

**DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED
SCIENCES**

**SPATIAL INFORMATION MANAGEMENT FOR
HEALTH CAMPUS: AN APPLICATION**

**by
Suzan GÜNER**

**November, 2012
İZMİR**

SPATIAL INFORMATION MANAGEMENT FOR HEALTH CAMPUS: AN APPLICATION

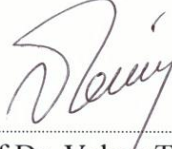
**A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Degree of Master of Science
in Geographical Information Systems, Geographical Information Systems
Program**

**by
Suzan GÜNER**

**November, 2012
İZMİR**

M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled “**SPATIAL INFORMATION MANAGEMENT FOR HEALTH CAMPUS: AN APPLICATION**” completed by **SUZAN GÜNER** under supervision of **PROF. DR. VAHAP TECİM** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.



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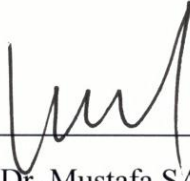
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ACKNOWLEDGMENTS

I would like to express my appreciation to my advisor Prof. Dr. Vahap Tecim, for his supports and valuable advises during the study.

For their precious contributions, supports and comments in my project I would like to thank GIS specialist / city planner H. Ceren DİNÇER and survey engineer Özlem H. KARACA.

Finally, I am grateful my mother Nazmiye GÜNER, for her support, her patience and confidence in me throughout my life.

Suzan GÜNER

SPATIAL INFORMATION MANAGEMENT FOR HEALTH CAMPUS: AN APPLICATION

ABSTRACT

The importance of information has been realized by today's communities that our time is called the "information age" and on this issue, countries have engaged in a great race. In this age, information is considered as a source and it might be optimized (Yomralıoğlu, 1994).

Use of information technology comes to the fore as a reflection of the transition process on the information age. As in all disciplines, it is also required as well as in the realization of the map-based applications to use information effectively with taking the maximum advantage of information. Particularly, spatial aided graphic and non-graphic information, which is described as mapping information, needs to be integrated within a system.

Universities are assumed as the leader institutions that inform the society so today also they must be the institutions that use information most effectively. It is also inevitable for the development of the universities to evaluate and update information and obtain new information with them. So universities are required to establish a system that based on an information technology in order to serve with the understanding of modern management.

In this study, spatial information system's design and implementation was carried out using Geographic Information Technologies regarding to the case study with emphasizing how such a system's basic infrastructure should be.

With this study, an environment was provided for making graphic and non-graphic questioning about the study area, after an appropriate database structure was created by transferring the basic map layers into the computer. For this purpose, it was used ArcMap and ArcCatalog software, which are technological tools of

Geographic Information System, in order to collecting data and processing queries. Thus, with the appropriate software and hardware, required test studies carried out under the project.

Keywords: Spatial information system, geographic information systems, campus information system

SAĞLIK KAMPÜSÜNDE KONUMSAL BİLGİ YÖNETİMİ: BİR UYGULAMA

ÖZ

Günümüz toplumlarınca bilginin önemi anlaşılmış olacak ki çağımız "bilgi çağı" olarak adlandırılmış ve bu konuda ülkeler büyük bir yarış içerisine girmiştir. Artık bir kaynak olarak kabul edilen bilgidен en iyi şekilde yararlanma yoluna gidilmektedir (Yomralıoğlu, 1994).

Bilgi çağına geçiş sürecinin bir yansıması olarak bilgi teknolojilerinin kullanımı ön plana çıkmıştır. Her alanda olduğu gibi, harita-destekli uygulamaların gerçekleştirilmesinde de bilgidен maksimum düzeyde yararlanarak bilgiyi etkili bir şekilde kullanmak gerekmektedir. Özellikle harita bilgisi olarak nitelendirilen, konuma bağımlı grafik ve grafik olmayan bilgilerin bir sistem içerisinde bütünleştirilmesi gerekmektedir.

Toplumun bilgilendirilmesinde önder kurum olarak üniversiteler sayılır ise, günümüzde bilginin en etkin kullanıldığı kurumların da üniversiteler olması beklenir. Mevcut bilgilerin değerlendirilip, güncellenmesi ve bunlardan yeni bilgilerin elde edilmesi de yine üniversitelerin gelişimi için kaçınılmazdır. Üniversitelerin çağdaş yönetim anlayışında hizmet verebilmeleri için, bilgi teknolojisine dayalı bir sistem oluşturmaları gerekmektedir.

