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Original article

Development of Cadastral Data Model based on LADM to Manage Cadastre Survey Results in Korea

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Abstract

To solve the inconsistencies between realistic boundaries and the cadastral record boundaries, the cadastral resurvey project has been funded by a large budget since 2012 and executed over a long period of time until 2030. However, if the causes of inconsistencies are not analyzed and addressed, these inconsistencies could possibly reoccur. Even though the causes of inconsistencies can be defined in several aspects, including regulations, surveying methods, and management of cadastre maps or survey results, and so on, this study focuses on analyzing the inconsistency problems in the management of cadastre maps or survey results.

In order to resolve the problems in inconsistencies between the cadastre maps and survey results, the study proposes to develop the cadastre data model based on LADM (Land Administration Domain Model) to manage the cadastre maps and survey results in better ways. In order to proposed the Cadastre Data Model, we analyzed the cadastre management system implemented in Korea and identified requirements to resolve the problems in inconsistencies, which are considered in the proposed data model as follows: 1) cadastral management system based on individual parcels, 2) synthesis of a realistic boundary and cadastral record boundary, 3) management of official and sharing reference data, 4) consistent management of survey results and parcel boundaries, 5) temporal managements of parcel boundaries. In the end, this study proposes a cadastral data model based on the LADM to integrate and manage the cadastral surveying results of the new cadastral management system.

Keywords: Cadastral Inconsistence, Cadastral Management System, Cadastral Management System Framework, Cadastral Data Model

1. Introduction

Land is the basis of society and the basic condition for human life (Ji, 2011). Therefore, to guarantee the basic living conditions necessary for humans and to protect the peoples' right to own land, the government has the obligation to manage the land in an efficient way. The cadastral is an important document that protects land ownership rights, and functions as the basis of national administrative data and various land information systems. The cadastral map is a graphical representation, in the form of drawings of land parcel boundaries, and aims to protect and manage the property rights of landowners. Korea has adopted the land border system by which ownership is determined based on the land border. The land border is recorded in the cadastral map and is used to manage ownership. However, owing to various causes, it is difficult to determine the property rights precisely because the actual ground boundary does not perfectly match with the road boundary.

Currently, the cadastral map in Korea has been developed

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- The initial research was conducted by the master thesis of one of authors (Kim. Y. J).

and managed through the land and forest investigation project, which had been conducted during the Japanese colonial period from 1910 to 1924. Owing to the decline of the cadastral reference points, which was caused by exposure over several decades, and the difficulty of managing the paper cadastral map, the contents registered in the cadastral study have become theoretical and the locations therein no longer match the actual status of the land (Moon *et al*., 2006). Land disputes occur frequently owing to land mismatch inconsistency, and the cost of litigation is estimated to several hundred billion won. This results in economic losses and requires excessive administrative manpower.

To solve these boundary inconsistency, the cadastral rehabilitation project was implemented to correct the boundaries and digitize the cadastral maps. According to the basic plan for cadastral rehabilitation, the cadastral rehabilitation project will be carried out by investing KRW 1.3 trillion from 2012 to 2030 in Korea. Even if the cadastral surveys are carried out with a large budget over a long period of time, boundary mismatches may reoccur if the causes for their occurrence in the post-survey boundary management stage are not carefully investigated and addressed.

Even though the causes of inconsistencies can be defined in several aspects, including regulations, surveying methods, and management of cadastre maps or survey results, and so on (Yeon, 2008), this study focuses on analyzing the inconsistency problems in the management of cadastre maps or survey results. In order to resolve the problems in inconsistencies between the cadastre maps and survey results, the study proposes to develop the Cadastre Data Model based on LADM (Land Administration Domain Model) to manage the cadastre maps and survey results in better ways. In order to proposed the Cadastre Data Model, we analyzed the Cadastre Management System implemented in Korea in three stages, which are the procedures of cadastre survey, parcel boundary determination and cadastre map management. As well, we identified requirements to resolve the problems in inconsistencies, which are considered in the proposed data model as follows: 1) cadastral management system based on individual parcels, 2) synthesis of a realistic boundary and cadastral record boundary, 3) management of official and sharing reference data, 4) consistent management of survey results and parcel boundaries, 5) temporal managements of parcel boundaries.

