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Chapter

Research on Technology Governance of IoT Smart City in Yilan, Taiwan: Taking Intelligent Disaster Prevention as an Example

Chang-Wei Chai, Yu-Heng Huang and Tseng-Wei Chao

Abstract

An advanced smart building platform should meet the needs of humanization and provide the best information and communication technology integration capabilities to enhance the digital upgrading and transformation of the construction industry. From the perspective of the technology governance of the smart city in Yilan County, this study proposes the direction of the sustainable development of intelligence in Lan-yang area and discusses the intelligent disaster prevention of the IoT smart city in Yilan, Taiwan. In the study, data related to technology governance were collected through literature review and validation of empirical fire drills, including the meaning of smart city, the development process of promoting smart city in Taiwan, and technology governance and smart city development. The content and analysis of empirical fire drills demonstrated the specific achievements of the smart city technology governance development in Yilan County, Taiwan.

Keywords: technology governance, intelligent city, Internet of Things, intelligent disaster prevention, fire protection

1. Introduction

Last year, IEEE held the 2021 IEEE International Conference on Electronic Communications, Internet of Things and Big Data (ICEIB 2021) international symposium in Yilan, Taiwan, and one of the papers was selected as the Best Paper Award. The paper provides forward-looking AIoT (The Artificial Intelligence of Things) Fairy technical capabilities through the Infairy IoT (Internet of Things) browser platform, integrates different communication protocols, realizes the interconnection and interoperability of IoT standards, solves the smart home fragmentation, and meets the needs of intelligent buildings to keep pace with the times.

The study site is located in Yilan County, northeastern Taiwan. The location is small and beautiful, which is conducive to the development of the pilot smart city market. Through the smart application of technology governance and industrial development, it will bring a new and better life experience, expand the energy of technology governance and the IoT industry, and introduce the smart city market.



Figure 1. Smart city official documents approved by Yilan County Government.

This study has been approved by the local government of Yilan County with the approval letter number: 1090066019, as shown in **Figure 1**, smart city official documents approved by Yilan County Government. The approved research field goals include the following seven aspects: (1) Demonstration Project of Intelligent Disaster Prevention and Intelligent Rehabilitation Aids in Yilan County Nursing Homes: Social Division and Health Bureau, (2) Old Building Access Control Upgrade Demo Construction Project in Yilan County: Construction Office, (3) Demonstration of intelligent fire joint defense system in Yilan County's smart city upgrade project: Fire Department, (4) Intelligent Agriculture and Breeding Platform Demonstration Site in Yilan County: Agriculture Division, (5) School Intelligent Science Laboratory Construction Project: Department of Education in Yilan County; Health Bureau, (7) Smart hotel, smart home project in Yilan County: Construction Office/Industry and Tourism Office.

This chapter focuses on the third field "Demonstration of intelligent fire joint defense system in Yilan County's smart city upgrade project" and combines the IoT technology as the core technology to build a smart city in Yilan, especially the intelligent fire detection and alarm system in Yilan County.

2. Literature review

The concept of smart city originates from the concept of "Smarter Planet" proposed by IBM. A smart city is a measure for the transformation of a smart planet from concept to concrete implementation. Smart city construction is to develop and

apply massive data, cloud computing, IoT, mobile information and communication technologies on the basis of intelligence, develop new urban concepts and governance methods, and improve urban operation efficiency. The construction of information and communication technology and environmental facilities will create a sustainable ecological environment, allow citizens and enterprises to enjoy a more comfortable and convenient environment, and enhance the competitiveness of the city. A smart city is defined as a city that performs well in terms of future economy, mobility, environment, citizenship, quality of life, and government [1].

Six thematic areas must be present and addressed in any Smart City proposal. They are: Smart Economy, Smart People, Smart Mobility, Smart Living, Smart Government, and Smart Environment, proposed by Boyd Cohen in the model, known as "The Cohen Wheel" [2]. Each subject area contains a set of city indicators.

