

Assessment of GIS Applications Usage in Urban Planning in Riyadh Region

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ABSTRACT

Received 24.1.2012

Revised 21.3.2012

Accepted 26.3.2012

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KEYWORDS

Urban planning, Geographic Information System, data, municipalities.

In light of rapid urban developments in the cities of Saudi Arabia, the municipalities of the Kingdom strives to take advantage of the rapid advances in information technology, particularly geographic information systems, in planning and development and providing spatial integrated databases to improve the performance of daily activities. Thus, this study aims to measure and assess the use of geographic information systems and their applications in the government agencies concerned with urban planning in Riyadh region, and to identify the most important elements and obstacles they face in the urban planning. The problem of the study focuses on identifying the effectiveness of the use of GIS applications in urban planning in government agencies that have introduced these technologies within their system of work in Riyadh, which represent (8.4%) of all government agencies in the region, because some municipal agencies do not adopt modern technologies in urban planning and for lack of information on the ways and methods of using these applications. The study depends on the use of the descriptive survey approach, achieved by questioning the members of the research community, through identifying the current situation of the use of these systems in urban planning agencies, conducting interviews with officials and users of the system and determining the importance and feasibility of providing integrated geographic information systems to increase the efficiency of planning and development in the region. The study concludes a number of elements, which can contribute to the success of the available systems, and identifies some of the obstacles that limit their use and continuity and the problems faced by users. The study recommends to develop the geographic information systems, qualify the existing staff and to activate online sharing of urban data and information and communication between different planning and development agencies.

Introduction

The cities of the Kingdom of Saudi Arabia are witnessing urban and population developments, associated with IT advancement comparable to the technological development in the world, in terms of using high technology, especially information and communication systems. The Geographic Information Systems are modern information systems currently used in most areas of urban planning that link the geographic locations for the service of several areas and different purposes, through linking the maps to data and information bases, making it easier for professionals and researchers in development and urban studies to benefit from their use online in an organized way, and to use them in the development of appropriate solutions to organize the planning process and to keep pace with the rapid changes associated with such urban development. In light of rapid urban developments in the cities of Saudi Arabia, the municipalities of the Kingdom strives to take advantage of the rapid advances in information technology, particularly geographic information systems, in planning and development and providing spatial integrated databases to improve the performance of daily activities, support decision taking in various planning processes (Abdul Jawad, 2006, Abdel-Aal, 2009), speed up completion of some planning tasks of urban space at all levels and provide quick and accurate practical

answers to help decision-makers and planners analyze the phenomena of increasing urban expansion in order to deal with it. Accordingly, it becomes clear that GIS is important and useful in planning and development and that the government agencies are required to provide integrated databases related to their spatial positions, which can be achieved by GIS to reach the desired urban pattern and to contribute to the service of the society, at several practical and applied levels, as the global use of geographic information systems in the management of urban development in general and to facilitate the duties of urban planning agencies in urban cities in particular, is not new (Yousef, 2007). The role of accurate geographical information in the planning process is necessary, as including the implementation of planning decisions on the long run. It also directly affects the function and quality of life in urban environments, where geographic information systems contribute to the building of integrated strategies for databases and to adopting the latest methods and techniques in conducting urban planning. It is no longer possible to think of any urban, social or economic development without taking into account the issues related to information systems and resources (Ali, 2005).

The use of GIS technology at the global level is not new in the management of urban development in general, and in the facilitation of enhancing the performance of local

administrations in particular. This technology has been used in many developed and developing countries, in addition to being a distinct tool that can be used in a variety of urban planning assignments. This study comes to confirm the importance of using such technology and to measure and assess the extent to which the government agencies concerned with urban planning benefit from using GIS applications, taking Riyadh region as a model in the light of the data and resources available and the benefits made from these applications within this area.

Problem Statement

The problem of the study is to know how effective is the use of GIS applications in urban planning at government agencies, which adopted them in their activities in Riyadh; to identify whether they are available as well as the quality of the available spatial and descriptive databases; to assess the services provided by these applications and their effectiveness; and to know the methods and processes used by the said government agencies to do their daily work using this technology. Given the important role that can be played by GIS applications in urban planning, and lack of information on the methods of using these applications by government agencies concerned with planning, it has become needful to study this case and identify its impact on the daily activities of these service agencies and make the necessary recommendations to them to ensure their success.

