Assessing the Business Needs and Readiness of Palestinian Municipalities to Adapt GIS to Promote Public Services

تقييم مدى جاهزية البلديات الفلسطينية لتبني نظم المعلومات الجغرافية لتحسين الخدمات العامة

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Abstract

This paper uses a case study approach to explore the extent to which the municipalities in Palestinian cities are ready to adopt GIS in their business procedures to improve service delivery and planning activities. For this purpose the business needs and data requirements of Bidya municipality which represent Palestine case were researched by adapting Tomlinson's approach for planning GIS. The research provide a list of Information Products (IPs) which are cases of how GIS will benefit the municipality and support the various work processes, whereas these (IPs) were used to extract a Master Input Data List (MIDL) and a database schema which reflect the actual and comprehensive data requirements to operate the needed GIS. The research concluded that in general most Palestinian municipalities do have other priorities which are considered prerequisites for adopting the GIS and getting the maximum benefits out

of it, such as; land registration, addressing system and activating the property tax collection system.

Keywords: Tomlinson's methodology, planning GIS, IPs, MIDL, database schema, Organizational structure.

ملخص

اعتمدت هذه المقالة على منهج الحالة الدراسية لاستكشاف مدى جاهزية البلديات الفلسطينية لتبني انظمة المعلومات الجغرافية في اجراءات العمل وذلك لتحسين تزويد الخدمات للمواطنين وتحسين الانشطة التخطيطية. ولهذا الغرض تم بحث متطلبات العمل ومتطلبات البيانات في بلدية بديا كحالة دراسية تمثل مدى واسع من البلديات الفلسطينية وذلك باتباع منهجية روجر تومانسون لتخطيط انظمة المعلومات الجغرافية، وقد قدم البحث قائمة من "منتجات المعلومات" وهي عبارة عن حالات تطويع انظمة المعلومات الجغرافية لمنفعة البلديات ودعم العمليات المختلفة، كما تم استخدام "وصف منتجات المعلومات" لتطوير مصفوفة البيانات الرئيسية للبلدية ومخطط اساسي لقاعدة بيانات شاملة تعكس المتطلبات الحقيقية من المعلومات التي تلزم لتشغيل نظام معلومات جغرافي فعال يشمل كافة الدوائر والاقسام. وقد خلص البحث الى ان البلديات الفلسطينية بشكل عام لديها اولويات أخرى يجب تحقيقها وهي عبارة عن متطلبات سابقة واساسية لتبني نظام معلومات جغرافي والحصول على الفائدة القصوى منه، وامثلة هذه الاولويات: تسوية وتسجيل الاراضي، تسمية وترقيم الشوارع والمباني بغرض العنونة والترميز اضافة الى تفعيل نظام جباية ضريبة الاملاك حيث تمثل هذه البيانات مدخلات اساسية للنظام كما تتم ادارتها بفعالية من خلاله.

الكلمات المفتاحية: منهجية تومانسون، قاعدة بيانات، تخطيط نظم المعلومات الجغرافية.

Introduction

The nature of local governments' work requires thorough knowledge of the complicated information in the surrounding spatial environment, in which most information in most sectors has components related to the geographic locations (Bishop, 2000; Ferreira& dos Santos Duarte, 2006; Somers, 2001; ESRI, 2007), and this is a difficult task when using manual and traditional tools, But the existence of an information system linking geographical locations and spatial elements with databases can help in proper planning and best use of resources (Mennecke, 2001, Mennecke, 1998). GISs can link geographical reality with integrated database which facilitate getting maps and information uniformly (Zellar, 2002). But GIS technology is expensive and requires both investment

cost to build it and operational cost to sustain it, so these costs need to be justified to help the senior management and political level take a decision for adopting it (Innes & Simpson, 1993) and this justification couldn't be done without proper planning (Tomlinson, 2003; Somers, 2001). Definitely, in case of adoption, the planner who has justified the cost of the project will bear the responsibility of accomplishing the benefits (Carr, 1999; Obermeyer 1999). So that the GIS planner has to plan carefully and study all the internal and external context within which the organization operates. Adequate GIS plan is a necessity for the GIS project to be implemented successfully (Tomlinson, 2003; Somers, 1996; Somers, 2001). The project planning should incorporate a deep analysis of business needs to identify exactly what benefits are to be achieved and what budgets are to be allocated for that.

This paper aims to introduce an evidence regarding the extent of the readiness of municipalities in Palestine as a developing country to accommodate a modern technological tool like GIS within their administrative system. To accomplish this objective Bidya municipality was taken as a case study to apply Tomlinson's methodology in planning GIS to examine the business needs and data requirements to adopt the system.

The significance of the study

1. This study expresses the requirements of GIS in the local governments in terms of data (spatial and tabular data) based on a deduction approach using a structured methodology.
2. The necessity of planning for any GIS project before implementation, to adopt a GIS project that meets the real needs within reasonable cost.
3. The lack of studies in GIS in Palestine, and specifically studies and researches that explains how to plan for a GIS project.

Background

State of GIS in the DCs

The ability of adopting GIS technology greatly differs between developing countries (DC) and industrialized countries (IC), due to the

different state of planning and development between them. The cities in the DCs are characterized by a range of interlocking features that impede the adoption of GIS within their administrative bodies. The high population growth rates in DCs have led to high demand on services which in turn led to the spread of slums to meet the demand on housing services, illegal construction activities, poor or unplanned utilities and infrastructure as well as different socioeconomic phenomena such as poverty and crime. There are planning issues in DCs that much influence the use and application of GIS technology; the diversity and incoordination in laws and provisions of land management, mostly not followed master plans, unplanned development, difficult acquisition of land by cities for public facilities, lack of spatial data and many other planning issues (Bishop, I.D. et al., 2000) negatively influence the use of innovative tools which were developed to fit the ICs that have very different general context. DCs suffer from poverty, lack of skilled personnel in dealing with GIS technology (Zellar, 2002), the substantial need for services and public infrastructure which take the attention away from technological innovations and institutional development to the basic needs on the grassroots level. As a result, using GIS in developing countries is limited and still in early stages (Yeh, A. G. O. 1991). The situation in the DCs is acting in contrast, that is; despite of the cities' over population, the growing demand on services and the different socioeconomic phenomena which need strict planning and data collection using smart tools and devices, but using GIS in DCs is something that seems very unusual for many people (Zellar, 2002). GIS utilization need capabilities which are mostly unavailable in the DCs such as financial resources and skilled personnel. The scarcity of these capabilities can also be impediments to GIS utilization in some institutions in the ICs, for example in the Japanese local governments, only (14.3%) of the local governments had implemented GIS in 2000 and after about two years (62%) kept operating them while (26%) had stopped and abandoned the system and this was mainly due to cost issues of operation and maintenance (Kohsaka, 2000). Thus at that time the GIS was not popular even within the Japanese local governments despite that it is considered an IC.

