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Full Length Research Paper

The Turkish cadastral information system and lessons learned

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The Turkish land registration and cadastre works were carried out in analog format until 1985. After that, the cadastre works have been performed in a digital environment, while the land registries continued to be sustained in analog format. The subsequent developments in geographical information system technologies and increasing user demands suggested the need to combine land registry and cadastre data in an information system framework at the beginning of the 1990s. The need was addressed a decade later with the Turkish Land Registry and Cadastre Information System (TAKBİS) project. During the implementation of the TAKBİS project, a lot of experience and knowledge have been gained. This paper introduces the background of the project along with a summary of the current Turkish cadastral system, outlines the aims, scope and constitution process of the TAKBİS, and concludes with the experiences gained during the project implementation.

Key words: Land registry, cadastre, cadastral information system.

INTRODUCTION

Cadastre is a parcel based, and up-to-date land information system containing a record of interests in land (FIG, 1995). While cadastral systems traditionally have a primary objective of supporting the operation of land markets, they are increasingly evolving into a broader land information infrastructure which supports economic development, environmental management, social stability, and sustainable development in both developed and developing countries (Williamson, 2001a; UN-FIG, 1999; Bennett, 2008; Williamson and Ting, 2001; Steudler et al., 2004; Williamson, 2001b; Rajabifard et al., 2007).

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Abbreviation: TAKBİS, Turkish land registry and cadastre information system; **EU,** European union; **GIS,** geographical information system; **GDLRC,** general directorate of land registry and cadastre; **ITRF,** international terrestrial reference frame; **INSPIRE,** infrastructure for spatial information in the European community; **NIN,** national identification numbers.

In this context, the responsible organizations are focusing on making spatial information, expertise and services available to other governmental organizations and to the wider society to respond to initiatives in technology, government needs and business opportunities (Thellufsen et al., 2009; Wallace and Williamson, 2006). Building up a countrywide land/cadastre information system which is a core component of national spatial data infrastructures is the main way used in performing this duty (Li et al., 2009; Enemark, 2005; Enemark, 2001).

Similar to this worldwide situation, the Turkish land registration and cadastre works were carried out in analog format between 1924 and 1985 with primary objective of supporting the operation of the land market. Later, the cadastre works were converted to be performed in a digital environment as a result of the technological developments, government needs and business opportunities, while the land registries continued to be sustained in analog format (Poyraz and Ercan, 2002; Demir et al., 2008).

On the other hand, the existing cadastre maps produced till 1985 were still in paper format, and the graphical maps