Section 2 of this paper reviews the previous researches related to the inconsistency problems between cadastre maps and survey results, and Section 3 describes the framework of Cadastre Management Systems to analyze the system in three procedures. The following section analyzes the Korean and overseas cadastral management systems based on the framework defined in the previous section. In the fifthe section, the cadastral data model is proposed based on the LADM to integrate and manage the cadastral surveying results of the new cadastral management system. The final section discussed several significant insights and limitations derived from this study.

2. Related Research

In this study, we analyzed the causes of boundary mismatches and investigated improvement measures. Moreover, we investigated data management solutions for the cadastral survey.

The causes of boundary inconsistency were analyzed from various points of view. A previous study categorized the causes of boundary inconsistency into various aspects,

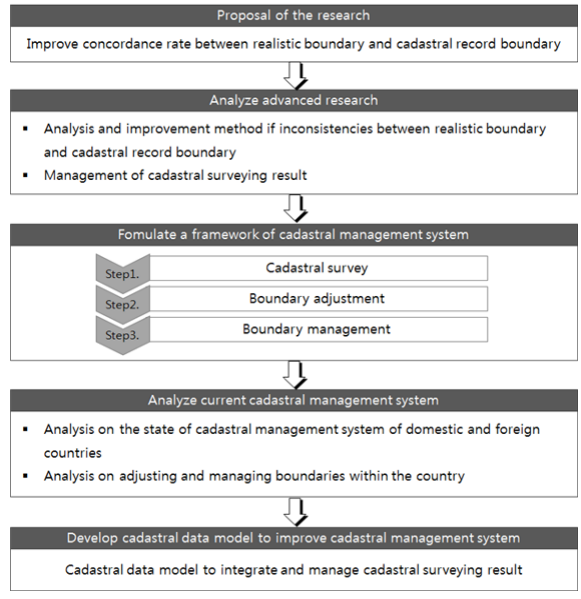


Fig. 1. Flow chart of this study

such as institutional, administrative, policy, and technical aspects (Yeon, 2008). The institutional causes are related to consistency and unity in accordance with the revision of the law, decrease in consistency owing to changes in the surveying system, and various theoretical departments and tasks. The administrative causes are related to drawing by hand, systematic errors owing to re-drawing, and the preservation management of drawings.

Policy determines the application of the reference point and coordinate system, and causes the occurrence of digitization errors. Finally, technical reasons were analyzed as errors caused by differences in the intended use of the reference points, and errors owing to various problems occurring when restoring the boundary points.

Improvement measures to resolve boundary mismatches were also analyzed from various viewpoints (Kim, 1998). This study analyzed institutional and policy aspects such as the implementation of the re-examination project, intellectual property dispute settlement, and LIS (Land Information System) development, in addition to administrative and technical aspects such as the cultivation and support of manpower excellence and the development of the latest surveying technology. To solve the boundary mismatch caused by the digitization of research drawings, we propose to change all theoretical non-compliant areas to numerical areas by suggesting concrete improvement measures (Yeon, 2008). We propose a plan to conduct a three-dimensional numerical cadastral survey by establishing and implementing an annual plan.

A study on cadastral surveying performance management has suggested a performance management system and institutional improvement plan for the objectivity and consistency of surveying performance (Yang, 2016). On the system side, we propose a service system that integrates the current system, which is managed by land mobility and non-mobility, and links with cadastral survey results. In the cadastral survey, the survey items, measurement history, decision points, buildings, and structures, are defined as service provision items. On the institutional side, we conducted a performance test on the boundary restoration survey and cadastral survey, and propose the provision of items from cadastral survey results.

Data set design studies have been carried out to link the released cadastral information regarding the cadastral survey performance management and non-digitized survey results (Lee and Kim, 2010). We received proposals from cadastral workers and service customers and selected linkage items based on the materials that are most frequently used for cadastral work and most referenced in cadastral surveying.

To maintain and manage the cadastral surveying performance systematically and permanently, and to utilize the basic cadastral surveying data efficiently, the cadastral properties have been upgraded and the cadastral surveying performance classification table (tentative name) has been presented (Kim *et al*., 2009). We added the use of a reference point, X-Y displacement amount of the reference point, cadastral survey result, rotatability, and survey history to the parcel property, while simultaneously managing the reference point. To specify the surveying performance of the parcels, the cadastral survey division charts the spatial extent as parcels, districts, and regions. This facilitates the determination of surveying performance and increases the efficiency of surveying and performance inspection work.

