Using a service blueprint and the service catalogue concept to plan a smart governance system: the case study of the southern Taiwan science park

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Abstract: To improve the Southern Taiwan Science Park efficiency, the administration of the park used the smart city concept to transform it into a smart science park. Beyond the information and communication technology (ICT), the key to the development of a smart science park was to consider the requirements of the park's relevant stakeholders. Hence, this study applied the concept of persona, a service blueprint, and the service catalogue concept as the planning methodology and used smart governance as an example to demonstrate our planning process. We held focus group meetings with each persona, used a service blueprint to visualise the group's requirements, and utilised a service catalogue to present the service contents of the related smart governance systems. The study suggested that the relevant authority should implement the smart governance data centre, a public equipment management monitoring platform, and a disaster management platform to improve the efficiency and effectiveness of the public service of the park.

Keywords: smart city; smart science park; service blueprint; smart governance; e-government; service catalogue; public service; persona.

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1 Introduction

To enhance the competitiveness of the Southern Taiwan Science Park (STSP), the Ministry of Science and Technology of Taiwan has requested the STSP to implement systems that will manage, monitor, and integrate public infrastructure and environmental information to transform the STSP into a smart park. These systems are similar to smart governance systems, which originate from the smart city concept. The theory of implementing smart science parks is similar to that of smart cities that apply state-of-the-art information and communication technology (ICT) to provide various services to the public. Smart cities are multifaceted and include governance, building, mobility, energy, environment, and public services (Lee and Lee, 2015). Smart governance is a significant aspect of smart cities, as smart governance not only describes the process by which residents participate in public services but also improves the efficiency and transparency of public services (Albino et al., 2015; Bolívar, 2015). Hence, the STSP plans to implement a smart governance system that will monitor environmental variables and provide information on flood risks, drinking water safety, water recovery rates, air and water quality, and other environmental variables to optimise the basic infrastructure operations of STSP.

Although smart cities and smart governance are ICT based (David et al., 2015), the requirements of residents are soft factors that should be prioritised in smart city planning efforts (Giovannella et al., 2014). For example, Angelidou (2017) noted, following a review of nine smart city implementation cases, that a major shortcoming of implementing smart cities is the lack of user participation. To grasp the typical park users' profile, considering an archetypal users (personas) may help to better understand

the collective behaviours of actual city residents (Marshall et al., 2015). Additionally, public services should be provided through specific procedures/processes as a means to deliver a variety of services. Therefore, a service blueprint will provide a visual description of the service system, clearly profiling the service procedures and the requirements of different personas (Fließ and Kleinaltenkamp, 2004). When planning smart governance systems, a service blueprint is a useful tool for presenting the overall information service process. In addition, a service catalogue, which provides a list of all provided IT services (Arcilla et al., 2013), is a valuable tool for showing current information services. A review of the related literature found that few studies have discussed methodologies related to planning smart cities and smart governance. Furthermore, Angelidou (2017) stated that improper planning may result in failure to achieve the objectives of a smart city.

The smart governance system envisioned by the STSP will use the advanced internet-of-things (IOT) technology to effectively deliver critical public services in support of the regular operations of factories located in the park. Thus, key elements of the STSP smart governance system will include air and water quality monitoring, electrical power monitoring and measures to prevent/control the impact of accidents and disasters. Considering the above, this study describes the smart governance planning process used at the STSP. The process described in this study, which uses both the persona concept and the service blueprint and service catalogue concepts to plan the smart governance system, may be referenced in the planning efforts of other systems and fill a gap in the current research on smart cities.

2 Literature review

2.1 Smart city

The term ‘smart city’ was first used in the 1990’s. The initial concept related to the integration of new ICT applications into a city infrastructure, while later, the concept shifted towards making cities ‘smarter’ by enabling them to use relevant information technology to improve the wellbeing of residents. ‘Smart’ covers a range of concepts, some of which incorporate ‘intelligent’ and/or ‘digital’ concepts (Albino et al., 2015). Solanas et al. (2014) argued that the term smart city had not been strictly defined and thus remains a vague concept. Although researchers have defined smart cities differently, the views presented in the literature are gradually becoming more consistent. For instance, Lee and Lee (2015) stated that smart cities use modern sensor-related ICT to provide various public services. Pérez-Martínez et al. (2013) and Solanas et al. (2014) argued that smart cities, while applying novel technology, must also work to improve quality of life for residents by fostering economic growth, encouraging participatory governance, and practising intelligent resource management, while also providing more efficient mobility to ensure the privacy and security of residents.

