

# Application of Road Excavation Management System for Seismic Disaster Preparedness

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## ABSTRACT

Tainan City has 37 administrative districts and an area of 2,192 km<sup>2</sup>, including 750,000 manhole, 49 pipeline authorities and total underground pipeline length of 36,000 km. To effectively integrate, manage the pipelines and prevent disasters from happening, Tainan City Government not only has installed public utility database and road excavation management system, but also has actively developed earthquake disaster prevention evaluation system and other surplus applicative functions. In response to the digital trend, the system has been transform from computer system management into mobile management and various mobile device application functions. It wielded actual effects on the February 6th earthquake of 2016, in which it provided disaster relief information within a short period of time so that underground pipeline problems can be handled precisely to prevent secondary disasters and enhance efficiency greatly.

Keywords: public utility database, mobility management, disaster prevention, earthquake.

## 1. Introduction

Tainan city with a size of about 2,192 m<sup>2</sup> and has a population of 1.88 million. There is a total of 49 pipeline management agencies that maintain about 750,000 utility manholes and over 30,600 kilometers of pipelines that include a number of hazardous pipeline systems for high voltage electricity, natural gas, and oil within the city's jurisdiction. Maps and data for these utility pipelines were mostly independently established and maintained by the respective agencies. However, the power and responsibility of supervision and management of these pipelines were distributed amongst various agencies instead of being integrated under a single standard due to the requirements of Taiwan's laws and regulations, leading to tough management issues during integration, supervision, and disaster prevention.

Tainan city is also a high-risk compound disaster area and local residents have dealt with threats stemming from multiple natural and man-made disasters for a very long time. Utility pipelines also face similar threats from these disasters as well. A most recent example would be the February 6th, 2016 magnitude 6.3 earthquake (hereinafter referred to as the "0206 Earthquake"), which had a maximum intensity rating of VII. The damages resulted in power outages for over 170,000 households and water outages for over 400,000 households in the city, and showed that damages to utility pipelines would be unavoidable during earthquakes.

According to the survey of the Central Geological Bureau indicated that there were 6 active faults in Tainan, 3 of first-type fault and 3 of second-type, giving the city the highest number and density of faults for any county and city in Taiwan. We can foresee a very high earthquake hazard potential. Realizing that, Tainan City Government takes actions to manage public utilities pipelines with the concept for disaster prevention and began to study how to make public utilities pipeline information available for disaster relief applications. There are four topics for public utility database management system (Figure 1):

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Fig.1 Topics for public utility database management system in Tainan City

## 2. Development and applications of Public Utility Database Management System

In order to develop disaster prevention functions for its utility pipelines, Tainan City developed management system with following features:

### 2.1 Pipeline maps accessible anywhere

The cell phone APP could be used to quickly retrieve the maps and information of pipelines located within 200 meters of the cell phone location (Fig.2). During disaster prevention, frontline personnel could employ the APP to immediately acquire information and distribution of underground pipelines without flipping through printed maps or performing on-site excavation. During the 0206 Earthquake disaster rescue operations, rescue personnel were able to access and peruse pipeline layouts around disaster sites promptly to determine the location of hazardous pipelines and to notify relevant pipeline agencies to activate emergency responses and standby at the site. This solution not only improved disaster rescue efficiency, but also reduced the incidence of secondary disasters that may be caused by hazardous pipelines.

