Chapter 14
Facility Management System: A Case Study of University Campus

Arifa Begum and Ashis K. Saha

Abstract Remote Sensing and GIS play very important role in creating future smart cities. Facilities management being an important component of smart cities assimilates infrastructural functions and processes. Moreover it defines scheduled approaches toward the optimization of resources, in turn, promoting efficiency and simplifying complex decisions. This study aims at developing a better facility management system at Delhi University North campus by utilizing an integrated approach of information technology and GIS. The case study pertains to meet the objectives like collection of information on various facilities (viz., Banks and ATM, Photocopy and Printout shops, Food Joints, Health Care and Medical shops, Hostels, etc.) in the Delhi University North Campus and collating that information to develop the facility management system in a GIS framework. For this study, high resolution satellite imageries of QuickBird (60 cm resolution), EICHER Delhi City Map and Google Earth have been used. The heads-up digitization has been performed for feature extraction (e.g., road network, canteen, Railway Reservation centre, parks, shopping centres, etc.) from the very high resolution satellite imagery and ArcPAD mobile GIS has been used to perform the survey related to facilities in the campus. The mapped facilities have been brought into a GIS-based network analysis to find out basic closest facilities, optimized route identification, service area identification, origin-distance matrix etc. The mapped facilities have been then published using open-source ArcGIS Explorer toolbox for common users.

Keywords Facility management system · Automated mapping · AM/FM · Mobile GIS · Network analysis · ArcGIS explorer

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Acronyms

AM/FM	Automated mapping/facilities management
ATM	Automated teller machine
FIMS	Facility information management system
OD	Origin–destination
GIS	Geographic information system
GPS	Global positioning system
UTM	Universal transverse Mercator coordinate system
WGS84	World geodetic system 1984

14.1 Introduction

Until the past century, the idea of a city to be smart was a fiction, but with the proliferation of the geospatial technologies embedded into various tools and devices, has paved the way for the city to be smart, turning into a reality. A city that incorporates and integrates the smartness in facilities (like road network, buildings, etc.) to connect it to the people and the city elements making it more liveable and sustainable.

Facilities management enhances better accessibility to the city infrastructure and services, which is definitely one of the pillars of integrated 'smart' city solutions. In today's dynamic world, instant access to information is the crucial component to effective decision-making. This can be accomplished through Automated Mapping/Facilities Management (AM/FM) and Geographic Information Systems (GIS).

Facilities Mapping (FM) is the process of digitally identifying and mapping facilities infrastructure with the explicit goal to improve operational management and planning tasks such as dispatching, inventorying, and maintenance. Some examples of facilities include utilities (gas, water, telephone, and electricity), airport sitting, and transportation planning. In our study, it includes facilities such as nearest ATM, bank, health centre, sports complex, police post, food canteens, hostels, etc.

Thus, AM/FM as an integration of two most influential and are totally organized application systems. These are basically differentiated on the basis of utility and urban facilities management. Automated mapping provides better digital map maintenance without any content destruction, whereas Facilities management system is capable of sorting, manipulating, processing and reporting data and it even generates a digital representation of the network (DimensionI GIS).

Together, both of them combine with GIS to provide an innovative outlook for facilities management system. The automated mapping facilities management provides simplest, most comprehensive, and effective function of generation of digital maps and reporting tasks that are active with an added features of advancement.

Instead of distinct roots, GIS and AM/FM system have a similar goal to channelize map drafting and manipulate previous functions to achieve futuristic results by saving time and money.

This research gives some insight on how to build a GIS-based Facilities Management System in a university campus. University of Delhi, a small unit of Delhi city is in need of a system to help organize and deliver facility information considering no system previously developed. Thus, managing effectively spatial and nonspatial data of a campus involves the understanding and manipulation of a large number of variables. The spatial nature of the facility and their associated resources which are linked to unique attributes makes Geographic Information System (GIS) an ideal campus management tool for facility management system. Hence, it would be helpful for the university administration, the students, visitors, and the people who work at the university to have an information system with spatial and nonspatial attributes handling capabilities. This system would help to:

- Store data in a central repository for several departments of the university
- Collect, manage, and display facility and ground data
- Access information through a simpler interface by users of the system.

