GIS TECHNOLOGY

Utility registration

Slovenia, China, Sweden and Turkey

Maja Bitenc, Kajsa Dahlberg, Fatih Doner, Bas van Goor,
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GISt Report No. 49

TU Delft

OTB Research Institute for Housing, Urban and Mobility Studies

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Summary

This report presents a study on the state-of-the-art in management of utilities in four different countries. The study was performed by a group of Geomatics students following the course Spatial Information in Utilities and the visiting researcher Fatih Doner.

Being an important part of daily rhythm of a city, the management of utility networks (such as electricity, water, gas, sewage, TV, etc.) has been always of great importance but also challenging. Two kinds of registration can be distinguished: technical and legal registration. One of the aims of the technical registration is to protect utilities from damage in case of works by third parties. The legal registration, on the other hand, provides registration of rights, restriction and responsibilities related to these objects.

Many organizations such as cadastres or municipalities have started initiatives to collect data of utilities in one centre in order to get easy access to utility information. Different countries have approached this issue in a different way. This report discusses approaches followed in four countries: Slovenia, China, Sweden and Turkey.

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Contents

1 Introduction

Utility networks such as water supply, sewage, power supply, heat supply, industrial pipelines and communication cables, are essential infrastructures in cities. They serve cities by transporting water, energy and information. Being an important part of daily rhythm of a city, management of utility networks has been always challenging due to numerous issues. Two kinds of registration can be distinguished to manage legal and technical issues of utilities: technical and legal registration. One of the aims of the technical registration is to protect utilities from damage in case of works by third parties. The legal registration, on the other hand, provides registration of rights, restriction and responsibilities related to these objects. Organizations such as cadastres or municipalities have started initiatives to collect registrations of utilities in one centre in order to get easy access to utility information.

However, many countries or local governments are still not able to manage utilities adequately. Insufficient, inaccurate and unclear information about location and depth of utilities have caused various problems and have resulted in tragic accidents. Many accidents such as the cut-off of gas, water and heat supplies, communication lines and even the overflow of sewage have been reported by city authorities in different countries (Du et al, 2006). The increased use of underground space requires more effective management of utility information than ever before. The intensive expansion and modernization of cities (involving re-construction and re-building of streets, buildings etc.) needs also reliable information about existing utilities. An effective registration of utilities will provide more efficient spatial planning, safer implementation of spatial activities and more efficient management of infrastructural objects, like the control over the public services and more economical use of the infrastructure objects. In this report, registration of utilities in different countries will be examined. These countries are Slovenia, China, Sweden and Turkey.

2 Registration of utilities in Slovenia

The act 'Spatial legislation' (accepted in 2002) can be considered as the beginning of the systematic registration of public infrastructure. The Cadastre of Public Infrastructure is established by two laws; 'Zakon o urejanju prostora, ZUreP-1' and 'Zakon o prostorskem načrtovanju, ZPNačrt' (i.e. Spatial planning act). The Surveying and Mapping Authority of the Republic of Slovenia (SMA RS) got the task to provide technical and organizational terms for the system, which will register and manage the public infrastructure on the national level (Figure 1). Until 2004, SMA RS in collaboration with the competent ministry, local municipalities and executants of public services, has:

- determined the method to register the public infrastructure,
- restored the Consolidated Cadastre of Public Infrastructure (CCPI) and
- determined the method to access and use the data of public infrastructure.

There is a strong believe that the registration of utilities will help many users to perform better their daily tasks. When the data about the public infrastructure are completed:

- an owner of the infrastructure will be safe against the damage of his infrastructure when excavation is needed (less damages, cheaper excavations);
- an owner of the parcel will know what kind of infrastructure exists on his parcel and where it is;
- public administration will have access on one place to the fundamental information about the infrastructure and also the directive where to find more detailed data for a certain infrastructure;
- the private sector will be able to access the data of the public infrastructure faster and easier and so better condition will be given for the development;

More detailed description of managing and maintaining the Cadastre of PI, is given in 'Pravilnik o vsebini in načinu vodenja zbirke podatkov o dejanski rabi prostora' (i.e. Rules on the content and method of keeping a database on actual land use) (Pravilnik 2004).

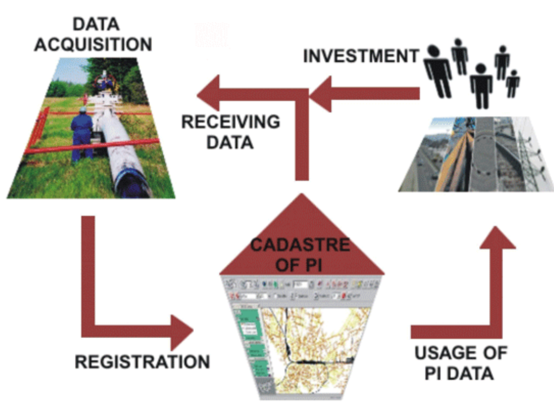

Figure 1: Public infrastructure data flow from acquisition to use (Mlinar, 2008).

The Consolidated Cadastre of Public Infrastructure (CCPI) is the communication point for users and owners of the data. Main actors in the complete organization model of the CCPI are:

- local municipalities, ministries and other owners of the infrastructure, who maintain the data,
- users, who need the data for their work and are able to use them according to the methodology of access of the system, and finally
- geodesy as the linking part of these two (Figure 2).

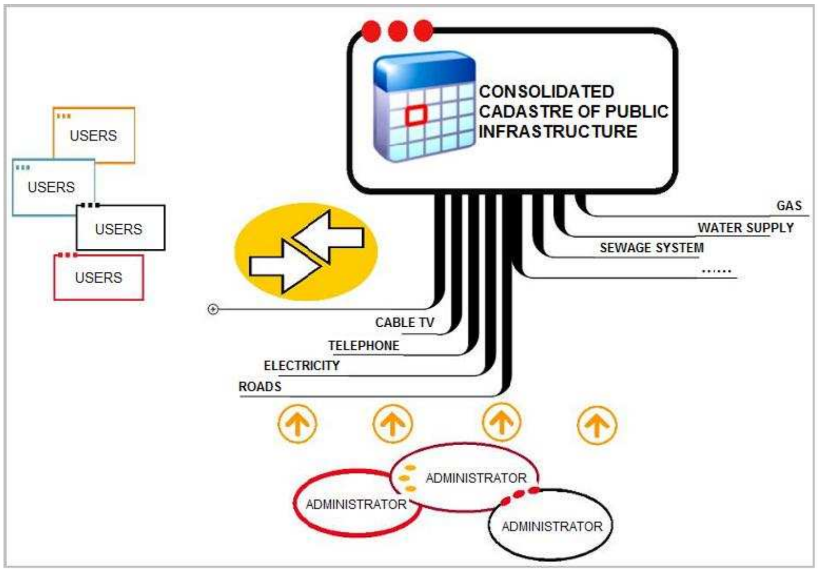

Figure 2: Main actors in the system of the Consolidated Cadastre of PI (Zbirni kataster, 2007)

The CCPI includes only the most important or basic data of PI, which must be by law intermediated to SMA RS by the owners of the public infrastructure. The procedure and the methodology of registration are described in more details in the Consolidated Cadastre of Public Infrastructure, 2007. In other words, the data registered in the CCPI are a join of many individual operative cadastres and evidences of PI, which existed already before and managed by owners and managers of infrastructure for their technical and business needs. Those operative cadastres describe the particular network in more detail (Figure 3).

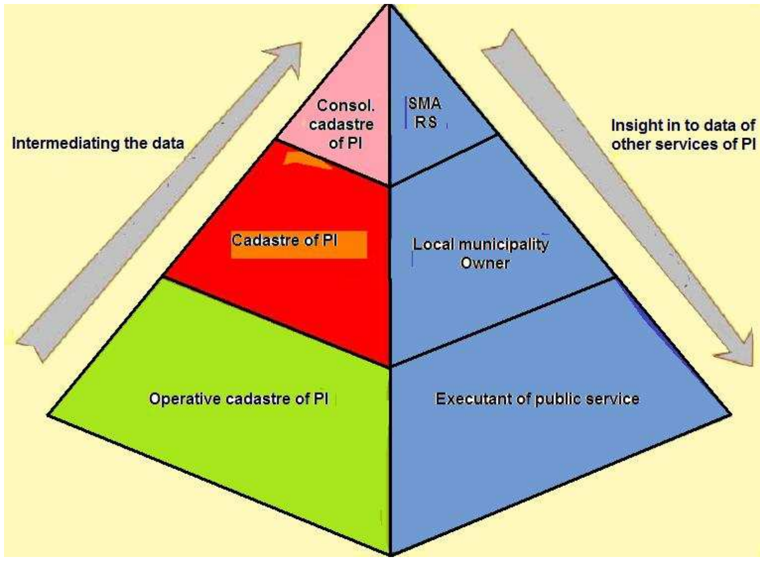

Figure 3: The complete organizing model of the Consolidated Cadastre of PI (Mlinar, 2007).

2.1 Information systems for administering the Consolidated Cadastre of Public Infrastructure (CCPI)

In order to facilitate efficient CCPI data administration, a special system infrastcuture has been designed. It consists of five components (Figure 4):

- procedure administration module,
- ArcMap with the additional PI module,
- production database (Oracle spatial 10g),
- distribution database (Oracle spatial 10g),
- on-line browser of spatial data.

The procedure administration module is used as a work administration part for receiving studies of changes, importing of data into the database and the attribute data control. ArcMap with the additional PI module enables the control of graphic data. The data are administered and updated in the PI production database Oracle spatial 10g (for the spatial data, they use Oracle spatial geometry types, for example simple polygons, lines and points), while the external users access data through the distribution system, where data are copied daily from the production environment. The CCPI system thus represents a whole, which provides the SMA with a powerful tool to receive, control and administer PI object data supplied by owners of individual infrastructures. Furthermore, the distribution environment provides the users with a simple access to the most current PI data, which are available together with other spatial data.