The state of GIS in Palestine

Palestine is one of the developing countries located in the middle east, most impediments of GIS adoption in the developing countries apply also to the Palestinian cities, add to that the political context in Palestine which is very special and unique. Palestine is under occupation, the Palestinian people face a conflict on the land possession against the occupier. This issue is related to land which is geography and therefore, it would influence the geographic information systems utilization.

Interest in (GIS) started in Palestine in the last ten years through academic institutions especially universities, which started to educate students about GIS, while some entrepreneur private firms interested in GIS projects implementation started to appear gradually. Recently, the formal bodies such as ministries and municipalities started to show a special interest in GIS applications despite of the obstacles facing them, some non- governmental organizations have implemented pilot (GIS) projects for services institutions, especially municipalities to find out the extent of the success of such projects and then expand the experience to other local bodies (Global Communities, 2014).

So far, the capabilities of municipalities in the use of GIS applications are considered very simple and modest, this is because of the lack of budget required to establish a complete GIS system especially under the large number of priorities and basic needs, and most municipalities lack the qualified specialists in the field of GIS, in addition to the lack of precise data and digital maps which are considered the base of any GIS project (Awad, 2010).

Despite of all obstacles and constraints, there is interest in GIS at the level of central government and local governments represented by municipalities, this is evident from:

1. The adoption of a unit for GIS in the organizational structure of the ministry of local government, this unit has recently launched a project of "Web Spatial Information Services" for municipalities (MOLG, 2015).

2. The adoption of GIS units in the organizational structures of municipalities of class A and B i.e. large municipalities **(**The regulations of local bodies' employees, 2010).
3. Very few municipalities have established a GIS department.

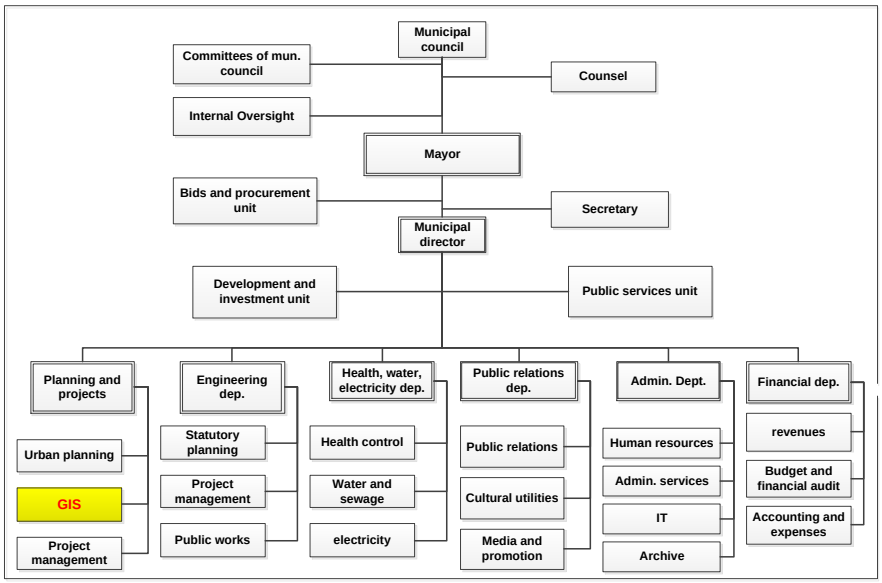

Figure (1): Organizational structure of a municipality class II (B). Source: The regulations of local bodies' employees.

There is an interest in GIS by non-governmental organizations (NGOs) such that:

1. Some NGOs collect funds to implement GIS projects for municipalities and nonprofit institutions such as "Global Communities" organization which encourages municipalities to prepare proposals or studies for GIS projects to help them collect funds.
2. Some NGOs offer free training courses in the field of GIS, such as "House of Water & Environment".

At the level of high education, universities have become more interested in the field of GIS in the academic programs and researches.

Despite all of that, GIS in Palestine is not familiar practice in the public and private sectors through a strategically planned and organized system.

The Local Governments in Palestine

The local governance system in Palestine consists of administrative units which practice their authority within identified geographic areas. These units are mainly classified into two main groups: municipalities and village councils. Municipalities are also classified into levels according to: administrative character, year of creation and population. Class (A) for cities which represent the center of a governorate, class (B) for municipalities which were existing before year 1994, or created after 1994 with population more than 15000, class (C) for municipalities of population between 5000 and 15000, class (D) for municipalities of population less than 5000 inhabitants (Toqan, 2001). It should be mentioned that the year 1994 represents a curve in the life of the Palestinian people, when they gained self-rule despite its partial application. Municipalities in Palestine are not fully decentralized. Although they are financially independent; the central state practices the role of monitoring and guidance on the municipal activities.

The organizational structures (OS) of the Palestinian municipalities range from simple for small municipalities to a complex OS for large ones. The OS of the large municipalities which are class A and B include a special department for GIS, while lower classes don't.

The main functions and authorities of the Palestinian municipalities are generally defined by the Palestinian local governance law No. (1) for the year 1997 as:

"Planning of city and streets, building permits, water and electricity provision to residents, waste water disposal, licensing of crafts and industries and prevent pollution, solid waste collection and disposal, Public health control and monitoring, monitor and organize advertising boards. demolition of ancient buildings. Transportation responsibility such as; create, organize and set positions of vehicles parking places. Set and organize graves. In addition to managing financial resources and properties of the local authority".