Importance of the Study

GIS technology has given the urban planning another dimension, which provides technical information and maps that can be easily updated on a periodical basis. It contributes to the clarification of the overall vision of the city, identifies the distribution of all types of services, land uses and helps study changes. It also assists professionals to develop the best plans for the city and specify the urban areas that meet future requirements, because of their capabilities and functions that can be used in the management of city urbanization.

Because of the rapid developments witnessed by all cities and regions of the Kingdom, most of the government departments and agencies started to use these technologies at

local, regional and national levels. The rising prevalence of this technology has created a need to learn how government agencies concerned with urban planning can apply and benefit from this technology and to link it GIS capabilities in urban planning as well as from the existing applications, which will directly contribute to the improvement of the efficiency and effectiveness of the planning processes and will be the basis for the development of implementation of the activities of such departments in non-traditional methods and the achievement of State policies designed to implement e-government in all its transactions.

The study aims to measure the benefits of using GIS as a modern technology improving the efficiency of the activities carried on by the government agencies concerned with planning process in Riyadh. To achieve the main purpose of using the systems and to identify the roles played by the agencies concerned with planning of cities in Riyadh, it was necessary to identify the extent to which GIS technology is used in urban planning and its importance in the decision making process for government agencies in charge of planning. It was essential also to identify the main obstacles that may prevent making the best use of this technology and its applications in the daily activities of urban planning.

Materials and Methods

This study is based on the descriptive survey approach, which is normally adopted in this kind of studies. This approach involves questioning all members of the research community or a large sample of them (Al-Assaf, 2002) to measure trends among those whom were covered by the study, including the supervisors of GIS departments in government agencies, who oversee the preparation of urban planning applications (4 supervisors) and the users of such GIS applications (10 users) and to identify their characteristics; and to identify the technical staff and available databases and applications used in urban planning. Data used were collected through interviews and answering the questionnaire by the concerned staff, documenting the remarks. Then, this data was analyzed, classified, interpreted and measured to draw the conclusions that would contribute to determining the appropriate means of the development and improvement of the real situation.

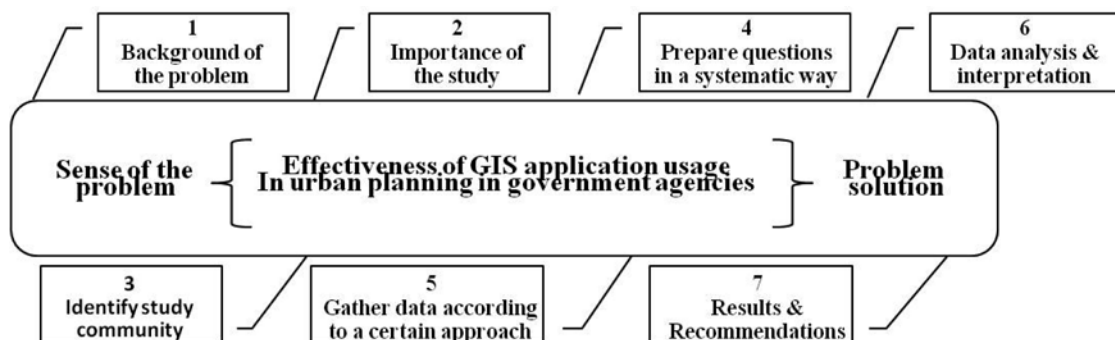


Figure (1) Methodology

Limitation of the Study

The study was limited only to government agencies that manage urban planning and development in Riyadh region, without addressing any other governmental and private institutions which complement the governmental agencies that are formally responsible for planning of cities. It was taken into account that the GIS department or unit and GIS application users in urban planning department, whatever its name might be, in each government body, shall be considered official representatives of the government apparatus. Thus, not all government agencies, which have departments of planning, were involved. Identifying the government agencies that manage cities urbanization in Riyadh, represented in "High Commission for the Development of Riyadh and Municipal Agencies," it was found that forty-four (44) government apparatuses i.e. 61.9% of the total number of government agencies do not have departments or units for geographic information systems. After exclusion of these departments, the total number of research community bodies appropriate for the study became four (4) government agencies. Therefore, the limitations of the study were as follows:

- **Spatial and temporal limitation:** "High Commission for the Development of the City of Riyadh", "Riyadh Municipality", "Municipality of Governorate of Al-Kharj", and "Municipality of Governorate of Dir'iyah" were identified as governmental bodies that will conduct the study in the first half of 2011.
- **Human Limitations:** The study was limited to the views of managers, supervisors and users due to the fact that this category of staff is best able to give a comprehensive and accurate picture of the relevant department uses of these systems. Each department appointed one supervisor or director in the GIS Department in addition to the staff benefiting from GIS applications produced in urban planning departments.