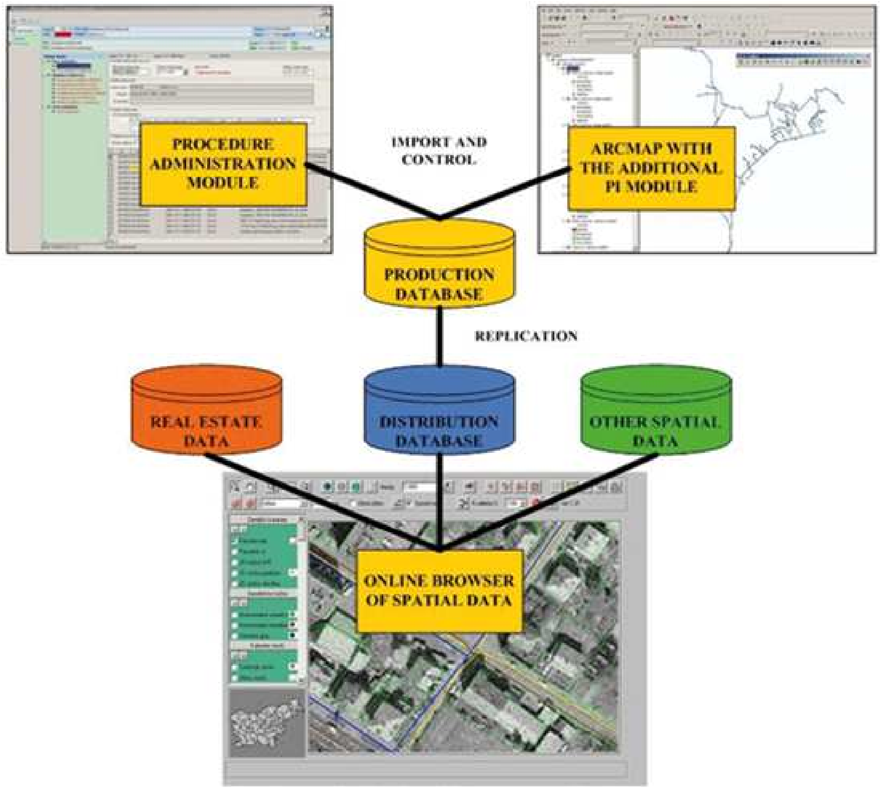

Figure 4: Information system of the Consolidated Cadastre of Public Infrastructure (Mlinar, 2008).

The CCPI is managed as an individual layer and includes (beside the data listed before) the geo-location as it is registered in the Land Cadastre. Therefore it is possible to combine and connect those data (using the geo-location tools), and obtain the list of infrastructures and objects that are present on every chosen parcel or run through it (underground or above it). An example will be presented at the end of this report.

2.2 The data in the Consolidated Cadastre of Public Infrastructure (CCPI)

CCPI allows for registering of different types of public infrastructures:

- traffic infrastructure (roads, railways, airports, ports),
- energy infrastructure (electricity, gas, heat, oil),
- public utilities infrastructure (water distribution system, sewage system, waste management infrastructure),
- water infrastructure,
- infrastructure for managing other kinds of natural resources and environmental protection,
- electrical communications (telephone, cable TV, telecommunications).

In November 2007 there were already 700,000 objects registered in the CCPI. The tables below give some numbers (Mlinar, 2007).

Table 1: Percentage of the registered national infrastructure.

Type of the infrastructure	Percentage
National roads	100 %
Railways	100 %
Gas pipelines	100 %
Water infrastructure	85 %
Infrastructure of electrical energy	15 %

Table 2: Percentage of the registered local infrastructure.

Type of the infrastructure	Percentage
Local roads	80 %
Sewage system	35 %
Water supply	40 %

Table 3: Percentage of other registered infrastructure.

Type of the infrastructure	Percentage
Forest roads	100 %
Electrical communications	20 %

Table 4: Length of the registered infrastructures in the Consolidated Cadastre of PI nowadays.

Length	Type of insrastructure
42,225 km	Roads
2,495 km	Railroads
1,772 km	Gas pipelines infrastructure
412 km	Infrastructure of heat energy
7,214 km	Water supply
2,139 km	Sewage system
3,351 km	Infrastructure of electrical communications

The deadlines to intermediate the existing data (or the data about existing infrastructure) differ with respect to the type of networks. Some of the networks are completed but others are still in process.

2.3 The methodology of registering the public infrastructure

According to the established legislation, in case of changes of existing network or laying-down of a new object, the owner has to report it by law to SMA RS within 3 months. The record of the individual object or network in the CCPI is done with the standardised form, the so-called 'elaboration of changes'. The statues give detailed description of the elaboration and its exchanging formats (Pravilnik, 2004). Depending on the type of the network or objects, different regulations determine what has to be recorded. Executants of public services, local municipalities and ministries, which are in charge of certain public services, can determine detailed requirements that are adapted to their needs and that they find useful to be collected in the cadastre of PI. In general the CCPI includes for each network or object following data (Pravilnik, 2004):

- the location data of the network or object (point, line, polygon in the national coordinate system),
- identification number of the network or object (is given by the SMA RS at the first registration of the PI),
- the type (CC-SI classification[1]) of the network or object,
- the length of the network or the area/surface of the object (capacity),
- the position accuracy of the network or object,
- link to the cadastre of PI (the manager or owner of the object or network), etc.

Table 5 gives a more detailed overview of all attributes and more information on how the attributes are organised in the Consolidated Cadastre of PI.

Table 5: Attributes of the objects (Zbirni, 2007).

Successive number	Attribute	Description of the attribute
1	TIP_SPR	Type of the change.
2	ID	Uniform identification number in the system of the Consolidated Cadastre of PI.
3	ID_UPR	Uniform identification number in the system of the owner's cadastre.
4	SIF_VRSTE	Type of the object.
5	CC_KLAS	The cipher of the object after the CC-SI classification.
6	TOPO	Topological shape of the object.
7	NAT_YX	Position accuracy.
8	Z	The absolute height above the sea level (for the apex of the point object).
9	NAT_Z	Height accuracy.
10	GIJ	Attribute of PI.
11	VIR	Source
12	DAT_VIR	Date of the source.
13	MAT_ST	Registry number of the object's owner.
14	MAT_GJS	Registry number of the object's manager.
15	ID_EL	Identification number of the last object's elaboration of changes in the system of the Consolidated Cadastre of PI.
16	DAT_EL	Date of the last record of the object in the Consolidated Cadastre of PI.
17	DIM_YX	Outer size of the object's ground plan (in m)
18	DIM_Z	Outer vertical dimension of the object (in m)
19	OPU	Dropped object.
20	ATR1	Special attribute 1.
21	ATR2	Special attribute 2.
22	ATR3	Special attribute 3.
23	ATR4	Special attribute 4.
24	ATR5	Special attribute 5.
25	OPIS	Additional description.

1 CC-SI is based on and executed from unified classification of objects with the title Classification of Types of Constructions (CC), which is used in European Union.

According to the mentioned 'space legislation' the investor, who is building the public infrastructure, must assure that a geodetic company takes proper measurements of the new objects. The 'responsible geodesist' has to make:

- a geodetic map of the new situation in the space, which is a prerequisite to get an application permission and
- elaborate on the changes to register the object in the consolidated cadastre of public infrastructure.

The process of registering utilities during laying-down depends on companies or managers of the utilities themselves. It could be performed using kinematic GPS, measuring the polygon points of the network with the total station, relative measurements with regard to nearby existing objects or networks. However, they have to provide the accuracy of those measurements. Usually utility companies use an information system based on CAD technology, so they can easily visualize objects and networks in space. The CCPI is using DBMS-based information system. In this way large amounts of data can be seamless stored (all utilities in the country with their attributes) and efficiently queried – via different identifiers linking the data in the CCPI with other collections of spatial or infrastructure data.

2.4 The methodology of accessing the data in Consolidated Cadastre of Public Infrastructure (CCPI)

The new CCPI enables to easily obtain the data about the objects and networks of public infrastructure on one single place, moreover just with a few clicks on the web page (http://prostor.gov.si). The latest eases the work for everybody who frequently needs and uses the data of the public infrastructure, when e.g. planning some construction, preparing the project documentation for building construction, building itself etc., and enables efficient management of the space on the national as well as on the local level. Moreover by law the data must be used for any spatial activities ('call, before you dig'), to obtain the prerequisite building and applying permit (for certain network/object). Via the web viewer PREG users can view and order the data, and get additional help via web services.

Surveying and Mapping Authority of the Republic of Slovenia made in 2007 four different web applications to view and to access data:

- public insight into data;
- insight into data for companies (for business reasons);
- accessing/ordering the data for administrators and owners of the public infrastructure;
- accessing/ordering the data for public administration.

Table 6: Four different web applications for accessing the data.

	Web application enabling the access to the data			
	public insight into data	insight into data for **companies**	accessing the data for **administrators** and **owners** of the public infrastructure	accessing the data for **public administration**
Who	everybody	everybody	administrators and owners of the public infrastructure	local communities, Ministries
What	public infrastructure on a certain parcel	all data in the Consolidated Cadastre of Public Infrastructure	detailed report, objects that they own	data in the Consolidated Cadastre of Public Infrastructure for the territory of that local community
How	no limitations	registration, to be paid, public administration for free	registration, digital certificate	registration, digital certificate, HKOM

The pictures below show the public data, i.e. those available for everyone. After choosing the cadastral local community (field 'Katastrska občina') and typing in the number of a certain parcel (field 'Parcelna številka' in Figure 5), we can have a look at the:

- list of existing objects of public infrastructure on that parcel (Figure 6) and
- graphical overwiev of that parcel with the objects of public infrastructure (Figure 6).