The common applications of smart cities are largely limited to governance, mobility, energy, the environment, public services, the people, and the economy (Albino et al., 2015; Lee and Lee, 2015). Anthopoulos et al. (2016) synthesised the concepts in the International Standards Organization (ISO), BSI (UK), as well as the US National Institute of Standards and Technology (NIST), and observed that smart cities focused primarily on enhancing six dimensions of urban life: the people, the government, the

economy, mobility, the environment, and quality of life. Anthopoulos et al. (2016) proposed the unified smart city model (USCM), which comprises eight classes of viewpoints: architecture, governance, planning and management, data and knowledge, energy, health, people, and environment. Neirotti et al. (2014) classified the application domains into hard and soft domains, with the hard domains including sensors, wireless technologies, and software that are applied to enhancing the quality of life of city residents. In addition, Neirotti et al. (2014) stated that hard domains include the following:

- *transport, mobility and logistics*: considering traffic conditions and energy consumption and providing users with dynamic and multi-modal traffic and transport information for the optimisation of transportation and logistics in urban areas
- *energy grids*: employing ICT to make energy delivery and usage more efficient
- *public lighting, natural resources, and water management*: managing public lighting and exploiting renewable resources such as heat energy, solar energy, water, and wind
- *waste management*: applying innovative approaches to recycle and reuse waste materials effectively
- *environment*: using ICT to protect and better utilise environmental resources and related infrastructure to increase sustainability
- *office and residential buildings*: using sustainable building technology to create energy-saving homes and work environments.

Although the smart city is based on the application of ICT (David et al., 2015), the needs of residents and communities should be incorporated as important considerations in all smart city planning work (Albino et al., 2015; Angelidou, 2016). As previously noted, the term ‘smart cities’ initially focused on the utilisation of new ICT in city infrastructure (Albino et al., 2015). However, the shortcomings of this limited definition led to many major cities experiencing difficulties in implementing effective smart city programs. Thus, Angelidou (2017) conducted an in-depth case study exploring nine individual smart city cases in Barcelona (Spain), Songdo (South Korea), Stockholm (Sweden), Chicago (USA), and other cities, discussing the shortcomings experienced during smart city development and implementation. Angelidou (2017) also found that developing smart cities often involved very large financial investments and mandatory changes to user behaviours. Situational factors involving improper policy implementation and strategic factors, such as a lack of proper planning, ICT infrastructure planning and poor coordination of communications within the organisation, led not only to non-participation, or resistance, of users but also to a failure to secure follow-up funding. Thus, the smooth implementation of many smart city plans was prevented.

2.2 Smart governance

Most of the related research defines smart governance as the implementation of ICT to improve coordination, decision-making processes, the efficiency of public services, and the transparency of governance systems, with the effectiveness of implementation often measured by the online public availability of institutional information (Lin, 2018;

Bolívar, 2015; David et al., 2015). However, governance is a relatively broad concept that includes governance structures, processes, and procedures. Thus, the comprehensive process of governance is not easy to define (Šiugždinienė et al., 2017). Scholl and AlAwadhi (2016) focused on the aspect of capability, proposing that smart governance is defined by the capacity to apply intelligent and adaptive acts and activities to examine and make decisions concerning public affairs. Bolívar and Meijer (2016) conducted a systematic literature review and reported that the six elements of smart governance included using ICT, external collaboration and participation, internal coordination, decision-making processes, e-administration, and outcomes. Ruhlandt (2018) also analysed relevant studies and categorised these studies into four categories which included components, measurement, contextual factors, and outcomes. Ruhlandt (2018) further used the inductive approach to develop seven components of smart government: stakeholders, structure and organisation, processes, roles and responsibilities, technology and data, legislation and policies, and exchange arrangements. Although the categorisation approaches of Bolívar and Meijer (2016) and Ruhlandt (2018) were different, both identified the important elements of smart governance, including roles, technology, processes, collaboration, and outcomes. Moreover, Cartaxo and Hossain (2018) argued that implementing smart governance should rely on digital transformation and incorporate new ICT solutions such as open data and big data. All of these components will be important parts of smart governance.