GIS-based Facility Information Management Systems (FIMS) offer several advantages over traditional CAD-based FIMS systems, particularly in integrating land management (campus or site level) and facility management (building, floor and room level) into one package (Srivastava and Brad 2009).

The embracing new technology, i.e., Internet technology is now the current and future platform for FM. Hence, it would be helpful for the university administration, the students, visitors, and the people who work at the university to have an information system with spatial and non spatial attributes handling capabilities through web like the nearest and the closest one. Thus, the development and rapid expansion of Geographic Information System (GIS) technology has a significant impact on the field of facility and human resources management. The campus GIS was conceived as a tool to support all of these functions. Hence, it is rightly said; "By using geographic data and systems, the port is able to use geography as the common factor to bring together data that otherwise is difficult to integrate" (Meikle 2007).

Mobile Mapping or Mobile GIS is the combination of geographic information system (GIS) software, global positioning systems (GPS), and mobile computing devices. Mobile GIS fundamentally changes the way information is collected, used in the field, and shared with the rest of an organization. ArcPad software is used for mobile GIS and field mapping applications (ESRI), for this study. ArcPad lends itself to a variety of industry uses. The ability to collect information in any location and store it in a spatial database enables improved processes and new efficiencies. ArcPad applications range from large deployments with hundreds of users to small applications of a single piece of software. Regardless of deployment size, all share a common benefit: improved efficiency and more accurate data collection. The basic

facilities include like locating an ATM, Bank, Canteens, Health centres, Photostat, etc., were collected using ArcPad.

14.2 Objectives

- Collection of information on various facilities in the Delhi University North Campus
- Development of Facility Management System in a GIS framework.

14.3 Study Area

The area covered under this study is geographically located in the extent of 28° 41′ 25.47″N and 77° 12′ 36.79″E. It covers an area of around 2 km^2. The present study is for University of Delhi, North Campus (Fig. 14.1).

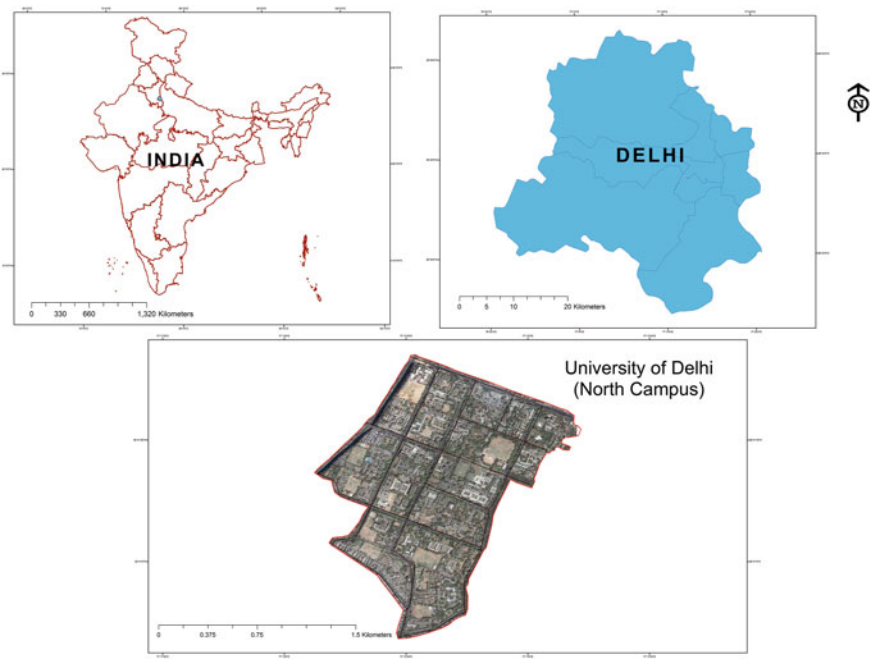

Fig. 14.1 Location of study area

14.4 Data and Methodology

(i) GPS data on Facility location
(ii) Maps and Satellite Images (Eicher City Map of Delhi, QuickBird Data).

This study provides the rationale for facility mapping in the north campus of university of Delhi. The basic facilities include like locating an ATM, Bank, Canteens, Health centers, Photostat, etc.