Figure 7 shows a result of a cross section between a parcel (red outline) and the CCPI. In this way, we obtain information about the utilities network and the objects, which are on this parcel, like water supply, sewage system, road and gas pipes etc. Further on we can see also neighbouring parcels (from the Land Cadastre) and buildings (from the Building Cadastre) laid over a colour orthophoto. In such a manner, joining different (all) existing evidences, the integrated information about the space is presented.

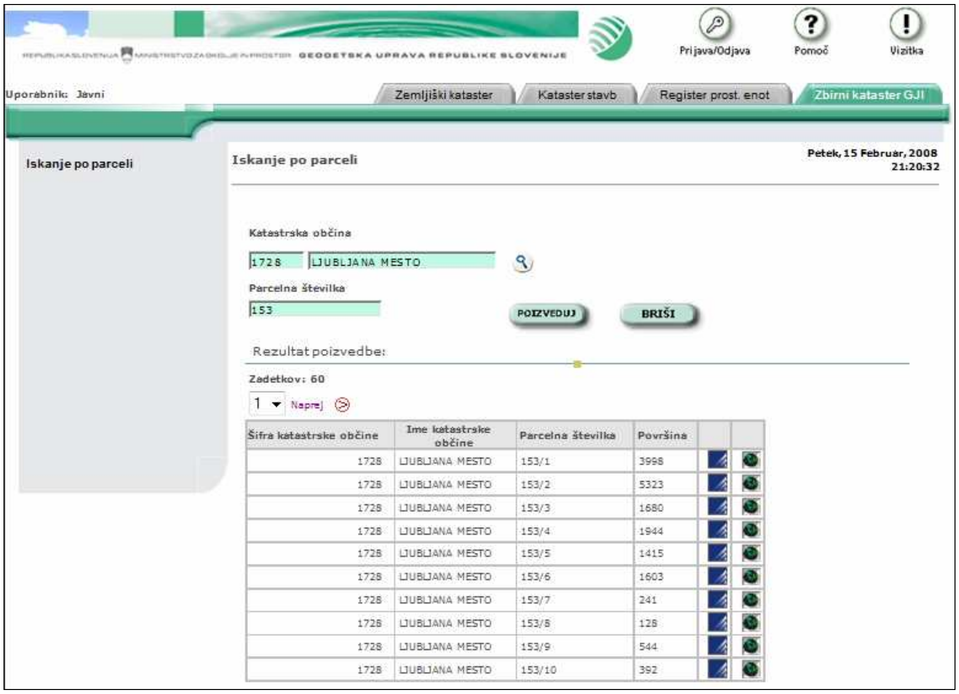

Figure 5: Web application for the public user.

REPUBLIKA SLOVENIJA MINISTRSTVO ZA OKOLJE IN PROSTOR GEODETSKA UPRAVA REPUBLIKE SLOVENIJE

Uporabnik:Javni

Sreda, 13 Februar, 2008 18:50:38

Transakcijska številka: -

ORA-00942: table or view does not exist

Podatki o GJI *

Identifikator GJI	Ime tematike GJI	Ime sloja iz ZK GJI	Šifra vrste GJI	Ime vrste GJI	Mera GJI na parceli
701100	Ceste	Ceste - linijski objekti	1101	Cesta (os ceste)	65.26m
701100	Ceste	Ceste - linijski objekti	1101	Cesta (os ceste)	65.26m
502558	Vodovod	Vodovod - linijski objekti	3101	Vodooskrbna cev	21.32m
504103	Vodovod	Vodovod - linijski objekti	3101	Vodooskrbna cev	2.14m
588406	Vodovod	Vodovod - točkovni objekti	3199	Drugi objekti vodovodne infrastrukture	-
543677	Kanalizacija	Kanalizacija - linijski objekti	3201	Kanalizacijski vodi	31.31m
537049	Kanalizacija	Kanalizacija - linijski objekti	3201	Kanalizacijski vodi	20.23m
622109	Kanalizacija	Kanalizacija - točkovni objekti	3206	Jašek	-
746801	Elektronske komunikacije	Elektronske komunikacije - linijski objekti	6101	Telekomunikacijski vod	9.93m

*Opomba!

Seznam objektov gospodarske javne infrastrukture je pridobljen s pomočjo grafičnega preseka parcele iz zemljiškega katastra z objekti gospodarske javne infrastrukture iz zbirnega katastra gospodarske javne infrastrukture. Zaradi različne lokacijske natančnosti podatkov iz zemljiškega katastra in zbirnega katastra gospodarske javne infrastrukture ter zaradi nepopolnosti podatkov iz zbirnega katastra gospodarske javne infrastrukture lahko pride do napačnega grafičnega preseka med podatki. Tako dobljen seznam objektov gospodarske javne infrastrukture lahko ne odraža dejanskega stanja na terenu. Za pravilno razlago dobljenih rezultatov je potrebna ustrezna strokovna interpretacija grafičnih podatkov.

Figure 6: List of existing objects of public infrastructure for chosen parcel.

REPUBLIKA SLOVENIJA MINISTRSTVO ZA OKOLJE IN PROSTOR GEODETSKA UPRAVA REPUBLIKE SLOVENIJE

Prikaz grafičnih podatkov ZK GJI

Šifra katastrske občine	1728		
Ime katastrske občine	LJUBLJANA MESTO		
Parcelna številka	153/10		
Vključeni sloji	Digitalni ortofoto načrti 1:5000, Parcele s parcelnimi številkami, GJI		
Merilo	1 39 metrov		
Legenda	Državne ceste Občinske ceste Gozdne ceste	Ceste	Železnice
		Letališča	Pristanišča
		Žičnice	Električna energija
		Zemeljski plin	Toplotna energija
		Nafta in naftni derivati	Vodovod
		Kanalizacija	Ravnanje z odpadki
		Vodna infrastruktura	Elektronske komunikacije

Figure 7: Cross-section of Land Cadastre and Consolidated Cadastre of Public Infrastructure, with underlying orthophoto.

3 Registration of utilities in China

With the increasing urbanisation of China, registration of utilities becomes more and more important and plays a significant role in promoting the construction and establishment for the city. Currently in China, the utilities can be subdivided in to two groups: pipeline based systems, such as gas, water, wastewater, etc; and cable-based system like electricity, telecommunications, cable TV and the Internet. All the utilities mentioned above are paved under the ground to form a complex line system and each exerts its own function as part of the system. It is commonly accepted that the registration of the utilities is more or less same in different local areas and regional zones. Nevertheless, it is still compulsory to complete this registration procedure no matter how small the city or town is. All materials concerned, e..g., the maps, files, measurements and so on after completing the construction project should be handed in to the superior National or Urban Construction Archive (NUCA).

3.1 Information acquisition for excavation

To obtain the qualification of excavating in a certain position or area, the relating excavator has to apply for the registration license from the local Municipal Bureau of Urban Planning (MBUP) to acquire the admission for excavation. In the meantime, it is also necessary to be offered by the Municipal Administration Commission (MAC) for the approval and authorization file. In addition, before the application of the license, the excavator needs to investigate the detained information concerning about the pipelines and cables under the ground from the Urban Construction Archive and submits it to the Municipal Bureau of Urban Planning. Otherwise, the Urban Construction Archive must inform the excavator what materials and measurements need to be handed in to it as backup for the future resources to other excavators. Once approved by the two institutions, the excavator should initial an implementing report to the Municipal Bureau of Construction (MBC) on how to take the project and when to start-up. Afterwards, the Municipal Bureau of Construction will hand on a document with some guideline information on it for instruction to the excavator. After finishing all the procedures, the excavator is allowed to construct under the ground.

Figure 8 shows the collecting process and the providers of the information for excavation. The local MBUP provides the excavator with most of the information, including spatial data for digging and the name of companies who own existed utilities in that region. MAC and MBC supply some relating information. Some excavators ask for more detailed information from the utility companies to ensure an efficient excavation without damages.