A causal analysis and a plan to improve the border disagreement of the existing study were carried out within a multi-faceted area. The investigation of survey performance data management mainly emphasized the importance of data management and defined the data to be managed. In this study, we analyzed the causes of border mismatches and investigated ways to improve them. It is significant that the cadastral data model, which is proposed as an improvement measure, provides a new surveyable and integrated management data model based on the land administration domain model of the international standard and the model using the Korean cadastral register.

3. Framework of Cadastral Management System

To understand the cadastral management system and its current status, the framework can be identified in three stages as shown in Fig. 2.

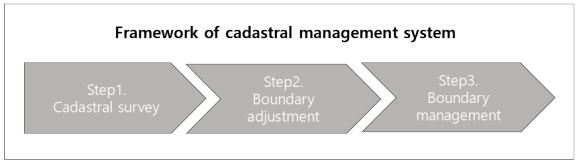


Fig. 2. Framework of cadastral management system

The first step is the measurement phase. The cadastral survey defined in the Act on The Establishment, Management, etc., of Spatial Data refers to a survey that sets boundaries or coordinates and areas of parcels to register land in cadastral studies, or restores the boundaries registered in cadastral studies on the land, and includes cadastral surveying. This is not much different to ordinary surveying in the sense of acquiring the location information of real space. However, in this case, after the survey the boundary is determined according to the parcel boundaries of existing drawings or the boundaries of adjacent parcels.

In the second step, which is the boundary decision, the location information of the parcel boundary of real space is obtained, and then the boundary is determined according to the existing cadastral map. A general topographic map does not cause a problem, even if a part or the entire change is renewed when a feature is changed. However, since the cadastral map is a drawing that specifies the land ownership rights based on drawings from approximately 100 years ago, ownership conflict can occur during the renewal process. Therefore, it is necessary to develop a process of matching the existing drawings defining land ownership with the actual current situation. Additionally, the boundaries between the neighboring parcels must completely match each other in the drawing.

Finally, the determined boundaries are managed in the boundary management step. Specifically, this is the management of cadastral drawings in the map area and the coordinates registered in the boundary point coordinate register in the numerical area. Over time, the paper drawings become damaged owing to new construction, abrasion, etc. To prevent this, it is necessary to update the drawings by hand. Additionally, the digitization of drawings and the conversion of the global coordinate system for the utilization of GIS (Geographic Information Systems) are included in the process of boundary management.

4. Analysis of Cadastral Management Systems

To analyze the cadastre management system, we may have to use the tree stages of framework described in the previous section. However, the limited scope of this study, the current state of the Korean cadastral management system and the state of overseas cadastral management systems were analyzed and compared based on the third stage of framework, which is the cadastre boundary management. Additionally, we analyzed the actual cadastral survey data and the management system with regard to the decision and management part of the parcel boundary in the Korean system to determine the problems of the Korean cadastral management system.

4.1 Analysis of Korean and overseas cadastral management systems

To analyze the differences between the Korean and overseas cadastral management systems to manage cadastre maps and survey results, the status of each cadastral management system was analyzed and is presented in Table 1. The analysis of overseas cadastral management systems was based on the cadastral management system introduced by France and Germany, who exerted a great influence on the establishment of the cadastral system in Korea, Japan, and Taiwan.

In what follows, we describe the France and Germany cadastre systems based upon the work of MOLIT (Ministry of Land, Infrastructure and Transport.) The cadastral surveys in France and Germany are carried out by private surveyors who are qualified according to the requirements defined by the government. In Korea, the cadastral surveys are conducted by LX (the Korea Land and Geospatial Informatix Corporation) and other private cadastral surveyors. After the cadastral surveyor completes the survey, a parcel can also be surveyed by an inspection agency. In Korea, a surveying result map is created after surveying. When land movement is recorded in the cadastral register, a surveying result test is carried out. However, a surveying result test is not carried out for boundary relocation surveying and reconnaissance

surveying that were not recorded in the cadastral register. The surveying result map in France records information such as boundaries, reference points, corridor names, and building names and numbers. The surveying result map in Germany records information such as boundaries, reference points, building names, boundary points, name and number of corridors, constants or sewers, and bearing. The Korean surveying result map records the reference point number, distance, azimuth, and coordinates, and provides an explanatory diagram for the measurement point location.

