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Spatial data-based e-municipality applications

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Information and communication technologies (ICTs) are playing an increasingly vital role in the daily lives of people, revolutionising work and leisure and changing the rules of doing business. In the realm of government, ICT applications or e-government are promising to enhance the delivery of public goods and services to citizens not only by improving the process and management of government, but also by redefining the traditional concepts of citizenship. e-government is the use of information and communication technology, combined with organisational change and new skills to improve public services. There are two main types of web-based applications for spatial data-based e-government applications over the internet: (_a_) interactive web-based maps that can be queried on the internet and (_b_) spatial data-based e-government information that can be accessed by the clients or public on the internet. In Turkey, although there is a remarkable improvement in the non-spatial data-based e-government applications, there has been little progress in spatial data-based e-government applications. This paper discusses spatial data-based e-government applications developed so far to allow the user to access e-government spatial information through the internet. The paper presents results of a pilot application of the system design developed to carry out e-municipality applications.

1. INTRODUCTION

Municipalities are leading institutions that are charged with providing services to citizens living in urban areas. Municipality activities are determined by regulations through urban planning, building construction, transportation, infrastructure and mapping (Geyman _et al._, 2008). To discharge their duties effectively, municipal governments must be able to use spatial information effectively, mobilise data intensively and share the data it produces with the general public. Spatial information is geo-referenced to known locations on the Earth's surface. To ensure that location is accurately recorded, spatial data always employ a specific coordinate system, unit of measurement and map projection (Gonzales, 2005). The urban information system (UIS) is a spatial-based information system organising and managing all types of graphic and non-graphic spatial information needed by local governments. In each phase of the so-called spatial-based services, citizens are face to face with municipalities. In this respect, internet is one of the most efficient methods of establishing relations between citizens and local administrations (Baz _et al._, 2004; Geymen and Yomralioglu, 2006).

Technology helps governments achieve some important goals through quality websites that provide convenient and accessible information and e-government services to citizens. Technology also assists in decentralising public administration and enhancing the government's ability to oversee key activities. e-government provides services to business, government employees and citizens (Prybutok _et al._, 2008). Definitions of e-government range from 'the use of information technology to free movement of information to overcome the physical bounds of traditional paper and physical based systems' to 'the use of technology to enhance the access to and delivery of government services to benefit citizens, business partners and employees'. The common theme behind these definitions is that e-government or interactive municipality involves the automation or computerisation of existing paper-based procedures that will prompt new styles of leadership and new methods of debating and deciding strategies, transacting business, listening to citizens and communities and organising and delivering information. The most important advantage of these systems is that it is easy and clear to access information. More importantly, it aims to help strengthen government's drive towards effective governance and increased transparency to better manage a country's social and economic resources for development. It aims efficiently to access information on the desired date and hour, departing from the limitations of the service style. With the help of these systems, taxes can be paid, results of individual or institutional applications can be monitored and documents such as on-line zoning status or application sketches can be submitted using the internet.

Governments worldwide are increasingly using the internet to provide public services to their constituents (Layne and Lee, 2001). Much of the research has focused on practical and technical dimensions while research on how to improve e-government for users remains scarce (Bertot and Jaeger, 2006). Web-based technologies offer governments more efficient and effective means to better serve their citizens compared with traditional physical channels (Evans and Yen, 2006; Raney, 2000). The non-hierarchical nature of the internet and its ability to speed communication with 24/7 access offers real potential to improve interaction. Discussions about the promise of e-government generally stress three features: easier access to information; more efficient service delivery; and improved

communication. The goal is to create a more dynamic government with greater citizen involvement.

As stated by the Council for Excellence in Government in 2001: 'We do not just advocate substituting electronic for personal communications between people and public servants…we envision more strategic and satisfying personal communications of higher quality, supported by electronic information, sources, transactions, and interactions' (Taft, 2001; Tillett, 2000; Verton, 2000).

In the mid-1990s, governmental agencies had high expectations about the take-up and increasing usage of electronic service channels. At present, however, studies from various countries such as Switzerland (Ebbers *et al.*, 2008), Canada (Miller and Miller, 2003), Australia (Australian Government, 2005), the Netherlands (Pieterson and Ebbers, 2008), Brazil, Mexico and Argentina (Lau *et al.*, 2008), show that governmental agencies still face high numbers of contacts by way of more traditional service channels, that is phone and desk. This is unfortunate for governmental organisations given the fact that its cost-efficiency makes electronic channels ideal from the viewpoint of organisations (Pieterson and van Dijk, 2006). In the Netherlands, some forms of government have been in existence for over 20 years (e.g. remote retrieval of citizens' information). However, the forms of e-government in the Netherlands have been limited in their diffusion and adoption, and only recently has there been an extensive outgrowth of public websites with designs based on some type of e-commerce web-based business models. Currently, there are more than 1800 public organisations and 500 private organisations offering one or more websites related to governments, policy-making and public services.

Moon (2002) sought to compare and contrast e-government rhetoric with the reality. As an initial step, he identified five stages in the development of e-government: (1) information dissemination; (2) two-way communication; (3) service and financial transaction; (4) vertical and horizontal integration; and (5) political participation. After an analysis of data collected by the International City/County Management Association, he concluded that municipal governments were still at stage (1) or (2). In his view, they had focused on providing information and the two-way communication that did exist was highly structured. He described the state of e-government for many municipalities as 'primitive'. e-government is still developing, of course, but a pattern is now becoming clear (Moon, 2002; West, 2004).

West (2004) determined that more governments have a website and that these sites have become increasingly sophisticated in the way they present information; however, use of the internet has not evolved to higher levels of sophistication. West notes that what has been seen to date is more of an incremental change and not a transformational stage.

Akinci (2004) studies geospatial web services technology for an interoperability infrastructure for e-municipality in Turkey. He finds that web services are very promising for the e-municipality infrastructure. In his research, he also investigates the activities of the municipality and determines the problems of the traditional system. As a result, he finds that

web facilities enable quick, high-quality service and financial savings in software development.

Sahin (2007) concludes that the studies implemented for applications of e-municipality by non-governmental organisations and academic quarters are generally based on theoretical information, web page analysis and questionnaire applications, and that only 17·5% of the municipalities within the context of the research have a website.

Bensghir (2005) analysed the websites of Istanbul, Ankara, Izmir, Kocaeli, Izmit, Antalya and Kayseri municipalities and made the following conclusions.

