究室。實驗室研中，有研究員們每天所使用的電氣器材，如筆電、主機、手機、電池等，電器走火常是實驗室起火的原因。而實驗室中的書本、紙箱、布質辦公座椅等易燃物在火災時容易導致火災的快速蔓延，形成猛烈的火勢。

編號	圖例	品名	數量	單位
1		二氧化碳滅火器	5	只
2		差動感知器	27	只
3		偵煙感知器	1	只
4		定溫感知器	3	只
5		懸掛自動滅火器	4	個
6		緊急自動照明燈	2	個
7		安全門出口燈	2	個
8		單向指示燈	3	個
9		乾粉滅火器	8	個
10		綜合室內消防栓	2	組
11		避難位置標示燈	2	個
12		緩降機	2	組

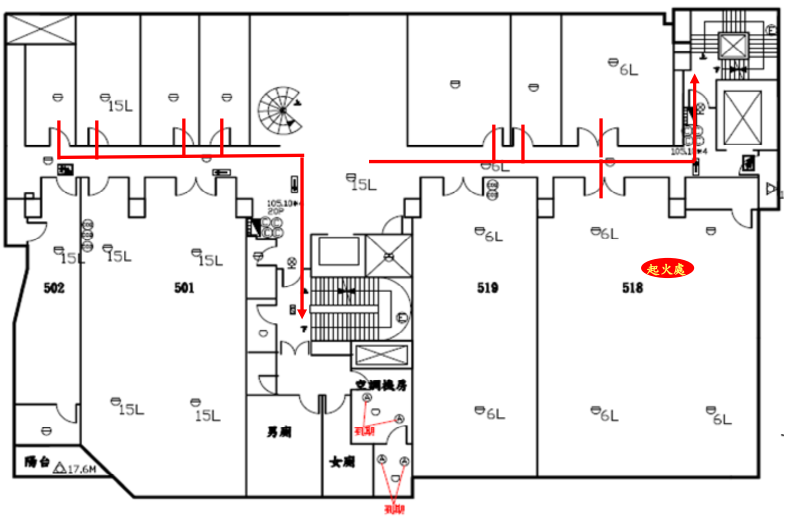


圖 V-19 新大樓五樓的平面圖與初步逃生出口

表 V-5 資訊所自衛消防隊編組

自衛消防隊長（兩位副所長）：指揮、命令（於展開自衛消防活動時，擔任指揮發號施令，同時與消防隊保持密切連繫，順遂展開救災活動。）及監督自衛消防編組。
自衛消防副隊長（兩位行政人員）：輔助自衛消防隊長，執行任務並為隊長之代理人。

隊/班/別	成　員	任　　　　務
指揮班	班長 成員 三位	1.設置自衛消防本部（資訊所舊館 1 樓）。 2.輔助所內其他大樓地區隊隊長、副隊長（當隊長及副隊長不在時，代理其任務）。 3.向所內其他大樓地區隊傳達命令及情報。 4.攜帶消防防護計畫書，向消防隊提供情報，並引導至災害現場，其重點如下： **重 點** ・指引往起火場所之最短通道。 ・引導至進出口。 ・引導至緊急用昇降機。 ・起火場所、燃燒物體及燃燒範圍。 ・有無受困者、受傷者等。 5.其他指揮上必要之事項。

通報 聯絡班	班長：	1.向消防機關通報，並確認已通報。 **重 點** - 火災！在研究路二段 128 號， 中央研究院資訊所 - 在新館 5 樓的 518 研究室在燃燒。 - 報案人電話：2788-3799 2.聯絡有關人員 **重 點** - 單位各級主管：○○○○－○○○○ - 單位應變人員：○○○○－○○○○ - 本院行政大樓值班室：2789-9999 - 大駐警隊門崗亭：2789-1834 - 總務組水電房：27899707～8 - 電力公司：2785－9020