GIS in Urban Planning

The basic concept of GIS is to find proper solutions and reach sound decisions based on the processing and analyzing various kinds of data and information, after linking them to their geographical locations. This system is distinct from other information systems by the virtue of its strong capability to analyze information linked to its correct geographical locations, the spatial relationships between the information, its capabilities of analyzing information and data, its integration with other systems to link information directly to their locations on the cadastral, geographical or planning maps, easy modification and update, and its ability to convert the data into spatial images in the form of maps (Al-Zeidi, 2007). The importance of this GIS has emerged as an advanced method for dealing with data in all scientific fields in general and in geographic studies in particular (Salma, 2000).

Geographic information systems are currently used on computer systems to prepare perceptions of geographical

data (Bernhardsen, 1999). The benefits of using GIS may differ from those of using other systems, depending on the quality of the applications used and the nature of geographic information stored in the databases. The benefits of GIS are achieved through the features of those systems and software, which enable them to provide advanced methods for building databases and analyzing inputs and then the production of the outputs that meet the requirements. It has become an effective and important element, particularly in the administrative entity of the government institutions, because of their importance in the development of work and raising the efficiency of the planning process and its use in decision-taking process support, as Warnecke et al. (1998) indicated the need to adopt and use the technology of geographic information systems being more sophisticated and due to their ability to integrate new tools and techniques of the systems assisting in spatial decision-making. GIS also contributes to the rapid completion of some tasks of urban space planning at all levels, and provides quick, specific, practical, accurate and analytical answers of the phenomena of increasing regional urbanization. It also can determine, plan and prepare the urban extensions for decision-makers and planners, in order to address this growth, allowing daily access to movement of change that occurs to many equations and indicators affecting this growth and monitor, record and specify their locations, influences, dynamics and areas of congestion. Then, it will be easy to take the proper action.

Some studies have tried to identify the government and private users of geographic information systems in the Kingdom of Saudi Arabia. It was noted that there are some obstacles and difficulties faced by users, such as data inaccuracy, low quality of software, difficult exchange of information, the need to develop these systems and unify data and operating programs and the standards, qualify the GIS specialists, technicians and operators by developing standards and specifications to take advantage of the systems available and to study their economic feasibility because of the rapid developments witnessed by the systems locally and internationally (Kabbara, 2002). In the meantime, Barhaman et al. (2010) indicated the establishment of a geographic information base for regional planning for Mecca region, and creating a base map and its applications in the environment of geographic information systems and to the benefits which offered the use of GIS technology in studies on regional planning and to the importance of the shift from the personal geographical information systems to the institutional geographic information systems, to make a quantum leap in the implementation of development at the regional level and to support the spatial, planning, executive decisions taking and help to easy and speedy information exchange.

The study recommended relying on institutional GIS in development planning projects, paying more attention to the rehabilitation of staff and establishment of a central institutionalized geographic database, and developing mechanisms and responsibilities for updating the system in order to prevent duplication of efforts. It was also indicated by Bolatto et al. (2000) to the experience of the municipality of city of Turin, Italy, which established an Internet-based

urban information system for the city, to ensure flexibility in management performance and integration of services provided, facilitate access of a large number of citizens and professionals to spatial information about the city and enable them to find all laws and regulations of urban planning, urban regulations and maps within or outside the municipality, meet the requirements and facilitate functions of urban planning, provide automated integration between automated systems for the participation of many different parties in the completion of the works at the same time. GIS can be used as a tool to improve the efficiency and performance of activities and enhance the management planning process through training human resources and improving their performance skills. This is based on the existence of a comprehensive strategy to support and improve the management integration through the implementation of development programs and GIS applications for the preservation of resources of the institution and the training of human resources (Abdul Hameed, 2001). The database is a prerequisite for the work of departments of geographic information systems for the components it contains, representing spatial phenomena and landmarks in their real engineering geographical form. It shall be the starting point to activate the system operation after providing it with the required hardware, software, applications and human resources (Al-Garni, 2007).

