A Study on Use of Cadastre Information for Management of Urban Facility

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Key words: Cadastre, Feature, Facility, Management, Classification, etc.

SUMMARY

The purpose of this study is to more effectively operate the cadastre information that is updated in real time to manage urban facilities. Currently, the urban features and facilities are managed by several authorities in different ways and the overlapped management causes the inefficiency of the administration. To solve this problem, the study intended to identify the common management items for features and facilities that are currently under the responsibility of different authorities, select items that cadastral agencies can support among them and, ultimately, improve the effectiveness of urban facility management. Thus, this study selected common standard items for the urban facility management and facility items on which cadastral agencies can acquire the information. To select items, the study first searched the list of facilities managed by municipalities and then, surveyed demands of KCSC (Korea Cadastral Survey Corporation) and other authorities which manage the facilities. Finally, the study selected the standard items for the facilities that are demanded frequently and managed in common. Because KCSC can provide common information for the authorities responsible for the management of the facilities, based on the selection of facilities, this process of selection will contribute to diversify the businesses of KCSC and increase its revenue.

SUMMARY (Korean)

본 연구의 목적은 도시시설물 관리를 위하여 실시간으로 업데이트되는 지적정보를 보다 효율적으로 운영하기 위함이다. 현재 도시지역의 지형지물 및 시설물의 관리주체는 동일 시설물에 대해서 여러 기관이 다르게 관리하고 있어 이로 인하여 업무의 비효율성이 초래되고 있다. 이러한 문제점을 해결하기 위하여 기관마다 달리 관리하고 있는 지형지물 및 시설물에 관하여 공통적으로 해당되는 표준항목의 현황을 파악하고, 지적분야에서 제공할 수 있는 항목을 선정하여 도시시설물 관리의 효율성을 높이고자 하였다. 이를 위해 도시시설물의 공통 표준항목과 지적분야에서 취득가능한 시설물 항목을 선정하였다. 이를 위해 지방자치단체에서 관리하고 있는 시설물 목록을 조사하였고, 지적분야에서는 시설물을 관리하고 있는 외부기관 및 지적공사를 대상으로 수요조사를 실시하여 수요 요구가 많고 공통적으로 관리되고 있는 표준항목을 선정하였다. 이렇게 선정된 시설물은 관리기관에 공통정보를 제공할 수 있으므로 앞으로 수익창출 등 사업다각화에 이바지 할 수 있을 것이다.

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1. INTRODUCTION

Until now, the cadastral survey has considered the parcel boundary as the most important information because the boundary is the essential gauge of tax and private property. But, as the society develops rapidly, lands are used in diverse ways and the need increases for the comprehensive land information. In the cadastral survey field, the necessity of informational cadastral survey is getting emphasized to satisfy the demand for various cadastral information. In the past, all works were concentrated on the achievement of the survey result to determine land boundaries. However, to catch up with the rapidly developed informational environment and the demands of cadastral information users, today's works should be focused on various information and high quality cadastral survey services.
In such environment, KCSC(Korea Cadastral Survey Corporation) faces challenges to acquire value added information such as data on facilities to diversity its business, in addition to its own assigned business, and to improve its revenue structure. In order to establish the basis for the management of urban facilities, this study intends to analyze problems in facility layers faced in field works and identify the reasons for the problems to find appropriate solutions, centered on the total survey system, the kernel in acquisition and management of cadastre information, and to establish the management system for facilities used frequently and in common. For such purposes, this study searched facilities used in GIS and geodetic information including cadastral survey and used the method of selecting facilities available to use in the cadastral survey field.

2. CURRENT STATUS OF SURVEY DATA

2.1 Acquisition of Cadastral Survey Data

2.1.1 Existing Cadastral Survey

The cadastral survey can be divided into plane table survey and theodolite survey conducted in numerical areas. While plane table surveying area amount to 96.7% of the whole land of Korea, numerical survey reaches only 3.3% that is recorded in boundary point coordination directory. The plane table survey is a method that matches the boundary registered in public registry with the line representing surveyed shape on the maps to determine the adjustment result artificially. Meanwhile, numerical area refers to the area of which numerical coordination is surveyed in the method of theodolite survey and its boundary point is registered in numerical coordination. Thus, theodolite survey recovers the registered coordination as the control point to the field.