<table>
<tr><td></td><td></td><td>3.適當進行場所內廣播，應避免發生驚慌。
緊急廣播（重複 2 次以上）
"這裡是資訊所緊急應變防災中心！
現在在 5 樓發生火災！
滅火班請立即進行滅火行動。
避難引導班請依照配置位置就定位！
請同仁請依照引導人員之指示避難逃生；且不要搭乘電梯及按電梯鍵。"
4.通報鄰近所處。</td></tr>
<tr><td>滅火班</td><td>班長：
成員：
五位</td><td>1.指揮展開滅火工作。
2.使用滅火器、消防栓進行滅火工作。
<table><tr><th><u>滅火器</u></th><th><u>消防栓</u></th></tr><tr><td>①拔安全插銷
②噴嘴對準火源
③用力壓握把</td><td>①按下起動開關
②連接延伸水帶
③打開消防栓放水</td></tr></table>3.與消防隊連繫並協助之。</td></tr>
<tr><td>避難
引導班</td><td>班長(於側邊大門處)

成員：
五位(於大門處)

一位(於側門處)

七位(於貨梯處)</td><td>1.大聲指引避難方向，避免發生驚慌。
2.打開通往 1 樓戶外之緊急出口（安全門等）並確認之。
重 點
・指引離開場所之最安全通道。
・有無受困者、受傷者等。
・通道轉角、樓梯出入口應配置引導人員(以起火層及其上層為優先配置)。
3.移除妨礙避難之物品。
4.操作避難器具，擔任避難引導。
5.確認所有人員是否已避難，並將結果聯絡自衛消防隊長。
必要裝備
・各居室、避難出口之萬用鑰匙。
・手提擴音機。
・繩索。
・手電筒。
・其他必要之器材。</td></tr>
</table>

安全 防護班	班長： 成員： 一位	1.關閉防火門、防火鐵捲門、防火閘門。 重 點 - 關閉避難通道之防火門時，應先與避難 - 引導班充份連繫。 2.緊急電源之確保、鍋爐等危險設施之停止供給運轉。 3.昇降機、電扶梯之緊急處置。 4.設定禁止進入區域。 5.通知鄰近建築物加強警戒。 重 點 火災！在本院資訊所所新館 5 樓 518 實驗室在燃燒，現在正進行搶救中，請加強警戒，並引導建築物內人員避難、疏散。
緊急 救護班	班長：	1.設置緊急救護所（必要時請本院醫護室人員配合搶救，醫護室電話 2789-9437）。 2.緊急處理受傷者及登記其姓名。 3.與自衛消防隊長和消防人員連繫，並提供情報。
其他班 (點名)	班長： 成員： 一位	在集合處(舊館大門前)點名，並將名單報告於自衛消防本部。

表 V-7 火災演練流程

項次	時間	任務	備註
一、演習前通知	13:20	廣播：全體同仁大家好，待會下午 1 點 30 分，將進行 103 年度消防安全緊急逃生演練，屆時全所消防警鈴發出告警，請全體同仁配合避難引導班進行避難疏散，謝謝配合。	櫃台人員廣播
二、假設起火點：518 實驗室	13:29	1. 發現新館 518 實驗因電器走火發生火災。 2. 就近電話通報服務台，請求支援。(詞:新館 518 發現電器走火正在燃燒，趕快通知幫忙滅火) 3. 按下警鈴	
三、消防警鈴啟動	13:30	1. 接獲確認新館 5 樓 518 實驗室因電器走火已發生火災，請滅火班前往起火點滅火。 2. 通報所長及相關人員。 廣播:"全體同仁請注意"(兩次) ◎新館 5 樓 518 實驗室發生火警，初期滅火失效，請各樓層立即「啟動」自衛消防編組。	櫃台人員通報、廣播