Cities face tight budget, which have led to budget cuts in addition to cost-cutting measures. Therefore, smarter and resilient infrastructure is essential to oversee urban challenges and transform urban environments [3]. The integration of smart city technologies can help achieve the goal of smarter and resilient infrastructure [4, 5]. Currently, proposals for cost-effective solutions to data-based decision-making are best involving IoT-based technologies [6]. The IoT is one of the technological paradigms destined to exponentially increase the connectivity of various devices. The main advantage of IoT is its high impact on the daily behavior of potential users [7].

The IoT and Artificial Intelligence (AI) are current hot research topics due to recent industry achievements, and they have been shown to achieve better results in many disciplines such as automated factories, public surveillance, asset monitoring, waste management, weather monitoring, etc. Combining the IoT and AI is an effective way to intelligently upgrade existing information systems [8].

Infairy Technology Company has been engaged in the research and development of the IoT technology for more than 10 years. It integrates all communication standards and provides a smart IoT platform for true connectivity. The traditional IoT is limited by the problem of non-interoperability of standards, while Infairy Technology has not changed its hardware standards. Compatible with the original standards, coupled with the "standard interoperability" technology, solves the problems of the traditional IoT [9].

In Taiwan, there are many master's and doctoral dissertations related to smart city research. These relevant dissertations can be used as a reference for the literature review of this study [10–16].

In terms of promoting smart cities in Taiwan, the Economic Development Council of the Executive Yuan (now the National Development and Reform Commission) passed the "Third National Construction Design in the New Century (2009~2012)" in 2008, in which the main axis of national development policy of spatial reconstruction is the fifth project, namely "Smart Taiwan." Since 2014, the National Development and Development Council has actively promoted the overall development plan of smart land and proposed the overall development plan and planning strategy of smart land. The content and analysis of the development of science and technology governance in Yilan County and the empirical fire drills of smart cities show the specific achievements of technology governance and smart city development in Yilan County, Taiwan, as follows: [17]

1. Governments at all levels in Taiwan are actively promoting the research planning and pilot tests of smart land. For the development of Information and Communication Technology (ICT), the Yilan County Government provides a process that takes into account the different aspects and characteristics of the problem, as well as various impacts and challenges, to form views and ideas that belong to Yilan. In the process of thinking about developing a smart country.

2. List the 104-year planning goals: In view of the problems faced by the urban development of Yilan County, through the operation of smart Yilan software and hardware, observe and understand the information environment of Yilan County's future development problems and propose solution to introduce big data and GIS-related technologies for planning "smart cities." Through big data, open data, GIS, and other processing and cloud computing, it provides intelligent information that can be applied to smart cities, whether it is urban governance, improving people's quality life experience, promoting the development of local industries, and extensive public services as the foundation of smart land and city governance.

The graphic text description of Smart Land Map of Taiwan (Figure 2) is as follows [17]:

- 1. Smart land = smart city + smart urban and rural areas (smart townships) + environmentally sensitive areas (mountain and sea monitoring)
- 2. The category of smart land: smart environment, smart economy, smart life, smart planning and governance, and smart society.
- 3. Smart country is an extension of smart city. ICT is introduced to assist in the development of cities and towns, as well as monitoring of mountains and coasts in environmentally sensitive areas. Advanced technology is used to improve the efficiency of government governance and the effective use of resources.



Figure 2. Smart Land Map Yilan County in Taiwan [17].

3. Research methodology

Knowledge production within the field of business research is accelerating at an alarming rate, while still being decentralized and interdisciplinary. This makes it difficult to keep up with the latest technologies and to be at the cutting edge of research, as well as to assess the collective evidence for a particular area of business research. This is why literature reviews are more relevant than ever as a research method. Traditional literature reviews often lack thoroughness and rigor and are conducted ad hoc, rather than following a specific methodology. Therefore, questions can be raised about the quality and credibility of these types of reviews. Literature review as a method of conducting research provides an overview of different types of reviews and some guidelines to how to conduct and evaluate literature review papers [18].

Empirical research method is a special form of scientific practice research. According to the needs of existing scientific theory and practice, propose a design, use scientific instruments and equipment, and determine conditions, through purposeful and step-by-step operations under natural conditions, according to the changes in phenomena accompanied by observation, recording, and measurement in the activity of causality between phenomena. The main purpose is to illustrate the relationship between various independent variables and a dependent variable.