Bu çalışmada böyle bir sistemin temel altyapısının nasıl olması gerektiği üzerinde durularak, örnek bir kampüs üzerinde, Coğrafi Bilgi Teknolojileri ile bir konumsal bilgi sisteminin tasarımı ve uygulaması gerçekleştirilmiştir.

Bu çalışma ile, temel harita altlıklarının bilgisayar ortamına aktarılarak uygun yapıdaki veri tabanlarını oluşturup, çalışma alanına ilişkin grafik ve grafik-olmayan sorgulamaları yapacak ortam hazırlanmıştır. Bu amaçla, verilerin toplanıp, sorgulama işlemlerinin yapılabilmesi için gerekli olan teknolojik araç olarak ArcMap ve

ArcCatalog Coğrafi Bilgi Sistem yazılımları kullanılmış, uygun yazılım ve donanım üzerinden gerekli test çalışmaları da proje kapsamında gerçekleştirilmiştir.

Anahtar kelimeler: Konumsal bilgi sistemi, coğrafi bilgi sistemleri, kampüs bilgi sistemi

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CHAPTER ONE

INTRODUCTION

Information is one of the most important elements in community life. To own the information and to use it more efficient maintains importance throughout history. Recently, information had a key role in all areas by becoming more important than the before.

Information is perceived as a production factor that brought up the "speed" concept in terms of its production and spread form. In this way, it is emerged that the meaningful information will be possible by the management of the information.

Information technologies, which are evolving rapidly, have enabled the emergence of new dimensions of knowledge management. Processing data and putting them into use are becoming more important in terms of utilization of the advantages that information will ensure in the long term. The use of information technologies such as Geographic Information Systems (GIS) came to the fore as a result of the gained importance of the location-based information and the increased need for the location-based decision-making processes in the information management.

GIS is an organized collection of computer hardware, software, data, and personnel designed to capture, store, update, manipulate, analyze, and display of geographically referenced information for a specific purpose (Tecim, 2008). Geographic Information System technologies are the most important element of the spatial decision-support systems that they also increasingly felt the impact of decision-making processes.

As in all disciplines, also in the map-aided applications, it is required to use information effectively by taking advantage of the maximum level of information. To accomplish this, it will be sufficient to use modern information technology in these areas. Particularly, spatial aided graphic and non-graphic information, which is

described as mapping information, needs to be integrated within a system. In this way there will be a healthy and quick access to information that stored in.

Educational institutions are one of the institutions that must benefit from information technologies and the opportunities they bring up. An educational institution that aims to use information technologies must create an information system within its own organization. This information system which is created will present readily how is the current structure of educational institution and what are the needs of the institution. Thus, information system will be qualified to be a guiding for the people who influence in the decision-making. When information system is demanded for presenting by associated with a geographic base, it is beneficial to utilization of Geographic Information Systems.

At the universities, which have an important role among the educational institutions, an effective information system must be used. Universities exploited the opportunities brought by the Geographical Information System for the creation of an effective information system. What is important here is to manage information on a regular basis with management organization.

In this study, with which map-based spatial information management system was required to create, first of all, definitions will be given on the basic concepts. After the definitions of the system in the first chapter, the Geographic Information System, the science was used during the installation of the system, will be informed shortly. In the second chapter, it will be shown how to benefit from the Geographic Information System in the campuses of universities, especially in the health campuses, with the examples of universities that have similar structures in this area in Turkey and around the world. In the third chapter, it will be taken through the stages of a sample application was prepared. Details will be shown about how the system was created and what the results will be reached as a conclusion of a spatial information system, which was created in the Health Campus in Inciralti Campuses of Dokuz Eylül University. In the conclusions and recommendations chapter, the information will be given about what has been achieved as a result of this study that

may constitute a recommendation for other studies.

1.1 Definition of the Problem

One of the most fundamental problems in organizations today is to reach the necessary information. Current data storage without a regular structure causes the emergence of this problem. In addition, to produce new information from the existing information or healthy and fast way to have information when needed is the most willing administrative demands of today's institutions. These demands are also true for universities, such as many institutions.