Application of the planning process

Planning is a basic process for an kind of projects or activities, and it is more important for GIS projects because GISs have unique techniques, unique expertise, unique data types and tools and their success is dependent to a great extent on the institutional and organizational environment (Mennecke, 2001), so that unplanned GIS projects are definitely failing, while planning will rise the likelihood of success. The lack of an adequate GIS plan can be considered one of the main reasons for difficulties and problems at various stages of GIS development and operation (Taleai. et. al, 2009). "most successful GIS projects are implemented according to a structured process that assures that the final product will meet the users' needs" (somers, 2001). In this statement Somers has indicated planning methodologies which were set by expert planners to best plan for the GIS. There is a variety of methodologies available in planning GIS projects such as:

1. An eleven- step process - GIS Development Guides for State of New York (1997)

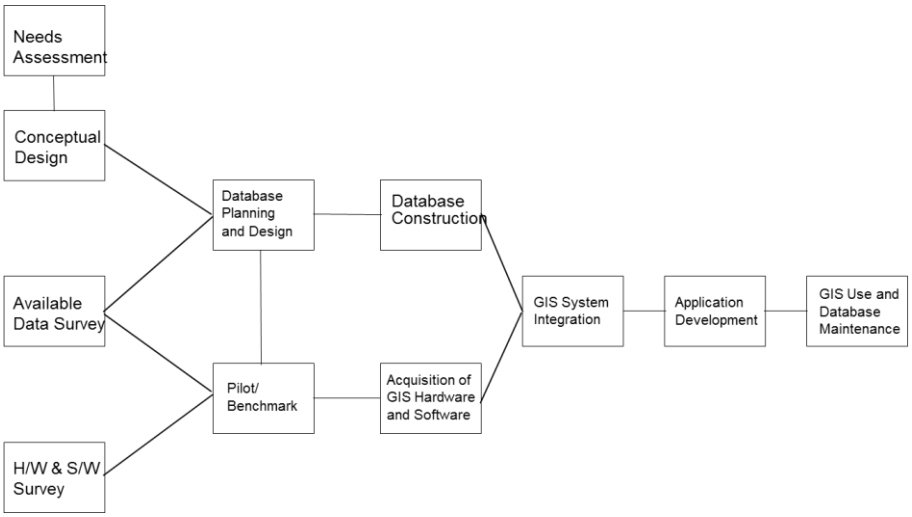

Figure (2): Eleven Step Planning Process.
Source: http://www.sara.nysed.gov/pubs/gis/gisindex.htm

2. Fourteen step Planning Process by Longly, et. al.

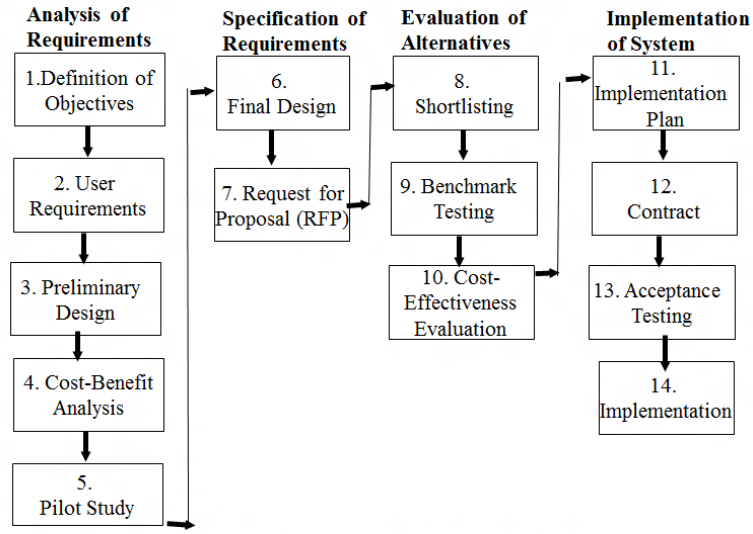

Figure (3): Fourteen step Planning Process. Source: Longley, et. al. p. 391

3. Five-step Process by Somers.

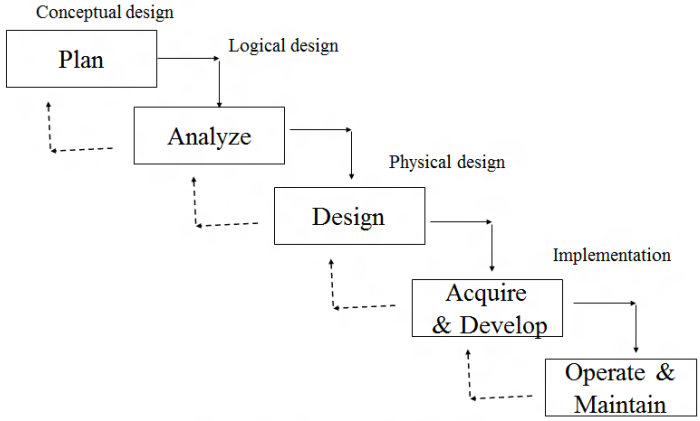

Figure (4): Five Step Process. Source: Rebecca Somers, Quick Guide to GIS Implementation and Management Park Ridge, IL: Urban and Regional Information Systems Association, 2001, p.7

4. A 10-Stage GIS Planning Methodology by Roger Tomlinson

In this context we followed Tomlinson's methodology (figure 6) to study and identify the specific business needs for Bidya municipality and inspect the status and preparedness for adopting such project.

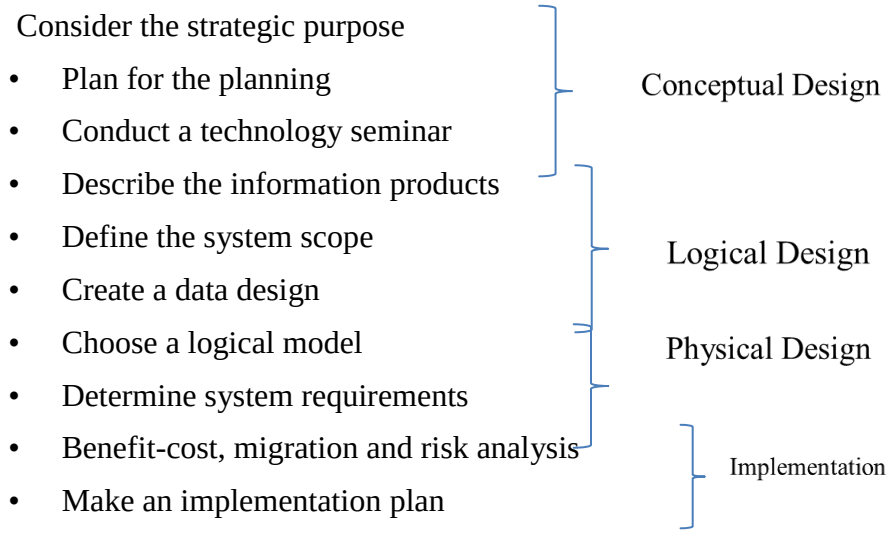

Figure (6): Roger Tomlinson's methodology. Source: Tomlinson, 2003, Thinking About GIS, hand book.

Despite that it is not an objective of this study to recommend a methodology for planning GIS projects, we here point out why this methodology was selected to conduct this study.