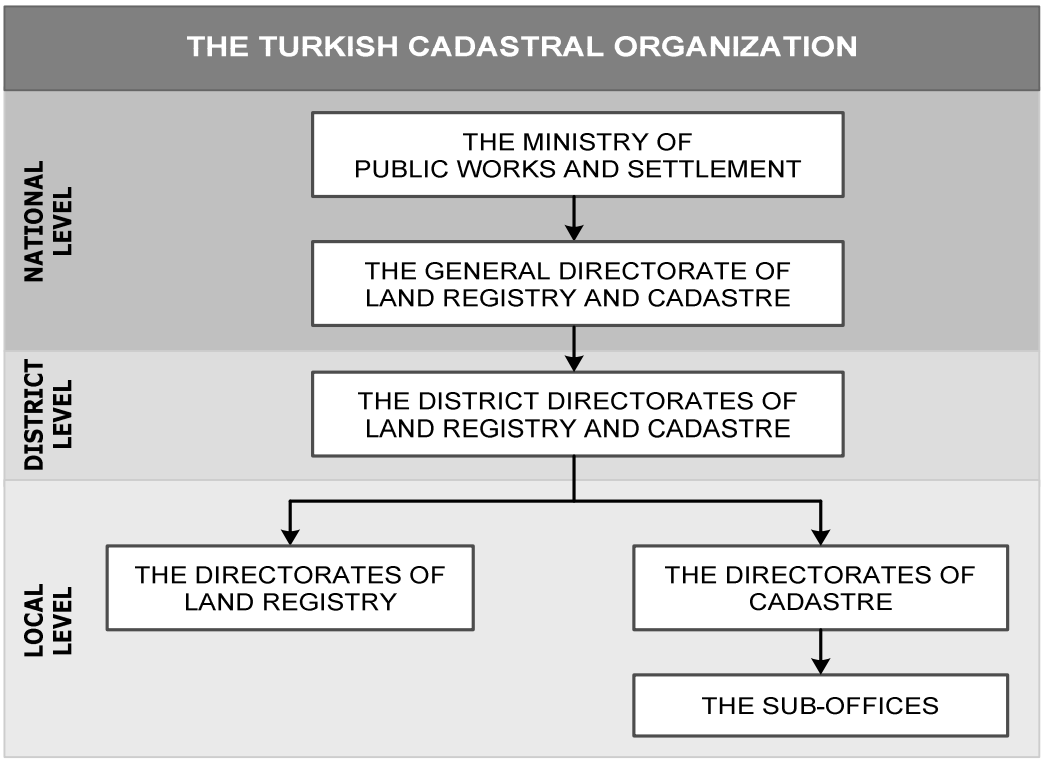

Figure 1. Organizational structure of Turkish cadastral system.

constituted with chain surveys were highly inadequate to meet the user needs (Demir et al., 2008). Therefore, the "Mapping-Cadastre Reform Project" (Harita-Kadastro Reform Projesi, or HAKAR) was initiated in 1986 to digitize land registry and cadastre data to be the base for the cadastre information system (Köktürk, 2003; Demir and Çoruhlu, 2007). However, the project was not sustained after the system analysis phase. The inefficiency of the cadastral data continued to be an issue.

This forced the Turkish government reform the cadastral system with the goal of developing a computer-based cadastral information system. In this context, the development of the Land Registry and Cadastre Information System (Tapu ve Kadastro Bilgi Sistemi, or TAKBİS) project was planned as one of the most important national projects in 1990 (Türker and Kocaman, 2003; Alkan, 2005). However, implementation of the project was started almost a decade later in 2001 (Zakout, 2008).

This paper aims at defining the TAKBİS project and the lessons learned during the project process. In this context, it begins by summarizing the Turkish cadastral system to provide a better understanding of the TAKBİS project. Then, it outlines the aims, scope and constitution process of TAKBİS, followed by the expected gains from the project. Finally, it concludes with the lessons learned during implementation of the project.

THE TURKISH CADASTRAL SYSTEM

In this section, the present situation of the Turkish cadastral system is summarized considering legal, organizational and technical aspects.

Legal aspects

The Turkish Civil Code No. 743, dated 1926, founded a land registry system integrated with cadastre maps in order to describe the rights, responsibilities and restrictions on real estate throughout the country (Official Gazette, 1926). Following the Code, the Land Registry and Cadastre Laws were put into force to establish the Turkish Cadastral System. The laws have been revised several times based on the requirements arose over time.

Organizational aspects

The institutional structure of the Turkish cadastral system was organized in 1936, and the same structure is still in use today (Demir et al., 2008). The cadastral works at the national level are carried out by the General Directorate of Land Registry and Cadastre (GDLRC) affiliated with the Ministry of Public Works and Settlement (Figure 1). The main responsibility of the General Directorate is to

Table 1. The Turkish cadastral maps and used production methods (Bakici, 2008).

Production method	# of sheets	% of total
Digital	154 008	29.5
Polar	127 118	24.4
Graphic	91 804	17.6
Photogrammetric	81 334	15.6
Orthogonal	61 271	11.7
Photoplan	1 782	0.3
Others	4 220	0.8
Total	521 537	100.0

Table 2. The Turkish cadastral maps and used coordinate systems (Bakici, 2008).

Coordinate system	# of sheets	% of total
ED-50	286 624	55.0
Local	110 817	21.2
No coordinates	97 154	18.6
ITRF	26 942	5.2
Total	521 537	100.0

organize implementation of land registry and cadastre works. It carries out this duty with its 22 District Directorates, which organize and supervise 1018 Directorates of Land Registry and 325 Directorates of Cadastre with 133 Sub-offices at the local level. However, the technical portion of the cadastral works could be contracted to private surveyors in appropriate areas, according to the 'Cadastre and Land Registry Law', dated 1934.

Technical aspects

Turkish land registration data have been sustained in an analog environment with land registry and condominium books. The books have various problems related to the updating process. They register with dead landowners and old land use types are the most common of them.