In France, during the border decision stage, the boundaries are determined after examining the results obtained by private cadastral surveyors. In Germany, private cadastral surveyors have a more prominent role and are licensed both for surveying and inspection under the supervision of the Federal Office of Surveyors. In France and Germany, after the surveys are completed, the land is classified according to its parcels, and a sketch map, such as that shown in Fig. 3, is created. In Korea, the drawing area is created for the subdivision area, and the numerical area is created for the boundary point coordinate register of the parcel unit. In the sketch map of the French system, the area division method, new boundary, previous boundary, signers' display, creation date, surveyor and their signature are recorded. In Germany, the sketch maps include zone boundaries, parcel identifiers, parcel boundaries and boundary marks, house and building outlines, house serial numbers, road names, road boundaries, and survey enforcement dates. Since this is a sketch map for one parcel but also shows the adjacent parcels, it is possible to understand how the boundary with adjacent parcels is set. Additionally, France has a border management report, and Germany keeps a border management performance record by entering new boundaries and transfer boundaries.

In France and Germany, the boundary type that indicates legal ownership is based on the terrestrial boundary, while in Korea it is based on the ground boundary. Overseas, ownership is defined through the ground boundary; therefore, boundary mark management regulations are provided. In France, it is mandatory to establish a border point, and Germany requires that the boundary mark is linked to two

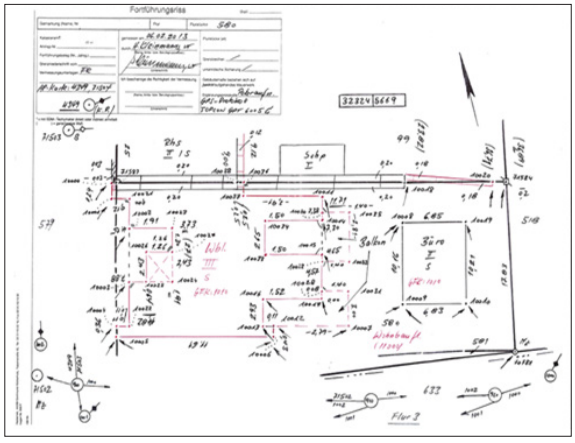


Fig. 3. Sketch map in german system (source from Yang *et al*.,, 2017)

or more national geodetic reference systems. To manage the border of the roads, France and Germany also manage the cadastral map of the sketch units and the cadastral maps with various parcels registered together in the country. Cadastral maps are managed for uses such as tax levying, which is not easy for parcel management. In Korea, a cadastral map, forestry map, and boundary point coordinate register are managed by the government. The survey result maps that can manage the survey history are not managed as official documents (Yang *et al*., 2017). If a land survey is carried out, the results of the survey should be submitted to the relevant authority to manage the survey results as official documents.

To match the parcel boundary on the ground with the cadastre boundary on the map, first, the ground boundary should be accurately expressed as a cadastre boundary, and the cadastre boundary should be accurately restored to the boundary on the ground. By analyzing the Korean and overseas cadastral management systems, it was found that Korea does not have an official document to register a single parcel (except some regions) and does not publicly manage the survey result maps. Therefore, it is concluded that the survey reference data and history managements are insufficient. Because a regulation to manage the terrestrial boundary does not exist, boundary inconsistency can occur owing to the ground boundary and the cadastre boundary not being managed together. In the next section, we discuss our investigations with regard to the boundary decision and

management steps in the Korean cadastral management system, and analyze the factors causing boundary mismatching.

4.2 Analyzing parcel boundary determination and management procedures

Although the framework of the cadastral management system is divided into three stages, this study analyzed the problems in the boundary decision and management stage of the Korean system, with the exception of the cadastral survey stage. As a result of analyzing the status of the Korean and overseas cadastral management systems, there are some limitations in cadastre managements in Korea, where various reference data are not registered when determining boundaries.