Tomlinson's approach -which is the product of his years of experience in the GIS implementations of large and small projects in public and private sector institutions- was seen as the most appropriate one for conducting this study, it is straightforward and simple to follow. It learns the planner what to do and how. It takes into consideration some important aspects for example: 1) users participation which is explained and emphasized in this methodology, 2) training and education of the users which is emphasized at the early stages through the stage "conduct a technology seminar" that aims to learn the participants general

knowledge of the GIS to enable their effective participation in addition to the design of a training program for the end users at the final stage of the planning process. 3) addressing a feedback mechanism at each stage that return the process to the previous stages to ensure that the project is on the right track and fulfill the objective and requirements definition. 4) Tomlinson's methodology includes an approach for analyzing the business needs and describing the system information products (IPD) such that if performed properly and thoroughly it can provide answer for any question during all the stages which follow.

Case study - Bidya municipality

For the purposes of this research the municipality of Bidya has been taken as a case study. Bidya population is estimated at about 10,000 inhabitants, while the area of Bidya town is about 21,000 Donums, about 2000 Donums are within the approved master plan. Bidya municipality can represent many other municipalities which has similar circumstances and characteristics, this may be evident from the statistics published by formal organizations such as:

1. It can represent 82 out of 135 municipalities in terms of population (pcbs, 2015).
2. It has the same rank as 75 out of 135 municipalities in terms of performance assessment done by municipal development and lending fund in year 2015.
3. Bidya like 65% of the Palestinian lands suffer from the total absence of parcel maps and land registration and division system which is very essential issue for the urban and strategic planning (Albarghothi, 2015).

Bidya municipality has an OS - figure (7), while its work is similar to the tasks described by law here before. The municipality structure of departments and divisions is described in figure (7) below.

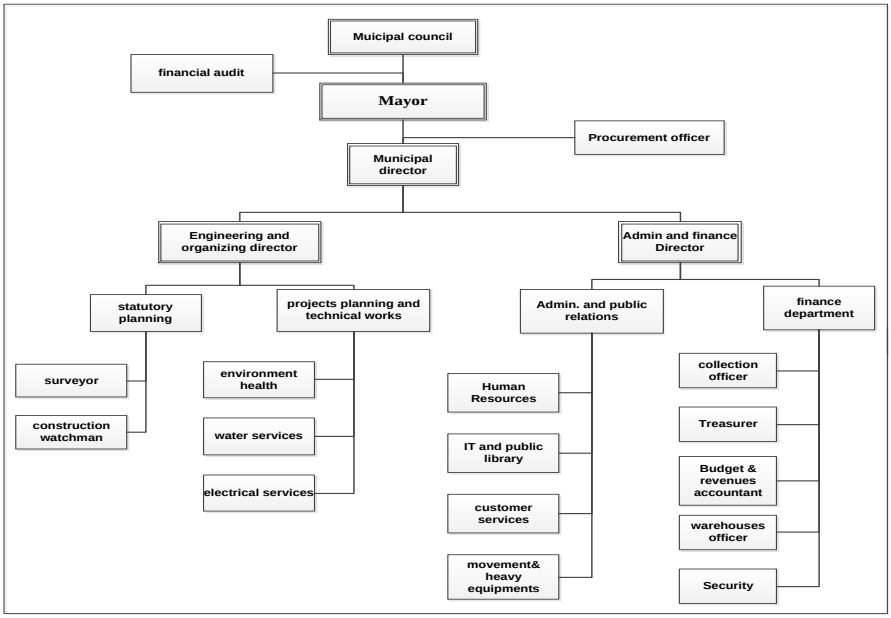

Figure (7): Organizational Structure of Bidya Municipality. *Source: Bidya Municipality.*

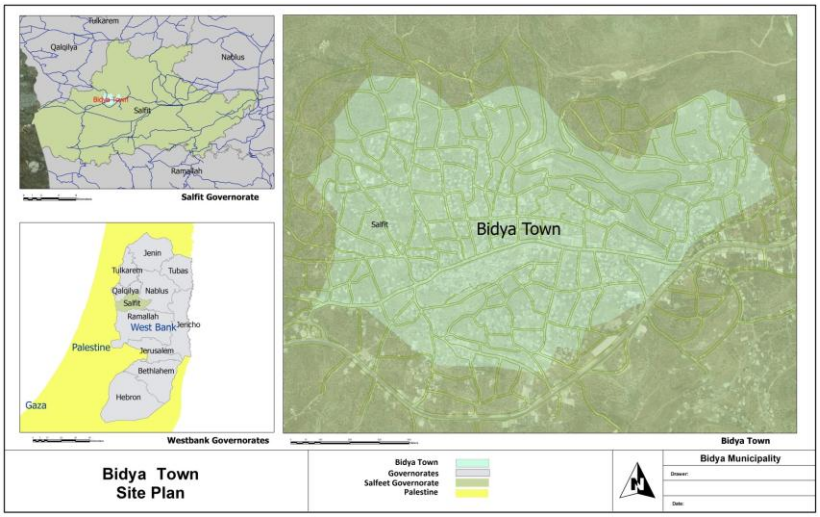

Figure (8): Location Map of Bidya. Source: Prepared by Researcher.

Analysis of business needs

The core of this stage is the determination and evaluation of organization's requirements in details. It is not enough for the GIS planner to know the overall tasks of main units and departments of the municipality in order to figure out how the GIS could benefit it. He needs to have thorough understanding in procedure and workflow of each transaction. Several meetings with senior and junior personnel was conducted to understand in details the nature of the tasks they perform, or the nature of business reports they usually need, especially that Bidya municipality doesn't possess procedure manuals that show the details of business - technical and administrative – workflow. Officials of departments were asked to list all tasks and transactions they usually perform, during that there was a need to review the laws and regulations which rule the work, as well as job descriptions of all the employees which were available. Then a workflow documentation was developed for most of the tasks and transactions to gain data which help in identifying GIS uses in the municipal work in Palestine. The final product of this stage was an initial list of information products.

Table (1): Initial list of Information Products.