Software engineering is more than technical solutions. It also largely deals with organizational issues, project management, and human behavior. For a discipline like software engineering, empirical methods are crucial because they allow the incorporation of human behavior into the research approach taken. Empirical methods are common practice in many other disciplines. One motivation for using empirical methods in software engineering research is that it is needed from an engineering perspective to allow for informed and well-grounded decision. Empirical research methods in software engineering continue with a brief introduction to four research methods: controlled experiments, case studies, surveys and postmortem analyses. These methods are then put into an improved context. The four methods are presented with the objective to introduce the reader to these methods so that they can select the most appropriate method in a specific situation [19].

This chapter applies research methods such as literature research method and empirical research method to analyze and discuss actual research cases, so as to fully present the technical governance application of smart city IoT intelligent disaster prevention in Yilan County, Taiwan. The research design is as follows:

3.1 Current status of disaster prevention

For the construction of the intelligent fire joint defense system in the study, after the firefighters entered the fire scene, because they could not grasp the internal space conditions, and the surrounding smoke was dense, the visibility was insufficient. , Lost direction, no way to get out of the predicament of export research, analysis, and control. In previous cases, such as the fire at the Jingpeng factory in Taoyuan City, Taiwan, the regrettable death of firefighters has occurred continuously. The reason why firefighters are so helpless is because they have too little information on disaster relief. In the past few decades, firefighters have only relied on heavy and heavy paper to grab pictures, which are not only difficult to preserve, but also inconvenient to carry. They failed to provide interpretation to front-line personnel in a timely manner, making firefighters almost blindly rush into the fire scene. In addition, the KTV fire in Taipei City, Taiwan, further highlights the importance of self-management of fire safety by the industry. Due to the complete shutdown of fire safety equipment such as smoke exhaust, sprinkler, alarm, and broadcasting systems, consumers cannot escape in time, causing heavy casualties. We should keep pace with the times, and only by combining technology can we improve the efficiency of disaster prevention and relief.

3.2 Intelligent disaster prevention solution strategy

In this research, an intelligent fire joint defense system is constructed in combination with the IoT technology, which provides real-time information for firefighters, so that firefighters can grasp the internal space situation after entering the fire scene. Using IoT technology to provide fire-related information for firefighters to interpret, reducing the casualties of firefighters due to insufficient information. In addition, actions that endanger public safety, such as the fire alarm system being closed privately by the operator, can also be communicated to the fire authorities through the real-time warning notification system to avoid the complete shutdown of fire safety equipment such as smoke exhaust, sprinkler, alarm, and broadcasting systems, resulting in consumption. The person cannot escape in time, resulting in the risk of serious casualties.

4. Research results

This research carried out a fire drill on June 20, 2020 at the Natural Beauty Dormitory, Wujie Township, Yilan County, Taiwan. The results of the relevant application of the IoT research were displayed in the fire drill. It is the first IoT technology disaster prevention exercise in the country. The fire chief of the county and city, the director of the Disaster Prevention Office of the Executive Yuan, and major media were all present. The research and development system combined industry-government-academic resources, led by the Fire Bureau of Yilan County Government and Chairman of Yilan County Council Jian-rong Zhang (Chief of Yilan County Volunteer Fire). The parliamentary secretary, Yu-heng Huang, was assigned to coordinate the liaison, participate in joint research and development, and introduce the first IoT-based intelligent fire protection system in Taiwan to improve disaster prevention and safety in Yilan County and more effectively reduce the danger of firefighters in the fire scene. The results of the relevant fire drills are as follows (**Figures 3–5**):

This exercise applies intelligent cloud platform of Infairy IoT browser technology as the IoT application infrastructure, combined with the firefighter's mobile positioning device of search action technology, intelligent smoke detection of Horing Lih industrial co., Ltd., temperature, gas wireless sensors, and other equipment to build a set of a security disaster prevention and relief system based on the IoT, research team members develop intelligent sensing technology, external sensors detect the operation of the trusted switchboard, and actively report abnormal behavior (ex. power is turned off) to create a smart fire city system. The system can actively report the operation of the fire safety equipment and the location of the fire in the event of a fire. It can receive the positioning signal in real time through the combination of the alarm device and the positioning device and send the plan of the fire site and the position of the firefighters back to the on-site commander's tablet computer. In order to avoid disasters in public places such as KTV in Taipei City, at the same time, this study cooperated with Taiwan Connection Co., Ltd., to enhance the LINE



Figure 3. *Real photos of fire drills in Yilan County, Taiwan.*



Figure 4.