This makes accurate boundary reconstruction difficult and exacerbates boundary mismatches. Additionally, in overseas systems, the individual parcels of the cadastral map and the cadastral map itself are managed in accordance with the intended use. However, Korea is managing the parcel boundary by the scaled cadastral map. in most of countries, survey results and achievements by individual parcel are recorded and managed by the government. Therefore, Korea only manages parcel boundaries on the cadastre map legally; however, the parcel boundaries on the ground are not managed sufficiently. Therefore, we analyzed the problems of the Korean system according to these differences.

Presently, Korean land is divided into an area represented analogue cadastre maps and an area represented by digital cadastre maps. The digital maps on several areas have been generated by digitizing cadastral maps and conducting cadastre renovation projects. However, many of them still fall into the analogue map area. When a registration conversion survey is carried out in the map area, the newly surveyed boundaries of the cadastre map on the forestry zones move in accordance with existing cadastral maps when the boundaries are separated from the existing cadastral boundaries. Fig. 4 was converted into a cadastral map and moved 3.8 m in the x-axis and 2.6 m in the y-axis to align the forest boundary with the cadastral boundary in the registered result file.

Table 1. The state of cadastral management system of domestic and foreign countries (source from Yang *et al*., 2017)

Cadastral management system \ Country			France			Germany		Korea	
Cadastral survey	Main agent		Private cadastral surveyor			Licensed surveyor		LX Private cadastral surveyor	
	Output		Plat of survey			Plat of survey		Survey paper	
	Inspector		Government surveyor			Licensed surveyor		Land change: Government surveyor non land change: X	
Boundary adjustment	Main agent		Government surveyor			Licensed surveyor		Land change: Cadastral surveyor after inspection by government surveyor Non land change: Cadastral surveyor	
	Output		Sketch map(for one parcel) boundary representation result			Sketch map(for one parcel) boundary confirmation result		Graphical cadastral: Cadastral map for grid Numerical cadastral: Digital cadastral map for one parcel	
Boundary management	Form of legal boundary		Realistic boundary			Realistic boundary		Cadastral record boundary	
	Regulation status for manage boundary monument		O			O		X	
	Main agent for managing boundary monument		Landowner			Landowner		Government for cadastre	
	Management of cadastral record boundary	Main agent	Government for cadastre	National tax service	Register office	Government for cadastre	Register office	Government for cadastre	Register office
		Management object	Cadastral map for one parcel, Index map, Cadastral map for application	Original cadastral record	Sketch map, Paper for boundary confirmation, Registration book	Index map, Sketch map, Survey paper	Registration book	Cadastral map, Forestry map, Digital cadastral map	Registration book

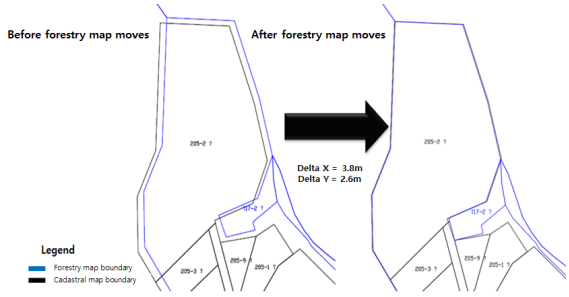
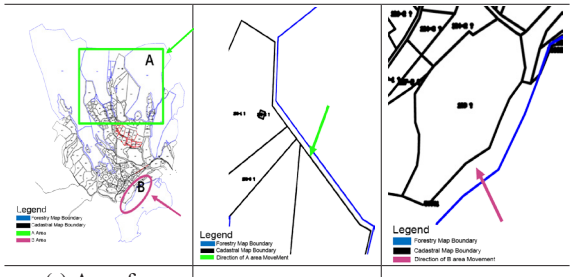


Fig. 4. Cadastre map boundary on forestry zone movement for registration conversion