No.	Information Product (IP)	Department
1.	Bldg. licenses map & list	Statutory planning dep.
2.	Site map (for Bldg. license)	Statutory planning dep.
3.	Area regulatory provisions map & list	Statutory planning dep.
4.	Land parcels location map and list	Statutory planning dep.
5.	Roads location map & list	Statutory planning dep.
6.	Bldg. location map & list	Statutory planning dep.
7.	Walls location map &list	Statutory planning dep.
8.	Road names and numbers map	Statutory planning dep.
9.	Building numbers map	Statutory planning dep.
10.	construction monitoring map and list	Statutory planning dep.
11.	Topographic features photo	Projects and Statutory planning dep.
12.	3-D simulation model of the town	Projects and Statutory planning dep.
13.	Web service for public about regulatory provisions and structural map	Statutory planning dep.
14.	Schools & public institutions map & lists	Projects and St. planning dep.
15.	Digital elevation model	Projects and St. planning dep.
16.	Roads analysis map & list	Projects and St. planning dep.
17.	municipal property location map &list	Projects and St. planning dep.
18.	implemented projects analysis map & list	Projects, public relations dep.& municipal director
19.	water network elements location map & list	Water dep. / Projects and St. planning dep.
20.	Electricity network elements location map & list	Electricity dep. / Projects and St. planning dep.
21.	Sewage network elements location map & list	Sewage dep. / Projects and St. planning dep.
22.	professions and crafts location map & list	Health of Env. dep. / Projects and St. planning dep.
23.	property tax collection map &list	Finance dep.
24.	Tracing vehicles movement map	Mov. & heavy equip. dep.

Information Product Descriptions (IPDs)

(IPD), is defined briefly as thorough descriptions of information specifications that will allow the actual product to become a working reality. This stage is considered the crucial step in the planning process, if accomplished properly, the remaining stages of the planning process will be achieved automatically (Tomlinson, 2003), it includes the identification of the following components:

1. Title of the IP.
2. Name of the department that will use it.
3. Overview of the IP as a narrative summery.
4. Map requirements.
5. Tabular data requirements.
6. Text documents.
7. Image requirements.
8. Schematic requirements.
9. Steps required to make the product.
10. Frequency of use.
11. Logical linkages.
12. Error tolerance.
13. Wait and response tolerance.
14. Current cost.
15. Benefit analysis.

The initial list of IPs was improved, by choosing the most important of them and trying to merge some of them and reformulate the titles to make a short list of the most important ones. Each IP was then described systematically by identifying all of the above 15 components. More than 10 IPs was described, these IPs can significantly improve the business procedures and then increase the work efficiency. During that we recognized that certain data sets will produce several information products. During this step the required GIS functions were identified in terms of type and frequency of use, the diagram in figure (8) show these functions, it is noted that some functions have extremely high frequency of use such as plot, display and edit, these functions are expected to be utilized by the public through a web based GIS, these functions should be designed to operate efficiently. The functions in the middle of the diagram provide essential functionality and also are of frequent use, so the system should be checked thoroughly for these functions during the

design and procurement process. Some functions are not used frequently, they should be in place but the efficiency is not a necessity.

It was found that the most usable GIS functions relating the nature of work at Bidya municipality are query and overlay functions related to both spatial and attribute data.

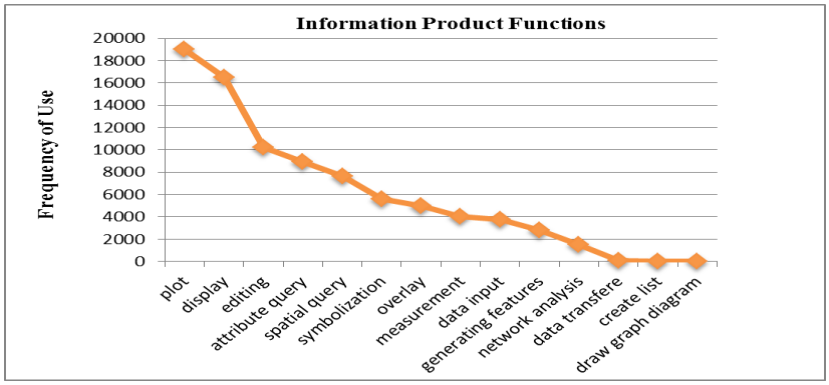

Figure (8): GIS functions. Source: Information Product Descriptions prepared by the researcher.

The users need:

- **large extent of attribute and spatial query functions for example:**
  - A user needs to know the number of new buildings within a certain polygon (specific land use polygon) during a certain period.
  - A user needs to view the distribution and length of water pipes of certain diameter.
  - A user needs to know the distribution and list of subscribers fed by certain transformer.
  - A user needs to know the number, type, owners and distribution of industrial plants within certain area such as (out of master plan (MP) boundaries).

And so many other uses.

- **Also, there found a significant need for the graphic overlay**

functions for example:

- A user needs to display a map which show existing roads, land parcels, buildings and MP boundaries for the purpose of planning new roads or to study the capabilities for a new road construction or expansion.
- A user needs to display the planned roads, the administrative boundaries and MP boundaries in addition to buildings to study the possibilities of the integrated physical planning with the surrounding towns.
- A user needs to display the infrastructure of a water network and the buildings within a road segment for the maintenance purposes.
- A user needs to display the distribution of industrial plants, roads, residential buildings and agricultural fields to assess the environmental impact of industries.
- A user needs to overlay a land survey to the MP to check for class regulations…etc.

- **"Generating Features" functions are needed repeatedly for data update to keep up with urban changes.**
  - "Display" functions are needed to navigate through maps and take a whole picture about the situation relating certain issue such as complaints, providing services or development projects to best support decision making.

GIS is powerful in displaying the overlaid maps of the diverse spatial entities to inspect their relations and influence on each other. For example: in order to construct a new road, the decision maker needs a preliminary study to imagine the influence of this project on the surrounding environment and its effect on the social and economic context, to get a comprehensive picture about the impediments which may face the implementation, this will help in putting alternative solutions for the potential problems. For this purpose, engineer needs a map of the land parcels overlaid with planned roads to make a report in

the affected parcels, owners, deducted areas, amount of compensations if any, This information is very crucial in decision making. Engineer needs the map of the planned roads overlaid with the map of buildings and walls to detect any obstacles which may impede or delay the road construction, obstacles of this kind may prevent the work or impose a change in the plan. Not only that, decision maker also needs the map of the planned roads overlaid with the map of the agricultural crops and areas of high agricultural value, to know the influence on the economic context.

Layers of the MP are also important, MP boundaries, classification polygons and the different regulations in order to check the new situation of the parcels after the deduction for road construction and its effect on the planning i.e. the compliance to the regulations in terms of the remaining areas of the parcels, their form, geometry, and dimensions.

The map of the planned roads need to be overlaid with the infrastructure maps of water, electricity and sewage networks to inspect the points from which the new road could be served and the costs and requirements of accessing these services to this road. The "display" and print functions are extremely important and support the decision making. The "measure" function is also of great importance in the engineering and planning work and is expected of high frequency.