As for cadastre, the works with a completion percentage of 88.1% as of 2009 and have been carried out by various surveying methods, scales and coordinate systems in Turkey (Demir and Çoruhlu, 2008; Zakout, 2008; URL-1, 2009). The most commonly used surveying methods include graphic, classic, photogrammetric and digital ones (Table 1). The scale of cadastral maps changes between 1/500 and 1/5,000. ED-50, local and the International Terrestrial Reference Frame (ITRF) are the most widely used coordinate systems in the production of the cadastral maps (Table 2). In addition, almost 20% of the produced cadastral maps do not have a coordinate system (Bakici, 2008). Briefly, the data is not in a homogenous structure, which leads to various problems in cadastre-related works. One of the most important problems is transferring the cadastre data from analog format into a digital format. This is mainly because the cadastre maps contain features with low positional accuracies and lack a coordinate system.

THE TURKISH LAND REGISTRY AND CADASTRE INFORMATION SYSTEM

The TAKBİS project is intended to take land registry and cadastre data use to the next level by spreading its benefits to people, businesses and multiple sectors by facilitating better access to real estate information through the e-government platform (Mataraci and İlker, 2002; Ercan, 2003; Zakout, 2008). Based on the National Programmed of the Turkish Government, the TAKBİS also takes part in the projects that should be carried in the medium term during the European Union accession period of the country (URL-1, 2009).

This section defines the constitutional process, aims and scopes of the TAKBİS as well as the expected gains of the project.

Aims and scope

Turkish land registry and cadastre data play significant social, economic, and legal roles in the country, and they are used extensively by individuals, and public and private organizations. However, the current data is in paper format, as stated above, and the workload of the GDLRC is growing continuously because of the increase in the transactions of real estate, and the new duties dedicated to the General Directorate. Therefore, the current management system of land registry and cadastre data does not meet user requirements in an accurate, rapid, secure, and simple manner. The TAKBİS project is designed to respond properly to all these requirements by developing new functionalities and technologies in the digital era.

The main target of the project is to transfer the paper-based land registry and cadastre data into a digital environment using a standard framework throughout the country. In addition, the project targets (URL-1, 2009; Cete and Yomralioglu, 2004):

(i) Making the work carried out by officials in the land registry and cadastre directorships easier;
(ii) Increasing the use of cadastral data in the decision making process of various organizations;
(iii) Providing the land registry and cadastre data to public and private entities in a secure environment;
(iv) Planning, managing and servicing the GDLRC's activities in a better, faster, and more secure and efficient way; extending the scope of the land registry and