For this study to be carried out, city map (Eicher) of Delhi was georeferenced and then the study area and all the facilities of the city were extracted from that city map

Eventually, using the high resolution satellite imagery (QuickBird) for the study area, the feature extraction such as buildings, grounds, library, parks, etc., was performed. Since, the QuickBird data was of the year 2008; the Google earth was used to update the features for the recent data available. Finally, the geospatial database was updated and used the same for mere inspection on the field to check the basic facilities available in the university campus (Fig. 14.2).

Mobile GIS has been used in this study for updating and gathering information on the features and facilities in the university campus. It helped in updation of essential attributes related to the facilities in the field itself, which saved a lot of time and money. An HP iPAQ navigation device has been used in which ESRI ArcPad has been installed and also GPS available was used for capturing the coordinate information related to each facility and also update any other information on the field itself.

The following facilities have been considered during the survey:

1. ATM
2. Bank
3. Bus Stop
4. Food Joints
5. Hostels
6. Library
7. Medical Shop
8. Photocopy and Printout Shops
9. Railway Reservation Centre
10. Shopping Centres
11. Sport and Stadium
12. Stationery and Other Shops.

After doing a geo-rectification of the features with a coordinate system of Universal Transverse Mercator (UTM) and a datum of WGS84, the topology for the dataset has been built.

Furthermore, the network analysis was done to perform certain geoprocessing analysis for facilities mapping in the campus.

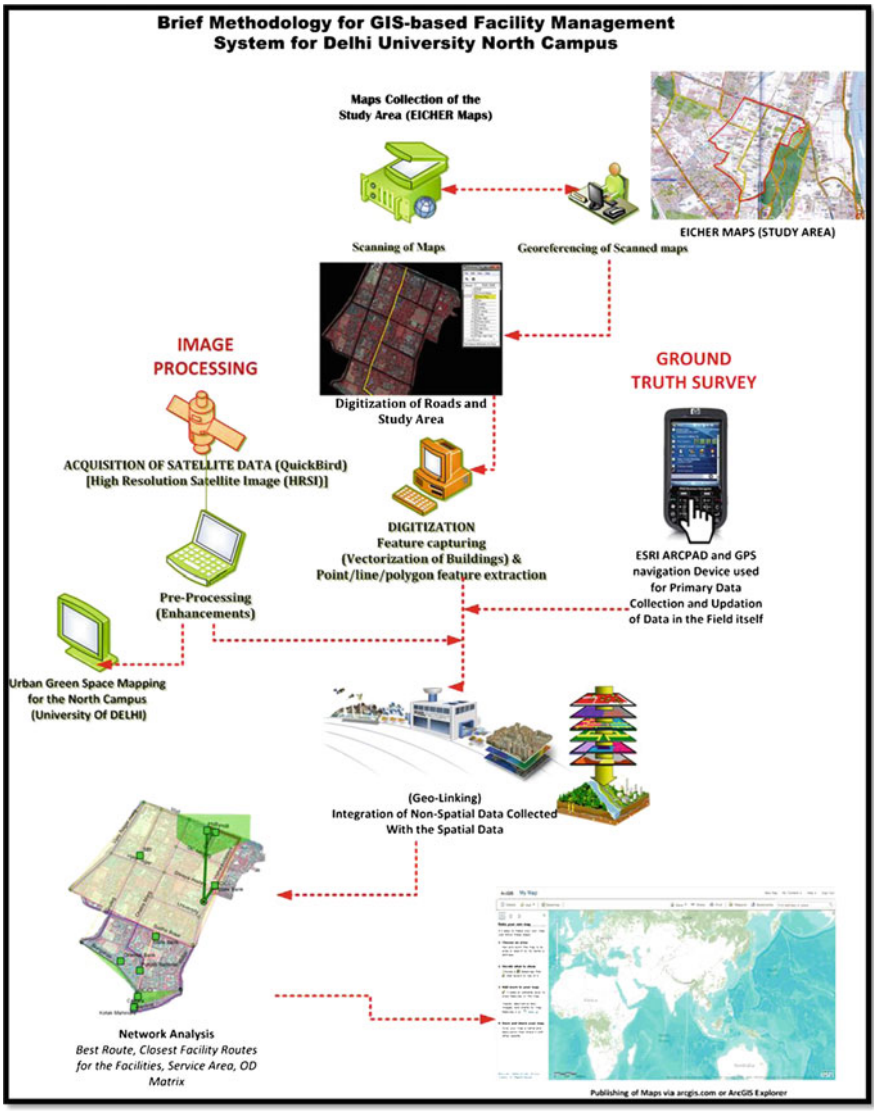

Fig. 14.2 Flowchart of methodology

After creating the Network dataset (Fig. 14.3), it was used further in ArcMAP (ArcGIS) for Network analysis to find out the best optimum route first, using the roads layer. Then, using the facilities, further analysis was done to find out:

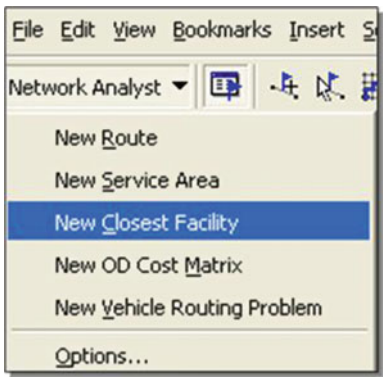

Fig. 14.3 Network analyst toolbar

- Best Route
- New Closest Facility
- New Service Area
- New OD Matrix.

Following maps were analyzed for finding the best route with the help of 'New route' tool available in the network analyst toolbar (ArcGIS). The roads are taken as inputs for this analysis to find out the best route in the campus. Two of the maps displays the existing routes of the bus services: metro feeder (Fig 14.4a) and university special bus service (Fig 14.4b); while one map displays routes is a new suggested route for covering the whole of the campus (Fig: 14.4c).

Finding Best Route Using Network Analysis

The output maps shows the metro feeder bus service route, the university special DTC bus route service and the newly suggested route covering the whole of North campus.

The following maps were generated considering three aspects combined and displayed together in order to understand the spatially explicit conditions underlying them.

Closest Facility, Service Area, and OD Matrix

The maps given below represent the important facilities available in the north campus of the University of Delhi. In all the banks, the red lines depicts the closest facility route to the facilities from the administrative block of the campus, except for the map representing bus stop facilities, where green line represents the closest facility of bus stops from the administrative block.

Similarly, Origin–Destination (OD) cost matrix lines (a table that contains the network impedance from each origin to each destination) have been represented in the maps and the best network path has been discovered for each origin–destination pair (administrative block- facilities, and vice versa).