In the plane table survey that is conducted reaching 96.7% of whole land, the land boundary is marked on the maps, which accompanies technical error such as drawing error, scale error or

stretching error. In addition, because the survey result for paper map is determined based on the public record with various scales including urban area (1/600, 1/1,200), agricultural area (1/1,000, 1/1,200) and forest (1/3,000, 1/6,000), it is impossible to determine accurate survey due to the disagreement between scales. Also, because the surveyed data is matched with registered boundary and adjustment is determined artificially, accurate result cannot be achieved without rich experience and expertise. Therefore, the board survey has inherent limitation in achieving the accurate result of cadastral survey.

2.1.2 Total Survey System(TSS)

Total Survey System in the cadastral survey includes pen computer for field work, and the total survey system using digitized files in KLIS(Korea Land Information system) in the work of cadastral survey. The total survey system refers to the system that processes from survey to drawing, consisting of a total station measuring angle and distance, computers for data process and various output units and software. The total survey system was completed to develop during the first development phase from October 2001 to March 2003 and its programs have been complemented and updated through pilot operation. Now, the total survey system is regarded as the typical electronic board system.

Today, the total survey system has various functions including status adjustment function to calculate various cadastral survey data and determine the result, GPS data process function and 3-dimensional coordination creation function. The total survey system is utilized in more than 90% of cadastral survey conducted in KCSC.

2.2 Current Status of Laws and Regulations for Management of Facility

2.2.1 Facility in GIS Area

In Korea, the survey is divided into geodetic survey and cadastral survey and the two areas are subject to different laws. For the GIS area, Land Surveying Law article 9 provides that features in numerical maps should be marked in the form of figures or symbols and the information on each feature should be collected in a separate attribute files or represented directly with letters or numbers on the maps. The article also provides that the features in numerical map version 1.0 should be classified according to the classification system of railroad, road, building, tributary, facility, landform, administrative and regional boundary and annotation, to link them with other numerical maps.

In addition, the law specifies that the features in numerical map version 2.0 should be classified according to the classification system of traffic(A), building (B), facility(C), vegetation(D), hydrosphere(E), landform(F), boundary(G) and annotation(H), to link them with other numerical maps. The chief of National Geographic Information Institute(NGII) may sub-divide the classification system for the purpose of the numerical map and an institute that draws a numerical map may use other classification system in consultation with the chief of NGII when the purpose of the numerical map does not match with the classification system established by NGII.

In accordance with Law of Establishment and Utilization of Nation Geographic Information System , GIS related authorities are constructing basic geographic information DB that is basis of GIS and is used in common in the GIS field to provide better GIS service. Article 15 (Construction of Basic Geographic Information) of the law specifies that as the essential geographic information approved by President, administrative district, traffic, marine and water resource (including hydrosphere), cadastre, survey control point, landform, facility(including central government and local government designated cultural properties), satellite image, aerial photograph and other geographical information selected by the chief of related central government agency after review of the committee can be deployed.

Item	Facilities
Traffic	Railroad Boundary, Central Line of Railroad, Road Boundary, Central Line of Road
Facility	Building, Cultural Property
Marine and Water Resource	River Central Line, River Boundary, Lake/Reservoir, Basin Boundary, Coastline
Administrative District	Administrative Boundary
Survey Control Point	Survey Control Point
Cadastre	Cadastre
Landform	Contour Line
Satellite Image & Aerial Photograph	Digital Ortho-image

Table 1 Basic Geographic Information Items and Features

2.2.2 Facility in Cadastre Field

For the cadastre area, article 52. 6 of cadastral job process regulation provides that the result map of cadastral survey should be drawn to identify the location of current structures according to the drawing method of result map of cadastral survey.
In addition, in 2007, as the Cadastral Survey Result Registry was newly prepared, the law was amended to draw location explanation drawing of measuring point after identifying the relationship of facilities around measuring points to improve the accuracy and reliability. The purpose of this amendment is to improve and complement the current form of cadastral survey result map, which only some experts understand, so that the public can also understand the form.