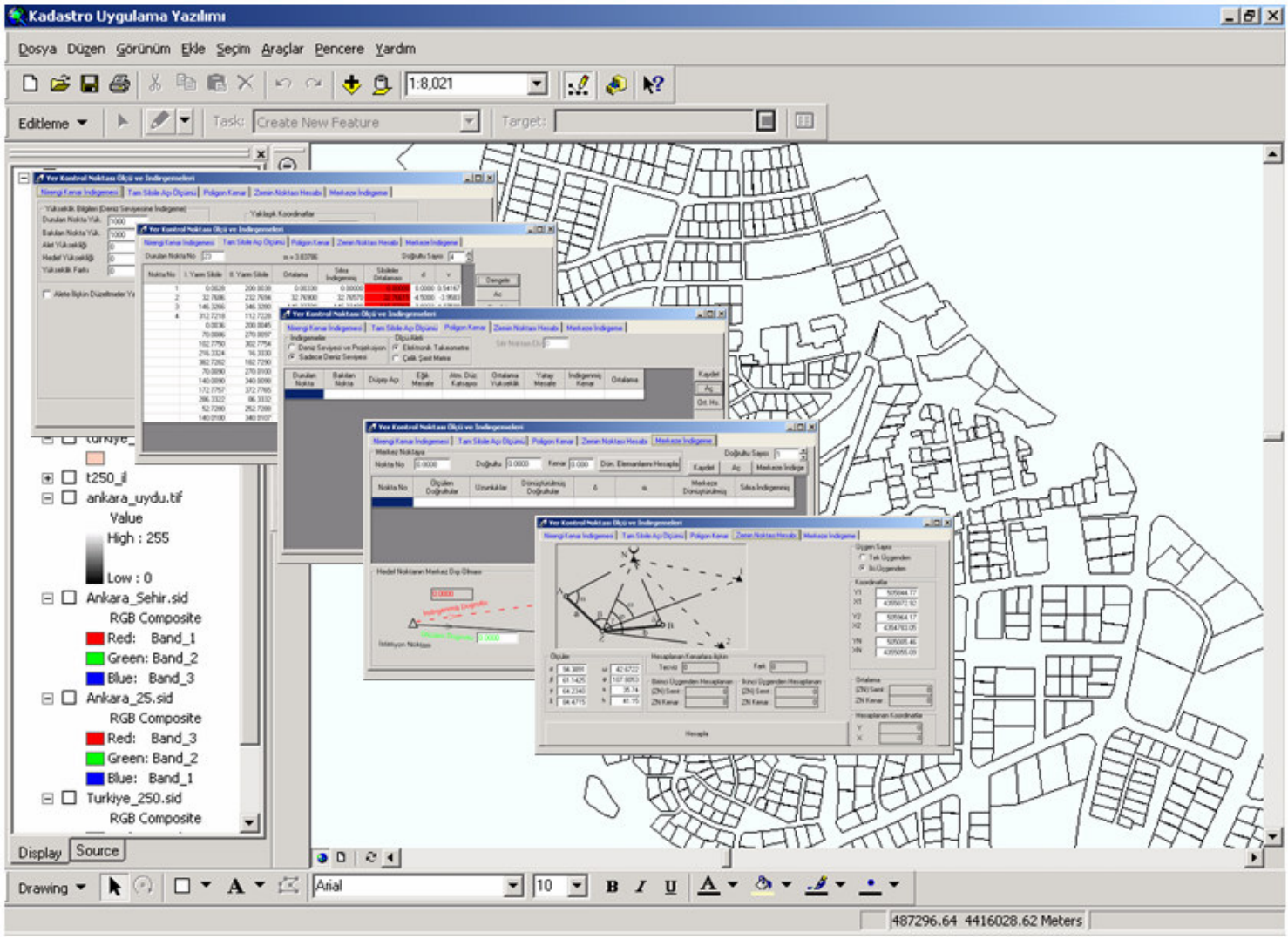

Figure 2. The user interface of cadastre application software (Boynukalın et al., 2002).

cadastre data by taking, for example, requirements of information technology into consideration, such as adding unique personal identification numbers into land registry records;
(v) Enabling wide-spread use of land registry and cadastredata by upgrading the quality of the data;
(vi) Constituting a base for the national land information system; and
(vii) Transforming coordinate systems of cadastre data from local to a national system.

The TAKBİS project was designed based on the current administrative structure that has two components: land registry and cadastre, as discussed in the above sections. In the project, land registry data, which is only composed of attributes, is stored in a central database, whereas cadastre data, which consists of cadastral maps, is stored in distributed local databases. That is to say, both databases are functioning individually at this time, although, they will be integrated in the framework of the TAKBİS.

Now that the pilot stage is complete, the plan is for the TAKBİS project to be extended to the whole country. The system integrates all existing analog land registry and cadastre data in a digital environment. It is composed of four software applications: (i) land registry, (ii) cadastre, (iii) project monitoring, and (iv) resource management (Figure 2) (URL-1, 2009).

Constitution process

The TAKBİS project is implemented in three phases: TAKBİS-I, II and III (Figure 3). TAKBİS-I phase was initiated by the GDLRC and Havelsan Company in February 2001. The organizational structure, works and