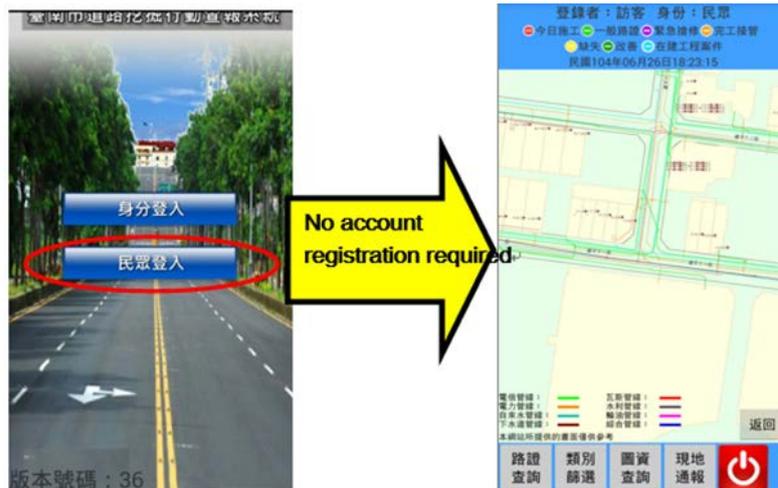


Fig.2 APP for Public Utility Database Management System

### 2.2 Preliminary review of disaster potential

Worked with the Disaster Prevention Research Center (DPRC) of National Cheng Kung University (NCKU) to develop the Earthquake and Disaster Prevention Evaluation System and

established earthquake simulation data for the 6 fault zones in Tainan City. An example would be the analysis of the Houjia Village Fault (Fig. 3). Subsequent studies helped to demonstrate how pipelines of different materials, diameters and age would sustain the shock during earthquakes to identify areas that may be affected more severely during disasters. Taiwan Water Corporation would then be recommended to initiate preventive measures to improve the safety of water supply systems.

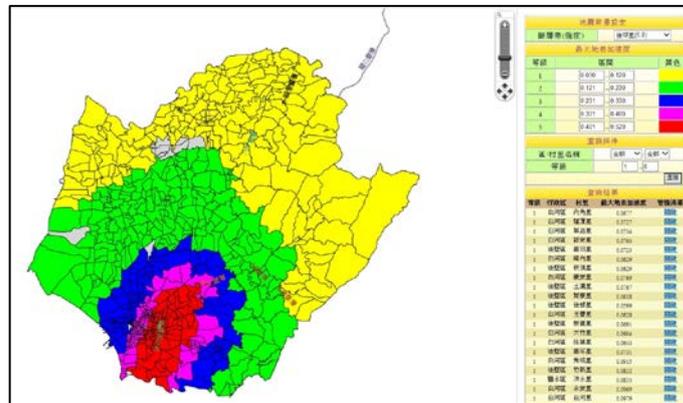


Fig. 3 Earthquake simulation of the Houjia Village Fault

### 2.3 Exposing all hazardous pipelines

When applying for road excavation works, the areas around the excavation site must be verified by the utilities to identify any hazardous pipelines. The road excavation management system was required to display the hazardous pipelines map layer so that these pipelines could be avoided during construction to prevent any dangers (Fig. 4). The system will also provide a reminder if the excavation area includes military pipelines.



Fig.4 Searching for hazardous pipelines close to the excavation site

## 2.4 Active reminders to prevent damaging excavation works

When public utilities carry out their construction and excavation works, the system will automatically overlay the zones with the hazardous pipeline map as shown in Fig. 5, allowing the utility easily to study their excavation area when overlapped with natural gas pipelines and reminds them to take special precautions during the actual excavation procedure.