The GIS can provide alternatives and presentation capabilities for many options and solutions in the spatial environment, which can view the advantages and disadvantages of each, in a highly effective visible way, from which comparison or weighting and preference can be carried out, to choose from several alternatives of urban geographical phenomenon movement. Comparing the previous situation before the use of GIS, it was difficult to view these maps, superimposed on each other, due to lack of high accuracy in manual drawing, which causes mismatching of maps or the lines with each other. In general, the GIS technology can achieve sound and integrated urban planning system, where the importance of its use has become clear as a tool in the departments' work according to their responsibilities. This technology can be used in many daily activities, including meeting major requirements of urban planning process of individuals, organizations, institutions and agencies; facilitating the requirements and tasks of urban planning, providing automated integration between automated systems, in which many different parties take part in the completion of a task at one time, and providing detailed and up to date digital information to make sound decisions.

Data Collection and Analysis

The study adopted interviews and survey techniques to achieve its objectives, which are the most appropriate method for data collection. A standard form was used for interviews, which was completed during the interviews conducted with supervisors of geographic information system departments. The form was divided into eight sections as follows:

The first section deals with the characteristics of the demographic sample of the managers of these departments

(the department name, job title, years of experience, qualification, specialization).

The second section included information on the department in which they work (reporting in the organizational structure, department objectives, sections / units of the department, the related functions).

The third section addresses the financial resources available to the department (separate budget, provision for maintenance, provision for design and development of applications, sustained advance payment from agency, other resources, level of the agency support for the department compared to other development projects).

The fourth section is about all available databases (consolidated database, sources of information, templates for data inventory and entry, quality of the works used).

The fifth section is concerned with the identification of equipment and personnel available (number of personnel working in the department, quality of hardware and software, staff working-level and training).

The sixth section is about the measurements and criteria used for the department (database design specifications, data dictionary, measurement standards, the coordinate system used).

The seventh section is about exchange of information with other users of the system (level of exchange of information with other bodies, method of exchanging information, the desire of other "government / private" institutions to share information, the quality of information exchange with other departments in the apparatus, website for publishing the information).

The eighth section deals with the benefits of using GIS applications in urban planning (quality of existing applications, involvement of the concerned department or users in designing the application, types of output, level of applications use, apparatuses dependence on the outputs of applications). In addition, a close-ended questionnaire was designed for the users of applications at departments of urban planning. It comprised questions illustrating the characteristics of the selected sample (demographic characteristics, capacity of staff using the applications, characteristics of hardware and software, quality of available applications, making use of the existing applications in the daily work, the most important problems and obstacles that limit the effective use of these applications). This study adopted statistical methods for analyzing several variables to get the results. Furthermore, a number of other statistical descriptive methods, such as statistical tables and percentages, were used to measure the relationship between variables.

Results and Analysis

This section reviews the findings of collected data and information, classify and integrate them, and express them to reach conclusions and recommendations.

First: Geographic Information System Departments

This part contains data on the results of interviews conducted with supervisors of geographic information system departments in Riyadh, with a view to reaching accurate answers to the questions, through the following themes:

First theme: Characteristics and qualities of individuals

The interviews showed that the job title of the officials of departments of geographic information systems in such government agencies (High Commission for the Development of the City of Riyadh, Riyadh Municipality, Municipality of Governorate of Al-Kharj, and Municipality of Governorate of Dir'iyah), vary, where the title "manager or head of geographic information systems" represents 50%, while the other percentage of them carry out other duties, in addition to the management of the system. For service in the current job, it was found through interviews that the average number of years of service in the job was (9.5) years. With regard to academic qualifications and scientific specialization of supervisors, the interviews indicated that three (3) members of the research community hold a bachelor's degree, majoring urban planning; and one (1) supervisor majoring computer science, and another one holding a diploma in computers.

Second Theme: Characteristics of Departments

This section shows the characteristics of geographic information system departments, where it became clear that the number of departments directly reporting to the President or Vice-President of the apparatus is two. This gives a good indication that these departments are convinced of the existence and support of geographic information system, and two other departments are linked to the management of urban planning. Only two departments of the "research community" have other sections or units connected to them, supporting the available system; three (3) units identical in names; "data, applications, technical support", and three additional departments in the other apparatus, "production of maps, auditing and quality training." It turned out also that a number of technical departments in each apparatus associated with these departments, which indicates that the geographical system supports the other departments of the apparatus.