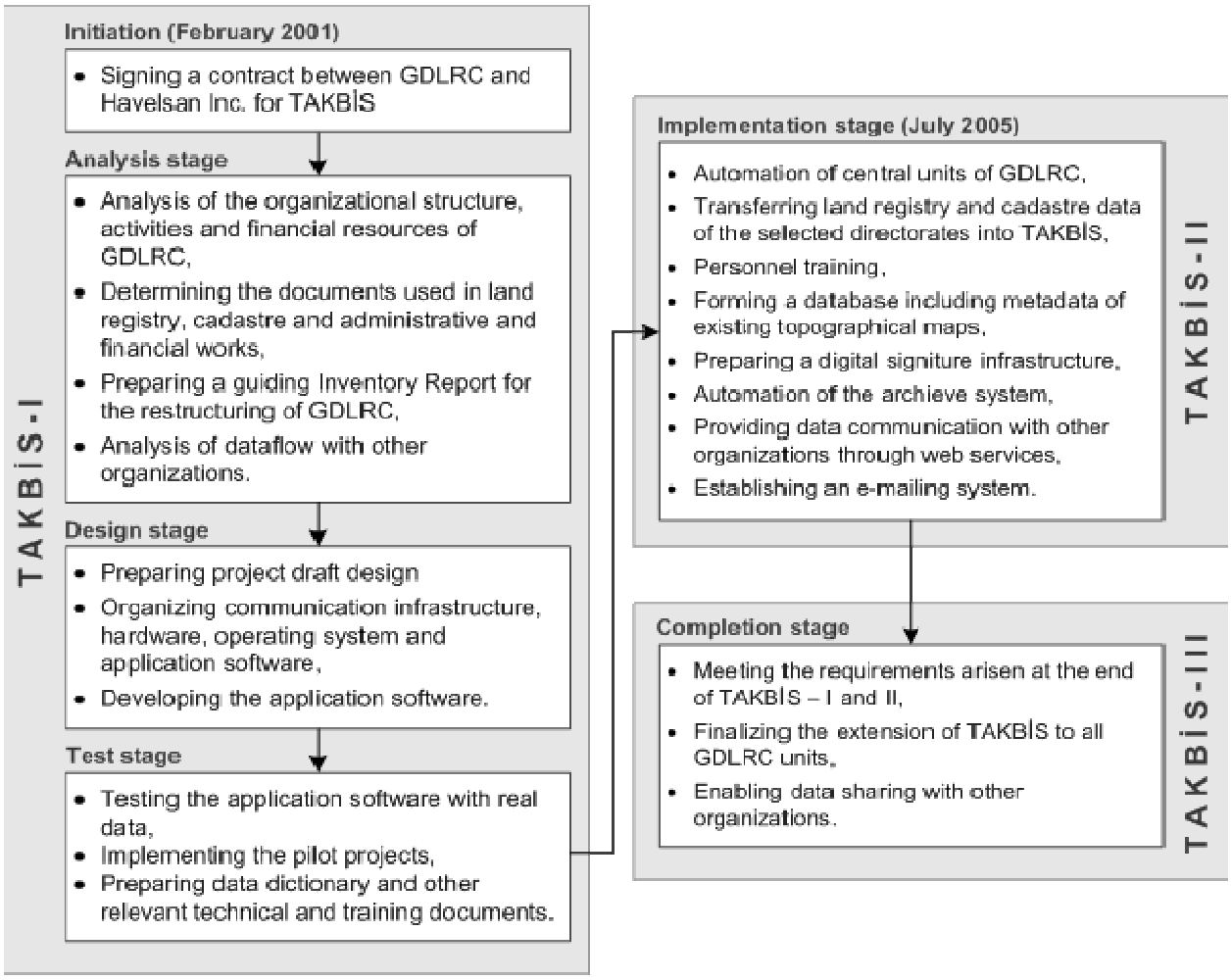

Figure 3. Workflow of TAKBİS project.

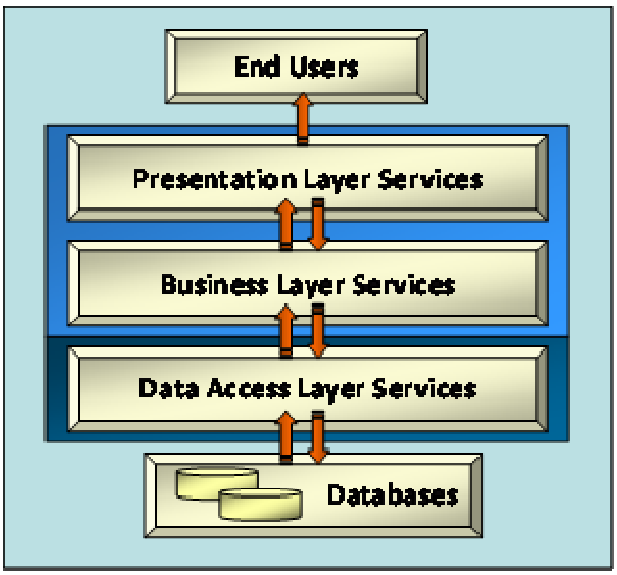

Figure 4. TAKBİS software architecture (Havelsan, 2009).