There is always a need of healthy information at every stage of the processes of universities from the planning to the management. Particularly, querying the identity of physical structures, the size and the needs of the campus, areas within the campus, the size of the lower and upper structures, namely data such as land use information can be considered as some of these needs.

Our age is the time of the optimal use of information and utilization of the information in accurate, current, fast and effective way using with information technologies. So the classical methods of collecting, modeling, processing and analyzing of information will result in a loss of time, cost, and labor as in the existing structure. In addition to the compilation of available information within a particular order, production of new information and quickly meeting the needs of the users are only possible with an information system.

At first glance, it may appear as a very inconvenient investment regard to the cost and the time, but installing a spatial information system that contains especially the topographic structure of the university campuses, physical structures such as the lower and upper structures beside the administrative information has become an inevitable requirement. Today, geographic information systems can respond to these needs. However, the system established must be designed and implemented regard to answer the needs.

1.2 Objectives of the Study

The main objective of this study is to design the formation of “Spatial Information Management for Health Campus” using by Geographic Information Systems with the goal directed to establishing a spatial information system for a university’s health campus and carry out it in the form of a pilot project.

With this sample project designed, a basic map will be established with the existing use of the space in the health campus and management of the building and mass properties of the upper structure. At the same time, with this basic map, future needs and services for all kinds of decisions will be fast and in a healthy way concerned with planning. Regard to this opinion, an appropriate database structure is created by transferring the basic map layers into the computer in order to provide an environment for making graphic and non-graphic querying on the campus area.

AutoCAD Map that is a cad-based software and Arc/Info, which is one of the Geographic Information System software, will be used for the data collection, processing and querying operations. Under this project, also required testing works will be tried to perform over the appropriate software and hardware with update of the systems to meet the user needs.

1.3 Methodology

The following way for the realization of this study will be monitored:

- Determination of objectives and targets of the system to be established,
- Examination of the need for spatial information management in the health campus,
- Identification of needs,

- Determination of software and hardware used in the application,
- Reviewing literature studies required and examination of the concepts related to Geographic Information Systems for the realization of information system in the health campus,
- Design of the information system,
- Data collection: land use maps, site plan, satellite photos, floor plans and other graphic and non graphic data collection,
- Editing of the data and creation of the layers in the system by using AutoCAD and ArcMap software,
- Production of the required basic map layers,
- Creation of data bases and attribution with the spatial data,
- Testing of the system with spatial query and analysis processes and examination of the results.

CHAPTER TWO

BASIC CONCEPTS

In this study, in order to prevent conceptual confusion, a priority will be given to the descriptions of concepts that are mentioned in the study.

2.1 Definitions

2.1.1 Data

The definitions, which don't have too much significance alone but make sense when coupled with other facts, are called data. Data are the representation format and the raw material of knowledge. Data are expressed as the collection of every kind of signs, letters or figures that can be transformed into information (Yomralıoğlu, 1999). Information is obtained when data are classified and combined according to a specific order.

2.1.2 Information

Information can be defined as the whole truths and principles to which human intelligence can access (Ağar, 1974). In general, searching and investigating social, scientific, economic, cultural etc. topics, and emerged information as a result of learning, research and observation are significant sources and needs to shape the daily developments (Yomralıoğlu, 1994).

2.1.3 System

A method should be followed in obtaining the information to achieve more success than the other communities. In this context, the concept of the system is encountered. The system is a set of processes and applications that aim to fulfill a specific function.

2.1.4 Information Systems

There must be a specific system for information gathering, processing and converting. The systems that set up on this purpose are called in general as information systems, in addition to this information systems are defined as a mechanism which gathers, stores, produce and distributes information to support administrative functions (Association for Geographic Information, 1991). Therefore, information system can be detected as a system generated for easy access to information and more efficient use of it (Star & Estes, 1990). An information system, as shown in Figure 1, consists of a series of observation, data gathering and analysis process.