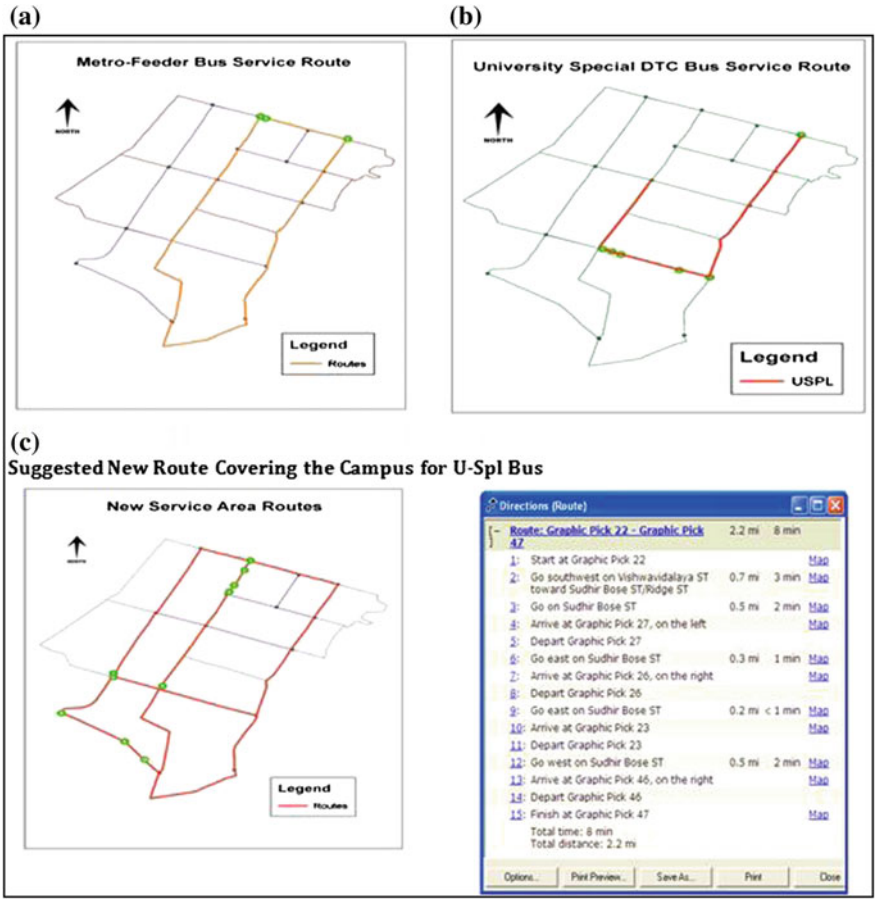

Fig. 14.4 **a–c** Existing and new routes in the campus

The maps also infer the service areas around any location on the network. (A network service area is a region that encompasses all accessible streets—that is, streets that lie within a specified impedance.) For instance, the 0–1-min service area for a facility includes all the streets that can be reached within 0–1 min from that facility.

Apart from doing Network analysis, proximity analysis was also done for the selected facilities in the campus.

Proximity Analysis

The proximity analysis especially buffer analysis including multiple ring buffer analysis was performed in order to find out the accessibility of certain facilities in

the University of Delhi campus. For this study, a point layer has been created for the university gate, which was the input and around which buffers were created for numerous facilities within the campus, to estimate their accessibility in meters

The buffer analysis showed that the chemist shop is within 500 m of the university campus.

Similarly, the miscellaneous facilities like computer facilities, shopping areas, stationary shops, repairing services, etc., are shown according to their accessibility through buffers in the map, like the computer printout facility is within 750–1000 m buffer.

Eventually Facility layers such as ATM (Fig 14.5a), Sport, Petrol Pump, Police, Food Canteen (Fig 14.6a), Bank, Health Centre, etc., are uploaded through ArcGIS explorer to make it web enabled, so that users in the system can easily access it and callout useful information out of it. The beauty of this free explorer is that it has high resolution satellite imagery also in the backdrop, which actually enables users to relate the information available on the layers to the actual ground reality (Figs. 14.7 and 14.8).