2.3 Persona and service blueprint

The concept of persona was proposed by Cooper (1999), who defined it as a virtual and specific role that may be used to represent the end user (Madureira et al., 2014; Nielsen and Hansen, 2014; Wang, 2014; Marshall et al., 2015). Setting up a persona may improve a planners' understanding of the end users with respect to how and why they use a product or a service. The notion of persona has been widely used in the design of commercial products and IT systems, marketing, service design, and other fields (Madureira et al., 2014; Nielsen and Hansen, 2014). Since a persona simulates end user behaviours, it helps create a profile of user habits and may be used by design teams for internal communications and coordination (Pruitt and Grudin, 2003). Furthermore, the concept of persona has been applied to system design. For example, Switzky (2012) virtualised several characters to consider the process of online registration, purchasing, bills inspection, payment, purchase records inquiry, and after-sales service to increase the design efficiency of a portal site. As for the design and formation of a persona, it is possible to form an understanding of the characteristics of the end user through field study techniques such as surveys, interviews, and observations (Nielsen and Hansen, 2014). Madsen et al. (2014) used semi-structured interviews to form several personas and explained the job role, motivation and purpose, and the pain point of each.

The components of the service blueprint are physical evidence, customer action, onstage/visible contact action, backstage/invisible contact action, and the support process (Hossain et al., 2017). These components may be modified to fit the contextual requirements. For example, the modified service blueprint used by Song et al. (2015) and those of Song and Sakao (2017) contained only the five components, the product-using domain, the product-management domain, the visualised-service domain, the invisible-service domain, and the resource domain.

2.4 Service catalogue

ISO/IEC 20000, the earliest IT service management standard, identified the specification of a service catalogue as important to providing quality IT service (Arcilla et al., 2013). Moreover, the Information Technology Infrastructure Library (ITIL) stated that a service catalogue was a very important aspect of IT service management (Elephant, 2007). A service catalogue is a formal document that describes the available services; Mendes and da Silva (2010) stated that a service catalogue is an essential basic requirement for IT organisations, as such catalogues allow users to discover the available services. Furthermore, a review of the IT service management-related literature by Melendez et al. (2016) found that many other studies had also identified service catalogue management as an important part of the IT service process.

A service catalogue uses business terms to list the scope and characteristics of available IT services in a manner similar to restaurant menu listings (Arcilla et al., 2013). A service catalogue further confirms that the listed items are services the IT department regularly provides and maintains. Mendes and da Silva (2010) believed that common IT service catalogues tended to group services logically, clarifying the subitems and services contents for each group. For example, service catalogues often include hardware services, application systems, communications, consulting, and supporting systems. Application systems may be subdivided into enterprise portals and system development; enterprise portals may be further subdivided into internal corporate websites, financial management systems, email, document management systems, file storage services, and internet services. In planning standard IT service catalogues for small businesses, Arcilla et al. (2013) grouped information services into hardware, email, internet, application software services, and backup categories. The researchers further subdivided software services into the installation, update, and maintenance of specific software and the installation, update, and maintenance of base software.

3 Planning methodology for smart governance at the STSP

The planning methodology used in this study was divided into three steps. The first step defined the relevant users of smart governance and used focus group interviews to explore users' preferences and requirements. To explore the requirements for smart governance at the STSP, this study created personas for the four categories of the STSP stakeholders: management authorities, manufacturers, experimental high schools, and citizens. Because some of the employees of the STSP and the STSP experimental high school teachers were citizens of the STSP, the study used them as residents' representatives. Focus group meetings were then held to explore their requirements.

The second step plotted service blueprints to visualise the smart governance service process. After aggregating the user requirements for smart governance resulting from the focus group meetings, the study used a service blueprint to visualise the smart governance service process. To clearly depict the service process of the STSP smart governance, the study referred to Song et al. (2015) and Song and Sakao (2017) who modified the elements of a service blueprint to reflect the relevant roles and users, the smart governance system's actions, the related units of the relevant authorities, and the smart governance system's service domain. The overall service blueprint was constructed to facilitate internal communications with the STSP authority.