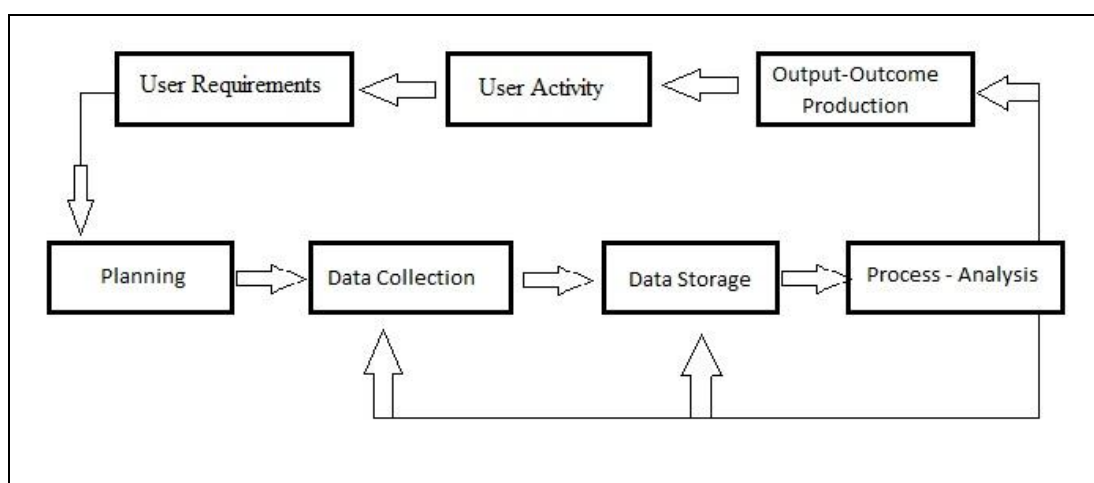


Figure 2.1 Processing flow in an information system in simple terms (Star & Ertes, 1990)

Information systems, which have a wide range of application area that depends on technological developments, often classified according to the application forms.

Accordingly, information systems can be divided into two groups as spatial and non-spatial information systems (Yomralıoğlu, 2000).

2.2 Geographic Information Systems

The use of Geographic Information Systems (GIS) and Geographical Information (GI) plays a key role in human activities today. GIS is widely applied in everyday life by many of the services we rely on. It is one of the fastest growing uses of computer technologies and is a fundamental part of modern geography (Ramirez, 1996). GIS is a tool that is being used extensively by researchers, scientists and administrators to inform decision making about real issues (Birkin *et al.*, 1998). The application of this technology is increasingly being found in such areas as the environment, resource and hazard management and infrastructure development (Htun, 1997). GIS operates at many different scales, including whole countries and increasingly in international circumstances (Patterson & Siderelis, 1998).

GIS requires digital map information, data for the maps and software to process the maps and data. It uses powerful computer tools to bring these three things together and is capable of assembling, storing, manipulating and displaying geographically referenced information (Blake *et al.*, 2003). GIS also provides a system of ordering, managing, manipulating and transforming large quantities of information, leading to opportunities to combine, overlay or integrate data sources, based on spatial location. GIS is also capable of high quality, complex cartographic representation and visualization of information. GIS is applied to solve problems related to analysis, management and efficiency (Camara, 1999). It thus provides an effective aid to decision making and management.

According to some researchers, GIS is a concept that contains all the spatial information systems and according to others, it is a system used with a special purpose inside the spatial information system. Therefore during the classification of the systems, debates about GIS's place are still continuing. This concept is defined in different ways because GIS has users from different disciplines. Some of the definitions of GIS are:

- “An information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a system with specific capabilities for spatially-referenced data, as well as a set of operations for working [analysis] with the data.” (Star & Estes, 1990)
- “A system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially-referenced data for solving complex planning and management problems.” (Cowen, 1989)
- “A working GIS integrates five key components: hardware, software, data, people, and methods.” (ESRI, 1997)
- “GIS is a form of information management system which is for viewing general map information.” (Devine & Field, 1986)
- “A GIS is a computer-based information system designed to efficiently capture, store, update, manipulate, analyze, and display many forms of geographically referenced and associated tabular attribute data.” (Fischer & Nijkamp, 1993)
- “Geographic Information System is an information system, which performs the functions of collection, storing, processing of the graphic and attribute information from location-based observations and their presentation to the user in integrity.” (Yomralioğlu, 2000)

GIS can be defined in summary as follows:

GIS is a computer- based system for mapping and analyzing the resources and object in the real world.