(*a*) Websites are mostly in the form of unilateral simple information transmission rather than supplying e-service.
(*b*) Web pages are designed according to the desires of the administrators.
(*c*) There is no application for providing or encouraging the participation of the citizens in the management of the websites.
(*d*) There is no application of electronic commerce in websites of the municipalities.
(*e*) Applications of the websites are mostly public relations oriented.

The applications mentioned above deal with the non-spatial data, which can be organised and transferred on the internet environment by using classical web tools. However, many government agencies not only deal with non-spatial data but also with spatial data. There are two main types of web-based geographic information system (GIS) applications for spatial data-based e-government applications over the internet.

The first type is online and includes interactive maps which can be used for spatial query, address search, route analysis, buffering and overlaying analysis. The second type of web-based GIS application relates to transmitting spatial documents of various agencies to their clients over the web. The contents of these documents include information such as land usage plans, landowner boundaries plans and construction permission plans. The number of e-government applications using non-spatial data has been continuously increasing, while few applications using spatial data have been conducted by the related government agencies. As more agencies provide spatial data-based services, web-based GIS applications will become more common in the near future. In this study, the structure of the web-based GIS applications was investigated and web-based interactive maps and the applications of developing parcel-based spatial documents were introduced.

2. METHODOLOGY
The Munis Project was used in this study (Dobrev *et al.*, 2002). The study strategy consists of transferring and adapting best-practice parcel-based spatial documents applications for municipal work and services to citizens from Turkey.

The methodology is divided into two main stages.

(*a*) The first stage is focused on the study and analysis of best practices of municipalities, of the information and communication technologies (ICT) infrastructure and the

Figure 1. Components of system development within the e-municipality study
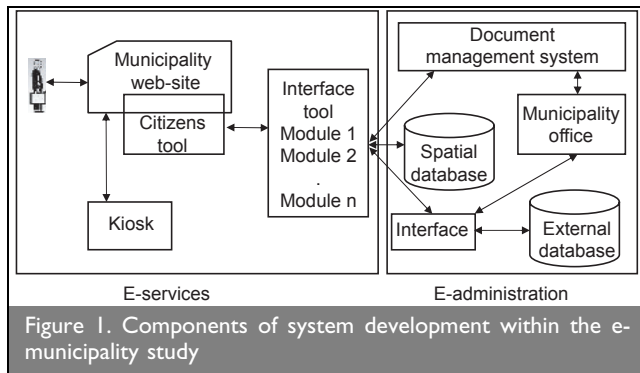
demand for improvement in the e-performance of working practices.

(b) The second stage includes improvement of existing transferable applications, providing e-services to citizens (e-service) and e-municipality office (e-administration). The e-municipality office consists of an electronic document management system, an interface tool for external information resources and a municipality office information network. Online services for citizens will be achieved through transfer and adapting/improving standardised municipality and city websites, a citizen's software toolkit allowing the citizens to request and receive services by way of internet, as well as an interface toolset for access to municipality information resources needed for provision of requested e-services by citizens (Figure 1).

Tuzla, Istanbul city, was chosen as a pilot region. The Tuzla municipality was chosen because it represented a good medium-scale municipality. Municipalities with a population of 5000 and over are defined as medium-scale municipalities. Large-scale municipalities are those covering cities within the municipal borders, for which there are more than one district. These types of municipalities are referred to as metropolitan municipalities.

3. APPLICATION MODULE INTERFACES

In this study, a system for medium-scale municipalities which implement e-municipality applications is designed. This application prototype design comprises four main modules

(a) follow-up and evaluation of spatial applications of the municipality
(b) online generation of information and documents that have spatial content (zoning status, application sketch, building-licence sketch)
(c) presentation and analysis of maps over the web
(d) monitoring tax debts of citizens.

The install file was created with Install Shield Express software. With the help of a set-up file, the software can be installed on other platforms. When the installation is complete the program will open modules of interface design developed as prototype and sub-menus. Definitions of these modules are also shown. Each of the interface modules is password protected; this ensures control of edits and access to the data. Graphical and attribute data are stored on a central server.

3.1. Module 1: follow-up and evaluation of spatial applications

This is the interface for dynamically monitoring the flow of documents which deliver the required information regarding spatial activities in units, providing coordination among the institutions within the municipality and standardisation in communication. Applications of any individuals, commercial associations, formal agencies and courts to institutions are stored in computer media within the designed system and can be immediately seen on electronic media.

Operation of the system is password controlled. Only those authorised can enter, register and deliver applications to related units, for example managers who deliver the application and staff who will produce it. Separate forms are accessible according to the username and authorities of the individuals who make entry.

For spatial service requests of the citizens that make their application through the internet, an interface is designed that is web-based and operates online (Figure 2). Regarding the application form for online completion by citizens in Figure 2, keyed information is designed as 'text line' and information selected is designed as 'combobox'. As well as saving the entered information in the server after approval by the design system, the information is automatically delivered to related units. After the application arrives at the related unit and is examined by the supervisor, it is delivered to the related staff (Figure 3(a)). Staff and workload can be monitored online (Figure 3(b)). Bold-coloured applications in Figure 3 represent applications to which a response has not been made.

As well as statistical calculations of staff working on the same form, weekly and monthly productivity calculations of institutional activities can also be made (Figures 4(a)–(c)). Therefore, with the help of performance measurements of unit and staff, auto-control acceleration is brought into the system. Accordingly, the level of satisfaction experienced by citizens using the system can also be determined using statistical data.

When user name and password are entered, the 'staff work follow-up' form is opened (Figure 5). With the help of this form, users working in the related directorate can see applications delivered to them, write replies and submit reports related to the application. After the user opens the project (Open Arcview Project), the document can be retrieved by entering the appropriate 'parcel ID' number (Figure 5).

This module is an active online application for municipalities, providing a high-quality, efficient and constant service to citizens allowing them to participate in decision-making processes in their municipalities. In addition to citizens being able to see the results of their applications in internet media, the workload of both citizens and municipality staff are decreased.