Third Theme: Available Financial Resources

Financial resources are one of the most important reasons for the success of any geographic information system in order to keep pace with the requirements of developing this technology and its multiple related applications, hardware, software and data as well as training and qualifying human labour, which is reflected directly on its effectiveness. The interviews indicated that a separate budget had been allocated

for each department, of which a provision is made for the maintenance of systems and applications and their design and update, except for one system, the establishment of which was completed; but no other budgets were allocated to support its continuation. It was shown also that there were other financial resources available for only one department other than the allocated annual budget. These resources are represented in the revenues of selling some of the maps produced by the apparatus, which cannot be used to support the department, according to the regulations applicable in the Saudi governmental bodies. The supervisors of these departments said that the support of GIS projects over the past five years was high compared to other development projects except for only one apparatus. As for the apparatus' support of these departments, it was transpired that their support was like the other development projects of the apparatus.

Fourth Theme: Description and uses of databases

Interviews with the supervisors of these departments revealed that GIS databases are standardized in each department and that each apparatus provides standard forms for data collection, entry and update to all departments. According to the interviews, there were many sources of information for the database of these apparatuses: 57% from the apparatus projects, 29% from other government agencies, and 14% from the private sector. The departments covered by the study relied on maps and satellite imagery obtained from the Ministry of Municipal and Rural Affairs by 57% and from King Abdulaziz City for Science and Technology by 43%. As for the available data, it was found that 50% of the department had up-to-date data, and that only one apparatus updates this data on an annual basis. As for the use of the available data, it was found that all maps and planning studies are produced using geographic information systems and their applications, and 75% of the reports produced and queries performed are made through the processes used, and 50% for planning, analysis and data archiving processes, and 25% for operations management of cities covered by the study. In view of these results, it is clear that all databases available with each apparatus are unified, they are fairly based on each apparatus projects, the sources of maps and areal imagery are limited to only two sources, and that the up-to-date data is moderately available, and maps production is the most important output of these departments.

Table 1. below shows GIS systems and applications are used for the production of maps and planning studies, and that they are used in 75% of the processes used for the production of reports queries, 50% of planning, data analysis and archiving processes, and in 25% of processes of the management of cities covered by the study, out of the total processes used on these systems.

Processes Used	Frequency	%
Production of maps	4	100
Planning	2	50
Analysis	2	50
Planning studies	4	100
Query	3	75
Management	1	25
Reports production	3	75
Archiving	2	50

Table 1. GIS systems and applications are used for the production of maps and planning studies

Fifth Theme: Hardware and Human Resources

This section identifies the types of systems, without addressing their specifications, available in these departments, as well as the qualities of human resources working there. To determine the types of hardware and the number of human resources in these departments, we classified the research community into three categories (large, medium-sized, and small) according to the number of staff and the availability of hardware (Al-Humeli, 2005). Table 2. shows that there are one large GIS department, one small GIS department and two medium sized GIS departments.

Table 2. Classification of geographic information systems departments by size, according to number of existing staff and equipment.

Department size	Description	%
Large	No. of staff is more than 10 No. of central servers is more than (3) Work stations is 10 or above. No. of PCs is more than 5	25
Medium sized	Where the maximum of the description of the large department and the minimum of the small department are achieved.	50
Small	No. of staff is less than 5 No. of central servers is 2 or less No. of work stations is 3 or less. No. of PCs is less than 3	25

It was shown that 50% of the personnel working in these apparatuses develop applications according to business needs, while the other hire specialized companies to do so.

According the supervisors of departments, less than 25% of employees have the knowledge to handle the full functionality of these applications properly, 25% can deal with them well, and 50% have a medium knowledge to handle them.

It was also turned out that 75% of the research community suffer from lack of qualified national staff to work in these departments and lack of vacancies for the recruitment of educationally competent and experienced staff; they face the problem of migration of staff to other sectors; and 75% of the existing job titles are not compatible with the nature of work and experience of those who work in the field of geographic information systems. In terms of staff training and development, it was indicated that all departments of the research community train and develop personnel working with them, and that 75% of these departments provide training courses for their staff through joint sessions with other government agencies within and outside the apparatus.

These results show that the GIS department exists in appropriate size in one apparatus only. In order to work efficiently, these systems need modern facilities for meeting the needs and requirements of all departments and sections. It was also shown that these departments depend fairly on their own staff in the preparation and development of applications, and that there is a lack of highly qualified personnel to use these applications in addition the rare presence of staff with specialized academic qualifications, due to the lack of vacancies with job titles appropriate to them, let alone the problem of staff migration, which constitutes the major challenges faced by these departments.