		◎在室內的同仁請勿驚慌，打開房門，隨手關閉周邊電源，跟隨「避難引導班」人員的引導，請勿搭乘電梯，前往近的樓梯間出口進行避難疏散。	
四、自衛消防編組展開工作	13:31	1. 滅火班:前往起火處，就近拿滅火器進行初期滅火。 2. 避難引導班:攜帶哨子前往各樓層進行指揮、監督及調度，並將各樓層防火門打開。(引導時，提醒同仁保護頭部安全和注意地面障礙物以防跌倒) 3. 緊急救護班:設置緊急救護站於舊館大門前，準備醫藥箱、紙、筆，以緊急處理受傷者及登記其姓名、性別、電話、時間。 4. 通報班: 打 0-119:有火災!在研究院路 2 段 128 號，中央研究院資訊所，新館 518 實驗室有電器走火發生火災，電話 2788-3799。 5. 安全防護班:從頂樓開始將防火門關上。	
五、火勢太大滅火失敗	13:32	班長:火勢太大，請滅火班人員立即全數撤退。	
六、各班回報	13:32	1. 滅火班:報告指揮官，火勢太大，已請滅火班人員全數撤退。 2. 通報班:報告指揮官，通報班已完成通報 119。 3. 避難引導班:報告指揮官，__館__樓已全部淨空。 (指揮官:請人事協助清點人數，確認所有人員都已經疏散) 4. 救護班: ◎119?中研院資訊所火災現場有 1 人受傷，請救護車前往支援。 ◎指揮官，目前緊急救護站受傷人員一名，為同仁 XXX 已初步處理，等待救護車送往醫院治療。 (指揮官:請救護班派兩位同仁陪同傷者前去醫院並回報治療情形，必要時亦請連繫他的家人)	
七、指揮官指示	13:34	1. 請指揮班成員 YYY 前去大樓各門口，拉設黃色警戒線，並管制人員進入。 2. 請指揮班成員 ZZZ 隨同本人向消防隊提供情報，並導引至災害現場，協助消防人員滅火	
八、最後回報	13:35	1. 人事：報告指揮官，大樓新(舊)館人數清點完畢，應到_人，實到_人，請假_人。 2. 副指揮官:報告指揮官，已在資訊所大樓拉設黃色警戒線，並在大門口管制人員進入，消防車	

		也已經到達現場。 3. 指揮官: (1) 好，今天消防逃生演練任務到此圓滿結束，謝謝同仁配合演練，大家辛苦了。 (2) 感謝消防局舊莊分隊(南港中隊舊莊消防分隊)親臨現場指導與協助。	
九、演練講評	13:36	請大隊長為本所今日的演練講評。	

Appendix VI 法規議題

本計畫所研究與提倡之公共建築緊急避難指引系統 (Intelligent Emergency Evacuation Systems for public buildings, 下文中簡稱為此類系統或 IES) ，除了系統規劃設計階段必須考慮資料使用、流程設計、及技術整合開發等問題外，未來推動執行時也可能面臨智慧財產權與資料隱私等法律問題。本附件將討論初探本計畫所涉及的法規議題，包含各級政府機關推動此類系統之法律基礎；此類系統建置及應用時所涉及之著作權法與個人資料保護法之議題；為完全達到 IES 之預期目的，未來法規應如何調整或增列。

(A) 各級政府機關推動 IES 之法律基礎

「公共建築」因其屬性不同，可能涉及諸多不同領域的法律，如交通建築另涉及交通相關法規，大專院校校內的建築涉及大學法有關大學自治自宜，本計畫以下以地方政府具有管理權限之一般公共建築為主要分析對象，並一併說明應用 IES 時所需相關通訊業者配合之法律基礎。

- **災害防救法** 依據地方制度法第 18 條、第 19 條、第 20 條之規定，各層級之災害防救之規劃及執行，分別屬於直轄市、縣（市)、鄉（鎮、市）之自治事項。本計畫研究之「公共建築緊急避難指引系統」落實於各公共建築時，應屬前開災害防救之規劃及執行，屬於各級地方政府之自治事項，有關災害防救法、消防法等法律適用之主管機關，將依具體個案狀況為各級地方政府。

災害防救法乃是我國與災害防救有關之基本法律，其第 1 條規定曰:

一、為健全災害防救體制，強化災害防救功能，以確保人民生命、身體、財產之安全及國土之保全，特制定本法。

二、災害之防救，本法未規定者，適用其他法律之規定。

IES 之推動，無論係中央或地方層級，均將以災害防救法為其法律基礎，而特定具體事項之落實，則可能會另外涉及其他法律，例如：若日後擬將相關資料蒐集或訊息發送設備列為公共建築之消防安全設備，則可能須透過消防法相關規定處理。

災害防救法中與本計畫最密切相關者為各級政府應經災害防救會報核定之災害防救計畫。以本計畫所選擇為試驗場地之永和國民運動中心為例，災害防救法第 10 條規定，「鄉（鎮、市）公所設鄉（鎮、市）災害防救會報，其任務如下：