3.2. Module 2: online generation of information and documents with spatial content

With the help of this module, tax debts can be paid, results of applications to the municipality can be monitored and users can obtain documents over the internet (Baz and Geyman, 2006; Geyman et al., 2008).
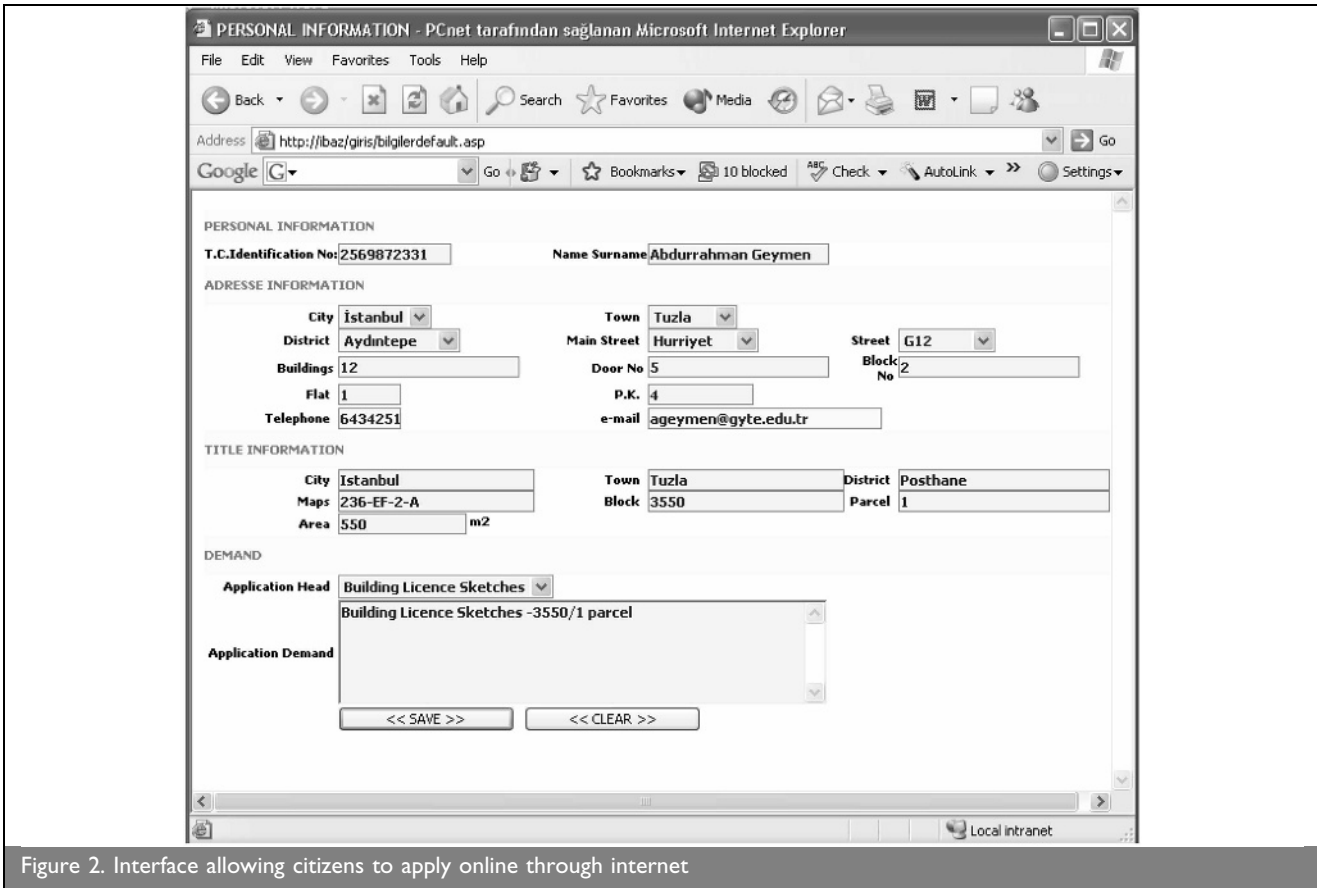
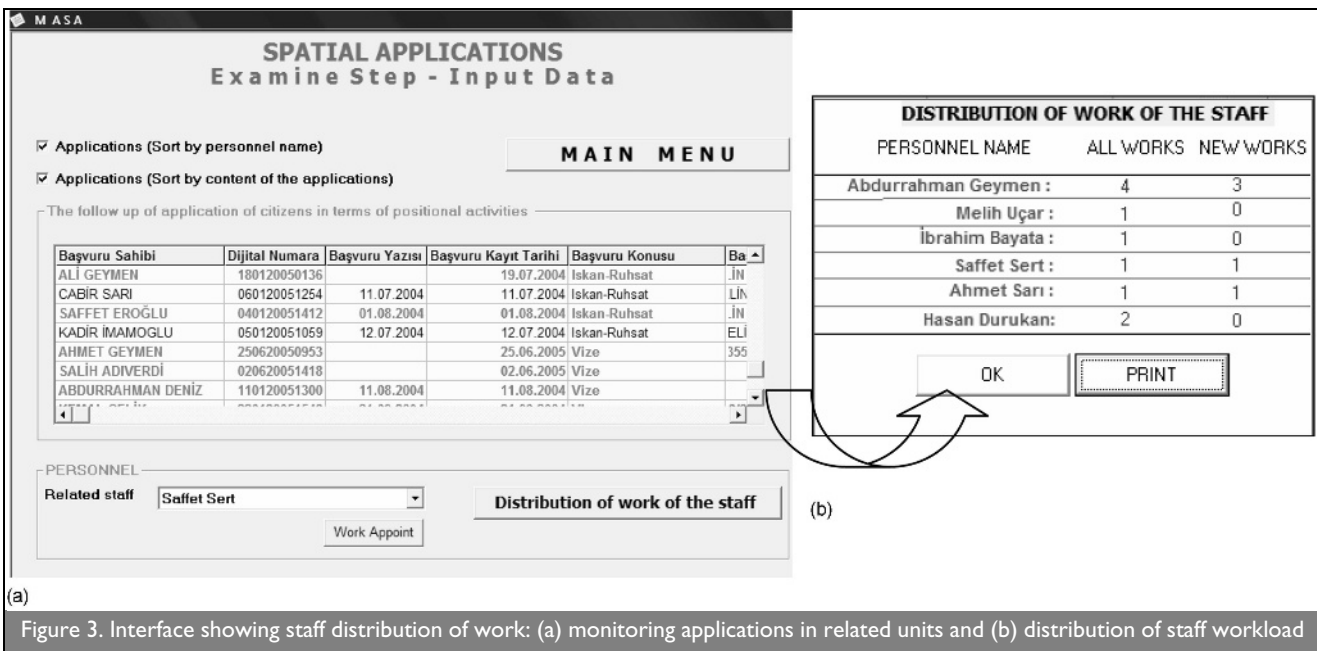Figure 2. Interface allowing citizens to apply online through internet

Figure 3. Interface showing staff distribution of work: (a) monitoring applications in related units and (b) distribution of staff workload

Preparing particular documents (e.g. elevation-section sketches, application sketches, building licence sketches, plan position and certificates) is the main task of municipality units. Institutions in crowded, rapidly growing areas, are struggling to cope with time-consuming tasks resulting from using traditional methods. These routine actions, when constant and repeated often, result in the slowing of the overall process as well as complaints from citizens and personnel (Baz and Geyman, 2006).