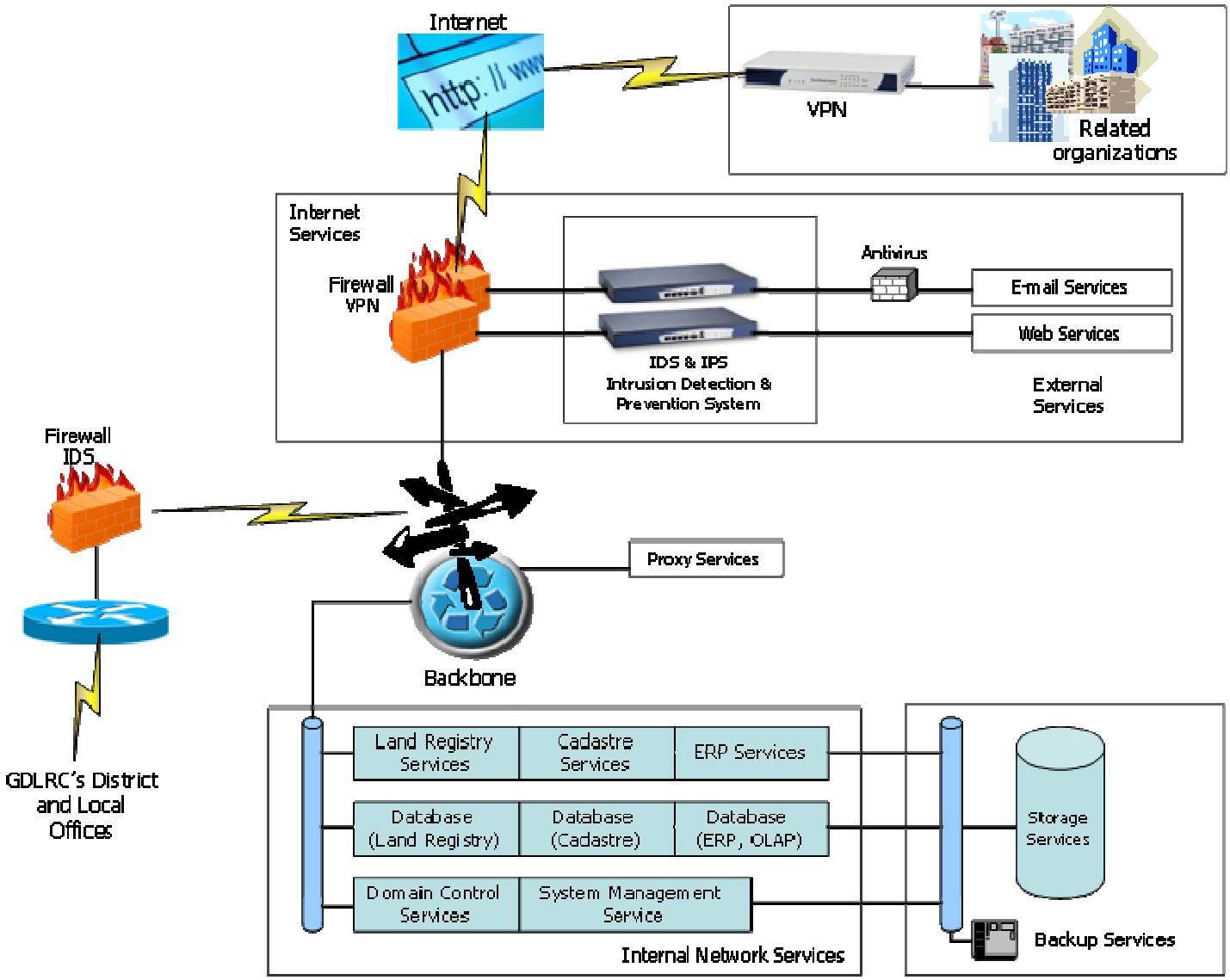

Figure 5. TAKBİS system architecture (Havelsan, 2009).

financial resources of the GDLRC, in addition to the relevant regulations, were examined. All documents regarding land registration, cadastre and administrative-financial works were determined, and an inventory report was prepared as a guide for re-organization of the GDLRC. The data flow of the GDLRC with the other relevant institutions was examined. The analysis phase took 3 months and concluded in June 2001. Next, the draft design of the project was prepared in the following 3 months.

The communication infrastructure, hardware, operating system and main software were ready for use in December 2001. According to the concept of Information and Communication Technology (ICT), the application software (Figure 4), developed in accordance with the designed system (Figure 5), was completed in June 2002. Then, the software was tested using the actual cadastral data and a data dictionary, in addition to other relevant technical and training documentations that were prepared (Poyraz and Ercan, 2002; URL-1, 2009). Following the analysis, system design, and software development and testing phases, the TAKBİS project was introduced to the regional directorates, and local cadastre and land registry directorates according to their priority established by the Administration (Poyraz and Ercan, 2002).In this context, 154 cadastre sheets that included 8500 land parcels and 132,000 landowners in Çankaya County of Ankara were digitized, controlled, authenticated and integrated to the system based on the data model.The system has been used by "1st District Directorate of Land Registry" and "Cadastre Directorate" in Çankaya in December 2002 and "Directorate of Land

Table 3. The Turkish public organizations that will use the TAKBIS (Mataraci and İlker, 2002).