2.2.1 Evolution of GIS

Computer hardware development spurred by nuclear weapon research led to general-purpose computer 'mapping' applications by the early 1960s (Fitzgerald, 2007).

The year 1960 saw the development of the world's first true operational GIS in Ottawa, Ontario, Canada by the federal Department of Forestry and Rural Development. Developed by Dr. Roger Tomlinson, it was called the Canada Geographic Information System (CGIS) and was used to store, analyze, and manipulate data collected for the Canada Land Inventory (CLI) – an effort to determine the land capability for rural Canada by mapping information about soils, agriculture, recreation, wildlife, waterfowl, forestry and land use at a scale of 1:50,000. A rating classification factor was also added to permit analysis.

CGIS was an improvement over 'computer mapping' applications as it provided capabilities for overlay, measurement and digitizing/scanning. It supported a national coordinate system that spanned the continent, coded lines as arcs having a true embedded topology and it stored the attribute and location information in separate files. As a result of this, Tomlinson has become known as the 'father of GIS', particularly for his use of overlays in promoting the spatial analysis of convergent geographic data (Tomlinson, 2007).

CGIS lasted into the 1990s and built a large digital land resource database in Canada. It was developed as a mainframe-based system in support of federal and provincial resource planning and management. Its strength was continent-wide analysis of complex datasets. The CGIS was never available in a commercial form.

In 1964, Howard T. Fisher formed the Laboratory for Computer Graphics and Spatial Analysis at the Harvard Graduate School of Design (LCGSA 1965–1991), where a number of important theoretical concepts in spatial data handling were developed, and which by the 1970s had distributed seminal software code and

systems, such as 'SYMAP', 'GRID' and 'ODYSSEY' – that served as sources for subsequent commercial development—to universities, research centers and corporations worldwide (Fisher & Lovison-Golob, 2007).

By the early 1980s, M&S Computing (later Intergraph) along with Bentley Systems Incorporated for the CAD platform, Environmental Systems Research Institute (ESRI), CARIS (Computer Aided Resource Information System) and ERDAS emerged as commercial vendors of GIS software, successfully incorporating many of the CGIS features, combining the first generation approach to separation of spatial and attribute information with a second generation approach to organizing attribute data into database structures. In parallel, the development of two public domain systems began in the late 1970s and early 1980s (GIS History, 2009).

The Map Overlay and Statistical System (MOSS) project started in 1977 in Fort Collins, Colorado under the auspices of the Western Energy and Land Use Team (WELUT) and the US Fish and Wildlife Service. GRASS GIS was introduced in 1982 by the US Army Corps of Engineering Research Laboratory (USA-CERL) in Champaign, Illinois, a branch of the US Army Corps of Engineers to meet the need of the US military for software for land management and environmental planning.

In the later 1980s and 1990s, industry growth was spurred on by the growing use of GIS on Unix workstations and the personal computer. By the end of the 20th century, the rapid growth in various systems had been consolidated and standardized on relatively few platforms and users were beginning to explore the concept of viewing GIS data over the Internet, requiring data format and transfer standards. More recently, a growing number of free, open-source GIS packages run on a range of operating systems and can be customized to perform specific tasks. Increasingly geospatial data and mapping applications are being made available via the World Wide Web (Fu & Sun, 2010).

Until the mid-'90s, organizations utilized geographic information systems that closely tied applications to a native, proprietary spatial data model. These early file

structures were highly optimized for fast access to data and were relatively easy to distribute between sites using the same GIS vendor software. Data sharing between organizations with different GIS vendor systems was limited to data converters, transfer standards, and later open file formats.

Gradually, GIS models evolved into geo-relational structures where related attribute data could be stored in a relational database that was linked to the file-based spatial features. In the mid-'90s, new technology emerged that enabled spatial data to be stored in relational databases, opening a new era of broad scalability and the support of large data layers.

As GIS technology continues to evolve the best long-range solution for data sharing and interoperability is Web services. This gradual on-going transformation is primarily fueled by the growing role of GIS in today's organizations, the increasing availability of spatial data and its inherent conduciveness to reuse (ESRI, 2003).

2.2.2 Classification of Geographical Information Systems

Nowadays, especially developments in computer technology caused the concept of "information system" to be pronounced more frequently. Information systems, with a wide application area, are classified according to the application forms. However, institutions and organizations look information systems from their own application areas and sometimes they use them in common. Because of these, it is difficult to classify information systems.