Data requirements

A thorough study is applied to the IPDs which are prepared in the previous step to confirm the data needed for each IP and think of the steps of creating it and the different cases of transactions and reports to ensure that no other data might be needed, After IPDs confirmation process completed, a list of datasets is extracted from all the confirmed IPD array. This list of datasets is the base of the GIS system design. Description of data is then started by firstly assessment of available data at Bidya municipality and studying the amount of required datasets (length of road network, number of buildings, number of crafts…etc.) based on available data, maps and statistics. Some properties such as scale and resolution is identified based on reviewing IPs already found in the departments which are being prepared using CAD software.

The following is a suggested hierarchy of dataset groups for map requirements as concluded from the IPDs.

Extracted dataset groups

Table (2): spatial data set groups.

Base Map	Master Plan	Landmarks	Real world representation	Land Registration	Transportation Network	Electricity Network	Water Network	Wastewater network	Crafts, Industrial plants
Administrative Municipal Boundaries	M.P Boundaries	Graphic entities	Aerial photo raster image	Blocks	parking complex	source point	Tanks	Treatment station	Plants & workshops.
Contour Lines	Urban Classifications			Parcels	Roads Centerlines	Transformers	Pipes	pipes	
DEM	Planned Roads Network			Parcel numbers	Road Edges	Towers	Valves	Manholes	
				Buildings	Traffic Signs	Switches	Subscriber connections	Subscriber connections	
				Building numbers	Roundabouts	Poles			
				walls	road names or numbers	medium voltage Cables (hanged)			
						medium voltage Cables (ground)			
						Low Voltage Cables			
						distribution boards			
						Subscriber Connections			
						subscriber meter boxes			
						Lightening panel			
						light Units			

Extracting dataset groups from the IPDs assures that each dataset should be required to generate at least one information product, no other data should be included in the dataset groups, this is to avoid the confusing array of unneeded layers and the cost of acquisition of such data which will never be used by anybody. (Tomlinson, 2003).

Tomlinson's methodology advocates that these spatial datasets with the corresponding attributes should be examined from different aspects to give a whole picture of the effort, time, and then cost of data collection and data entry and also to identify the suitable software and hardware requirements. During this step one should collect data about the data in terms of: name, ID, volume, source, format, scanning requirements, transformation requirements, coordinates system, and many other factors.

Spatial data requirements were best reflected from the master input data list which is a table contains all required spatial datasets in one column, and all of the above characteristics and descriptions identified

for each dataset group. While the attribute data requirements and the relationships among them are best reflected from the database schema.

Setting Priorities

After datasets had been identified; a prioritizing process have been conducted on data acquisition because it may be difficult or costly to build all data required to produce all information products, so the organization specifically Bidya municipality needs to know which datasets should be acquired or got delivered at the first stage of project implementation based on the relative importance in contributing to the municipality's objectives.

Scoring method is used to prioritize data, the criteria used for the datasets ranking is that the most frequent used datasets the most prior to be delivered, and the most frequent used data means data that either used for several information products or for an information product which is used very frequently by municipal departments. The table below shows a sample of the result of this criteria of datasets ranking.

Table (3): sample dataset priorities.

Headings	IP1	IP2	IP3	IP4	IP5	IP6	IP7	IP 8	IP 9	IP1 0	IP1 1	IP1 2	IP1 3	IP 14
MP boundaries	√	√	√	√	√	√		√	√	√	√	√	√	√
Land use polygon	√	√			√	√								√
Planed Roads	√	√	√	√	√	√		√	√	√	√			√
Parcels	√	√	√	√	√	√		√	√	√	√		√	√
buildings	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Road names	√	√	√	√	√	√		√	√	√	√			√
Electric transformers			√	√					√			√		
Medium voltage cables (hanged)			√	√					√			√		
Low voltage cables			√	√					√					
Subscriber connections									√					√

The table above shows in which information products each dataset is used either directly or indirectly. When we look at the table it seems that

some datasets are necessary for almost all information products such as planned roads, buildings, parcels and M.P boundaries, these data sets are top priorities. Some datasets such as those related to electricity network although they are needed mainly for electricity- related IPs but they are of great necessity because of their importance and the high frequency of use of the information product per year.

Municipal Database Schema

The main goal of an enterprise GIS (EGIS) is the diffusion of data and information throughout the organization using uniform methods and addresses and then provide consistent information to the public and other parties by different departments when applying spatial analysis, reporting or display to the business functions, by virtue of a comprehensive and uniform database for spatial and attribute data using codes and addresses that are consistent with other in-use technologies which can be integrated with the GIS. (ESRI, 2007).

(Halfawy and Figueroa, 2006) articulated that: "*A major challenge in building centralized data repository is the need to develop a data model and a corresponding database schema to represent and integrate asset life-cycle data in a unified, comprehensive, and preferably standardized, manner*".

In the municipal database system suggested for the case study (Bidya municipality), data is stored using relational data model in which data is stored as collections of tables that are logically associated to each other by shared attributes.

All the previous data modeling activities represented in IPD have enabled us to formulate a database schema for the municipality which can illustrate the structure of tables and relationships of the database. So database schema: is a collection of meta-data that describes in a concise manner the relations in a database. It can be simply described as the "layout" of a database or the blueprint that outlines the way data is organized into tables (Chapple, 2014).

The following database schema for Bidya municipality is built as a product of this applied research by studying all activities and businesses usually carried out by its staff, and the knowledge of the usually required reports and maps, so it can be considered as a comprehensive database of all aspects of the work of Bidya municipality.

In order to link the geographic entities with their attributes logically, or to link the attributes to each other, logical linkages should exist. In our case, it was found that the parcel number, the building number and the street name are basic requirements for the relational model of the database, these geographic codes should exist but really they don't in our case study. This fact is considered one of the impediments of the implementation of an EGIS at Bidya municipality.

The database schema figure (9) bellow shows the importance of these geocodes and their basic role in creating the logical linkages.