The third step developed service catalogues to present the suggested content of the smart governance service. The details of each step are described below. The smart governance system, which uses IOT-based information services, should provide a service catalogue that fully discloses to the STSP-resident companies the scope of information services available to them. This study further reconciled the requirements of the several personas within the STSP with the budget and capabilities of the STSP authorities.

4 Results

4.1 Each Persona's requirements and expectations

This two-stage study involved four focus group meetings. The first-phase focus group meeting focused on the relevant authorities in the STSP. Under smart governance, public services involve cross-sectional and cross-divisional activities. Therefore, the environmental protection section in the STSP environment and labour affairs division, the land planning and construction management section in the STSP land development division, the facility maintenance section in the STSP construction management division, and the planning section in the STSP planning division, were invited to participate in the meeting. A total of 24 participants took part in the meeting. The focus of the second-phase focus group meetings was to listen to the expectations and requirements of non-authority stakeholders and residents. The relevant individuals responsible for or involved in smart governance issues were invited to attend. A total of 56 participants from factories and seven participants from the STSP experimental high school joined the meetings.

After information from these meetings was collected, it was determined that each persona had a distinct perspective; the perspective of each persona is summarised below:

1 *STP authorities*: The authorities' requirements were from the perspective of institutional management that concerned providing adequate infrastructure for the factories. Hence, the authorities needed to monitor aspects of the environment such as air quality, water and electricity supply, and natural disasters, provide disaster warnings and respond to disasters, and transmit and archive the data for real-time monitoring and cloud computing.

2 *Factory representatives*: A risk-free business environment was their major concern. They wanted the authorities to provide stable water and electricity supply, so they wished to know the environmental information. Moreover, if disasters, such as earthquakes and fires, occurred, the representatives wanted to receive warnings, status information, and even instructions on how to deal with the event.

3 *The STSP experimental high school representatives and citizens' representative*: the STSP experimental high school is located in the STSP. Most of the STSP experimental high school teachers and staff not only worked in the STSP but also lived in the STSP's dormitory. They were concerned about health issues and wanted to receive the environmental information. They hoped that such information would be displayed outdoors.

4.2 Eight catalogues of smart governance system requirements

Owing to each persona having a different perspective on the governance issues, the study used a flow diagram concept, which began with the real-time monitoring of environmental information and ended with a cloud archive. Finally, we summarised the requirements of the personas and expectations into eight catalogues. Based on the service catalogue concept, each catalogue was then subdivided into a number of subcatalogues to clarify content requirements. These are as follows:

1 Real-time monitoring and data acquisition, including the following:

   1.1 Real-time monitoring via IOT of air quality (particulate matter (PM 2.5), ozone, hazardous gas, CO_2, CO, temperature, and humidity), wastewater (water quality detection), earthquakes (using a seismograph), fire (monitoring of chemical concentrations), electricity (power consumption, kWh), and water (overflow, gate opening, water level gauge, pressure gauge, and water consumption)

   1.2 Transmitting data via the cloud or existing networks.

2 2. Instant monitoring and presentation of data, including the following:

   2.1 Allowing instant query of monitoring data

   2.2 Displaying the monitored data outdoors.

3 Acquiring external open data such as data on upstream hydrology, chemical clouds, traffic, chemical data, waste information, water balance diagrams, and earthquake warning information.