一、核定各該鄉（鎮、市）地區災害防救計畫。

二、核定重要災害防救措施及對策。

三、推動疏散收容安置、災情通報、災後緊急搶通、環境清理等災害緊急應變及整備措施。

四、推動社區災害防救事宜。

五、其他依法令規定事項。

本計畫所研究之 IES 之建置可列為地區災害防救計畫，取得其實施之法律依據，此類系統亦同時可作為「推動疏散收容安置、災情通報、災後緊急搶通、環境清理等災害緊急應變及整備措施」的一環，使公務員有依法行政作為保障，得據以推動一個此類系統之建置及後續依此系統採取相關行政作為（如要求電信等業者配合一定作為、發送災害通報、提供緊急避難資訊、逃生指引等）。

當緊急情況發生、IES 所建議的反應和疏散行為應當考慮及符合《中華民國刑法》第二十四條第一項規定：「因避免自己或他人生命、身體、自由、財產之緊急

危難而出於不得已之行為，不罰。但避難行為過當者，得減輕或免除其刑。」第二項：「前項關於避免自己危難之規定，於公務上或業務上有特別義務者，不適用之。」構成要件為；

一、須有危難存在;

二、危難須屬緊急；

三、須為保全自己或他人生命、身體、自由、財產、所為的避難行為；

四、須出於不得已；

五、須無承受危難的特別義務；

六、須行為不可過當。

由於緊急避難為轉移危難於他方，故會涉及到是否可轉移生命危害的問題。生命法益在台灣仍即便當事人承諾亦不得阻卻安樂死(主動致死)的殺人罪，更何況未得當事人的致死緊急避難? 因此近期認為緊急避難不得適用於危害他人生命的情況。常見例子為甲乙二人海上遇難而只有一副救生設備，甲得否為了避免自己死亡而搶走「已經被乙取得使用的救生設備」？或是火車駕駛失速，行駛路線一邊為兩三名之鐵軌修復工，一邊為數百人的一般旅客，應行駛哪一邊? 這類問題因為不得主張緊急避難而被認為當事人是否有小危害可避難、大危害反要自己承受的荒謬狀況？實則應透過犯罪成立的第三階：責任考量之，在責任階段中的「期待可能性」可以認為「任何人在這類狀況都會移駕危害於他人」而予以減刑或免刑。

- **通訊傳播基本法** 通訊傳播基本法第 14 條規定，「遇有天然災害或緊急事故或有發生之虞時，政府基於公共利益，得要求通訊傳播事業採取必要之應變措施。」

電信法第 25 條規定如下：電信事業對下列通信應予優先處理:

一、於發生天災、事變或其他緊急情況或有發生之虞時，為預防災害、進行救助或維持秩序之通信。

二、對於陸、海、空各種交通工具之遇險求救及飛航氣象等交通安全之緊急通信。

三、為維護國家安全或公共利益，有緊急進行必要之其他通信。

廣播電信法第 7 條規定，「遇有天然災害、緊急事故時，政府為維護公共安全與公眾福利，得由主管機關通知電台停止播送，指定轉播特定節目或為其他必要之措施。」

衛星廣播電視法第 4 條規定如下:

一、遇有天然災害或緊急事故，主管機關得指定衛星廣播電視事業播送特定之節目或訊息。於發生天災、事變或其他緊急情況或有發生之虞時，為預防災害、進行救助或維持秩序之通信。

二、前項原因消滅後，主管機關應即通知該衛星廣播電視事業回復原狀繼續播送。

三、有線廣播電視系統經營者有關天然災害及緊急事故應變之規定，於衛星廣播電視事業準用之。

本計畫所研究之 IES 如欲落實將相關災害訊息通知予公共建築內之民眾，即可能需要多種通訊傳播方式之配合，以依電信法所定之「行動通訊業務管理規則」為例，第 62 條第 3 項「行動電話業務經營者通信系統應具有發送緊急簡訊至災害防救有關機關指定災害區域內基地臺涵蓋範圍使用者門號之功能，並應建置及維持該系統功能正常運作。」第 4 項行動電話業務經營者於災害發生或有發生之虞時，應優先協助災害防救有關機關發送災害區域緊急簡訊，並得向前述機關請求簡訊發送費用。」第 5 項，「前項所稱災害區域緊急簡訊，指災害防救有關機關對於可能發