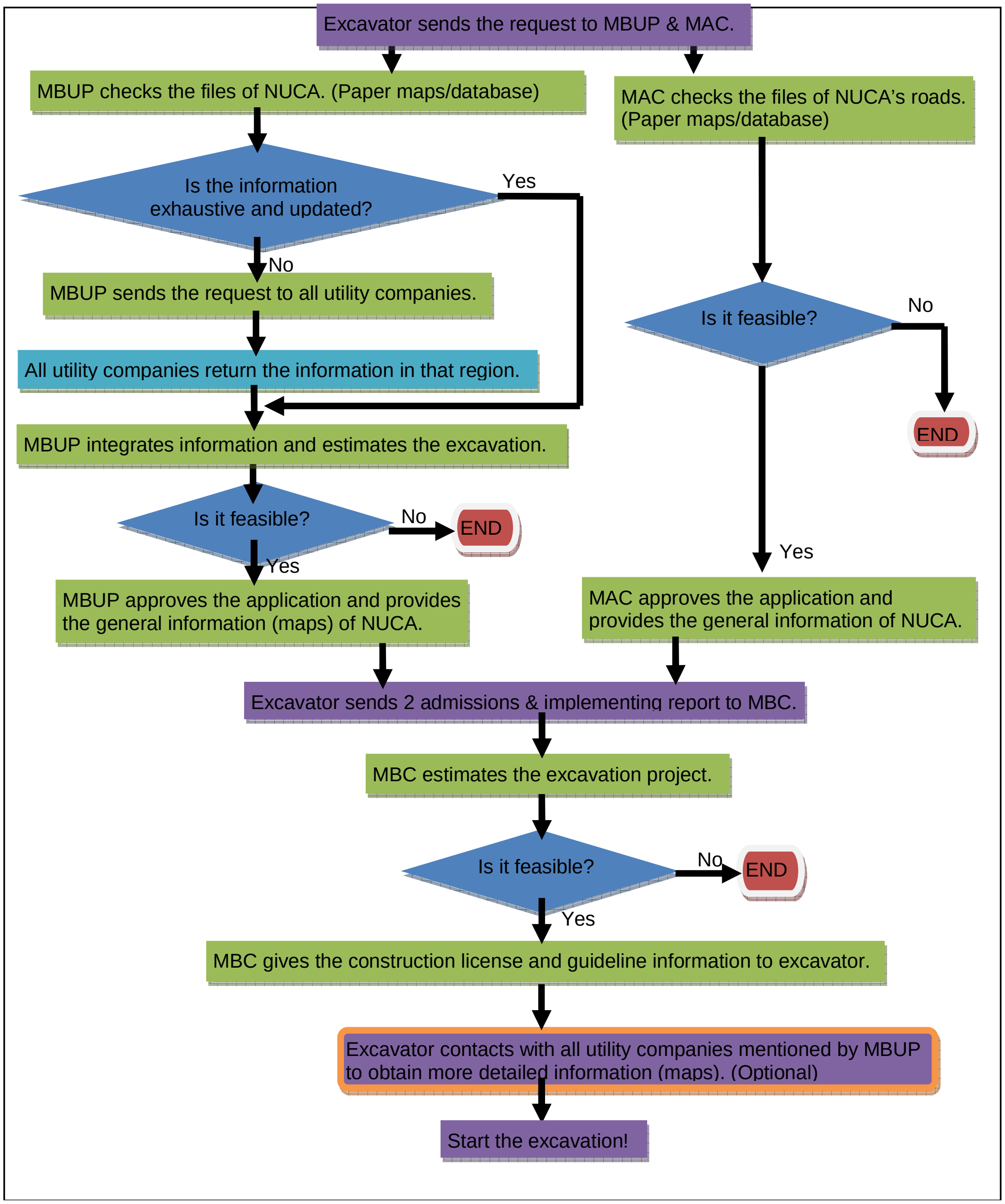

Figure 8: Process of obtaining information for excavation.

3.2 Registration process and registered information

During the process of pipeline laying down, commonly the radar detector is widely used to detect the depth and the position of the pipes. Moreover, the manholes can be seen as the tools to check the diameters and the materials of the pipes. According to all the measurements obtained above, the spatial coordinates of the pipelines & cables, the material and the diameter of the pipelines, the paving period, spatial positions, maintenance records and the owners will be saved as reference documents in the local Urban Construction Archive.

Below are the public infrastructures in China to be registered by means of utilizing the methods illustrated above (Figure 9):

- sewerage system, water supply and wastewater underground system,
- electrical communication systems (telecommunications, telephone cables, fibre cables),
- energy systems (gas, heat, oil).

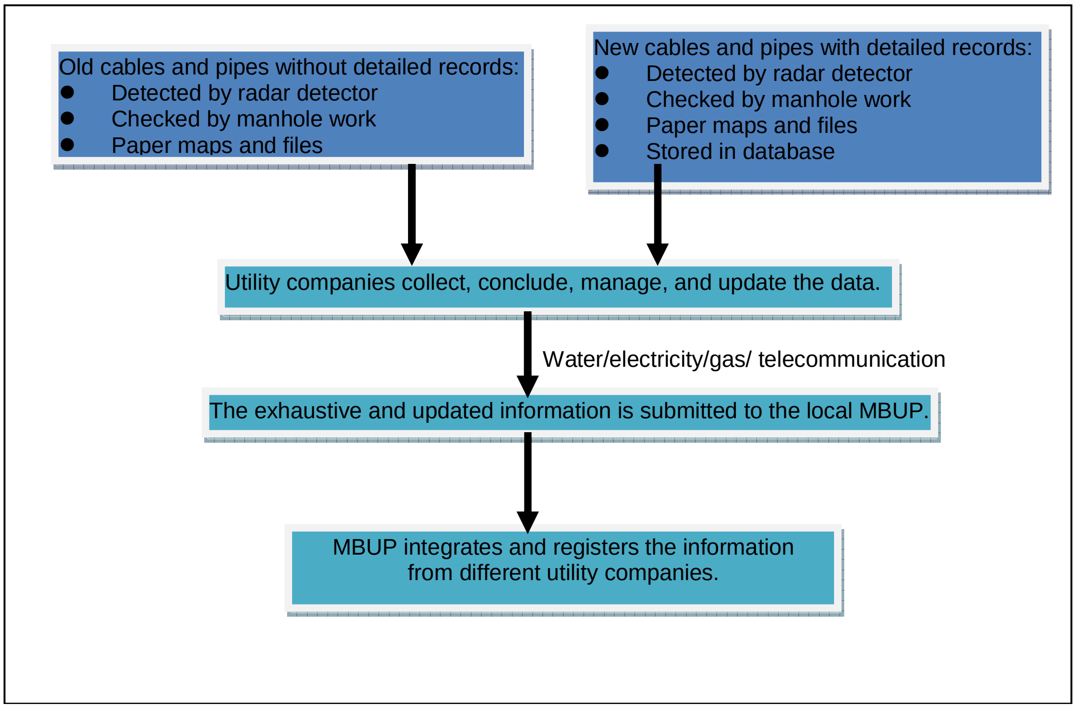

Figure 9: Process of registration.

3.3 Information systems

Geographic Information Systems (GISs) are widely used to display, manage and analyse the geographic spatial data. Therefore they are also largely utilized for managing utilities in China. CAD is mainly used as an aided design tool to draw the plan view and side view of the pipeline network. Moreover, CAD is responsible for the output of the drawing. Since the end of 1980s to the middle of 1990s, GIS and CAD technologies came to China and the General Bureau of Construction also initiated some kind of underground pipeline systems in pilot cities, such as Tianjin Municipal Underground Pipelines, Kunming fuel gas lines and Beijing Liquefied gas lines to promote this new technology. Gradually, GIS in China has evolved into the project application layer and the relating software. Nowadays, series GIS and WebGIS with mixed C/S and B/S configuration are becoming popular and growing to maturity. Moreover, the updating of the databases for the system has been a daily concern in China as well.

However, the current difficulty for the information system in China is hard to set up a uniform form to match all other files with each separate format. It still will take time to overcome these technical problems. Another problem is the weak real-time connection and low updating capacity for the statistical searching function. Since the information system is designed by software development corporation, new tools are not implemented on time.

Figure 10 depicts the user interface of GIS for gas network in Guangzhou. This system can be used to collect, save, display, manage and analyse the geographic spatial data and related attributions of the gas network. All forms of the gas network information in the geo-database are stored as different layers, e.g. point features (fixtures/brake points/monitor points), polyline features (high/mid/low pressure lines/roads), and polygon features (parcels). It also can be used to monitor the whole gas network all the time. Use is de made of GIS to monitor what is happening and to take specific actions in a specific area. Compared with the paper maps, it is easier to update (delete, insert, modify, create, query) the data records and to do some complex operations by using GIS.

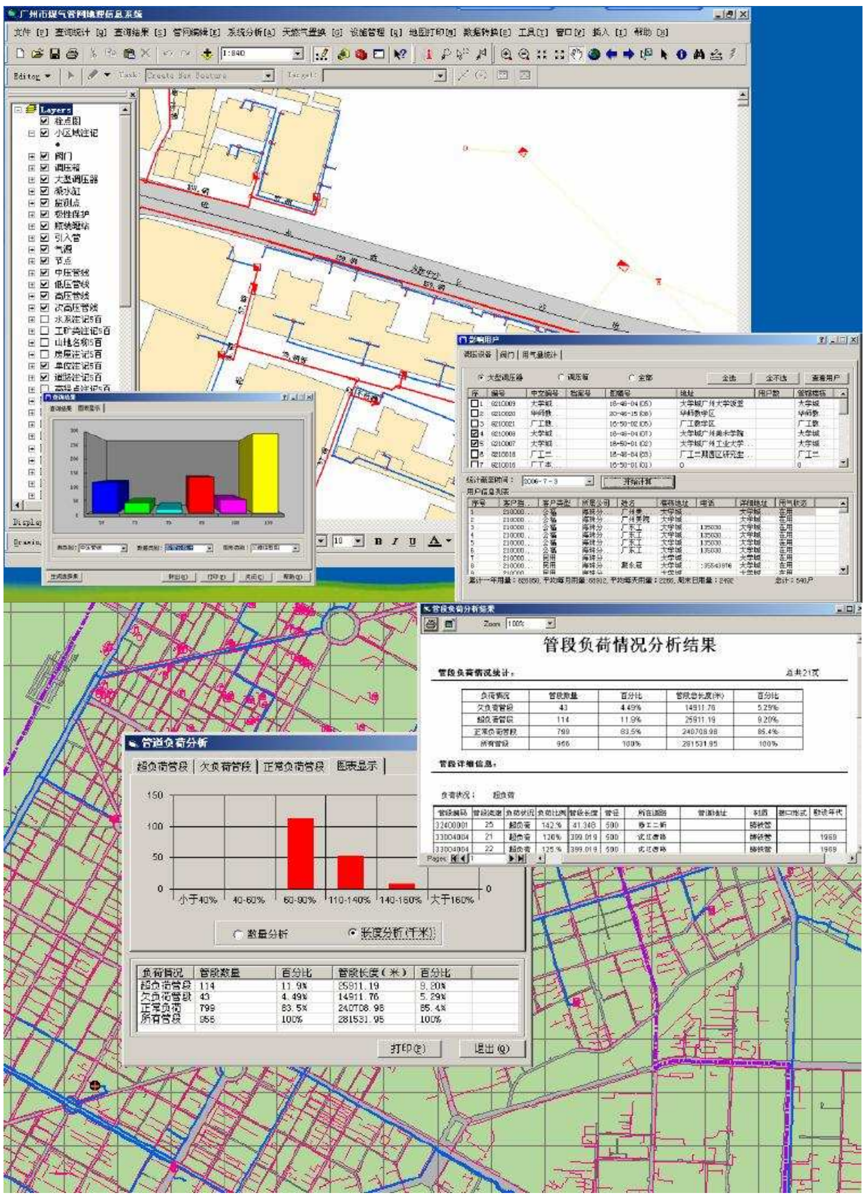

Figure 10: GIS for gas network in Guangzhou.