Organization	Using purpose
Ministry of justice	Judicial affairs
Ministry of finance	Management of the government-owned lands; tax collection
Municipalities	Urban Information Systems
Ministry of agriculture and rural affairs	Agricultural planning and supports; land reforms
Ministry of public works and housing	Development works
Ministry of transport	Determination of routes of roads, railways and other means of transportations; expropriation works
Ministry of the environment and forestry	Environmental works; forest cadastre
Ministry of trade and industry	Trade and industrial planning
Ministry of culture and tourism	Cultural and tourism works
Ministry of energy and natural resources	Works in dam, power line and others
Mapping services	As a base for different mapping works

Registry" in Gölbaşı, Ankara in January 2003. Thus, the TAKBİS pilot project and TAKBİS-I phase were finalized.

After approval of the Turkish Ministry of Finance in July 2005, the TAKBİS-II stage that aimed to extend the project to 225 land registry and 7 cadastre directorates was initiated. In this stage, automation of GDLRC's central units, transferring land registry and cadastre data of these directorates into TAKBİS, personnel training, building a metadata database of existing topographical maps, preparing a digital signature infrastructure for GDLRC, automation of the archive system, providing data communication with other organizations through web services and establishing an e-mailing system were planned to be realized.

Although, the implementation of this stage is ongoing, the cadastre component of the TAKBİS-II stage was suspended in early 2009 (URL-1, 2009). The reason of the suspension is the inadequacy of the cadastre application software, and the requirements for its revisions.

In the last stage, TAKBİS-III, the requirements that arose at the end of TAKBİS-I and II are planned to be met, and the extension of TAKBİS project to all GDLRC units and data sharing with other organizations will be realized. While the expected completion date for the land registry portion of TAKBİS is the end of 2011, it could take more time for the cadastre part.

Expected gains

There will be various benefits upon the completion of the TAKBİS project. Although, there is currently not enough standardization in land registry and cadastre data, the TAKBİS will provide data standardization using unique software in all units of GDLRC. This will also turn low-quality cadastral data into qualified one and improve the Data Archives of the General, District and Local Directorates of Land Registry and Cadastre.

Accessibility of property data will be improved by transforming paper-based cadastral data into digital environment with the TAKBİS information system structure. In this way, a number of organizations (Table 3), along with the Turkish Courts using land registry and cadastre data for diverse purposes, will be able to access the data more easily in a short period of time with a more contemporary manner (Mataracı and İlker, 2002). After setting the necessary legal regulations, landowners could also access the cadastral data on a temporal basis on the web using a unique number assigned to each landowner in the TAKBİS. Furthermore, individuals can handle the procedures and transactions related to real estate with the same approach. In addition, the cadastral data infrastructure required in various geographical information system applications would be provided (Ercan, 2003).

While real estate related procedures and transactions can be carried out in the land registry office where they are registered now, it will be possible to accomplish them in any land registry office throughout the country in the framework of the TAKBİS, which uses a central database. Another benefit of the central database is that authorities will be able to query all property data belonging to an individual or organization.

Many public organizations that are not aware of the land they own today will be able to identify it using the TAKBİS. Thus, an increase in government revenues would be provided (Bandeira et al., 2010). Various difficulties encountered in the statistical analysis of real estate data due to the volume of data in analog format would be handled easily in the TAKBİS, which will diminish the workload of officials in the land registry

offices. In addition, the TAKBİS application software will minimize or eliminate any risks related to the procedures carried out by officials by warning them during the procedures about changes in regulations (Poyraz and Ercan 2002).

LESSONS LEARNED FROM THE TAKBİS PROJECT

A lot of experience has been gained in the analysis, design, testing and implementation stages of the TAKBİS project. These experiences can be categorized in legal, organizational and technical dimensions.

In the legal context, there is a need for considerable revision because the current land registry and cadastre legislation have been structured according to the analog systems (Baz et al., 2003). In addition, accession to property data is significant, but only real estate owners and the people who prove interest in the real estate can perform this act, according to the current Turkish regulations.