生或已發生災害區域內基地臺涵蓋範圍之使用者門號，所提供災害相關資訊之緊急通知簡訊。」簡訊的發送未必需要在主管機關知道具體個別民眾行動電話門號的情境下為之，可直接透過行動通訊業者的複數基地台定位，對特定公共建築（及其周邊）大致範圍的民眾發送簡訊。

「行動寬頻業務管理規則」第 55 條第 2 項規定，「經營者應免費提供使用者災防告警細胞廣播訊息服務。」第 4 項規定，「前項所稱災防告警細胞廣播訊息，指災害防救有關機關對於可能發生或已發生災害區域，提供相關訊息，經由經營者行動寬頻系統，在相關區域內基地臺以廣播方式傳送之災害告警訊息。」此等災害告警訊息以細胞廣告方式為之，雖然無法特定到特定精確位置的民眾，亦可作為整體系統建置的一環，以不同的通訊技術提供不同層級的訊息。

然而，由對於通訊傳播相關法規有關「災害」應變措施的檢索，本計畫亦注意到諸多使用者進入公共建築後，可能使用 WiFi 方式連網，則並未有任何災害緊急通報之機制，此主要係緣於 WiFi 連網服務除非像中華電信廣設連網設備將之作為一種電信服務，否則，多為各公共建築之營運管理單位或相關商家所自行設置，無須另行依電信法取得經營許可。然而，以現行國內手持式設備使用的現況，透過 WiFi 蒐集、發放相關資訊，亦為本計畫可以考慮之方向。例如：倘民眾進入本計畫所模擬之永和、汐止、樹林國民運動中心，若使用各運動中心無償提供之 WiFi 服務，像是 iTaiwan 或其他新北市政府提供之無償連線服務，在技術可以支持的前提，可以透過前述「地區災害防救計畫」，要求公共建築在設置 WiFi 連線設備時，加裝一定的軟體作為此一系統建置、蒐集資料、發送資訊之依據。

(B) 著作權法相關議題

本計畫所研究之公共建築緊急避難指引系統 (IES) 在建置階段，將使用各該公共建築之 BIM 相關圖資，由於 BIM 相關圖資來源可能相對複雜，倘未能釐清權利歸屬，即可能涉及侵害著作權議題。

公共建築之 BIM 相關圖資，多數來自於政府機關興建時在設計、建造、營運各階段之各方參與者所繪製、製作，而圖形著作、美術著作、建築著作均為著作權法所保護之著作類型，BIM 相關圖資只要符合著作權法有關著作之要件，即屬受著作權法保護之著作。著作權包括著作人格權與著作財產權，惟以 IES 對於 BIM 相關圖資的利用，即令涉及著作人格權議題，因此類圖資的套疊、修改較不會涉及不當扭曲變更他人著作，主要應在於有關姓名表示權的議題，只要在系統適當位置標示作者姓名即可，故關鍵應該在於著作財產權的議題。若非擁有該等 BIM 相關圖資之著作財產權，未經合法授權而利用 BIM 相關圖資，除符合著作財產權限制（或合理使用）外，即會涉及著作權侵害糾紛。而合法取得各該公共建築之 BIM 相關圖資利用權利，大致可以分成取得著作財產權或取得 IES 建置、應用所需之授權，以下即分別簡要說明：

一、原始或繼受取得著作財產權 － 著作權法第 10 條規定，「著作人於著作完成時享有著作權。但本法另有規定者，從其規定。」第 11 條規定，「(i)受雇人於職務上完成之著作，以該受雇人為著作人。但契約約定以雇用人為著作人者，從其約定。(ii)依前項規定，以受雇人為著作人者，其著作財產權歸雇用人享有。但契約約定其著作財產權歸受雇人享有者，從其約定。Ⅲ前二項所稱受雇人，包括公務員。」第 12 條規定，「(i)出資聘請他人完成之著作，除前條情形外，以該受聘人為著作人。但契約約定以出資人為著作人者，從其約定。(ii)依前項規定，以受聘人為著作人者，其著作財產權依契約約定歸受聘人或出資人享有。未約定著作財