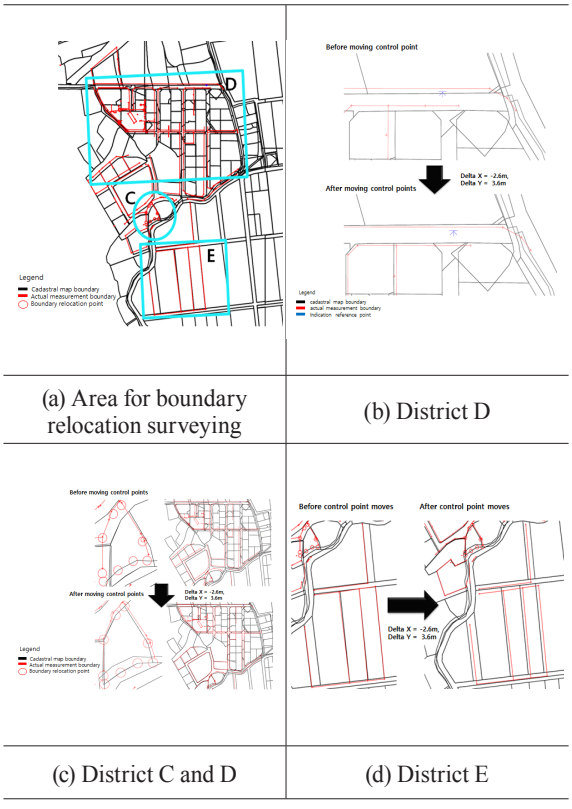
Fig. 5 shows that there exists a direction inconsistency when moving the boundary. It can be seen that Area A moved to the southwest, while Area B moved to the northwest and was bounded. A boundary mismatch occurs when aligning a new surveyed ground boundary to an existing drawing. In the surveying results, lacks of consistency occur because provision is not made for moving the distance and direction. Moreover, the discrepancy is further exacerbated because the movement amount is not recorded.



(a) Area for registration conversion | (b) District A | (c) District B

Fig. 5. Parcel boundaries moved for registration conversion

During the surveying of boundary relocation, the reference point and the actual line are moved to match the existing drawing. District D in Fig. 6(d) represents the boundary restoration survey target area, and Districts C and E represent the adjacent parcel area. In district D, to move the surveying reference point -2.6 m on the x-axis, and 3.6 m on the y-axis to match the cadastral boundaries, the adjacent district C and E had to be moved by the same amount. Consequently, the inconsistency reoccurred in district E, where the boundaries matched those of district C and D. However, the existing boundaries matched, and the boundary relocation surveying was not subject to the inspection of the cadastral authority because the cadastral study did not change. Therefore, the result of the survey line was registered by the subjective assessment of the surveyor. This made it difficult to maintain consistency in the result and caused boundary inconsistency.



(a) Area for boundary relocation surveying | (b) District D

(c) District C and D | (d) District E

Fig. 6. Parcel boundaries moved for boundary relocation surveying

In the numerical area, the boundary point of one parcel was written in the boundary point coordinate register and managed in parcel units. Additionally, a cadastral map was created. However, the cadastral map of the numerical area could not be used in the cadastral survey, which is used to gain an understanding of the overall situation and has the limit of boundary relocation. The relative position

between the boundary point coordinates of the boundary point coordinate register was correct. However, the absolute coordinates may include errors owing to rotation and parallel movement with respect to the coordinate origin of the entire parcel boundary. Additionally, the coordinate system and cadastral reference point at the time of the registration and restoration point should be the same. Boundary relocation is possible by applying the same measurement method using the same reference point network. For example, in a deterministic survey in the same region, but not in the adjacent region, the coordinates at the boundary of the region may not match during boundary restoration (Park, 2015). The boundaries of the parcels can cause rotation and translation. Because boundary point surveying does not register various reference data, it is difficult to accurately reconstruct the boundary point, even if the boundary point is managed.

In order to overcome the problems described in the above, overseas systems register the parcel boundary with an individual parcel cadastral map (called survey result maps or sketch maps) filled with various types of information. The cadastral map of the entire country is managed separately and is used as a utilization map that is not used for surveying purposes (Yang *et al*., 2017). The United States operates an individual parcel cadastral map as an official cadastral map, which is used for taxation, land valuation, and urban planning (Yun *et al*., 2012; Yun, 2013). On the other hand, Korea uses cadastral maps with map quadrangle units for cadastral surveys. Because Korea does not manage various information related to surveying that pertain to individual parcel management, it is difficult to restore the cadastral record boundary to a realistic boundary.