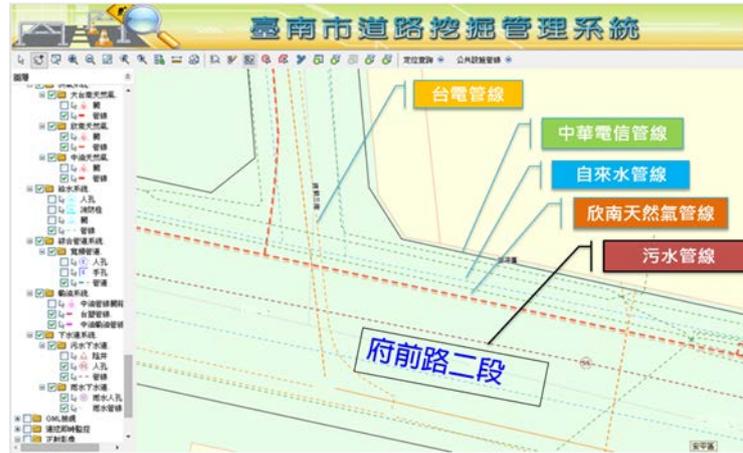


Fig.5 System overlaps the road excavation with different utilities pipeline

## 2.5 Establishing SOPs for emergency rescue and repairs of damaged pipelines

Disaster prevention and rescue processes have been defined using SOPs in order to ensure that every worker have general familiarity with the tasks they were supposed to handle during disaster prevention and rescue operations. Those who lack familiarity may reference workflows and guidelines to complete their tasks.

During the 0206 Earthquake, the collapse of the Weiguan building damaged a major water transmission line, cutting off water supply to more than half of the Tainan City. The rescuing process was handled according to the SOP shown in Fig.6.

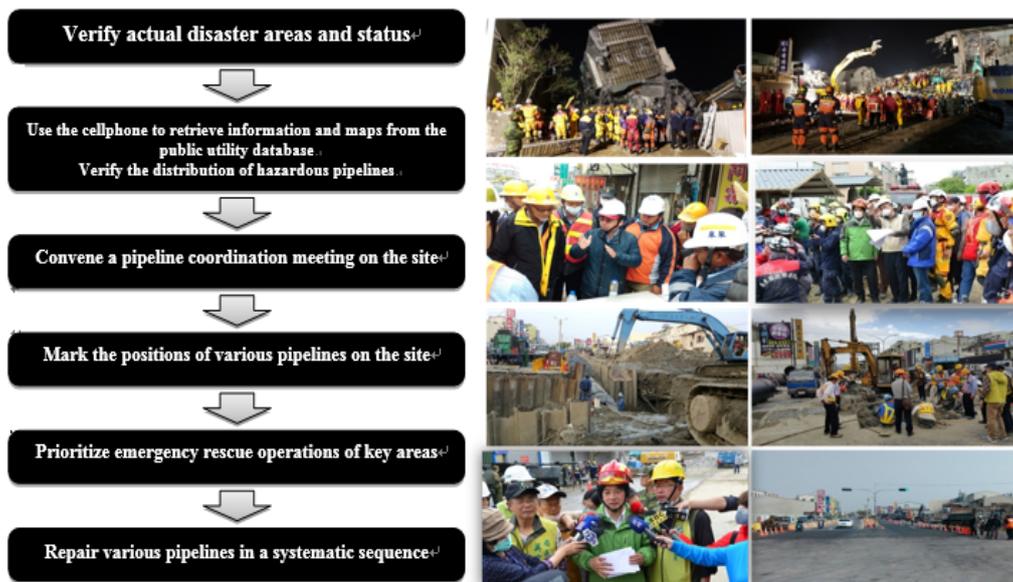


Fig6 SOP for the emergency rescue and repairs of damaged pipelines

### **3. Conclusion**

The Tainan City Government has invested a great deal of effort in establishing the public utility database and developed many innovative and practical functions to improve the standards and safety of utilities' pipeline services.

After the 0206 Earthquake, Tainan City continued to uphold the principle of prevention is better than rescue, and avoidance is better than prevention and developed many of Taiwan's first innovative applications in these areas. The solution provided integrations with the aim of preventing disasters before they occur and mitigating the impact when they do. The database system and cell phone APP were used in actual frontline rescue operations of the 0206 Earthquake, and demonstrated their abilities in quickly providing information needed by disaster rescue operations, helping to mitigate the impact of the disaster and avoid the incidence of subsequent secondary disasters.

Tainan City Government shall continue to cooperate with public utilities to build upon this experience of success to maximize public benefits and welfare and establish Tainan City as a safe, livable, and healthy city for the people.

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