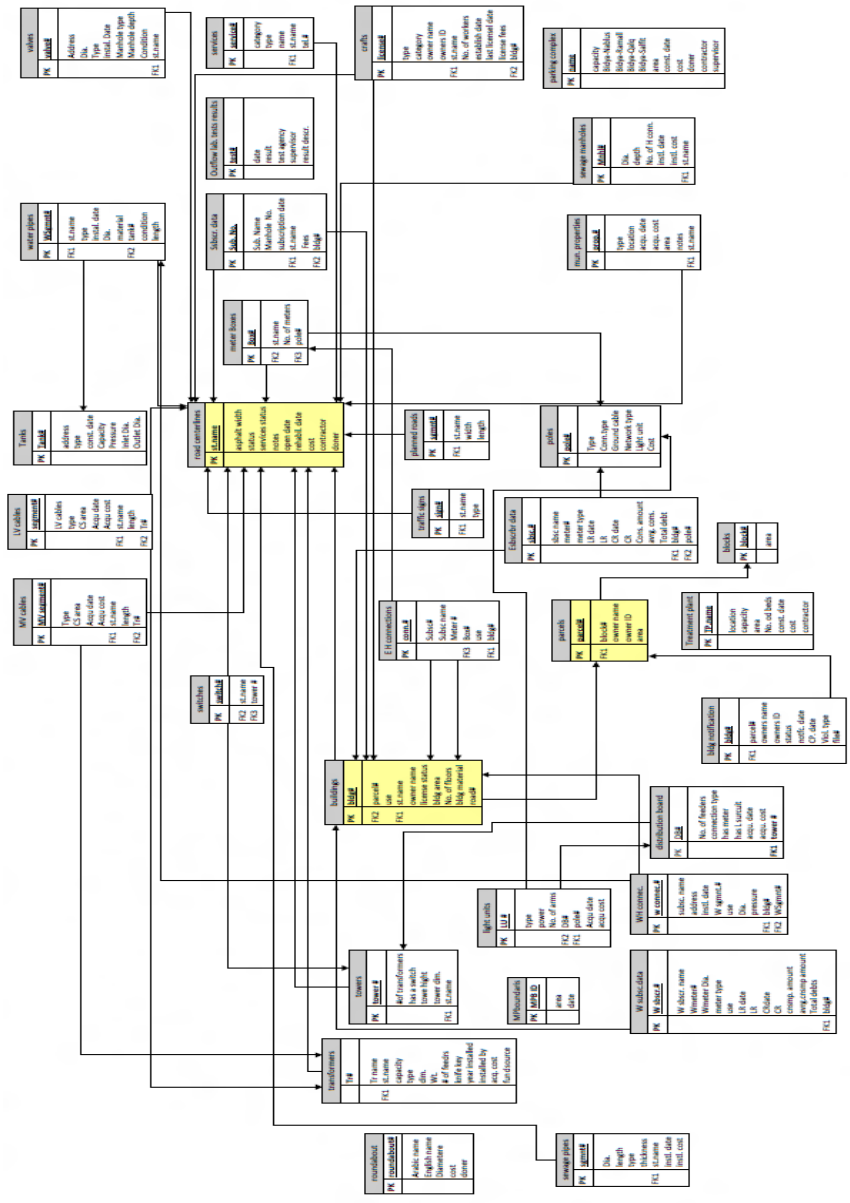

Figure (9): Municipal Database Schema. Source: prepared by the researcher.

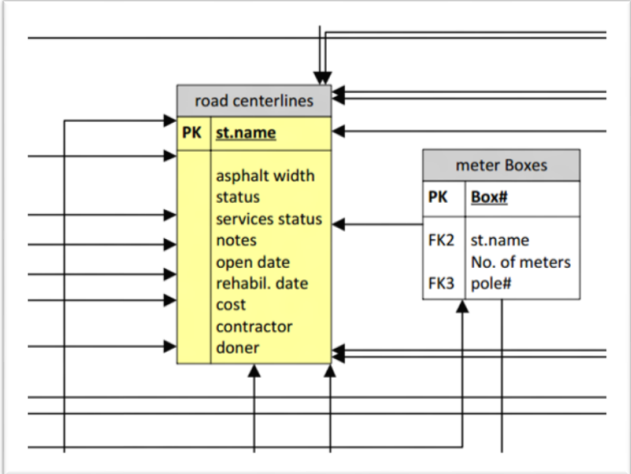

Figure (10): sample table of the database schema for Bidya municipality. Source: Source: prepared by the researcher.

The sample table of the database schema in figure (10) is for road centerlines, it has 17 arrows entering it, this means that 17 services or data elements are directly related to roads, this is right because public services are generally located within roads such as water, electricity, sewage networks and many other services. So, to create these relations in the relational data model we need a code or name for the road to make the logical linkages, this is shown in the first entity in the table (St. name). For a town like Bidya and many other similar towns in Palestine we can say that unified common names for roads should be found. This applies also for buildings and parcels which are distinguished in yellow in figure (9).

Data availability

By analyzing the data priorities and checking data availability, it was found that Bidya municipality lacks the majority of data needed for the system to operate, it lacks the following basic spatial data:

– Land management database: No maps of parcels boundaries and parcel numbers, no system for property registration and land division and so no land records. in fact this status apply for about 70% of land in the Palestinian cities which make it a problem at the national level.

(Samarah, 2005; Barghothi, 2014).

- Addressing system: No road naming, no building numbers. this problem also applies for the majority of the Palestinian built areas.
- Maps: in general there is lack in maps specially those of accepted precision for electricity, water and sewage.

Given these missing data the problem arises when we know that there is a real difficulty in creating some of these data because it requires higher policy cooperation such as land registration which requires the support of land authority as a governmental agency. Furthermore, this type of projects incorporates a high cost which is not available in the municipal budget and usually take considerable period of time i.e. years. So this needs separate project and budget.

An actual effort really is expected in collecting and entering the attribute data, they are fully scattered and many of them most likely not found.

Engineering work depend on a set of spatial data that are available in a CAD format, while there is an automated billing system for water and electricity services but not referenced spatially, crafts are managed manually using paper files. Property tax is not activated because it is directly linked to the property registration system. Taxes couldn't be collected on properties of which owners are formally unknown.

One of the paradoxes found during the study of the data requirements and data priorities is that: while land parcels map is not available and its production is considered a challenge, it is showed as top priority in the prioritizing table.

Also, buildings and parcels ownership data, are not available and directly linked to the registration system which is an absolute governmental authority, while they are top priority for the municipal EGIS to operate. The disappointing fact is that this status applies to 70% of the lands and buildings in Palestine, the land issue in Palestine is very critical because of the ongoing conflict on land ownership between Palestinians and Israelis. However, in some areas of the Palestinian country even the central government doesn't possess the authority of land registration, because it is under the security control of the Israeli

occupier, which prevent any activity within these areas.

This result is consistent with the results of previous studies on developing countries like (Yeh, 1999; Zerger & Smith, 2003; Silva, 2007; Mennecke, 2001; Zeller, 2002) which states that the data availability is one of the main constraints in the use of GIS.