Fire drill results presentation manual in Yilan County, Taiwan.

community function, and played the role of a new "Community Watch and Help." Through the LINE group notification function, the traditional "Community" Watch and Help Team has been advanced into a "Smart Community" Watch and Help Team Group, we can apply the IoT technology to build a smart city that makes people feel safe and secure at home.



Figure 5.

Invitation letter for the presentation of fire drill results in Yilan County, Taiwan.

The notification process for the use of IoT technology combined with the community software notification system is as follows:

- 1. When the smoke alarm is triggered in the home, LINE's "neighbor group" can be notified immediately.
- 2. LINE's "family group" can receive a notification immediately when the door is opened or when the elderly enters and exits.
- 3. When the electricity consumption is abnormal, the LINE "friend group" can receive abnormal electricity consumption information.
- 4. If a monitor is installed, watch it at the same time to transmit the monitor screen to each group synchronously.

The theme of this study exercise is "safety" and "relieved." During the exercise, through four major themes, this study will create an environment that will make Yilan County the most livable environment in Taiwan:

4.1 Intelligent disaster prevention linkage

When the smart sensor is triggered, the protective actions of firefighting through the Infairy smart cloud platform are as follows:

Open the windows of the home to exhaust smoke to avoid choking injuries and affect the escape time at the same time.



Figure 6.

Schematic diagram of intelligent disaster prevention linkage.

Turn off the gas to reduce the risk of increasing the fire due to gas leakage (**Video 1**, https://youtu.be/u9NxLUxXB9Q) (**Figure 6**).

4.2 Firefighters fire location

The personal safety of firefighters in the fire scene is also very important in this research. During the exercise, a fire location environment was built, and the



Figure 7. Schematic diagram of firefighters' fire location.

indoor positioning App built into the firefighter's mobile phone automatically transmits the current location information to the command center. The real-time position, stay time, and travel trajectory of firefighters in the fire scene are easy to grasp and dispatch disaster relief, and at the same time, it can effectively reduce the danger of firefighters in the fire scene (**Figure 7**) (**Video 2**, https://youtu.be/U2KZqa-OCbE).

4.3 Abnormal notification of fire detector central control

When the trusted switchboard of the firefighting equipment is turned off, the detector immediately detects the abnormal situation, immediately transmits the message through the LINE communication system through the Infairy intelligent cloud platform, and notifies the designated background (such as the command center of the Fire station and related personnel), in order to immediately notify the responsible personnel to dispatch personnel to investigate and report to prevent the occurrence of disasters (**Figure 8**) (**Video 3**, https://youtu.be/wcB_iEEGjEM).

4.4 Community watch and help announcement

The LINE group of the social software is not only a channel for communication between modern people, but also can play a new role of "community watch and help." The relevant watch and mutual aid delivery procedures are as follows:

- A. When the smoke alarm in the home is triggered, LINE's "Neighbor Group" can be notified immediately.
- B. People can receive a notification immediately in "family group" of LINE when the door is opened or when the elderly enters and exits.



Figure 8. Schematic diagram of abnormal notification of fire detector central control.



Figure 9.

Schematic diagram of community watch and help notification in LINE.

- C. When the electricity consumption is abnormal, the "friend group" of LINE can receive abnormal electricity consumption information.
- D. If a monitor is installed, LINE can simultaneously transmit the screen of the monitor to each group at the same time.