This software application is designed to solve these kinds of problems for preparing parcel-based information and

documents. Its aim is to produce documents rapidly. A parcel ID number is the minimum required data to retrieve a desired information (Figure 6).

The system is composed of two modules, namely the intranet and public level usage over the internet. In the intranet module, designed to operate an effective UIS, data management regarding the so-called documents is controlled by technical staff. Data transfer from other sources to the software database can be implemented automatically with the help of transfor-mation programs. Additionally, any changes made in the form,
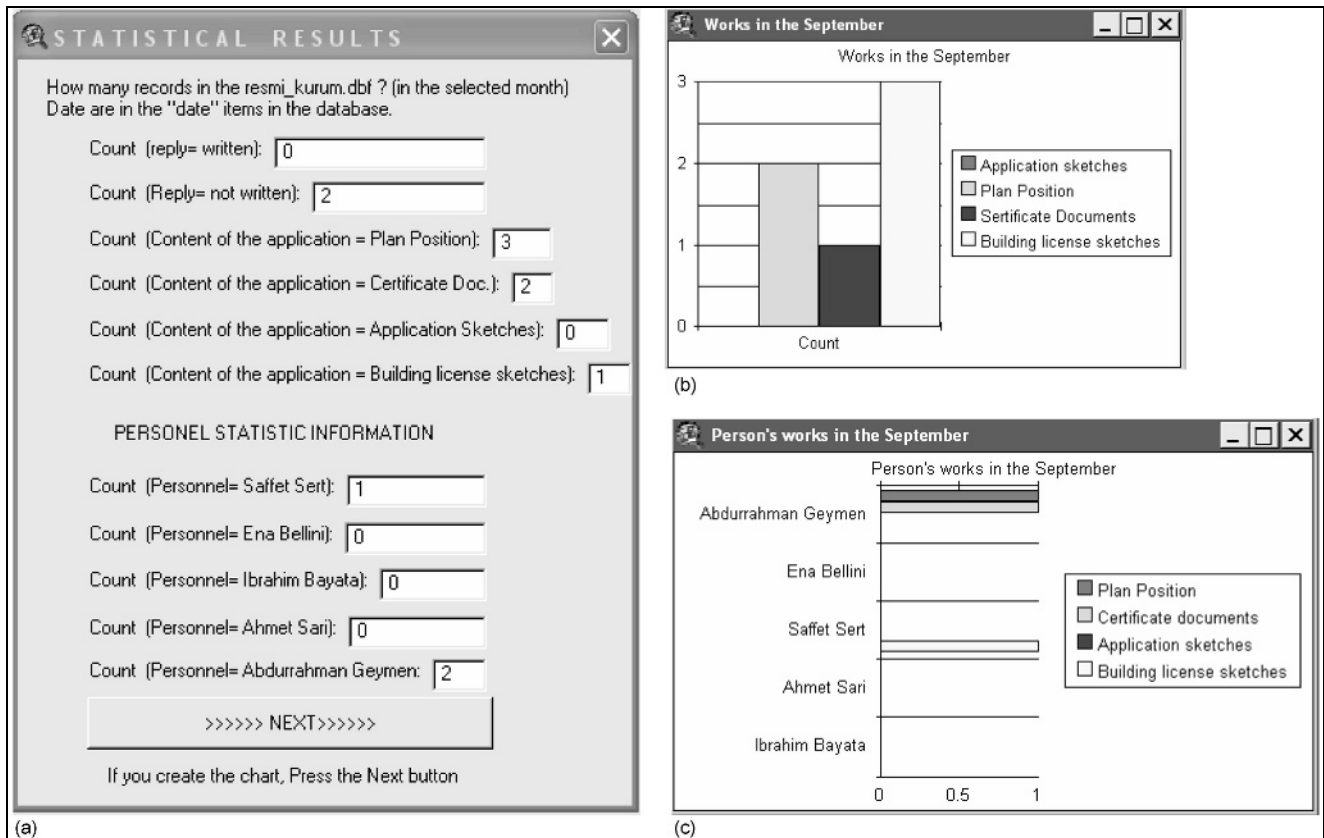
Figure 4. Monitoring of distribution of user workload in municipality units: (a) interface form monitoring statistical info; (b) statistical results according to work branches; and (c) monthly statistical results according to work branches

Figure 5. Interface of monitoring applications delivered to the staff

including attribute data, are applied automatically during the preparation of the documents. For example, when the distance of the front garden on the document on the screen is changed, the distance on the screen is immediately refreshed. In addition, when scale division is changed, the figure is redrawn in the requested scale.

3.3. Module 3: presentation and analysis of maps

By using communication between ArcView-Avenue and the languages of Internet Explorer (Asp, html) and Dialog Designer Extension (DDE), web-based designs for spatial data can be made. By saving the page that is obtained as index.html the design can be monitored. Raster data can be saved in graphics interchange format (GIF) or JPEG format and vector data and text objects can be saved in scalable vector graphic (SVG) format.