產權之歸屬者，其著作財產權歸受聘人享有。(iii)依前項規定著作財產權歸受聘人享有者，出資人得利用該著作。」前述條文為著作權法有關原始取得著作財產權之規定，著作依著作權法第 10 條規定，原應屬於實際創作者所享有，但例外在受雇人職務上完成之著作與出資聘人完成之著作，可以透過契約約定屬於雇用人或出資人享有。

BIM 建置過程中，多數創作者都是在受雇或受聘的情形下進行創作，若屬單一層級的受雇或受聘關係，直接依前開著作權法第 11 條或第 12 條規定處理，原則上先判斷實際創作者與其雇主、出資人間契約約定。如契約未約定時，受雇人職務上完成之著作，著作人格權屬受雇人享有，著作財產權屬雇用人享有；出資聘人完成之著作，著作人格權及著作財產權均屬於受聘人享有，出資人依第 12 條第 3 項得利用之。亦即，各級政府機關可以透過前開著作權法規定，在一開始即取得著作財產權，以作為這類系統後續建置與利用之基礎。

即令未能在一開始即取得著作財產權，依據著作權法第 36 條規定，「(i)著作財產權得全部或部分讓與他人或與他人共有。(ii)著作財產權之受讓人，在其受讓範圍內，取得著作財產權。著作財產權讓與之範圍依當事人之約定；其約定不明之部分，推定為未讓與。」亦即，相關單位可以透過契約約定的方式，事後受讓原屬於他人之著作財產權。因此，解決著作權議題的方式之一，是可以推動各級政府在進行公共建築相關政策採購案件時，約定由各級政府取得或受讓 BIM 相關圖資之著作財產權。

二、取得相關著作利用授權 – 然而，並非所有的 BIM 圖資，均是該特定公共建築之設計、建造、營運各階段之參與者所自行繪製、創作，可能是利用他人與該特定公共建築無關的案件之創作成果，亦可能各階段參與者因經費或其他因素，不同意將著作財產權讓與各級政府機關。因此，另一個解決著作權議題的方式，即為透過各階段的契約，要求相關參與者應將 BIM 相關圖資，為各該政府機關取得自行或委託他人建置、應用「公共建築緊急避難指引系統」等利用之權利。

三、著作財產權限制（或合理使用）- IES 雖屬於一種非營利的利用，但並非只要非營利，即符合著作財產權限制（或合理使用）的規定，須個案由法院依據著作權法第 65 條第 2 項規定，「著作之利用是否合於第四十四條至第六十三條所定之合理範圍或其他合理使用之情形，應審酌一切情狀，尤應注意下列事項，以為判斷之基準：(i) 利用之目的及性質，包括係為商業目的或非營利教育目的。(ii) 著作之性質。(iii) 所利用之質量及其在整個著作所占之比例。四、利用結果對著作潛在市場與現在價值之影響。」進行綜合判斷。

另外一個可能解決方案，是著作權法第 1 條規定，「為保障著作人著作權益，調和社會公共利益，促進國家文化發展，特制定本法。本法未規定者，適用其他法律之規定。」過去曾有關於專利公報的影印，因專利申請書上之說明、圖示等，仍可能受著作權法保護，而引發是否涉有侵害著作權的爭議，其後以專利法第 47 條規定 屬於「本法未規定者，適用其他法律之規定」，認為依專利法第 47 條所為抄錄、影印等行為，未構成侵害著作權 。

(C) 個人資料保護法

若是 IES 將透過公共建築現場相關設備、民眾手機或其他裝置蒐集民眾的位置與特殊資料 (例如：幼童、老人與身障人士)，此等資訊如可特定個人，將涉及個人資料保護法相關議題。茲初步分析說明如下：

依據個人資料保護法第 2 條第 1 款規定，「個人資料：指自然人之姓名、出生年月日、國民身分證統一編號、護照號碼、特徵、指紋、婚姻、家庭、教育、職業、病歷、醫療、基因、性生活、健康檢查、犯罪前科、聯絡方式、財務情況、社會活動及其他得以直接或間接方式識別該個人之資料。」舉凡可以直接或間接方式識別特定個人的資料，即屬於受個人資料保護法所規範之「個人資料」。