Sixth Theme: Quality of measurements and the criteria adopted

Measurements and standards used for geographic information systems in the developed countries are subject to a set of standardized digital or descriptive laws and regulations to avoid shortage and duplication of work and to save efforts and money during their implementation by the community of users. Through interviews with the supervisors of the GIS departments, the research community, it was revealed that all departments have standards and specifications that had been established according to their needs before setting up the databases used in urban planning activities. It was shown also that two departments adopt data dictionary and measurement standards approved by the Ministry of Municipal and Rural Affairs, two other departments adopt special description of their data and their own measurement standards and that all departments of the research community depend on the Saudi Arabian Geodetic Reference (Ain el Abd).

Seventh Theme: Level of information exchange

This section explains the level and quality of information sharing among government agencies and between government agencies and other governmental or private bodies. All the departments of the research community indicated that there are actual benefits from information exchange with

other agencies and 75% of the departments said that they had exchanged information with government agencies. According to the interviews, 25% of the research community periodically exchange information with government agencies, private institutions or individuals benefiting from this data and the terms of information sharing is different, where it was found out that 50% of government agencies of the research community provide the beneficiaries with data and information for free, only 25% receive data, and 25% provide information for certain fees. As for the desire of other parties to share information with the “research community” government agencies, it was found that 50% of government departments have constant contact and excellent desire to exchange information, 25% share information well if so requested, and 25% do not have the desire to do so. With regard to private sector, it was indicated that 25% of the research community have the desire to share information and 50% do not have the desire. The reason for this level of information sharing, as indicated, was the organizational affiliation to the apparatus. In addition, 25% of the research community said that they have the desire to share information under formal contracts and agreements with the other parties while 25% stated that they share information according to the applicable policy for providing data to the beneficiaries.

It was revealed also that all government agencies of the research community believe that data sharing with other entities or individuals does not underestimate the importance of the apparatus. As for exchange of information within the apparatus, it was shown that 50% of the research community support the departments of urban planning with applications to accomplish their daily activities through a local network, and 50% of the apparatuses that have applications for urban planning support other external bodies or branches as required. In addition, 75% of the research community indicated that there are no websites containing applications for urban planning to serve external beneficiaries. Supervisors estimated that 52% of the total staff of departments covered by the study benefit from the services provided by GIS departments.

Eighth Theme: Usage of GIS applications in Urban Planning Department

Urban planning applications support and facilitate the decision-making process as it is considered a good means for providing integrated vision of the completion of the work of these departments. Through the interviews conducted, it was indicated that 75% of urban planning departments were involved in order to identify their needs before launching the system development projects. As for urban planning applications available to these departments, it was shown that 75% of them are developed on a continuous basis according to business needs and that heads of departments and employees are involved prior to their preparation. It was revealed also that these applications are available only in two apparatuses, (i.e. 50%) of these apparatuses. However, their outputs are not utilized, as only one system was approved for official use, which is currently being developed. It was transpired from the

interviews that the outputs of the urban planning applications were as follows: 50% maps for urban plans, 25% for revision of these plans; 50% for daily transactions and 25% for other purposes (building permits, spatial resolutions, technical reports, emergency communications, lighting systems). As for obliging all staff to use these applications in everyday business and to rely on their outputs in the course of the daily activities, it was found that only 25% of departments of the research community are obliged to do so. It was also found that 75% of the total outputs of GIS applications are adopted in various urban planning activities.

Second: Users of GIS Applications in Urban Planning Departments

This section reviews the results and analysis of data obtained through the “questionnaire form” completed by the relevant officers in the urban planning departments, which use these applications, who constitute 25% of the research community¹.

The form was divided into six main sections.

I. Demographic characteristics

Questionnaire results showed that “planning engineer” job title accounts for 70% of the titles of all staff using urban planning applications; “GIS operator” accounts for 20%; and “GIS expert” represent 10%. It was also shown that 70% hold the bachelor degrees, of which 71% majoring in urban planning and 29% in geography; 10% hold a PhD degree in remote sensing; 10% hold masters’ degree in geographic information systems, and 10% hold diploma in electronics. Given the results of the respondents, it is clear that there is correspondence between the activities of high percentage of those who use the application and their educational qualifications.