SVG format, in addition to being a graphics file format that provides the opportunity to zoom in or out or pan without losing the attributes of cartographic data in web media, is a web language based on extensible markup language (XML) (Ferraiolo, 2004). It provides the use of high-quality graphics
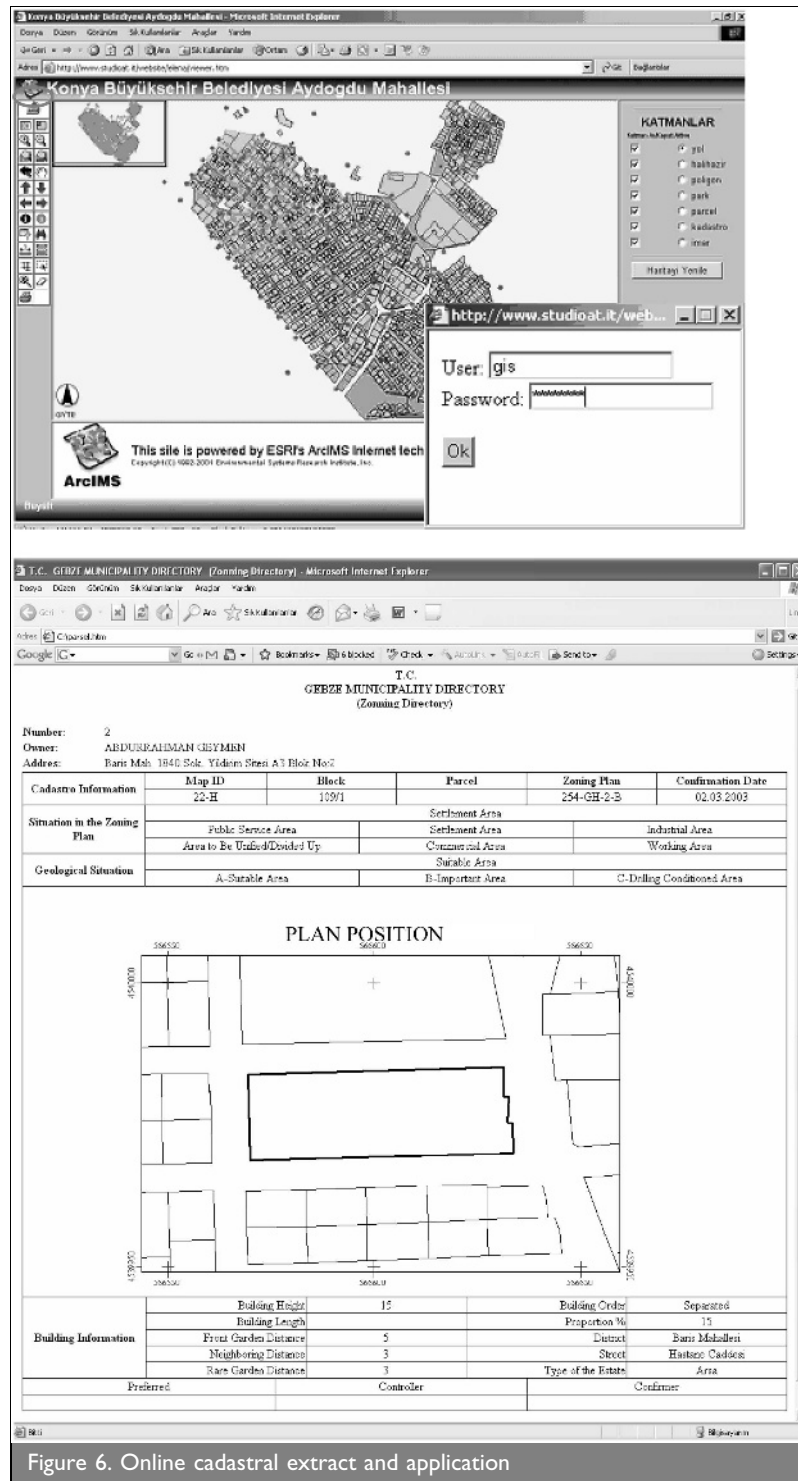
Figure 6. Online cadastral extract and application

for the users. It accesses data quickly within the browser. SVG also supports attribute data. These data are saved as an XML file within the project, and are called by different methods within the web page. By selecting the graphic object, attribute data can be monitored within the web page. SVG format can be implemented by all of the graphic and software firms operating on the web (e.g. Adobe, Autodesk, Corel, Bit-Flash, Hp, IBM, Kodak, Microsoft, Macromedia, Netscape, Open Text, Sun Microsystems and Xerox), who also support the ArcView GUI (Chris and Jackson, 2005).

Operation of web-based enquiries and the system for obtaining resultant files requires the following

(*a*) 1·5 MB disc space
(*b*) Windows 2000/NT/XP operating system
(*c*) Internet Explorer 5·0 (or higher)
(*d*) ArcView GIS 3·x and DDE that operates within this software.

By selecting the presentation tool, index files are generated. It is a work in progress, and collaboration is actively invited. The presentation script generates a main SVG file containing geographic coverage, small legend SVG files and an html file for displaying the results. The html file includes tags to reference the Adobe SVG plug-in, attribute data on features as Java script arrays and some basic Java script coding to display those attribute data. Point features are exported as

simple circles with a radius of 2 pt, no stroke and a solid fill colour equal to the foreground colour of the ArcGIS theme. Arc features are exported as unclosed SVG path objects with no fill, a solid stroke, a stroke-width of 0·5 pt and a stroke-colour equal to the foreground colour of the ArcGIS theme. Polygon features are exported as closed SVG path objects with a solid fill colour equal to the foreground colour of the ArcGIS theme. Attribute table columns chosen by the user for export are translated into Java script arrays and included in an html page. The content of the index file is obtained by selecting attributes on the forms.

The requested layers can be opened and closed on the web page depicted in Figure 7; picture, video and web pages can be accessed. By using enquiry and analysis tools, enquiries can be submitted. Information such as parcel owners, features of buildings, people living in the buildings and taxes paid by citizens to municipalities can be retrieved. In the example in Figure 7, a spatial enquiry for a parcel layer is made.

In Figure 8, attribute, hotlink and panoramic views of objects can be accessed by selecting the enquiry icon or by clicking on objects belonging to the park layer. Movable objects on the picture can be rotated 360° or zoom views can be obtained.

In Figure 9, an example of an information request regarding the present map layer is given. By using the enquiry button, attribute information of the present map layer can be accessed.

By linking present map layer information with house.dbf graphic data, information such as building attribute, residents of the building, taxes that are paid to the municipality and debts to the municipality can be accessed.

3.4. Module 4: monitoring tax debts of citizens

It is possible to query whether a citizen has a debt to the municipality or not by selecting the 'Real Estate Debt of the Concerned' button (Figure 10).

In order to finance and achieve these services, in most countries such as Turkey, important income is collected by way of real estate tax and environment cleaning tax from land owners (Yildirim and Nisanci, 2005). However, because of lack of an efficient address-based information system in Turkey, approximately 20% of real estate taxes and 18% of environment cleaning taxes are not collected by municipalities (Yildirim and Yomralioglu, 2004). For collecting such taxes and managing basic urban activities in a modern way, the existence of a network-based geospatial information system is crucial. Specifically, an address-based information system is fundamental for collecting these taxes in order to provide some valuable services to individuals. Such a system can set up a very good relationship among the basic geospatial data layers for a city and directly link these geospatial data with correspondent objects (Yildirim et al., 2000).