3.4 Trends and future plans

In the future, the National Bureau of Construction will integrate and manage all sorts of system information from the Municipal Bureau of Urban Planning and Municipal Bureau of Construction yearly. Besides that, each registration department (water, electricity, gas, and telecommunication) must be responsible for the variation of the database and hand it into the upper administrative institution periodically. For the developed cities and areas which have already established electronic databases, the direct inquiry and approval can be executed immediately. However for poor areas with a low level database, it is necessary to summarize all the suggestions and opinions from every administrative department involved and to wait for the final approval for some time. The application of GIS will definitely increase not only in the scope, but also in depth. It will be embedded into the comprehensive workflow of the enterprises and serve as a tool for multiple decision-making and operational management. In the future, well-know software, such as ARC/INFO, MAPINFO and GENAMAP will be widely used as basic tools. Last but not the least, all the serving interfaces and different forms of files will be uniformed as a whole to make the system more efficiently.

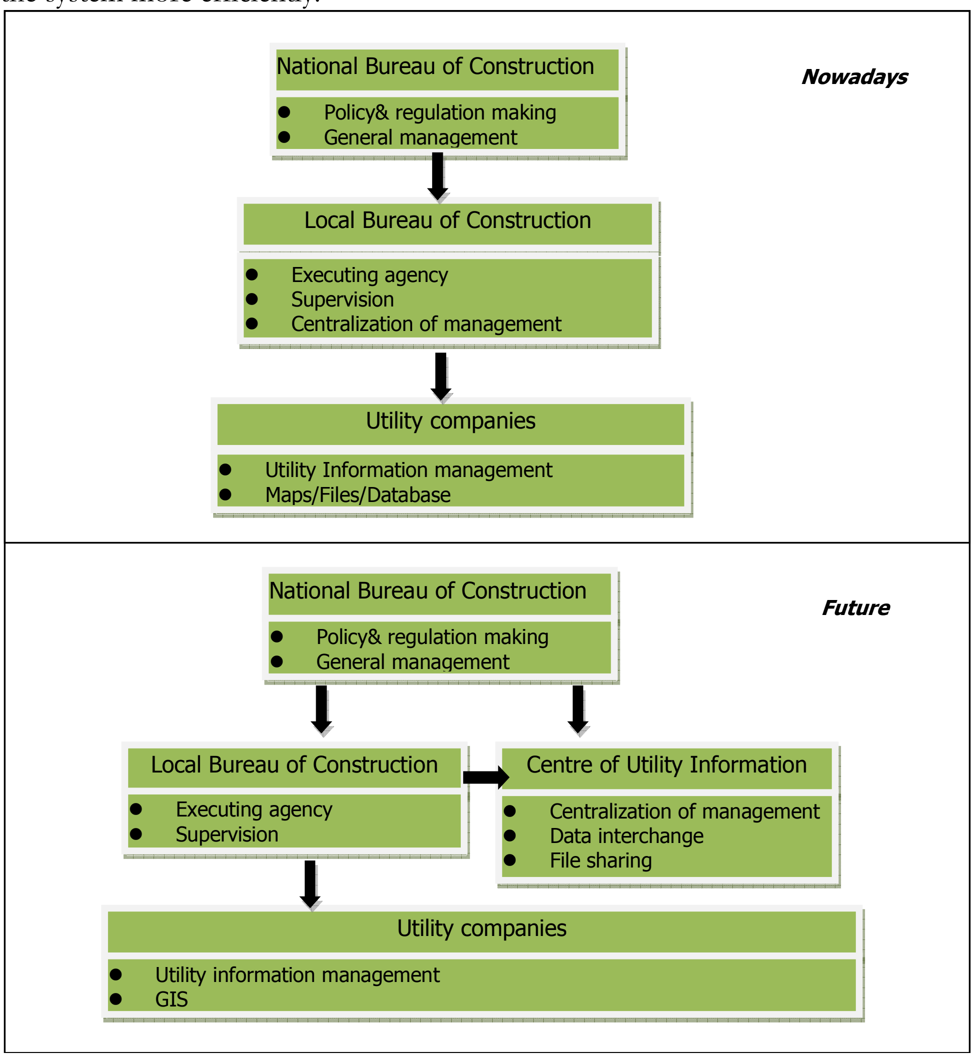

Figure 11: Comparison of three management levels of utilities in China.

4 Registration of utilities in Sweden

In Sweden there is no registration of utilities at a national level, nor is the registration compulsory on any other level. In theory utility owners can decide for themselves whether pipes and cables are registered or not, in the practice naturally all authorities and companies with pipes or cables in the ground have some registration of their utilities, otherwise they would have no right for compensation if a cable would be damaged during an excavation. They also need the information themselves to handle the maintenance of the utilities in an effective way. How the registration is done and by whom it is done is up to the owner, either they administrate the registration themselves or outsource the commission to a consultant. This description applies to the general case, in some regions in Sweden a framework for how the registration should be done has been implemented. This is mainly for the regions that are working with a common registration platform of utilities. For every region there is one company or department of the municipality responsible for maintaining and developing some of the utility infrastructures. This is because in the past many networks were owned by the state and the state was the only provider of the service. With the privatization of the utility services the network infrastructure was kept and the providers paid the network owner to make use of the network.

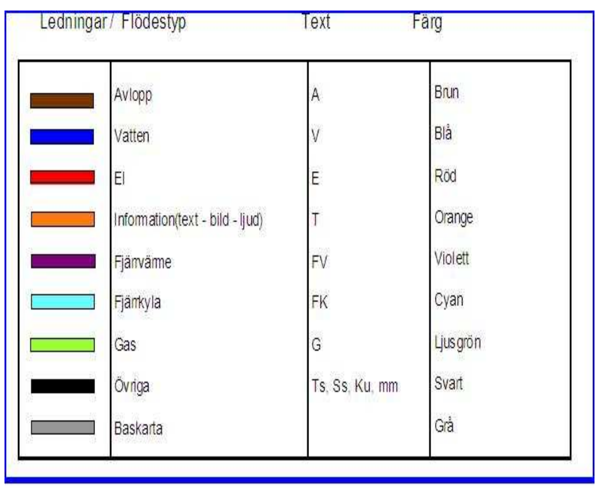

Figure 12: An example of the recommended standardized cartographic layout.

In Sweden the organization Stanli, which is a part of the Swedish Standards Institue (SIS), develops standards for geographic data. In the year 2000 Stanli developed a standard for registration of technical utility systems. The standard covers three domains for exchanging utility information: emergency excavation, planning of a project and combining utility information from different sources (Ny Teknik, 2000).
The standard comprises (SIS, 2000):

- a conceptual model that defines the different parts of a network,
- a schema that specifies how the geometry and quality of a network should be defined and how attributes can be connected to utilities,
- object type index,
- recommended cartographic properties of utility maps (Figure 12).

Several municipalities and regions have started an initiative to collect registrations of utilities in one place to facilitate for excavation. The local authorities realize that a common registration of infrastructure facilitates the daily work and saves money. Since all municipalities have their own way of handling the data and are using different systems we have chosen to focus on a specific region in Sweden. The region we have chosen is the municipality of Gävle, located in the central east of Sweden. This region is one of the few regions that provides a service for excavators which eases the work before the excavating when information about utilities are being collected and permissions are being applied for. Another municipality that provides an information service is the city of Stockholm. A short description of the current situation is given, to give a more complete idea of the utility registration in Sweden and the most appealing current initiatives.

4.1 Information systems for registration

The municipality of Gävle owns most of the utility network in the region. Gävle Vatten is the owner of the water and sewer utilities in the region. They use VAFocus to handle the registration of the utilities. This software is part of the MELDIS package based on ESRI's platform ArcGIS 9.2 (Lindmark, 2008) and was developed for the registrations in Gävle (ESRI, 2008). The data is stored on a SQL server and managed with ArcSDE, which can handle spatial data. The utilities are built up as a network with nodes and edges. The Geographic Information department of the municipality maintains a map of the region, which is used as a base map for the registrations.

Gävle Energi owns the electrical and long-distance heating infrastructure in the region. They also use ArcGIS 9.2 for the registration of their utilities (Hejdenberg, 2008). The fact that both of the departments are using the same platform and the same version is a strategic choice to facilitate the exchange of information between the departments. For this exchange, IBM Information Management Services are used.

During the 1980s a large project was carried out concerning the registration of all the utility networks in the municipality. Information on the position of the utilities was digitized from paper maps and documents. When no maps or other documents concerning the position were available, manhole covers were used as an indication, or the position was surveyed. Until 1991, a simple GIS was used to manage the data and to create maps. The system was not really suitable for the complex distribution networks, which was the main reason to develop their own information system, GISAM, which is actually the predecessor of MELDIS (ESRI, 2008). This system is suitable because the users do not need any knowledge about CAD systems. Also it provides functions like interruption notification, incident registration and functions for the maintenance of the utility networks.