II. Competency of staff using GIS applications

The results of the questionnaire show that 80% of those who use urban planning applications have attended GIS training courses, whether inside or outside the apparatus, and that all of them have the technical capability to use GIS software; and that 60% of GIS application users have the technical ability to update applications in line with business requirements. Based on the answers of the respondents, it was found that the department supervisors give training special attention to improve staff performance and competency, which has been reflected in the improvement of their professional capacities to deal with these applications.

III. Quality of GIS applications available

Urban planning applications are used in the development of strategies, plans, operational programs, monitoring and evaluation and they constitute an integral part of GIS department in performing its duties and responsibilities. Table 3. shows urban planning applications available to urban planning departments and their uses.

Table 3. Urban planning applications

Application	No.	Usage
Urban planning	5	Monitor city urban growth and produce all kinds of plans
Strategic studies	3	Develop city future urban growth and its trends in all areas of development
Transport	6	To conduct the necessary analysis to study the road network of current and future network construction
Environmental planning	1	Identify environmentally sensitive areas, including soil types and valleys and coral and knowledge of environmental risks
Public utilities	4	Study tracks the main lines and the capacity and base stations, coverage of civilian facilities such as electricity, water, sewerage and storm water drainage current and future

IV. Use of applications available in daily activities

The respondents indicated urban planning applications are virtually needed in daily activities, making it clear that these applications are used in their daily work as follows: 40% of these applications are used in their daily activities permanently, 10% often, 50% sometimes and 10% never. Regarding the benefit and effectiveness of using the applications in increasing the performance of the urban planning department, 90% of the users of these applications said that the department became more effective in terms of decision making support, either permanently or in most cases, and 80% of users agreed that the applications currently available meet all the requirements of the jobs assigned to them. In addition, 70% of the users stated that the current applications are produced based on business requirements. It was also found that 80% of users have the authority to use and update all data available in master database.

V. Major advantages and obstacles of benefitting from urban planning applications

This section reviews the main advantages of urban planning applications the subject matter of this research and the major obstacles faced by their users. The results of the questionnaire show that 70% of users do not face difficulty in dealing with the applications available, while 30% said that they face some obstacles that prevent the use of all their capabilities. The results also indicate that 90% of users are consulted by the department before implementing the applications to determine the requirements and needs. According the results, 70% of users said that the department notify them on a continuous basis of any update of the master database. Regarding the major challenges and obstacles of urban planning applications, Figure (2) shows that 8% of the application users do not face any obstacles, and 7% suffer from lack of maps. In addition, 26% of the users said that data available is not up to date, and 22% said that data available is not complete, and 11% said that data is inaccurate. It was tuned out also that 15% of users need training and 4% have problems in dealing with computer technology.

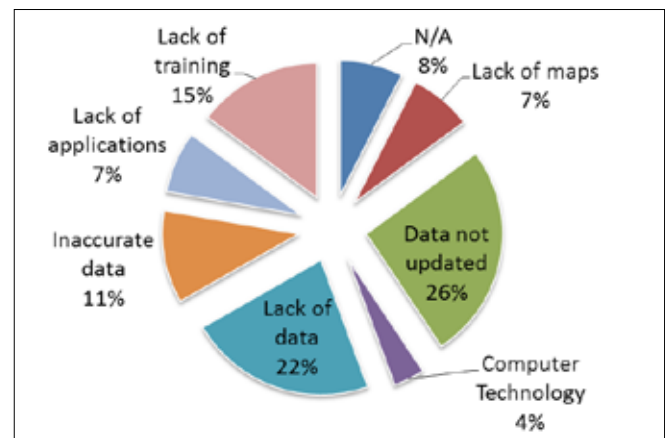


Figure (2) Major challenges and obstacles of urban planning applications.

Summary of Findings and Recommendations

Through this study, we can conclude the most important findings on the sue of GIS applications in urban planning, to what extent they are benefitted from , governmental sectors potential for them, and the major obstacles facing their users, as follows:

- **Administrative Elements**
 - Senior management in government agencies are convinced of the importance of providing and using geographic information systems.
 - A number of technical departments in the apparatus are linked to GIS departments.
 - Senior managements support GIS projects compared to other development projects.
 - Training and development programs for staff inside and outside of the apparatus are supported.
 - Supervisors of departments realize the importance of the participation of the concerned parties in developing the GIS applications and developing them as per their needs.
- **Financial Elements**
 - Government agencies that support these departments with independent annual budgets are increasing.
 - There are independent annual budgets that can support the continuity of the system.