Real estate values which reflect property characteristics are processed on streets by a GIS network analysis concept. Finally,
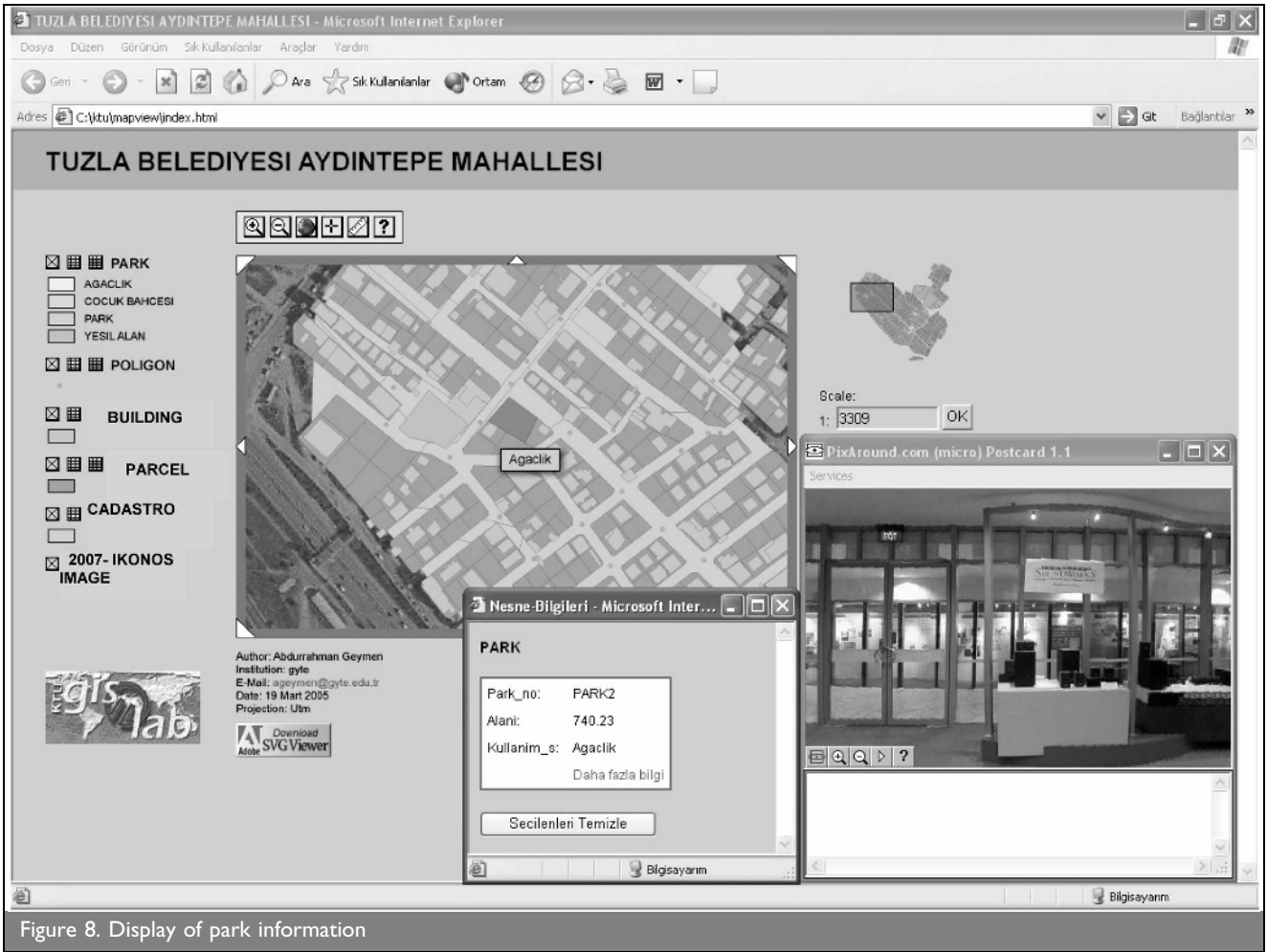

Figure 7. Main parts of web page

Figure 8. Display of park information

tax bills which are calculated automatically by this system are sent to related individual addresses to inform them. As a result, a successful property and environmental cleaning tax collection control system is provided and tax revenue is increased.

Different information systems are used in different areas. One of these areas is the address information system (AIS), in which querying and displaying of numerical processes are allowed in urban information system applications. Meeting the demands of these systems depends on the elimination of possible problems by way of project applications (Figure 11).

4. RESULTS AND FINDINGS

By forming a system approach for municipalities, user requests for information are dynamically processed. From the initial request to the final phase, the process is conducted electronically; use of UIS by staff is obligatory. With this system approach, communication between units, updating of geographical data, increase in product and operation characters, staff disposal, transparency and efficient execution are achieved without the knowledge of advanced information technology. With the study benefits regarding citizens, municipality and urban services are evaluated. The advantages that are provided by the prototype software developed for e-municipality applications are defined below.