本計畫所研究之 IES 在處理個人資料保護的議題時，大概有二種取向，一種就是在設計時，避免取得可以直接或間接識別特定個人的資料；另一種則是若個人資料的蒐集、處理及利用是無法避免的，則應遵守個人資料保護法相關規範。由於 IES 之目標在於提供個人化的緊急避難指引，可能難避免涉及個人資料之蒐集、處理及利用議題，以下即以可能適用之個人資料保護法相關規定進行分析說明：

- **應適用公務機關相關規範** 個人資料保護法因承襲電腦處理個人資料保護法之規範體系，將適用主體區分為公務機關與非公務機關，並分別適用不同的條文規範。公務機關指依法行使公權力之中央或地方機關或行政法人。
- **應具有合理正當關連性** 個人資料保護法第 5 條規定，「個人資料之蒐集、處理或利用，應尊重當事人之權益，依誠實及信用方法為之，不得逾越特定目的之必要範圍，並應與蒐集之目的具有正當合理之關聯。」
- **原則應採告知後同意 但公務機關執行法定職務之必要得免為告知** 個人資料保護法針對個人資料之蒐集、處理及利用，採取「告知後同意」原則。基本上須在向當事人告知法定事項後，取得當事人同意後進行蒐集、處理，才可以做後續合法利用

  第 8 條第 1 項規定，「公務機關或非公務機關依第十五條或第十九條規定向當事人蒐集個人資料時，應明確告知當事人下列事項：

  一、公務機關或非公務機關名稱。
  二、蒐集之目的。
  三、個人資料之類別。
  四、個人資料利用之期間、地區、對象及方式。
  五、當事人依第三條規定得行使之權利及方式。
  六、當事人得自由選擇提供個人資料時，不提供將對其權益之影響。

  然而，有些情形逐一向當事人告知將妨害正常的活動，故同條第 2 項規定，「有下列情形之一者，得免為前項之告知：

  一、依法律規定得免告知。
  二、個人資料之蒐集係公務機關執行法定職務或非公務機關履行法定義務所必要。
  三、告知將妨害公務機關執行法定職務。
  四、告知將妨害第三人之重大利益。
  五、當事人明知應告知之內容。

  IES 若係由各級政府機關或其委託之第三人進行建置或營運，則可能可以透過「公務機關執行法定職務之必要」的規定，認為在防災、緊急避難等法定職務的必要範圍內，可以在不事前告知的情形，仍可進行合法蒐集。然而，若欲減少民眾疑慮，一種方式是未來將「公共建築緊急避難指引系統」透過災害防救法、消防法等法律，直接列為各級政府機關法定職務的範圍；另一種方式則是仍採取適當的方式告知，例如：在該公共建築適當位置進行有關個人資料蒐集之法定應告知事項的公告、透過「公共建築緊急避難指引系統」相關訊息發送機制、民眾主動安裝 APP 的程序等，告知相關民眾。

- **須依法律規定為蒐集、處理及利用** 個人資料保護法第 15 條規定，「公務機關對個人資料之蒐集或處理，除第六條第一項所規定資料外，應有特定目的，並符合下列情形之一者：一、執行法定職務必要範圍內。二、經當事人書面同意。三、對當事人權益無侵害。」第 16 條則規定，「公務機關對個人資料之利用，除第六條第一項所規定資料外，應於執行法定職務必要範圍內為之，並與蒐集之特定目的相符。...」亦即，公務機關只能在法律規定的情形，才能進行個人資料的蒐集、處理，而亦僅在執行法定職務必要範圍，且與蒐集之特定目的相符，才能合法利用個人資料。