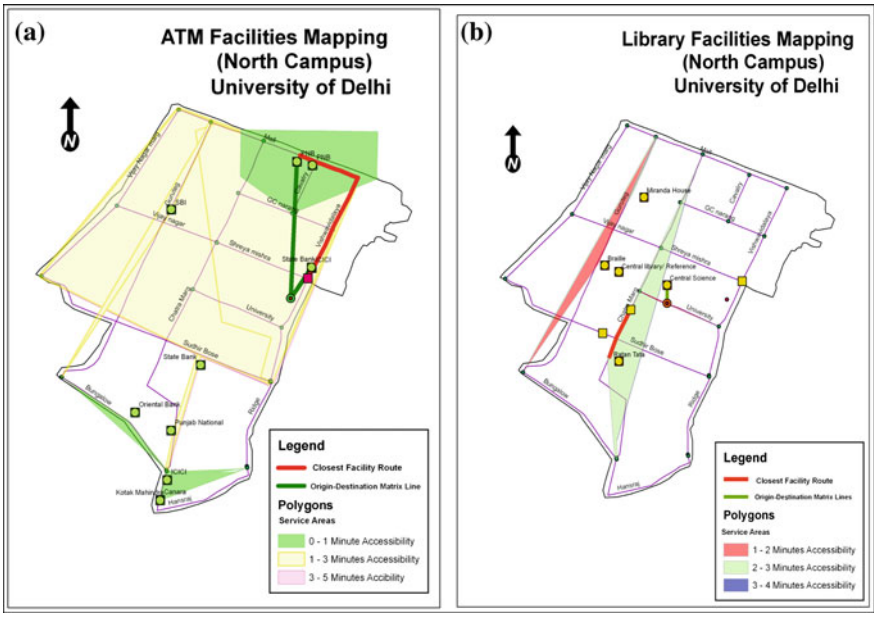

Fig. 14.5 **a**, **b** Mapping of ATM and library facilities

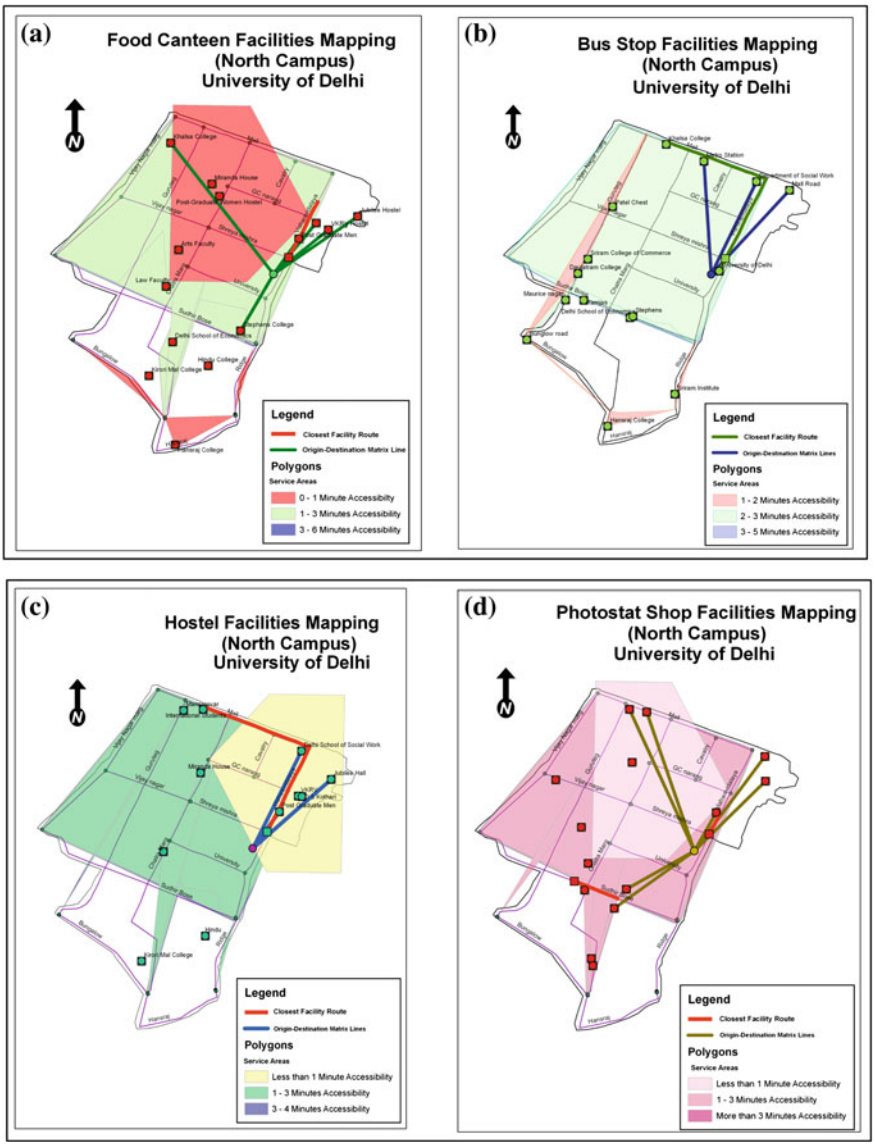

Fig. 14.6 **a–d** Mapping of food canteen, bus stop, hostel and photostat shop facilities