4.2 Registration process and registered information

The position of the utility network is important. An excavator wants to know where pipes are, so that the risk of damage can be minimized. Also for the maintenance it is important to know where the utilities are. In Gävle, surveying of the utility networks is done by the surveyors of the Geographic Information department of the municipality or by external consultants. Most of the surveying is done with GPS or, when this is not possible, using terrestrial surveying. In connection with new plans in development areas and in large reinvestment projects the position of the pipes and cables preferably is measured while the utility dikes are still open. When this possibility does not exist the position can be determined with help of manhole covers or with other marks and signs on the ground field. Break points and connections can be detected using camera inspections. All the field data is put into the registration system.

In the registration system, thematic information is added to the object. The different departments of Gävle register at least the following attributes:

- owner,
- who is responsible for the maintenance,
- type of utility,
- manhole function,
- position (x, y and sometimes also z-coordinate),
- the accuracy of the position,
- radius,
- length,
- material,
- plant year,
- year of renovation,
- what method was used for the renovation,
- etcetera.

For new utilities, all these attributes are assessed and gathered via the documents of the investment project. For the heating network there is also information about the heat-exchangers and the control valves, for example fabricate, capacity and date of installation (Hejdenberg, 2008).

4.3 Information acquisition for excavation

In the municipality of Gävle several departments of the municipality and some external parties concerned with excavation permission are working together in a service called 'Gräv i Gävle, which means 'Dig in Gävle' in English. This service was introduced in 2004 with the purpose to facilitate the excavators when the excavation is done on municipality land. Instead of going to several different administrations and offices in order to get permission for the excavation, the excavator can now go to the service. The parties involved in the service are Gävle Vatten (water and sewery system), Gävle Energi (electricity, long distance heating, television, internet cables and street lights), Tekniska kontoret (parks and roads), Bygg och Miljö (Geographic Information), which are all departments of the municipality, and Länsstyrelsen and Länsmuseumet (county administrative boards), which are the external parts ('Gräv i Gävle', 2008). The formal owner of the service is Tekniska kontoret.

A company that wants to dig in the ground sends a request to the 'Gräv i Gävle' service. The request is administrated at the energy department, Gävle Energi. The area of interest is marked as a polygon on a map. The polygon is an object with a unique id-number and with attributes such as who the excavator is and when and why the excavation will be done. The generation of a new polygon also generates a errand in the database. The id-number of the polygon is sent to the other involved parties in the service via e-mail and the map with the area and the attached information can be viewed by them on the Internet. In this web portal all concerned parties can report their comments about the errand, for example if there are any restrictions. Länsstyrelsen and Länsmuseumet are notified if the excavation area overlaps with the area of ancient monuments, so that they can inform the client about special rules that apply in these kind of areas. After all parties have handled the errand and reported their restrictions, the client gets a map with the different utility networks in the area of interest (Hejdenberg 2008). Additional information, depending on the errand (and therefore on the intension of the excavation), can be supplied to the excavator as well, like the depth of the pipes and regulations of how to handle the different utility pipes. The whole process, from request to information delivery, will take around five days.

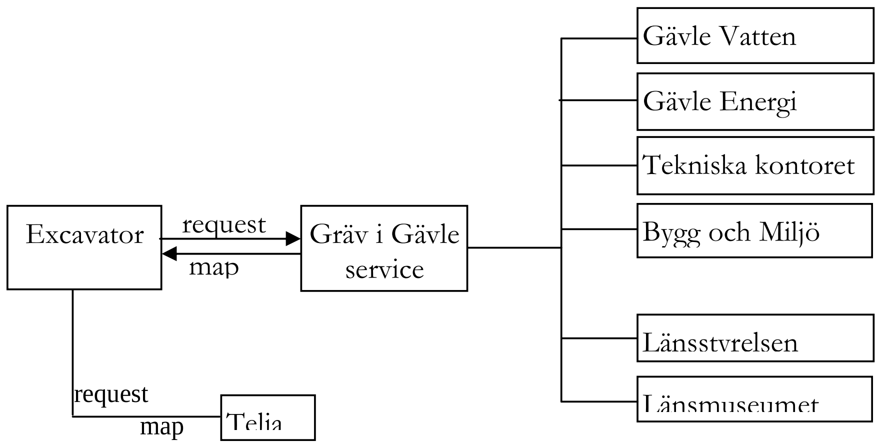

Figure 13: Overview of the Gräv i Gävle service.

The position of the utility network can be fuzzy. If this is the case, the Geographic Information department will send a surveyor to indicate the most likely position of the utility.

For excavations in municipality grounds, permission to excavate is needed. This can be done through this service as well. In the case that the excavation area is on or near a road, an extra application for traffic regulation has to be done. This can also be arranged through this service, via the roads department that is also involved.

Most of the utilities are registered in this service. The only thing the excavator has to do is ask for utility information at the telephone company, Telia, since they are not involved.

The service 'Gräv i Gävle' is optional to use. If the client wants to collect the information in another way he is free to do so. During the test period, started in 2004, the service was free. After a successful evaluation it was decided to charge a fee for the information. Money earned is used to cover administration costs and will be invested in the service, for development and updating the information in the database (Technical committee, 2006).

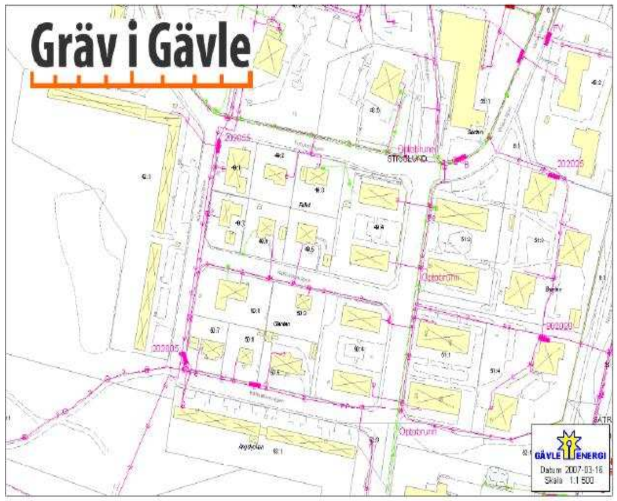

Figure 14: The resulting map from a request to 'Gräv i Gävle', the service which is providing utility information in Gävle, Sweden.

4.4 Information acquisition for excavators in Stockholm

The municipality of Stockholm is using a service called 'Samlingskartan' (collection map) to provide coordinated utility information. The collection map contains all the lines and pipes situated in the subsurface of streets and parks. This cooperation between the utility owners started in the 1980s and in the land agreement it is specified that all utilities in land must be registered and reported. Thus all the utility owners in Stockholm have to participate in the service and contribute with their utility information. The network owners are responsible for the quality of the data that they provide. The parties involved are Trafik & Markkontoret (roads and parks), Stadsbyggnadskontoret (urban planning office, provides the base map), Telia sonera (telephone network), Fortum distribution (electricity), Fortum Värme (long-distance heating, long-distance cooling, gas and electricity), Stokab (Internet cables), Stockholms hamnar (Ports of Stockholm), Stockholm vatten (water and sewer systems) (Stockholm Vatten, 2008). Every year about 3000 requests for a collection map are made to the service in Stockholm (Digpro, 2007). The map is a legal act and during a specified time period the map protects against contingent damages of a network. On the other hand, if the collection map has not been used during excavation and there is damage to the network the excavator is obliged to compensate the owner of the network.

The request for a collection map and the production of the map is done at Stockholm Vatten. Stockholm Vatten is functioning as a central part in the system of the service and is responsible for combing the data. The information in the maps is provided in a digital and standardized way by the utility owners. All the requests are made in a web-based order application developed by Digpro. The application is built on Digpro's own platform DP/Spatial which is based on Oracle Spatial 9i and Java 2D.

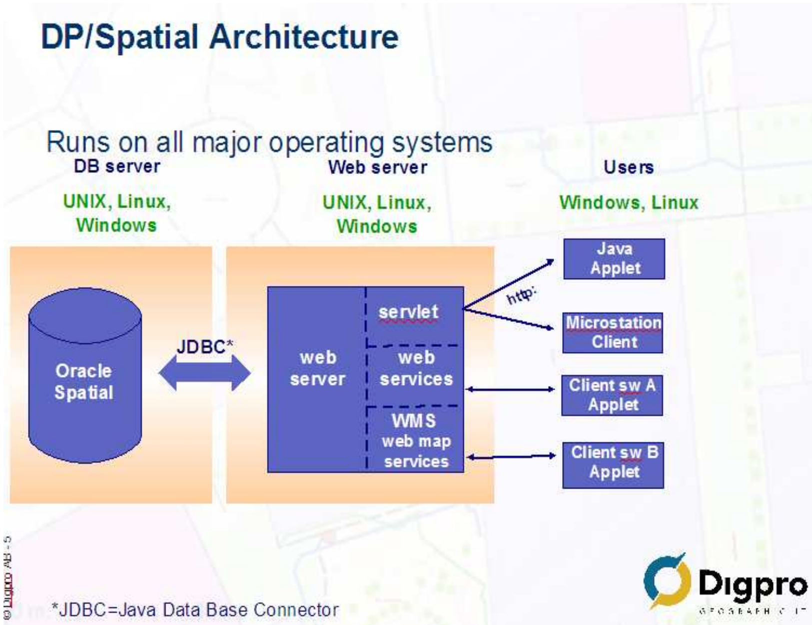

Figure 15: Architecture of Digpro's platform DP/Spatial (Digpro).

In the application the client has to log in to the service to be able to use it. All the log in information is stored in the database. After that the client can define the area of interest in the map or use map sheet numbers the make the order (Digpro, 2008). In the order process the intended use of the final product also have to be stated. The request is treated by the central (Stockholm Vatten), delivery time and price are communicated to the client. A request for information is sent to the utility owners who return the needed information within a certain time. The central compounds all the information, add the quality of the data and date of producing the map before sending it to the client. The resulting map is visualized in scale 1:200 in the inner city and in scale 1:400 in the outer areas. The base map is a primary map composed of parcels, block names and streets produced by the municipality.