4.1. Management advantages

As well as collecting data, it is also important that data are qualified, updated and presented in a timely manner, especially
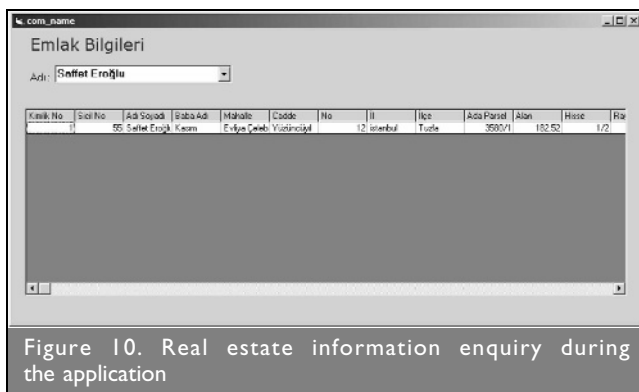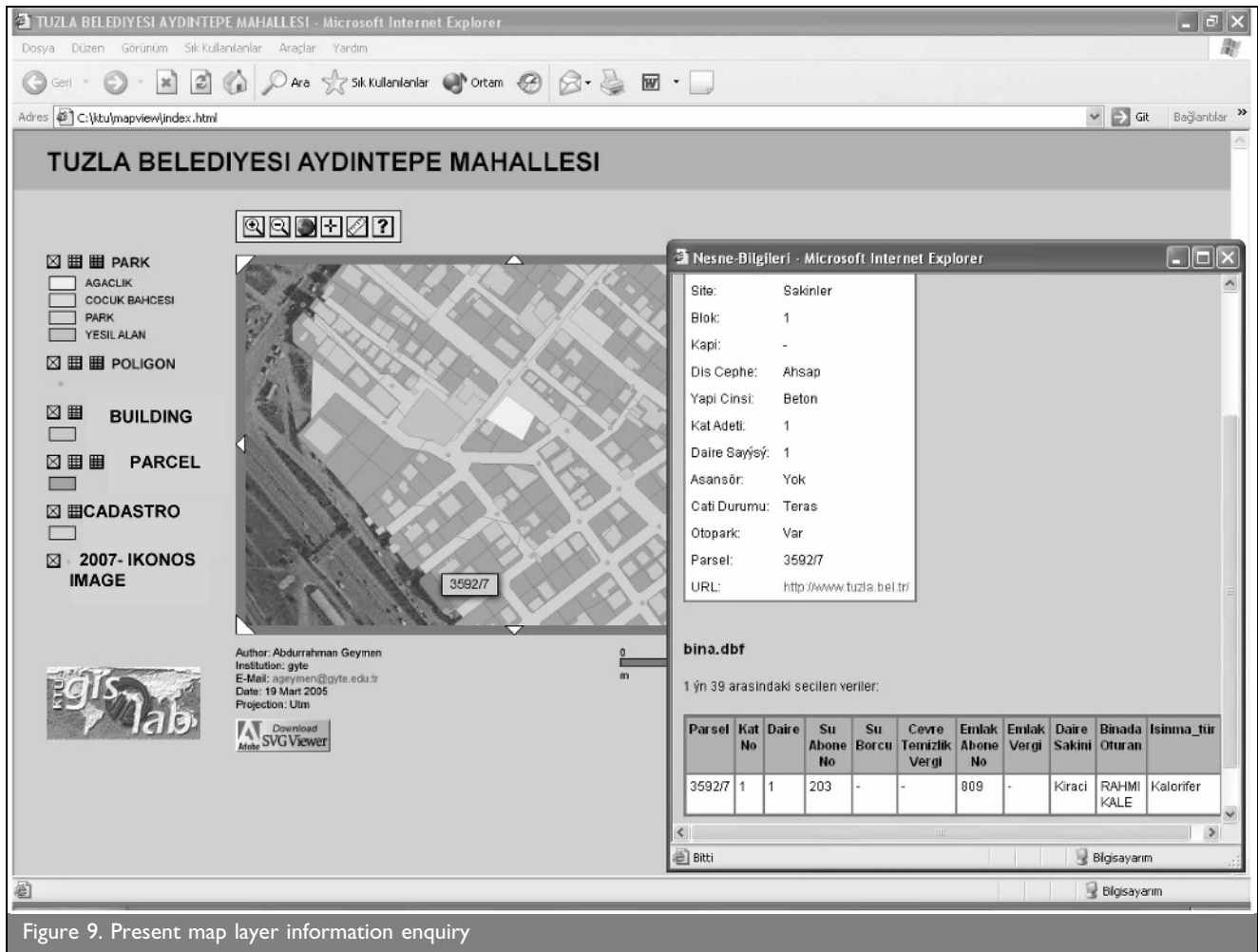
for decision makers. It will be possible for administrators in decision-making to evaluate the problems of the city as well as economic and social indicators. Projects will become easier to monitor. With the help of the system, managers will be able to follow up the work that is performed within all the units. The managers will be able to meet their requirements for information in order to make decisions and generate policies using these systems. The designed system provides managers with access to information from every department, allowing enquiries and reporting. It will also act as a medium for statistical results and evaluation. By monitoring applications that are made to the municipalities in computer media within the system, institutions operate more efficiently.

4.2. Updating spatial data

In Turkey, the use of UIS as a supporting tool for decision-making in different engineering implementations has been expanded. In order to obtain true and reliable answers to the expectations in these applications, useful data have to be updated.

The updating of the generated data cannot be completed quickly without using technology. By producing and updating data by traditional methods, it becomes hard to access information. Time spent obtaining required data can delay operations.

With this system approach, users will be able to update data in a shorter time. In case of information requests by users, the designed system is able to make alterations in electronic media. Standards are therefore formed for graphical and attribute information, which all the units adopt.

Figure 9. Present map layer information enquiry

Figure 10. Real estate information enquiry during the application

4.3. Presentation of information and economic aspect

When the activities of UIS are compared with classically performed activities, it is seen that the quality of product and operation increases. Cost and staff productivity is provided and transparency in activities is achieved.

For example, determination of a parcel's zoning status can be implemented in approximately one day using the classical method. The citizen, who would like to learn the zoning status of the parcel, first takes a cadastral extract from the concerned directorate. With this extract, an application is made to the concerned municipality by a petition. In the directorate of housing and city planning of the municipality, the plan of the parcel is determined. The plan and the cadastral parcel are

overlaid and, after examination of the plan notes and decisions, zoning status of the parcel is prepared.

However, zoning status can be determined within a couple of minutes with accurate and updated data, without requiring any effort or experience, using standard forms and with a detailed report. The software described here conducts the applicant's document to the directorate of editorship immediately upon submission. Obtaining information about the requested document by entering the parcel number is possible, paying the required charge by credit card. By using the number that is given to the citizen at the time of the application, progress can be monitored by the internet. The applicant will therefore not be required to go to the municipality, meaning efficient use of time for both the citizen and staff.