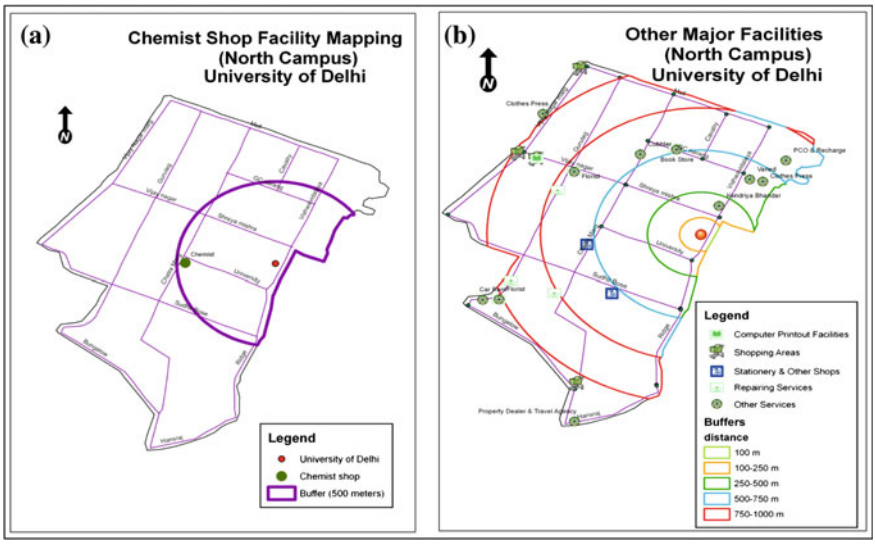

Fig. 14.7 **a**, **b** Buffers to the facilities

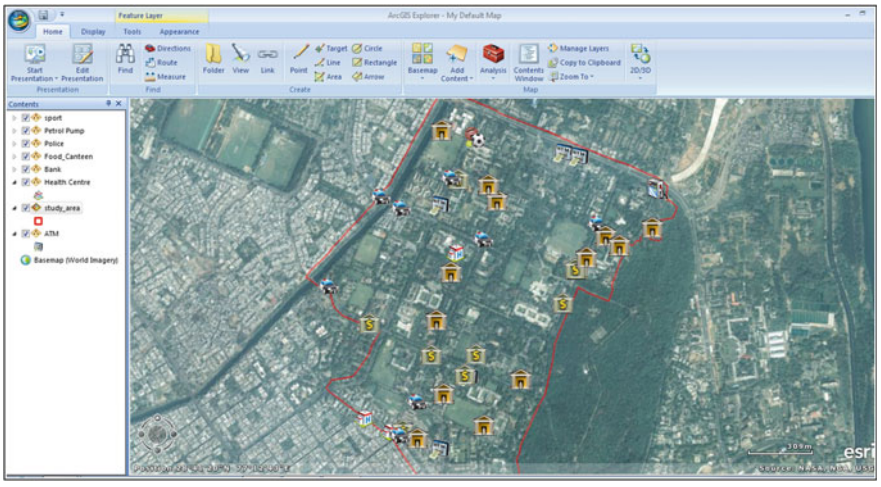

Fig. 14.8 Publishing of the major facilities of the campus ArcGIS explorer application

14.5 Conclusion

This research study attempts to develop a system in mapping and managing the facilities in the campus of University of Delhi. This system gives information on the facilities available in the north campus of the university. It in fact, provides

information on the facilities lying close to the administrative block of the university, along with the directions to reach to the facility location.

This system, moreover details out the service areas of the facilities in the campus, and also the time required getting the access to that particular facility. It also buffers out the location of the facilities to a particular distance from the administrative campus of the university. Further, this system brings out the origin–destination matrix lines from the administrative block of the university to the facility location. Surely, this system has led to the easy mapping and management of the facilities in the campus. In fact, here facilities of the campus have been mapped and managed, similarly, facilities of a town or a city can also be mapped using similar technology.

This system can further be web-enabled for easy access of information to every user. This system can also have the facility of 'Query,' which will deliver multiple results to a single query of the user. As for instance, a person new to the campus comes to the university, can have pre-hand information on the facilities of the campus, and can be informed about the campus. Detailed information about departments in colleges and other essential information could be added in this system, making it a full-fledged tool for executive decisions.

The whole system could be developed on ArcGIS Server platform or open-source open platform technology could also be used for developing this web GIS tool. However, distributing geospatial information on the Internet is an enforcing factor for information providers. Internet allows all levels of society to access geospatial information and provides a media for processing geo-related information with no local restrictions. Web-based GIS has evolved from different web maps and client server architecture to distributed ones (Alesheikh et al. 2002).

As such Internet reshapes all functions of information systems including: gathering, storing, retrieving, analyzing, and visualizing data. The high cost of GIS system, the release of system specific databases, and other development efforts on upgrading the system are fading, with the entry of web-based GIS. Furthermore, if this study gets incorporated into a mobile technology through an app would further enhance in better accessibility to the urban amenities and services. Hence, disseminating spatial information on the internet improves the decision making process.

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