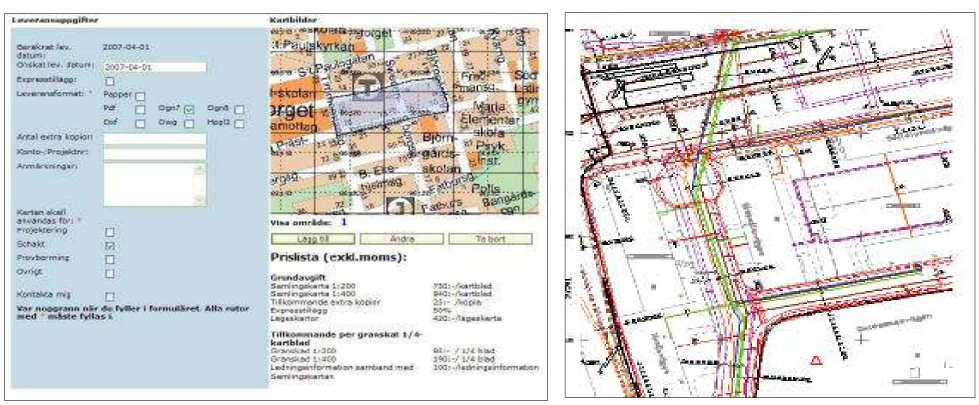

Figure 16: To the left is the interface of the web-based application for ordering utility information in Stockholm, Sweden and to the right is an example of a product from the service. Observe that the images are not from the same area (Tarandi, 2003).

5 Registration of utilities in Turkey

Management of physical underground objects and their legal relationship with private properties is one of the situations in which the current Land Administration (LA) system has shown limitations in Turkey. There is no integrated legal and physical registration in national level at Turkey. At this stage, two different registrations should be distinguished for utilities. Registration of rights and restrictions related to utilities in cadastre and registration of physical underground utilities at a source responsible for them. The first registration aims to secure rights when a utility intersect private property, while the second registers utilities to protect them from damage and to determine responsible companies and institutions.

5.1 Registration of utilities in Land Administration

In many countries, underground objects such as pipelines, tunnels, cables and their legal relationship with private properties are situations in which the current 2D LA systems have shown limitations in the registration of the legal situation. This is equally true for the Turkish situation. In Turkey, from a legal point of view, underground objects are not considered as immovables and therefore are not described in transaction deeds nor registered in LA. Moreover, many underground objects related to infrastructure (utility networks) are located under public lands (e.g. roads). According to Article 16 of the Cadastre Law (1987), public lands are not registered. Hence, the legal ownership situation of the utility infrastructure crossing these public lands remains unknown unless it crosses a private property. In addition to this, if the owner of the underground object is the same as the owner of the parcel no right/restriction is established on the parcel (e.g. in case an underground construction for water utility crosses a parcel owned by the municipality). Generally, easement rights are used to establish the legal situation when the utility network crosses parcels owned by a private person or corporation. The holder of the easement right is the owner of the underground object. Establishment of this easement right forces the owner of the parcel to tolerate the construction below, on or above his parcel and sometimes also to provide access to the utility construction. Another approach is to expropriate the parcels that cross a network. In this approach, the full ownership of the parcel belongs to the owner of the network. Therefore no right or restriction is established in the land administration that could indicate the existence of the underground network. In addition, the owner of the parcel can be forced to tolerate underground constructions (e.g. tunnels) which are built for national transportation purposes as long as existence of the constructions do not cause any inconvenience (damage, vibration etc.) on the surface construction. It is not clear in the law if this situation can be registered as a restriction or not in LA.

In Turkey, three cases can be distinguished in LA for the representation of the legal status of lands and underground utilities:

- The owner of the underground utility is entitled to use the space above or below the surface parcel by means of limited rights such as superficies and easement rights. If easements rights are not applied to the full parcel, 2D drawings are used to describe the location of the underground objects.

- The person who holds a utility network is also the owner of the surface parcel. No limited rights are registered. In case of expropriation before construction of the utility, the situation is the same because ownership of the parcel passes to the owner of the network.
- The owner of the surface parcel is forced to tolerate a network under his or her parcel unless there is justifiable objection against this usage. In this case, the person using space above or below the surface is not owner of the surface parcel and has no right on the surface parcel. In this case, no spatial information (2D/3D) can be found about the underground utility in LA.

In all cases the construction itself above, on and below the surface is not registered in LA. For the first case, an indication of the existence of these objects can be found by examining the limited rights that are established on surface parcels intersecting with a construction. For the last two cases, no information can be found in land administration about the underground construction.

5.2 Surveying and mapping the underground utilities

Since the ownership of underground objects is not subject to registration, LA does not deal with surveying and mapping these kinds of objects in Turkey. Apart from a legal notification on the parcel in LA, drawings for the limited rights can be included to LA if only some part of the surface parcel is affected by the limited rights. However, these drawings are only available as separate documents and not digitally linked to records describing the associated rights in land. Full geometry of the object (neither 2D nor 3D) does not exist in LA. At this stage, an exception is given for high voltage power lines. The whole geometry of a high voltage power line is drawn on the cadastre map if the line crosses several parcels (Figure 17). In addition, for affected areas in case of high voltage power lines, easement plans are presented in 2D. This means that only the footprint of the area is defined. The owners of intersecting parcels still own the land under the cables, but they are restricted in the remaining use of this land. This restriction is determined by other organizations based on different legislation, and the cadastre does not get involved in this question. However, this restriction on a surface parcel can be notified in the land administration (Doner and Biyik, 2007).

Figure 17: A cadastre map with high voltage power line (from Demir et al, 2008).

Several organizations are responsible for establishing utility services but in most situations, no integration and data sharing exists. Every organization maintains its own data related to the utilities with different systems and standards. In some situations it is even impossible to find spatial information (2D/3D) showing the location of the network. Often insufficient/incomplete documents are available describing previously existing pipelines or some of those documents are not accurate enough. Insufficient and unclear information about location and depth of underground utilities have caused various problems and even resulted in tragic accidents. For example, it was reported that in Bursa, the economic loss of the damage to gas pipelines was two-hundred-thousand US dollars in 2005 (Karatas, 2007). Also, in Istanbul, with its population of over fifteen million people, some accidents have occurred during excavation operations which resulted in damage to telecommunication networks and subway lines and caused an important amount of direct and indirect economic loss.

5.3 Infrastructure Coordination Center (AYKOME)

To provide coordination between different organizations which are responsible for infrastructure facilities within 500.000+ cities, a law (number 3030) was put into practice and the Infrastructure Coordination Center, AYKOME, was established in 1984. It is the responsibility of the AYKOME to plan, coordinate and inspect the projects for water, electricity, tramway, subway, gas, telecommunication etc. Primary objective of the establishment of AYKOME is to determine how space is occupied by public infrastructure objects in cities. Thereby it enables a more efficient spatial planning, safer implementation of under/above ground spatial activities, and better economical management of infrastructural objects. However, accuracy of positional data provided sometimes does not allow defining the underground objects clearly. Also in most situations, location of the object is in a local reference system and 2D.

Excavation permission is compulsory when excavation is needed to install or to repair utilities in a municipality land. Excavation permission is given by the AYKOME. The parties involved in the AYKOME are General Directorate of Highways, General Directorate of State Hydraulic Works, General Directorate of State Railways and departments of the municipality which are responsible for water, sewage, gas systems. When a request for excavation arrives, the area of interest is marked on a map to determine existing underground structures. In addition, depending of existence of data depth information can be supplied to the excavator. AYKOME also determines when the excavation takes place and how much the excavator has to pay. Time needed for completing the process ranges from five days to two weeks.

In recent years, some municipalities have also developed projects to maintain information for utilities on their territories with the help of GIS (Geographical Information Systems). Information on the position of underground utilities was collected by surveying on site or by digitizing paper maps and documents. Figure 18 is an example from a municipality in Istanbul. It shows natural gas and water supply pipelines together with other cadastral data sets such as buildings and parcels. ESRI's software, ArcGIS 9.2, was used as application platform to register underground utilities. Utility layers in this system include the following attributes:

- utility ID,
- length,
- diameter,
- type,
- pressure.

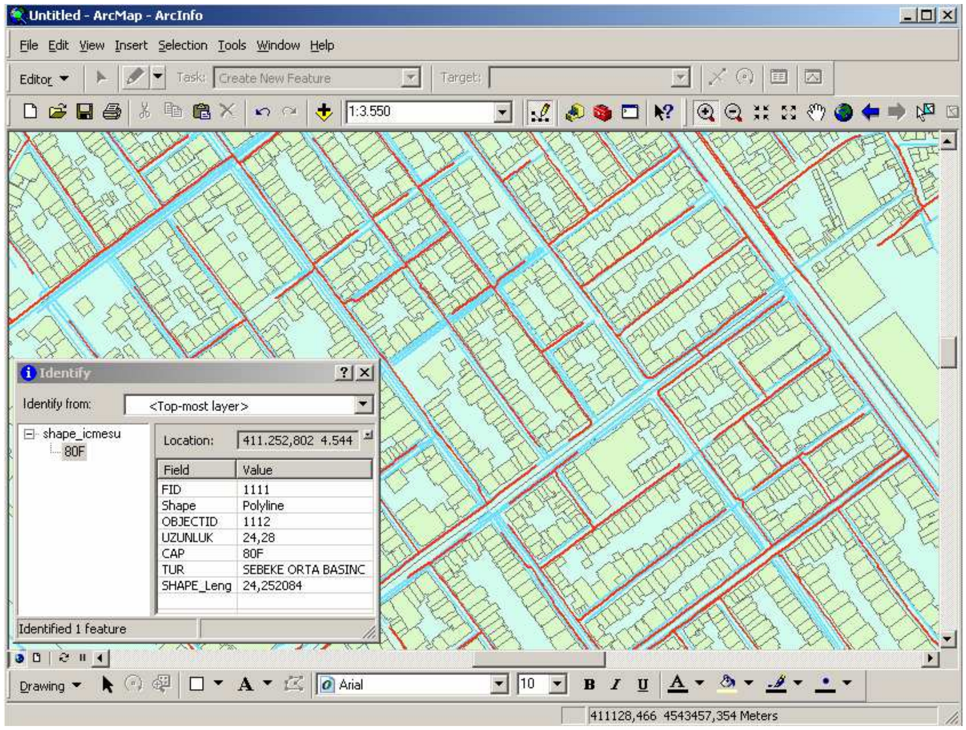

Figure 18: Network map of gas (red) and water (blue) supply pipelines together with cadastral data.