When the example given above is considered for the citizens needing zoning status, they have to go to the cadastre and land registry directorates and municipality several times. These possible situations cause citizens to waste time and become dissatisfied with the service. In these prototype interface designs for medium-scale service units of the municipality, users are able to monitor all the phases from the application to the municipality to the conclusion in electronic media. The previous applications and debts of the citizens to the municipality and whether a real estate declaration is made can be determined at an initial stage. Since unregistered tax payers can be identified, the revenues of the municipality will increase. These operations
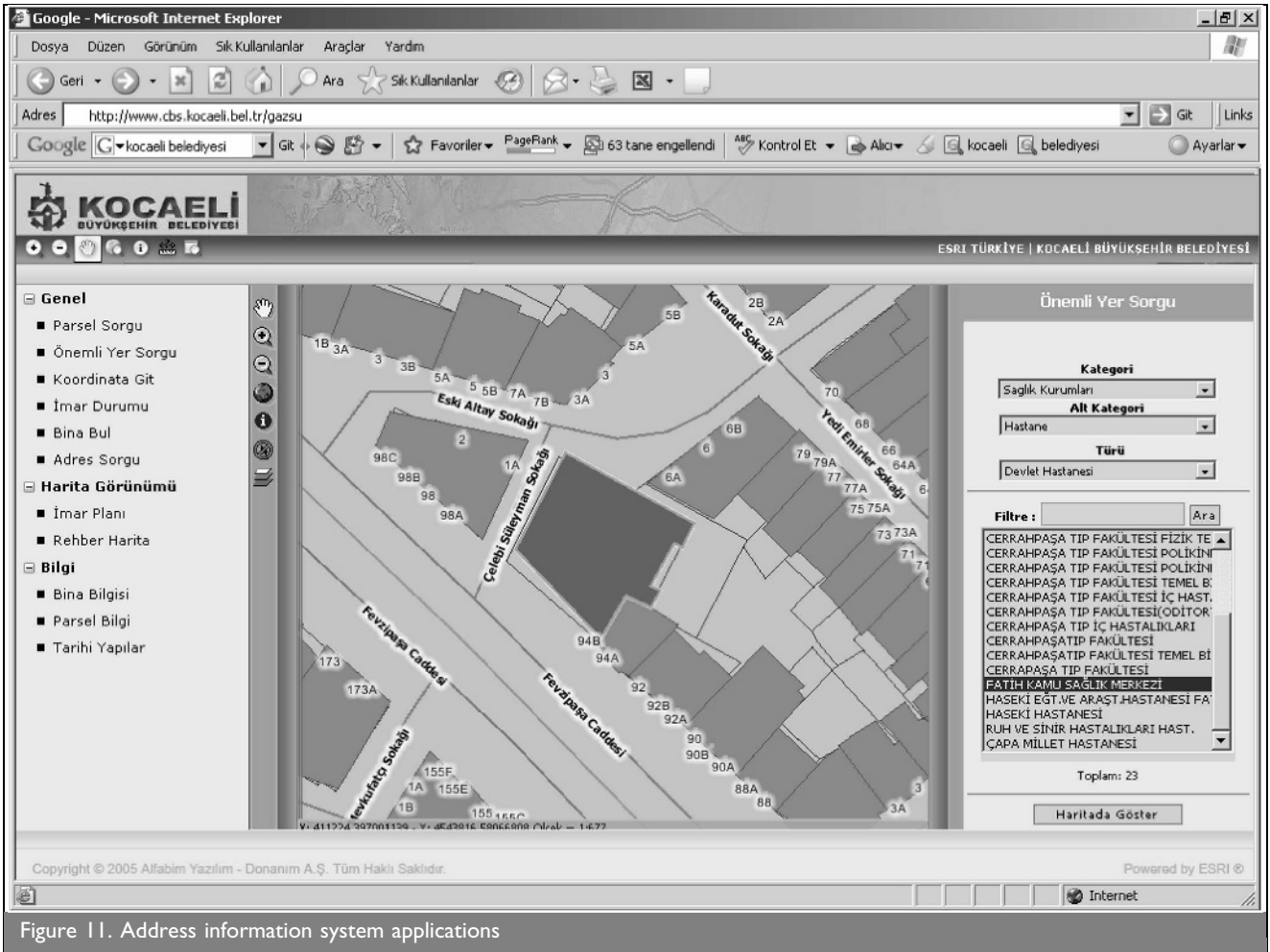
Figure 11. Address information system applications

will undoubtedly be a great opportunity for municipalities experiencing problems with revenue.

4.4. In terms of users

When the example that is given above is examined in terms of activities of the staff, there are possibilities of having duplicate copies of plans and notes, over-staffing during the operation, multiple archiving of documents (e.g. deed registries, extracts, plans and zoning status) as well as missing and out-of-date archives. Manual preparation of the related documents, different in one municipality compared with another, requires experienced staff. A deficiency in coordination for supervision and communication can cause time and effort to be lost, economic losses, a decrease in productivity, a reduction in quality of products and operations and dissatisfaction in staff.

It is known that local administrations use GIS and computer aided design (CAD) software. Nevertheless, use of and output from these programs are unregulated. This system was developed while considering that it will be available to the general public (consisting of both experienced and inexperienced users). The interfaces of the projects are designed for unqualified users; they are in Turkish and userfriendly. The use of the system will increase in proportion to the implementation of these points.

5. CONCLUSION

Local e-government is a hugely complex program that takes in almost every aspect of local government. The scale of the transformation which is envisaged, and the timescale in which it

is expected to be achieved, are both highly ambitious. Local authority staff and elected members have generally responded positively to this challenge. Existing services must be rethought and complex multi-agency change programs implemented – this is key to ensuring the objectives of the local e-government agenda are met.

Incremental adoption of e-government technologies does not indicate failure. Continued efforts to determine what citizens actually want will produce the best results.

The results of the system design and application described in this study are given below.

(*a*) Interface design enabling delivery of applications to the concerned units and staff and evaluation of resulting reports using electronic media is described. By determining work codes regarding spatial activities in the units, the phase of requested information can be determined. By implementing most of the operations in electronic media, document chaos in the institution is terminated.

(*b*) Previous applications and tax debts of people can be retrieved. An increase in revenue will be achieved, enabling accurate predictions for the future to be made.

(*c*) This prototype system is provided for users to make their applications directly through the internet. Making applications on the internet becomes an effective way of reducing the workload that is experienced in municipalities.

(d) The developed prototype software has a structure that can implement e-municipality applications. With the help of this module the users, by interrogating maps at web media, obtaining analysis and generating documents with spatial content online, can implement some operations such as the following up of the applications and monitoring the results. In all of the phases, citizens are in direct contact with the municipality. In this respect, these modules are one of the most effective methods that can be used in establishing communication between the citizens and local administrations. The most crucial advantage of these systems is that access to information is easy and clear.

(e) Increasing effectiveness and efficiency of the work of the municipal administration leads to a reduction in time needed for document processing.

(f) Improving the working conditions of the municipal administration employees is achievable by reducing the time and efforts needed for information processing.

(g) Citizen participation in all levels of local government life is increased.

(h) New information technology-based jobs, relating to the municipal administration processes, can be created.

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