  由於要取得當事人書面同意非常困難，並不適合 IES 此類透過資訊科技操作的系統，因此，對於公務機關如何「合法」蒐集及處理此類系統所需之個人資料，一種解決方案是如前述將「公共建築緊急避難指引系統」透過災害防救法、消防法等法律，直接列為各級政府機關法定職務的範圍，另一方式則是儘可能減少個人資料的蒐集、處理及利用行為，例如：僅有行動設備的硬體產品的特定編號，但不蒐集其行動電話門號、個人姓名；僅蒐集其在緊急避難之分類屬性（成年人、未成年人、是否有幼兒、老年人、行動不便者等），而不蒐集其個人肖像、姓名；僅有緊急狀況時始開啟定位功能；當事人離開公共建築物即刪除相關資料等，讓這類個人資料的蒐集、處理及利用行為，「對當事人權益無侵害」，亦是一可行的系統設計方向。若屬於緊急避難或救援目的之利用，亦可將相關資料透過資訊系統或其他方式，向參與緊急避難導引或救援行動之第三人，提供個人資料（例如：個人所在位置、分類屬性、通訊聯絡方式等）。

  至於若是需要向第三人取得個人資料，例如：向行動通訊業者取得在災害現場當事人之行動電話號碼、姓名等，以協助具體的聯繫或救援行動的配合，則電信業者對於該等個人資料之蒐集，本非為緊急避難、救援等目的，但可依個人資料保護法第 16 條（公務機關）、第 20 條（非公務機關）有關「為免除當事人之生命、身體、自由或財產上之危險」的規定，例外得合法作特定目的外之利用。

  由 IESIES 資料取數控制的觀點來看、個人資料保護法第二項[35]尤其重要：「有下列情形之一者，得免為前項之告知」，其中第二款：「個人資料之蒐集係公務機關執行法定職務或非公務機關履行法定義務所必要。」救災為消防人員之法定義務，若有取得(可能)受災者個人資料始能進行救災工作之必要時，可依據前述條款，不必告知當事人即可取得。

(C) 未來法規之建議

隨著都市發展策略的變遷，臺灣有愈來愈多大型公共建築出現，並結合多種機能共構，以促進空間的多元利用。然而，根據世界銀行評比，臺灣卻是高度暴露於多種災害風險下的國家之一。災害是臺灣未來發展不可避免的影響因子，因此本計畫認為未來推動大型公共建築緊急避難系統具有必要性。在防災與避難的目的之下，為使公共建築主管單位更有效率得取得建築與個人資料，並能發揮避難功效，建議比照「傳染病防治法」之立法動機，增立大型公共建築於緊急情況下可依循之法規，主要內容建議包含：

- 災害防救法雖某程度可透過地區災害防救計畫將 IES 或類似專家決策支援、防災資訊發送等建置、應用納入其災害防救計畫並予以落實，但終究並不是法律明確的規

[35] http://law.moj.gov.tw/LawClass/LawAll.aspx?PCode=I0050021

範，在推動上會面臨須逐一說服各級政府機關的困境，且無論是著作權或個人資料保護的議題，均無明確的法律依據可以例外適用，將回到著作權法、個人資料保護法的規定處理，需要更多細節的操作才能促使相關系統建置、應用得以合法無虞。

- 建議在災害防救法或消防法等有關防、救災的法律中，明確列入各級地方政府針對符合一定要件的公共建築應建置此類防、救災資訊系統的義務。如可進一步將防、救災資訊所需之建築相關圖資（BIM 相關圖資）、主動蒐集、處理及利用規定一併列入，將可以相關系統建置及普及應用更加快速。
- 個人資料的議題，並非概括式地在法律規範相關政府機關可以主動蒐集、處理及利用個人資料即為已足，仍應考量個人資料保護法有關合理正當關連性之規定，對於個人資料的蒐集、處理及利用，採取最小侵害原則（僅蒐集必要資訊，並採取適當匿名化處理），並將這樣的原則一併列入法律中，以減少此類系統建置時不當蒐集、利用個人資料的疑慮。
- 至於向第三人取得相關個人資料進行防、救災使用，本即可依據個人資料保護法有關特定目的外利用的規定為之，若另行在法律中明定，當然可以減少相關第三人的疑慮。
- 各通訊傳播業者若為須取得經營執照者，相關法律本即已明文規範其等應配合救災為適當之措施，此部分可在 IES 具體建置時，與各通訊傳播業者聯繫進行配套的資訊系統串接、測試等事宜，若面臨相關業者反應問題時，再具體個案會請通訊傳播委員會協調處理即可。