5. Proposed Cadastral Data Model

The proposed cadastral data model, such as that shown in Fig. 7, is required to address the problems identified in previous sections. The proposed cadastral management system proposed in this study was designed to reflect the implications of the analysis of the Korean and overseas cadastral management systems and solve the problems inherent in the Korean system.

First, to ensure the accuracy of the lot position information, the boundary should be controlled based on individual cadastral map parcels, and not on the cadastral map using map quadrangle units. The cadastral map should be controlled in terms of utilization combined with the register and other land information. The AAA (Official geodetic points information system-Official cadastral information system-Official topographic cartographic information system) data model in Germany combine the digital landscape model, digital television model, and digital topographic model to utilize high-quality data for intelligent administration and related businesses (Seifert, 2006). Using the same concept, Korea will be able to use a cadastral map in combination with the appraised value of land and similar information to impose taxes, conduct value assessments, and carry out urban planning.

Secondly, the realistic boundary and cadastral record boundary should be synthesized in individual parcels to ensure that the contour boundaries are always consistent. To this end, realistic boundaries should also be controlled with the cadastral record boundary. Moreover, for the management of realistic boundaries, a management system for the labeling of realistic boundaries must be introduced. Thirdly, it is necessary to manage and share reference data publicly. Korea only controls the final result data and not the data in the series of processes from which the results are derived. High performance can be achieved only when the reference data is shared seamlessly when synthesizing the separated schematic regions and numerical regions, or when conducting cadastration. Fourthly, the survey results and cadastre maps should be maintained consistently. According to the revision of the Framework Act on National Spatial Data Infrastructure, proposed in 2017, the tasks of confirmation cadastral surveying will be transferred to the private sectors in the near future. Therefore, cadastral survey data produced by private enterprises are expected to increase (Lee *et al*., 2014). At this time, consistent criteria should be applied to derive survey results for the purpose of avoiding confusion among survey subjects, and to ensure the consistency of survey performance. Finally, the survey results of parcel boundaries must be maintained in temporal. New errors can be included because human errors may occur when manually copying or updating the cadastral map or when digitization is

carried out. In the case of boundary conflicts, the data should be managed during the survey of the contour boundaries or during the renewal of the boundary to identify the change in the time series.

As shown in Fig. 8, the cadastral data model was developed to reflect the items of the new cadastral management system. ISO (The International Organization for Standardization), established ISO TC 211, which is the and ISO 19152, which is the LADM as international standards in 2012. Based on these international standards, A cadastral record application model developed analyzing the current state of the cadastral record in Korea (Lee *et al*., 2014). Based on the model by which the Korean cadastral record has applied the international standards, this study proposes new data models, which are capable of implementing the new cadastral management system.

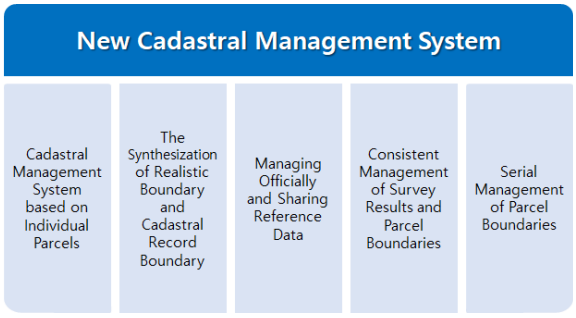


Fig. 7. The requirements for the proposed cadastral data model

Based on the cadastral register application model developed by applying the cadastral register in Korea, a class was added to solve the problems of the current cadastral management system. After the surveying, the survey output is written, and the parcel, parcel boundary, and boundary of the adjacent parcel are also recorded simultaneously. Additionally, the relationship between the control point and the control point network configuration used during surveying, and the relationship between the control points and the parcel boundary points should also be recorded so that the control points can be accurately restored to the ground through various types of information at the time of surveying. The survey inspection with survey output and association relationships records data regarding the parcel, boundary and the error of the parcel boundary point after a performance check. After the surveys have been completed, a boundary determination document is prepared based on the survey output. The boundary determination document records the boundary before and after the change. When realistic boundary results of the new survey are moved to the cadastral record boundary, the amount of movement of the boundary and the direction of movement are recorded. Based on this boundary determination document, an individual parcel cadastral map is created. The contents regarding the parcel boundary and boundary point, building of the boundary in the parcel, and boundary mark on the ground are prepared.