4 Setting alert values and warnings, including the following:

   4.1 Automatically notifying a fire station of a disastrous incident

   4.2 Notification of abnormal status

   4.3 Broadcasting alert messages.

5 Acquiring internal and external emergency information critical to the provision of real-time disaster warnings.

6 Collecting and presenting disaster information, including the following:

   6.1 Collecting disaster area information (e.g., concerning water, electricity, chemicals and air quality)

   6.2 Visualising disaster location

   6.3 Providing escape route recommendations.

7 Disaster monitoring and response recommendations, including the following:

   7.1 Real-time disaster monitoring

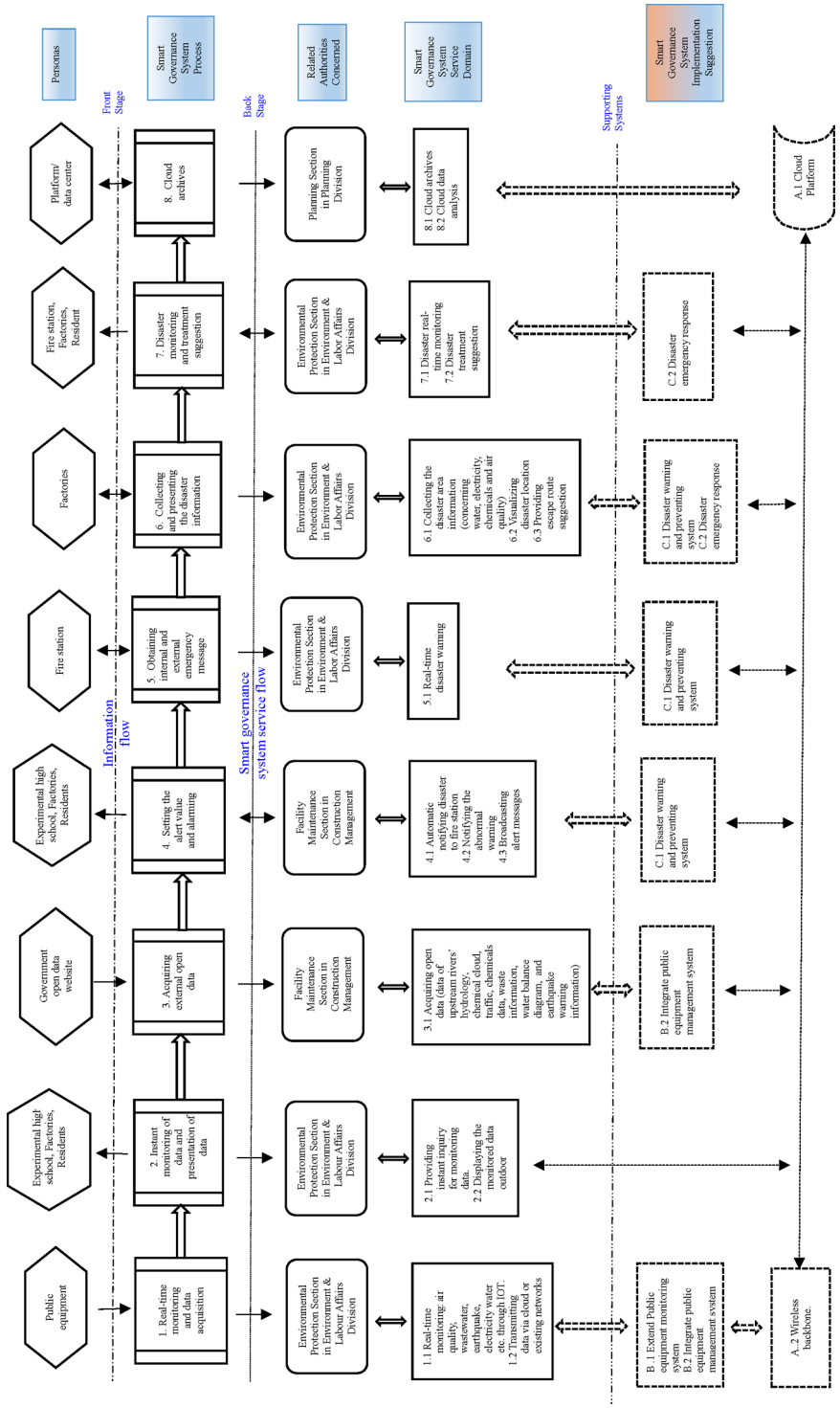
   7.2 Disaster treatment recommendations.

8 Establishing cloud archives, including the following:

   8.1 Cloud archives

   8.2 Cloud data analysis.

Figure 1 Service blueprint and services catalogue of STSP smart governance system (see online version for colours)



4.3 Service blueprint of the smart governance system

A visual representation of the service blueprint was developed after aggregating the smart governance-related requirements and expectations of the personas, shown in Figure 1. The four elements in the blueprint are described below:

1 *Persona/user*: Needs-related devices such as air detection devices, seismographs, watt-hour metres, water level gauges, and pressure gauges to monitor environmental variables. Factories, the experimental high school, the government's open data website, the fire station, and the backbone each play key roles in the smart governance system.

2 *Smart governance system action*: Eight catalogue system actions monitor variables in real time and upload the acquired data to the cloud archives (see Figure 1).

3 *Concerns of the relevant authorities*: The STSP authorities involved in the provision of the smart governance service include the environmental protection section in the environment and labor affairs division, the facility maintenance section in the construction management division, and the planning section in the planning division.