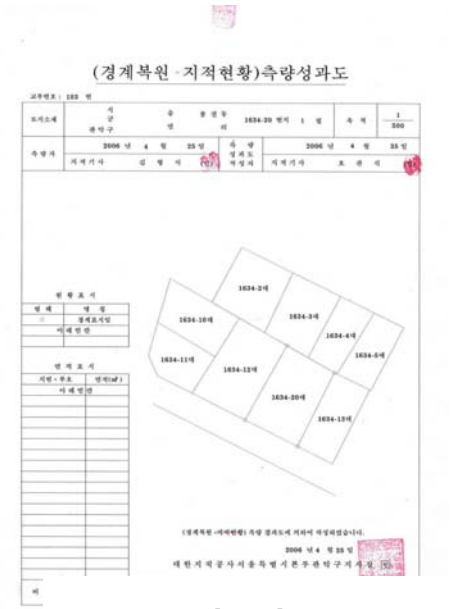

Figure 1 Cadastral Survey Result Drawing

The Cadastral Survey Result Registry consists of 7 parts: cover, cadastral survey result drawing, cadastral survey result performance table, location explanation drawing of measuring point, reference drawing, land notification and cadastral survey conductor. Cadastral Survey Result Performance Table

describes the survey method and survey result so that the public can understand the survey result without expertise. It contains survey history of last 5 years to secure the transparency of the survey and minimize the error in survey. Location Explanation Drawing of Measuring Point shows the measuring boundary, manhole and electric pole and notes the boundary point and distance as well as photo for boundary. Thus, when the boundary mark is damaged on the ground, a customer can recover the boundary based on the drawing, which saves the cost of survey and reduce public petition. Reference Drawing scales up the small scale (1/3000 or 1/6000) survey result drawing to help customer understand the drawing. Land Notification provides various notifications for lands such as official land price to help issue certificates related to surveyed lands. Cadastral Survey Conductor opens to the public the name and major career of survey conductor to encourage the conductor to survey responsibly.

3. PROBLEMS IN FACILITY MANAGEMENT

3.1 Urban Facilities

Currently, Korean municipalities deploy and utilize various facility management systems such as city infrastructure management system. Although the most facilities under the responsibility of municipalities are included in the common facilities, they are somewhat different in DB attribute items. When the same facilities have different DB attributes, universal management system does not work for the effective management. Thus, the DB attributes need to be standardized for the same facilities and unique code should be assigned to the facilities of the same specification. By doing so, all information on facilities can be accessed in GIS with the unique code and such easy access may contribute to improve the effectiveness of process, automation of management and minimization of error in data entrance.

Thus, when the list of city infrastructure managed by municipalities in common is defined and the standard items are selected in the cadastral survey, the facility can be managed systematically and effectively.

The facilities managed by municipalities can be divided mainly to road, water supply, sewage, electricity, telecommunication and gas. To search the usage of such facilities, this study surveyed and analyzed the list of facility management system in 3 municipalities(Seoul, Go-Yang City and Cheong-Ju City)

Facility	All Items	Common Items
Road	112	51
Water Supply	26	9
Sewage	14	2
Electricity	22	11
Telecommunication	17	8
Gas	15	6

Table 2 Common Management Item List of Urban Facilities

3.2 Cadastral Survey Data

The facilities used in the total survey system are classified into 2 layers: facility and boundary in broad aspect, into 9 layers in middle aspect and into 32 in narrow aspect. In addition, a classification system is made to explain facility in a text. Although all classification systems are made for the purpose of information acquisition, they are seldom used in practice, and even if they are used, the use of the system is limited to specific purpose or individual characteristic.

As mentioned earlier, the total survey system can minimize the limitation of diagrammatic interpretation and conduct more precise survey. Unlike the existing manual process, the system can handle repeated tasks by batch to minimize the error in individual processes and reduce the work time. However, the system has also disadvantages. To find the limitation of the system, it needs to see the problem related to the layer of the total survey system. First, the system does not provide itself with point, line, polygon and symbol for space analysis. The items should be in the form of layer that can be extracted whenever necessary. Second, as known in the location explanation drawing of measuring point and other way of expressing features, the expression form should be standardized for data to be shared. Third, the total survey system layer window displays features of three types: facility, boundary and text. But, they are not used widely at working groups. Field workers do not use the layer window because some do not know how to use it and other do not acknowledge the need for the function. This situation shows that workers do not understand the necessity of the total survey system and they prefer the existing practices and fast process to accurate process.