Through the LINE group notification function, the traditional "community" watch and support team has been advanced into a "smart community" watch and support group, and the use of IoT technology to build a smart city that makes people feel safe and secure at home (**Figure 9**) (**Video 4**, https://youtu.be/VAhDuhAUDVs)

The actual case of the application of IoT technology in technology governance successfully demonstrated in this research exercise. At the same time as the results of the exercise were displayed, Yilan County Mayor Zi-miao Lin led the announcement that Yilan County fully introduced IoT technology in agriculture, aquaculture, and the elderly living alone. Care, security update of old apartment access control, smart accommodation and other scenarios, and implement the IoT concept into the basic education courses of middle and primary schools, and establish seven major fields such as the IoT teaching practice laboratory in middle and primary schools, so that the IoT concept can be realized. Taking root downward, and taking Yilan County as a demonstration site, Yilan County will become the first smart city in Taiwan that can be felt by the public (**Figure 10**).

The research team has applied distance teaching technology to guide primary and secondary school students of remote indigenous tribes to learn new knowledge of science and technology, and the results have been unanimously affirmed and favored by teachers and students of remote indigenous tribes [20].

After entering the fire scene, the firefighters were unable to grasp the internal space conditions, the surrounding smoke was dense, and the visibility was insufficient. Although they were only a few steps away, they were disoriented due to the bad environment of the fire scene and could not get to the exit. There is too little disaster relief information. Over the past few decades, relying only on heavy paper to grab the pictures is not only difficult to store, but also inconvenient to carry.



Figure 10.

Schematic diagram of the application of IoT technology in seven fields of smart city in Yilan County, Taiwan.

The tragedy cannot be repeated again. The Fire Department of Yilan County Government decided to cooperate with the team of Yizhong Information Co., Ltd., through the project of the Industrial Bureau of the Ministry of Economic Affairs to develop the "Smart Fire 3D Reality Control System," taking the lead in the country and establishing the basis for visualization. 3D map data, personnel entry and exit control, and indoor positioning system will present information such as the internal configuration of the building, firefighting equipment, and storage of dangerous goods in a three-dimensional manner, assisting in real-time grasp of disaster relief and effective deployment and human life search and rescue. Among them, the indoor positioning system can provide a warning function, reminding the commander to send personnel to follow the line for rescue and assist each firefighter to walk out of the fire safely. It has been gradually extended to 239 places such as hotels and restaurants, large exhibition venues, shopping malls, and dangerous goods factories within the jurisdiction, which is expected to greatly reduce the risk of disaster relief.

5. Conclusion

The introduction of IoT technology into smart cities will bring more convenience and fun to the city's daily work and life. In the future, urban intelligence will not be just cold steel, cement, and equipment, but will become a good partner in life, providing a safer, more convenient and energy-saving lifestyle. For example, the results of this research help fire and disaster relief to accurately grasp key information and effectively carry out disaster relief deployment and human life search and rescue operations. Among them, the indoor positioning system can provide a warning function, reminding the commander to dispatch personnel immediately, follow the line to rescue, and assist each firefighter to walk out of the fire safely. Relevant technologies can also be extended to hotels, restaurants, large exhibition venues, shopping malls,

and dangerous goods factories in the county to reduce the risk of disaster relief for firefighters during disaster relief.

In addition, the establishment of a community watch and help LINE group in the research results can not only serve as a channel for communication between modern people, but also play a new role of "smart community watch and help," up to 1. When the smoke alarm in the home is triggered, "neighbor group" of LINE can be notified immediately. 2. "family group" of LINE can receive a notification immediately when the door is opened or when the elderly enters and exits. 3. When the electricity usage is abnormal, the "friend group" of LINE can receive abnormal electricity usage information. 4. If a monitor is installed, watch it at the same time to transmit the monitor screen to each group synchronously. By combining the IoT technology with the function of LINE group notification, the traditional "community" support team has been advanced into a "smart community" support group. The results show that people's homes are safer and more secure.

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Conflict of interest

The authors declare no conflict of interest.

Notes/thanks/other declarations

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Author details

Chang-Wei Chai^{1*}, Yu-Heng Huang¹ and Tseng-Wei Chao²

1 Chinese Culture University, Taipei City, Taiwan

2 Shih Hsin University, Taipei City, Taiwan

*Address all correspondence to: changwei.chai@gmail.com

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