4 *Smart governance system service domain*: Each of the eight main catalogues has 1–3 subcatalogue service contents (Figure 1).

4.4 Proposal to the STSP smart governance system

1 Reconciling requirements for smart governance with the existing implementation plans of the authority

After developing service catalogues in response to the aforementioned requirements, this study sought to reconcile these catalogues with the current projects and plans of the related authorities to avoid a duplication of efforts. A meeting was held with the related authorities to confirm their ongoing projects and plans, and efforts were made to integrate the items that were addressed by these current projects and plans into the proposed smart governance system.

2 Priority evaluation for the smart governance system

Funding is necessary to implement all aspects of this system. In light of the STSP budgetary limitations, this study prioritised each element of the smart governance system based on the four criteria of "urgency", "importance", "enhancing performance or reducing harm" and "integrating with existing resources".

3 Proposed STSP smart governance system

After evaluating the project using the priority criteria in the previous section, the aforementioned eight major catalogue requirements were converted into three major systems: the smart governance centre, the disaster management platform, and the public equipment management platform (Figure 1).

A *Smart governance data centre*: The purpose of this centre is to transmit all data, including open data and data resulting from real-time monitoring of IOT devices, archive data into the cloud or platform, analyse data, and respond actively or passively to user queries. This centre included two subsystems:

A.1 *Cloud platform*: Building a digital data transfer platform for smart governance. Smart governance requires that information be collected both inside and outside of the STSP. Although all of the current monitoring systems in the park have their own transmission and/or communication networks, some data must be connected externally to government-provided open data such as hydrological, seismic, and traffic data. This substantial interface system is part of the disaster management service platform. However, the interface and data format connected to the platform should be specified first. The related subsystem is of critical importance and urgency and was therefore assigned the first priority.

A.2 *Wireless backbone*: The data centre may achieve the necessary functionality in this area by strengthening the coverage of wireless signals using the STSP's current and partially built wireless network infrastructure.

B *Public equipment management monitoring platform*: The STSP partially uses IOT to collect data on the use of water and electricity (power consumption, kWh). Therefore, the development of this platform should:

B.1 *Extend the public equipment monitoring system*: install additional IOT-integrated devices to collect data on air quality (particulate matter, ozone, hazardous gas, CO2, CO, temperature, and humidity), wastewater (water quality detection), and earthquakes (seismograph).

B.2 *Integrate the public equipment management system*: integrate external environmental information such as the upstream water level, traffic information, and air quality for more comprehensive monitoring and management of the conditions across the entire STSP.

C The disaster management platform includes two subsystems:

C.1 The disaster warning and prevention system is mainly used to monitor information related to disasters such as floods and earthquakes and to set alert values and warning messages.

C.2 *Disaster emergency response system*: collect disaster-related information, visualise the disaster location, and provide response recommendations. The former subsystem has a higher priority than the latter.

5 Conclusion

Smart governance is a critically important facet of a smart city, as smart governance can significantly improve the efficiency and transparency of public services. Although proper planning is key to implementing smart governance, few studies have discussed related planning methodologies. This study combined the persona concept with a service blueprint and service catalogue approach to demonstrate the process of planning smart governance at the STSP. The results reveal that users expect the STSP smart governance

system to provide eight categories of information services, including real-time monitoring and data acquisition, instant monitoring and presentation of data, acquiring external open data, setting alert values and warning messages, providing real-time disaster warnings based on internal and external emergency information, collecting and presenting disaster information, providing disaster monitoring and response recommendations, and establishing cloud archives. Due to budget limitations and based on the application of priority criteria, this study suggests implementing three major systems, including the smart governance centre, the disaster management platform, and the public equipment management platform.

The planning process developed within this study used a 'bottom-up' approach that prioritised the expectations and opinions of users. One of our planning results, the services blueprint, presented all of the important components of smart governance that were proposed by Bolívar and Meijer (2016), Ruhlandt (2018) and Cartaxo and Hossain (2018), such as representing various stakeholders' requirement, using ICT-based technology, cross-departmental collaboration, external collaboration, diagnosing situations and taking appropriate actions, delivering public services online, and incorporating open data and big data. The methodology presented in this study may provide a reference for related systems planning work in the future.

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