4. SELECTION OF FACILITY ITEMS

4.1 Demand Survey

4.1.1 Selection of Customers

The demand survey for the selection of feature items consists of documentary survey and interview. The survey result was used to establish items and system for feature of new cadastre information. The main contents of the demand survey are as follows:

- Definition and Classification of Facility Information
- Definition and Classification of Customers of Facility Information
- Service Demand by Customers and Characteristic of Demand
- Selection of Feature Items with Higher Priority

The geographic information on facilities is provided by NGII(National Geographic Information Institute of Korea), map manufacturers and facility information providers that provide topographical maps and geographic information. That is, NGII, National Geographic Information Distribution Network, map manufacturers provides numerical maps and geographic information on traffic/water resource/facilities as the topographical map and geographic information providers. In addition, demanding authorities and customers were

selected as the target of demand survey based on the survey on major authorities selected based on documentary and data survey.

The authorities selected as customers based on the data survey are 250 municipalities, 19 government agencies (authorities and corporation that need facility status information), 4 map manufacturers(map manufacturers and navigation manufacturers), 15 architectural design companies, 80 construction companies, the HQ of KCSC and its branches. The demand survey was conducted on the current status and demands of these authorities and companies.

4.1.2 External Demand Survey

(1) Municipalities

Municipalities acquire geographic information and cadastre information necessary for administration from their own GIS and KLIS and their demand for cadastre information is not high until now. However, the municipalities need specified map service(graveyard, orchard, factory and boundary information) that GIS in use does not support and boundary information with high credibility.

(2) Government Invested Institutions

Government invested institutions use cadastre information for the major projects such as large sized house and land development. The information used by the institutions includes cadastre status drawing(information service for urban facility), landform information related to road development, general feature and customized electronic cadastral maps and general cadastral status information. In fact, each institution demands urban facility information service showing cadastre information more precise than aerophoto, mountain area information that existing topographical map does not provide, cadastre information service showing road conjunction area and cadastral map service necessary for housing site development and related compensation.

(3) Telecommunication Service Providers

Telecommunication providers demand the information on features that affect radio wave environment related to telecommunication, updated information rather than new information and information of lower cost than that of existing facility topographical maps. Especially, the cable telecommunication companies demand ground survey little and need topographical map rather than cadastral map. the main demanded information of these companies includes information on station(location, owning company), building information, fence information, parking lot and electric poles.

(4) Map Manufacturers

Map manufacturers demand mainly the status of buildings, parking lots, traffic related feature and traffic signs, all of which are necessary for the drawing of map and they need updated information on new facilities. Although the map manufacturers try to expand their business scope into cadastral boundary service, the service is not easy to commercialized because the property right related issue is very sensitive problem.

(5) Construction Companies

Construction companies usually receive necessary information from design companies or contracting companies. Thus, the main customer of cadastre information is not construction company but design company or contracting company. The construction companies demand seldom the information directly. But, they need the information when they carry out property management related project. In addition, contracting and design companies demand information necessary to draw architectural design. Such companies consider the credibility of the information provided by KCSC as the most important aspect because they may face problem of different survey result, inconsistency of boundary and areas unsuitable for cadastre.