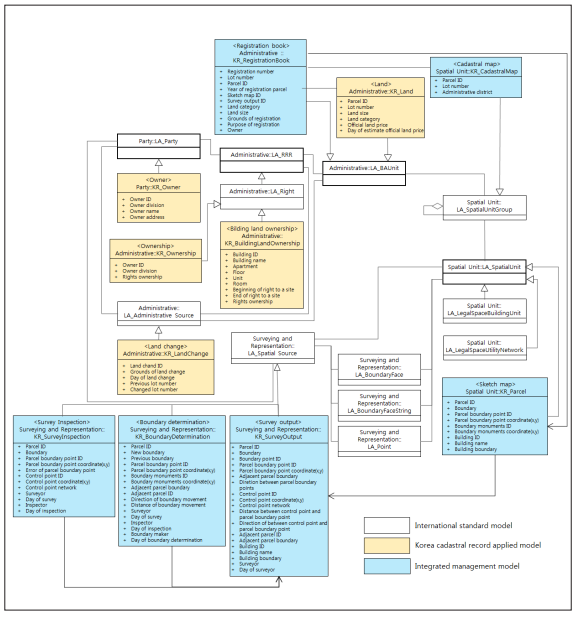


Fig. 8. Proposed cadastral data model based on LADM

The registration book records the information of the drawing ID, land category, land size, owner, etc., to refer to the parcel ID, address, sketch map, and survey output. The registration book is operated and managed for the purpose of managing owner-parcel relationships, rather than for the management of parcel boundaries.

The survey results proposed in the data model, such as the

survey output, survey inspection, boundary determination, sketch map, cadastral map, and registration book, should also be managed publicly to ensure that smooth data sharing is carried out. Additionally, all data and results used to determine the cadastral survey outcome by managing all measured data as reference data should be systematically integrated and managed. The French and German governments manage most of the information proposed in the data model. However, the surveying result map and boundary determination document are not managed in a DB (Database) but rather in the form of a digitized document. The cadastral data can be managed more systematically if they are entered into a DB, in the same way as in the abovementioned proposed data model.

6. Conclusion

The current use of cadastral maps that were developed decades ago has caused many problems and cadastral inconsistencies, which have resulted in boundary disputes and many economic and administrative losses. The cadastral resurvey project is underway to resolve these cadastral inconsistencies and digitize the existing paper map. However, cadastral inconsistencies may occur if their cause is not carefully analyzed and resolved. Therefore, this study analyzed the causes of parcel boundary inconsistency in the cadastral management system, proposed the cadastral management system to solve the problems, and suggested the proposed cadastral data model.

To analyze the cadastral management system, a cadastral management system framework was established for the three stages of the cadastral survey, boundary determination, and boundary management. As a result of analyzing the status of the Korean and overseas cadastral management systems according to the proposed framework, it was found that foreign countries manage the individual parcel unit cadastral map and the continuous cadastral map of the entire country is operated for utilization purposes rather than for management purposes. Additionally, in overseas systems, independent documents for boundary determination are created and managed by the government; therefore, the various reference data to determine boundaries are managed, shared, and maintained. Since the ground boundary is designated as a legal ownership boundary, it is necessary to set the land boundary mark, whose management responsibility will be assigned to the landowner.

We proposed the cadastral data model to reflect the best practices of the overseas cadastral management systems and solve the inherent problems of the Korean system. The direction towards which the new cadastral management system should proceed is that of a cadastral management system based on individual parcels, synthesis of the realistic boundary and cadastral record boundary, official management and sharing of reference data, consistent management of survey results and parcel boundaries, and serial management of parcel boundaries. In the data model of the new cadastral management system, various reference data at the time of individual parcel surveying, movement amount at the time of boundary determination, boundary before and after change, and landmarks, are recorded and managed publicly. Consequently, the data to manage the history and determine the survey results can be integrated, managed, and shared smoothly. In this paper, we proposed a new cadastral management system and suggested a data model to improve the current system. In the future, it will be necessary to remove the existing cadastral map and cadastral register and investigate a standard for the cadastral map of individual parcels.

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