The utility data can also be accessed via Internet. Figure 19 is taken from a web-based application for querying a specific utility construction on the map.

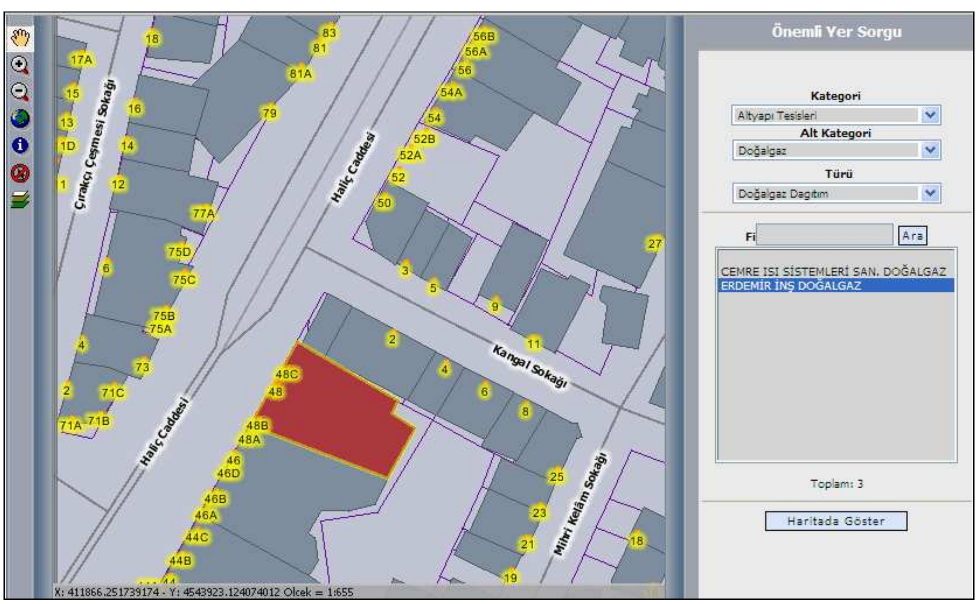

Figure 19: Interface of web-based application for querying utilities.

5.4 Situation of utility data in Turkey

The following graphs are some of the results of a study carried out to determine the legal and technical situation of utilities in Turkey (Karatas, 2007). In this study, a survey was applied to 155 utility operators, 80 of which are municipality departments responsible for water and waste water systems, 36 of which are operators responsible for communication cables and 39 of which are operators responsible for electricity networks.

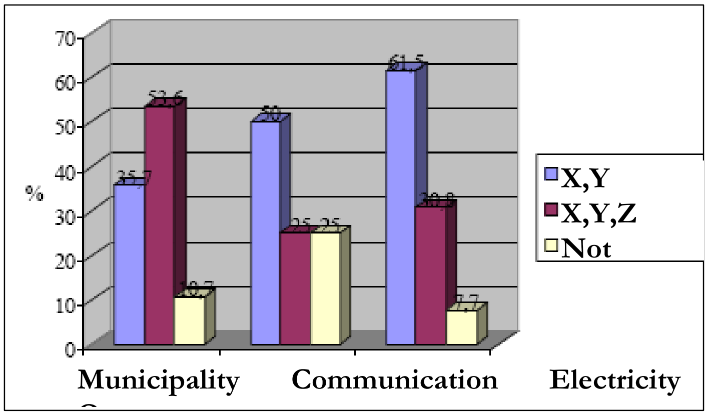

Figure 20: Coordinate dimension of utility data. Not useable means that the coordinates of utilities are not applicable to the field because of poor accuracy.

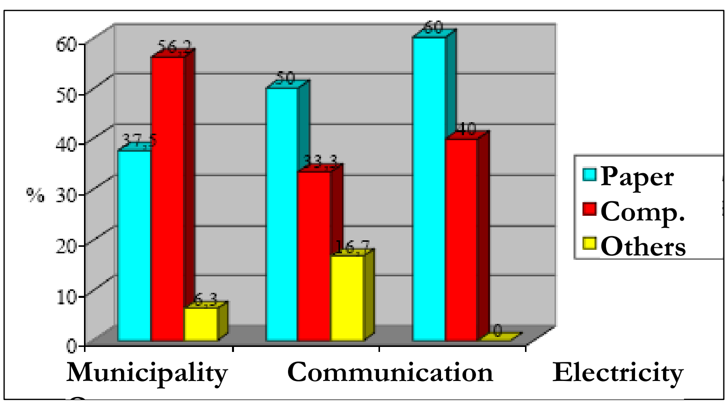

Figure 21: Storage environment of spatial data for utilities.

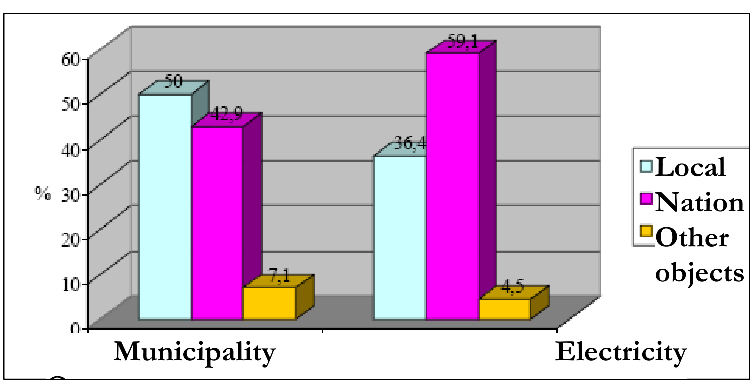

Figure 22: Coordinate system of utility data.

6 Concluding remarks

This study has clearly shown that registration of utilities is getting increasingly important in the last years in the four investigated countries. There are many variations in the selected registration, objects to be registered and organisation of data.

The system for registration in Slovenia is the youngest one established a few year ago. The system for registration aims to collect and provide the data about public utilities at the state, local and private level. Now, about 1,000,000 objects are registered in the Consolidated Cadastre of PI (CCPI), which means about 40% of all utilities in Slovenia. The CCPI allows users to obtain all the necessary data on utility objects at one place. After three years of operation of the CCPI the positive effects are already evident. The data model has been adopted by all the infrastructure owners in Slovenia, which enables simple connectivity of the CCPI with individual cadastres administered by the infrastructure owners themselves. One can also notice the indirect benefits from establishing the Consolidated Cadastre of PI. The infrastructure owners are even more aware of their properties. It is planned that in the coming years the CCPI will be linked to other sector records (the roads, water and sewage systems database and the water infrastructure database), which will add further value to the primary data in the CCPI. This will establish a powerful environment, in which one will be able to implement various data analyses that will further on help to make strategic decision at the national and regional levels.

The utility registration in China is much more complex, but the aim is similar. In contrast to Slovenia, the registration in China is independent for each city or town. There is some distinct difference for the total registration procedures between high-revenue city and low-incoming city. Some cities, like Xiamen, Beijing, Shanghai, have already established a more robust and comprehensive registration system to provide efficient and in time information to the excavator. The other small cities might still face the serious problems in searching for the useful documents about the true conditions underground or lacking the sufficient administrative departments to run and execute the whole operating process. The main reason is that establishing a whole and integrated utility system costs a large amount of funds and only some large-scale and notable cities can afford it.

Sweden has no compulsory registration of utilities at national level. In order to provide users of utility networks and excavators with accurate information about the pipes and cables in the ground, in some regions an initiative for a central information service has started. In the municipality of Gävle and Stockholm excavators can obtain all the information through this service, so that they do not need to contact all the utility companies to obtain information. However, even within some of these services, some companies are not participating, with the result that excavators still have to contact them separately. The current trend in Sweden is that more and more regions are starting up this kind of common registration platforms with a department or company owned by the municipality as centre part and core in the system and the other utility owners providing their information. Standards to enable exchange of the needed information in an easy way for these services have been established by Sweco in cooperation with SIS.

The utility registration in Turkey is also not organised at national level. Legal situation of underground utilities is determined by establishing limited real rights on surface parcels in land administration, while geometric information of utilities is maintained in databases of organizations responsible for them. AYKOME was established in 1984 to plan, coordinate and inspect the projects for utilities within some municipalities. In addition, several projects have already been started by municipalities in recent years to register utilities within their responsibility area. These projects have produced good results in terms of visualizing and querying utility data. Main characteristics of utility data in Turkey are that it is mainly 2D, in local reference system and in some situations not accurate enough. In future, sharing of utility data maintained in different databases could provide better management of legal and technical aspects of utilities.

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http://prostor.gov.si (portal of different services where data of geodetic administration can be obtained)
http://unn.people.com.cn/GB/channel302/305/980/983/200010/17/2244.html
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