Consequently, re-structuring the current regulations according to the designed access rules of public and private organizations and individuals in the TAKBİS is necessary (Baz et al., 2003). In this context, the approach adopted by the Swiss Government to solve the same issue in 2004 can also be applied in Turkey. Namely, while the approach allows one-by-one queries, the queries regarding all real estate of a person are not permitted. Only some institutions are authorized to access all property data of a landowner (Çete, 2008). Finally, carrying out renovation of cadastral maps was difficult at the beginning of the project because of the strict regulations. The issue has been resolved by re-organizing the relevant legal regulations.

One of the main organizational issues experienced in the project is an insufficient number of experienced staffs who are familiar with Geographical Information System (GIS) technologies (Poyraz and Ercan, 2002). The GDLRC staff was accustomed to using Computer Aided Design (CAD) software, instead of GIS software. The second issue was an inadequate budget to finance the TAKBİS project because digitizing cadastre data requires a huge amount of resources. The World Bank credit support for cadastral renewal and modernization project has been provided to address the issue (Zakout, 2008).

The bulk of the experience gained in the TAKBİS project has come out of working with the technology. These experiences demonstrate that the analysis, design, testing and implementation stages of the TAKBİS-I were completed in a short period (in a little less than two years), but without enough attention, which resulted in many issues that needed to be resolved. The draft design and the application software of the project were continuously revised during the implementation stage to meet the encountered requirements. In addition, the cadastre component of the project has been suspended due to software inadequacies in early 2009.

The land registry and cadastre data in analog format were transferred to the TAKBİS database without checking the correctness of the existing data. As a result, existing errors in the analog data were also transferred to the TAKBİS. In addition, necessary control mechanisms were not realized during data input, resulting with personnel mistakes. Therefore, the officials in land registry and cadastre directorates currently rely on the analog data because of the uncertainty in the correctness of the TAKBİS data. The integration of land registry and cadastre data is an important issue faced in the project. Due to the inconsistency of some land registry and cadastre data, the integration has become a difficult task (Mataracı, 2005). Therefore, necessary procedures and software requirements need to be developed in order to speed up identification of data inconsistencies and integration.

The lack of landowner National Identification Numbers (NIN) in the TAKBİS records leads to problems and impedes some intended advantages of the system (Çete, 2008). For example, requests of the courts regarding a landowner's real estate records are carried out with the name and the National Identification Number of the owner, but such queries cannot be carried out in the TAKBİS because of the reason declared above. Thus, there is a need for the development of new solutions to record the NIN of all landowners in the TAKBİS. Currently, the TAKBİS assigns a new unique number for each landowner instead of using the available unique NIN, whereas it would be better to associate NIN with the TAKBİS records.

The TAKBİS was designed to have a central database as stated above. It has been observed in the implementation period that this approach was very appropriate to get the most benefits of the project. The approach also enables realization of the software revisions relatively easy.

The main problems related to spatial data in Europe are fragmentation of datasets and sources, gaps in availability, lack of harmonization between datasets at different geographical scales and duplication of information collection. These problems cause difficulties in identifying, accessing and using the available data. Therefore, the European Union (EU) directive that establishes the "Infrastructure for Spatial Information in the European Community (INSPIRE)" was published to trigger the creation of a European spatial information infrastructure that delivers integrated spatial information services to the users. In this framework, cadastral parcels are one of the spatial data themes in the INSPIRE Directive (EU Directive, 2009). Turkey is a candidate country to join the European Union, but the INSPIRE directive was not adequately taken into consideration in the development of the TAKBİS data structure. There could be some integration issues that may occur in the future between the TAKBİS and relevant European geospatial information systems. As a result, the TAKBİS data structure should be revised according to international

data standards.

Conclusion

The Turkish Land Registry and Cadastre Information System (TAKBİS) is one of the most important sub-projects carried out in the context of the Turkish e-government. It will provide cadastral infrastructure of the country in a digital and easily accessible format. The main target of the project is the automation of land registry and cadastre data that are required in land-related works and decision-making processes throughout the country. To pursue this, it is necessary to establish a correct and integrated database in a sustainable manner. The various problems and experiences stated above have appeared during the TAKBİS project implementation.

The problems should be addressed according to the suggestions given in the previous section. In addition, the project stages and the lessons learned during the project presented in this paper could also be useful for countries that will implement similar systems in the future.

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