• **Technical Elements**

- Supervisors of GIS departments have good experience in the field and the employees working in these departments have fair capabilities to develop urban planning applications.
- There are government approved sources for maps and satellite imagery.
- Government agencies increasingly depend on GIS applications in the production of maps and in conducting planning studies.
- All databases of each apparatus are integrated and are based on its project with regard to providing data and information.
- All GIS departments rely on the geodetic reference.
- The availability of these urban planning applications in these apparatuses varies.

Obstacles faced by GIS Departments

• **Administrative Obstacles**

- 50% of supervisors of GIS departments carry out other duties in addition to working on the system and its applications due to their association with other departments.
- Lack of other sections or units that support the system, where 50% of these departments do not have this support.
- Lack of sufficient qualified national cadres to work in these departments.
- Loss of qualified staff. Lack of vacancies for the appointment of other staff having the required educational qualification and experience. Job titles are not compatible with the nature of the work and expertise of employees.

• **Financial Obstacles**

- Lack of financial resources outside the annual budget, as this technology is constantly renewed and some applications or apparatus may need update in different times of the year.
- Some resources generated by some departments, such as the revenues of the sale of maps and data, are not benefited from.

• **Technical Obstacles**

- The recent data is fairly available, and its periodical update process is weak.
- The GIS departments are medium sized in terms of number of apparatuses and operating staff.
- Lack of qualified personnel to deal with the full functionality of GIS applications.
- Lack of unified standards and measurements obliging these departments to use these applications.
- Poor level of information exchange, on a regular basis, among the departments of the apparatus as well as with government or private sector entities.
- Insufficient websites that contain the urban planning applications (25% only).
- The concerned employees in urban planning departments are sufficiently obliged to complete their work using GIS applications.
- Scarcity of urban planning applications produced by

these departments

- As for the obstacles faced by the users of GIS applications in urban planning, the study showed that there is actual benefit from using GIS applications in the current urban planning, where users expressed satisfaction with the system in general, except for some problems or obstacles as follows:
 - Lack of up-to-date effective spatial data and information.
 - Absence of data integrity.
 - Lack of appropriate knowledge of using computer technology.
 - Poor training and development.

Recommendations

- Through this study, a number of recommendations concluded, which can be summed up as follows:
- Departments or units for geographic information systems should be established in all municipal bodies in Riyadh.
- The Ministry of Municipal and Rural Affairs should support its apparatuses in creating and building modern and sophisticated geographical information systems, providing all relevant capabilities within a clear strategic plan, including the integration of applications and databases and standardization of its entity, standards and points of use.
- GIS departments should be supported with incentive financial provisions to ensure the continuity and development of existing systems by including special items for them in their annual budget.
- The senior management should pay more attention to study the requirements of qualified staff working on these systems, developing plans for the employment of national manpower with the required experience and who hold technical qualifications and practical experience in geographic information systems.
- It is important for the senior management to recognize the online sharing of urban and spatial data among various urban planning entities, facilitating communication between government agencies and private sector enterprises concerned with urban planning for the cities of Riyadh region, and working on the integration of GIS applications in urban planning used in different planning bodies, taking into account all the needs and variables of planning in the region, in coordination with each other and through sharing experiences and data electronically.
- The data available currently need to be updated and periodical plans should be developed to execute this updating process, in order to take the maximum advantage of the data.
- The different government agencies and private sector enterprises need to cooperate with each other to build databases and databanks, feeding them with spatial and descriptive up-to-date data as per the competence of each agency, using a coding system and common standards and criteria, and establishing a mechanism to update them on an ongoing basis in order to ensure continuous communication and prevent duplication of work, within a specific legislative framework.

- Applications should be made available in Internet environments for urban planning in governmental bodies, and their use should be mandatory.
- The best practices and successful experiences in the areas of urban information systems should be generalized and different urban planners should be encouraged to use them.
- Periodic training workshops should be held for the concerned staff, namely, application developers, data entry staff, or normal users; and training meeting the work requirements should be provided, according to clear training paths.
- It is important for the government agencies to establish websites for GIS application users, containing urban planning and its various applications, as well as all information services, and allowing the shared use of data. These websites should be able to meet the needs through the simple applications that provide fast access to shared data and that commensurate with all the requirements of the public or private sectors and individuals.

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