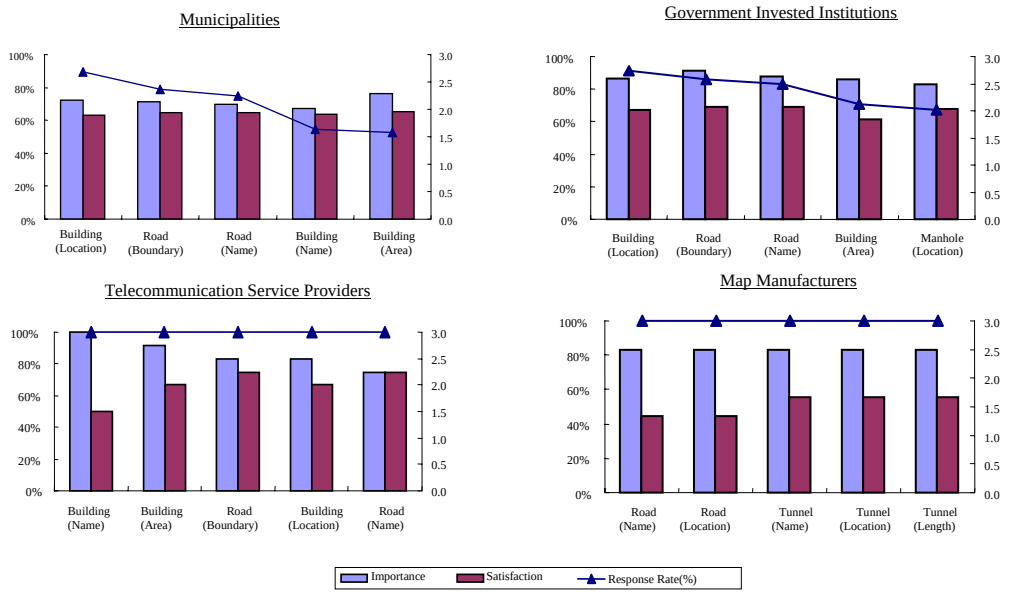

Figure 2 Response Rate, Importance and Satisfaction to top 5 Information by Customer Groups

4.1.3 Internal Demand Survey

The internal demand survey was conducted in the cooperation with HQ of each area and its branches. The survey items can be classified into road, facility, location, size, boundary, 3-dimensional survey information and land usage status according to the purpose of usage. The survey could identify which cadastre information is demanded and in which area the information can be utilized, based on the interview with the field workers. The top 20% of demanded information does not show difference in all areas but the rank is different depending on the attribute information. The top priority demand over all areas is the information on building and the information on road, graveyard and electric pole follows as 2nd and 3rd demand. Generally, the most remarkable feature is that top 5 information is not different over all areas.

Rank	Municipality	Government Invested Institutions	Design Company	Construction Company	Map Manufacturer
1	Road (Name)	Build (Area)	Building (Name)	Building (Name)	Bridge (Location)
2	Building (Location)	Road (Boundary)	Road (Name)	Building (Location)	Pedestrian crossing
3	Building (Area)	Building (Location)	Building (Location)	Graveyard	Station Road Name
4	Road (Boundary)	Road (Name)	Road (Location)	Gas pipe sign	Traffic signal
5	Building (Name)	Gas Pipe Sign		Tunnel Road (Name)	Mine
6		Graveyard		Footway (Location)	Parking place
7		Manhole		Building (Area)	
8		Building (Name)			
9		Tunnel (Location)			
10		Electric Pole			
11		Tunnel (Name)			

: Final demand information verified through the result of internal questionnaire

Figure 3 Priority of Internal Demand

4.2 Selection of Facility Item

The features and facilities were selected based on the existing document, demand survey and total survey system layer. The existing documents are precedent researches and documents mainly related to basic geographic information and the demand survey provides the priority information on facility extracted from internal and external demand surveys. And, the total survey system layer includes the information used most frequently among the layer information inserted into the current total survey system.
In selecting features, the clear application areas are set as the middle classification and narrow classification systems are prepared as concise as possible. The number of layers are minimized and individual space information are sub-divided as attribute information.

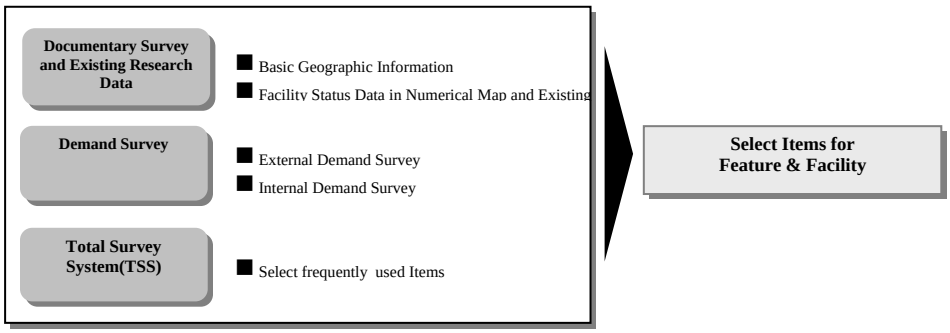

Figure 4 Method of Selecting Feature and Facility

To select items, the study classified the items into typical groups and then sub-divided the groups. The typical groups include 6 groups: traffic, hydrosphere, building, facility, boundary

and annotation. The study also determined the criteria for the classification of items in each group by specifying the details of the group.