Project implementation issues - costs, benefits and timeline

The analysis of business needs accomplished in this research, has demonstrated substantial benefits of the GIS to the municipality in terms of work efficiency and support of decision making. And this is valid when completing an enterprise GIS which represent a central database that supports all municipal departments using unified and consistent codes and addresses with minimum redundancies. Examples of benefits might be briefed as: reduce the dependence of the top management on the personnel for information, reduce citizens attendance to the municipality for information depending on web services; both of these benefits increase efficiency and devote employees for their original tasks. The acquisition of data and getting it available when needed is of great value in itself, especially for a municipality that lacks most of the data necessary for its work. sooner or later a central database is a necessity and a GIS is an ideal tool for its management. Some benefits comes spontaneously as a result of having the GIS and its database such as: activating the property tax collection which depends on land registration, while the availability of parcel maps much helps in its good management, creating addressing system which greatly support the emergency services and other managerial issues. Thinking of the GIS is good motivator for thinking of such issues seriously.

Exploring data requirements and data availability at the case study proved a long dated project completion due to the significant lack in data, significant cost and long time needed to get the data and build the database required for the system to work and produce the needed information. This fact compels an incremental approach in the project implementation especially with the limited resources of the municipality and the diverse needs in all other sectors.

GIS cost categories fall under: hard ware and software, data, staffing, application programming, interfaces and communication.

Analysis of these cost categories for Bidya municipality shows that the development of the GIS is costly and the data and staffing categories has the most significant share of the overall cost.

Cost issues vary from a situation to another, it depends on the specific status of the institution; data requirements and data availability, availability of qualified personnel, GIS illiteracy and training requirements are factors which greatly influence the cost of GIS development within an institution.

Bidya municipality lacks most of the needed data and also lacks a qualified staff in the GIS. This fact makes the planner think about the cost and time of acquiring this data as a prerequisite for implementing an enterprise GIS. In this case study the GIS may be thought of as a long term program which extends along five years in the minimum. This will be a must for the following reasons:

- The large scale of the project requires division to phases specifically because of lack of data: both spatial and tabular data, some kinds of data need separated projects such as land registration and producing maps for parcels.
- To cope with the limited financial resources of the municipality under the unlimited tangible needs and priorities.
- To let the staff gain enough training, practice and practical expertise in using the GIS to well support the system development, acceptance and diffusion through the municipality.

To manage this long-term and large-scale program a detailed annual plans should be created and all sub- plans should be integrated under the umbrella of the EGIS. Yearly assessment should be conducted to make sure that the project is on track. ESRI has advocated this gradual transition to the EGIS and emphasized that the EGIS implementation shouldn’t be sudden.

Discussion

By applying Tomlinson’s methodology for planning GIS projects on Bidya municipality as a case study of cities of the DCs which represent a wide range of the Palestinian municipalities in terms of financial situation and institutional and organizational circumstances, the focus in

this research was specifically on the first two stages of this methodology: conceptual design and logical design. This research process especially examining data requirements and data availability has led to a consensus with the results of the previous researches on developing countries that data issues are one of the major impediments of GIS success. GIS is a powerful tool for: 1) data management 2) improvement of the strategic and physical planning 3) the efficient and effective service provision. But to get these benefits GIS requires a solid foundation in terms of organizational and institutional environment. During the process of developing a database layout for Bidya municipality it was evident that these issues are interrelated and couldn't be managed independently. For example: service provision (for example: electricity subscription) is related to the building which will be served, the building should be licensed and the license is dependent on land ownership and land registration, also land parcels should have been divided according to regulations in terms of dimensions and geometry to enable the licensing process, while land registration and so division system are not found. Add to that, to enable the search and query functions by owner name in any automated system; the buildings and properties should be formally registered. This complicated configuration leads to difficulties in GIS implementation and success.

Another example is that property taxes are imposed on property owners and the ownership data needs a registration system, without this system taxes couldn't be collected.

The GIS at the municipalities is different from other institutions because of the nature of work of the municipalities. GIS at a municipality is greatly affected by the urban planning status which is encountering considerable issues in Palestine that constitute real obstacles in the way of development. This organizational and institutional disturbance may be fatal to the EGIS.

Again GIS system as a relational data model needs three basic requirements for suitable design and geocoding: **land** registration, parcel numbers, **building** numbers and **roads** names and numbers. these numbers and names are the basic linkage between spatial entities and their attributes, so a municipality like Bidya can't incorporate an

integrated GIS system without adopting a system for naming and numbering of lands, buildings and roads.

In fact, these requirements would definitely impose the incremental approach in enterprise GIS (EGIS) implementation. The term enterprise refers to a comprehensive information system for the entire organization. Incremental approach means that EGIS can be built on a service by service basis or departmental basis as needed then they could be combined to create a web application for the use of different departments and business processes. This gradual implementation is imposed, so the available data could be incorporated, while the missing data will be incorporated when they are available, but these activities should be implemented according to a preset plan.

Conclusion

Depending on the study of GIS requirements based on the information products needed to support daily task operations, and also the study of data requirements and data availability, it was found that:

1. Bidya municipality lacks most of the data needed to support and organize its work.
2. Some of the missing data -such as land parcels and registration- is basic for practicing urban planning, strategic planning and city management which are of the main goals of municipalities.
3. Some of the missing data such as road names and building numbers is crucial, it formulate the addressing system needed for emergency services.
4. Providing the missing data need separate projects which require time and costs.
5. An EGIS may be thought of as a multi-project program which is organized according to a predefined plan.
6. A GIS plan should include a time schedule.
7. Cost issues are very crucial, and costs should be compared to benefits to take a decision of adopting GIS.
8. GIS will not add a considerable value for the municipality, if the most important data were not available.

Recommendations

In light of this research it is recommended that:

1. The case study – Bidya municipality- focus on implementing GIS incrementally beginning with land registration and addressing process (naming and labeling of locations) according to the official methods and regulations.
2. The incremental approach in adopting the EGIS on a department by department or service by service basis is recommended for Bidya municipality and similar municipalities.
3. The priority in Bidya municipality and all municipalities of similar characteristics is for land registration project which is the real basis for physical planning and also city management, then GIS will be a good tool for this management.
4. Another priority which is basic for the database management system to operate and introduce the expected benefits is the geocoding which can simply be defined as expressing spatial locations such as roads, buildings and parcels by an accepted, fixed and common codes or names. The geocoding is a necessity for the city management to organize work and reference geographic locations whether it was manual or automated.

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