The broad classification is made in the form of point, line and polygon, unlike the classification form in other fields, in consideration of the easy implementation and convenience of management. The middle classification subdivides the broad classification into 6 categories: traffic, hydrosphere, building, facility, boundary and annotation, and each object in the middle class is assigned with unique number regardless of its form of point, line and polygon. For example, the same serial number is assigned to traffic although the broad classification of the traffic has different forms of point, line and polygon.

Broad Class(Code)	Middle Class(Code)	Narrow Class(Code)	Remark
Point(1)	Traffic(101)	Traffic Signal(101001)	Point, multi point object
		Sign(101002)	
		Station(101003)	
	Hydrosphere(102)	-	
	Building(103)	-	
	Facility(104)	Manhole(104001)	
		Electric Pole(104002)	
		Hydrant(104003)	
		Lamp Pole(104004)	
		Cultural Property(104005)	
	Boundary(105)	-	
	Annotation(106)	Survey Control Point(106001)	
		Boundary Point(106002)	
Line(2)	Traffic(201)	Road(201001)	Line, multi line object
		Railroad(201002)	
	Hydrosphere(202)	River(202001)	
		Coastline(202002)	
		Bank(202003)	
	Building(203)	-	
	Facility(204)	Fencer(204001)	
	Boundary(205)	Administrative Boundary(205001)	
		Land Boundary(205002)	
	Annotation(206)	-	
polygon(3)	Traffic(301)	Land Route(301001)	polygon object
		Bridge(301002)	
		Tunnel(301003)	
		Footway(301004)	
		Parking Lot(301005)	
	Hydrosphere(302)	Lake/Reservoir(302001)	
	Building(303)	Building(303001)	
		Stair(303002)	
	Facility(304)	Graveyard(304001)	
	Boundary(305)	-	
	Annotation(306)	-	

Table 3 Selected Facility Items

5. UTILIZATION PLAN

5.1 Survey Information Management Center(SIMC)

SIMC(Survey Information Management Center) is being constructed to achieve the vision of KCSC, '3-dimensional land information provider.' SIMC will accumulate cadastral survey result data through the management of survey result map history and establish the basis of business diversification through the re-use and process of survey data. SIMC aims to diversify the business through the accumulation and integrated management of cadastral survey information, effective human resource management and distribution of survey information. Especially, SIMC launched a project to create customized electronic cadastral map to acquire survey information (cadastre + facility), process and edit the information and provide credible and accurate data to private sector and customers.
Because the unified facility information should be considered in SIMC, the result of this study can be useful to the project.

5.2 Update of Numerical Map

The regulation of survey law specifies that a numerical map should be complemented more than 1 time every two year. But, the map is updated once per 4-5 years because of budget. Until now, it is not possible to update numerical maps with cadastral survey result because the cadastral survey result cannot be used in updating numerical maps due to the frequently made inconsistency, disagreement between numerical map and cadastral survey result. However, when the layer system is established for feature and facility related to numerical map and the numeral survey area is expanded, numerical maps can be updated on occasions. Appropriate update of numerical map will contribute to establish the credibility of the map, provide information updated in real time and save the cost of occasional update.

6. CONCLUSION

This study selected facilities on which information can be acquired, based on cadastre information, to help manage facilities effectively. Based on the existing researches and document and data on total survey system, this study selected and coded items for facilities on which information should be acquired and defined the survey items. First, the study selected facilities based on the existing researches and documents. Based on the selection, the study added facilities extracted from the questionnaire result(external and internal survey) and the facilities used frequently currently in the total survey system. And then, the study established the classification system for the facilities for which demand is expected to increase.

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