However, information systems initially can be divided into two groups as non-spatial information systems and spatial information systems.

2.2.2.1 Non-Spatial Information Systems

This kind of information systems contains administrative functions which are much more intended to institutions and organizations. For example, the legal

arrangements necessary to run an organization, working principles, duties and the inter-institutional cooperation while fulfilling these duties are the subjects of non-spatial information systems (Yomralıoğlu , Bıyık & Akyol, 1999).

2.2.2.2 Spatial Information Systems

It is an information system, which is not only about coordinates of objects, but also the identification of coordinates with attribute data. Spatial information systems are divided into four groups according to their characteristics and data types. These are;

- **Environmental Information System:** It is an information system that examines the physical or biological structure of the environment, and the effects of these with human-environment interaction.
- **Infrastructure-Engineering Information System:** The basic functions of this information system are the settlement of surface and underground facilities, their protection-maintenance-repair and the fulfilling of other basic services.
- **Cadastral Information System:** It performs tasks related to property that are based on cadastral operations. It regulates the relations between property rights, land use and planning on the basis of the parcel.
- **Socio-economic Information System:** It is a system that is based on gathering data necessary for the social and economic construction and processing them. It includes in particular demographic data like statistics, population etc. And determination of administrative region zones (Yomralıoğlu, Bıyık & Akyol, 1999).

The overlapping of many different spatial layers with the help of information Technologies and the use of these layers with each other and non-graphical data is

needed. In this context, the positioning of digitalized data in the same coordinate system is the basic condition of the above-described information system. Remotely sensed data are the coordinate addressable layers, as well as is an attractive source of information in land use mapping.

2.2.3 Components of Geographic Information Systems

Components that make GIS consist of five main elements as shown in Figure 2.2. These are hardware, software, data, people and methods.

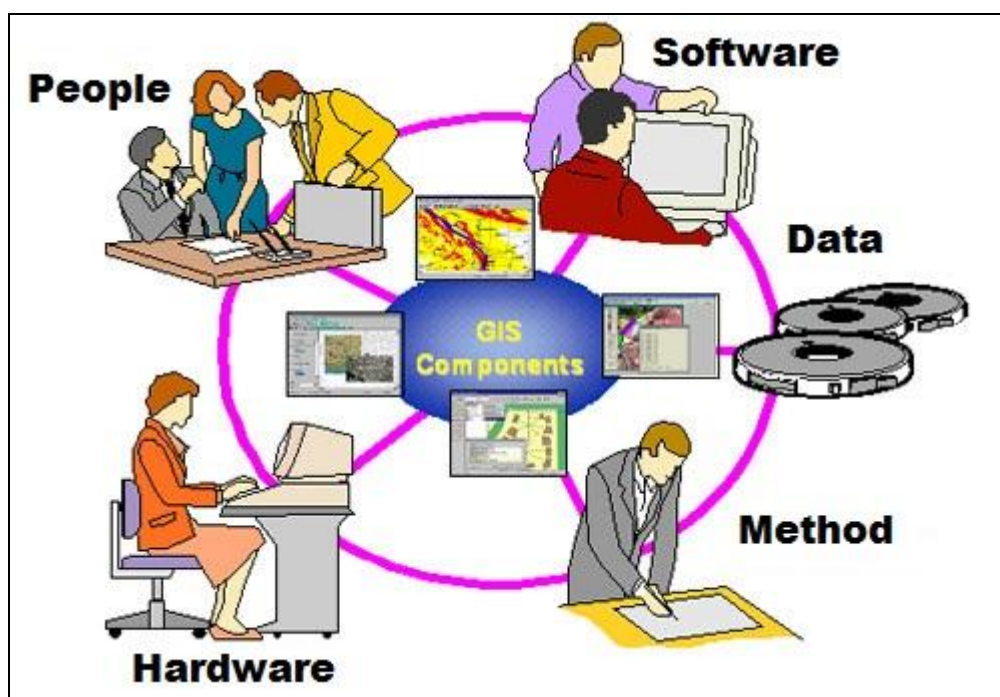


Figure 2.2 Components of GIS

2.2.3.1 Hardware

Computer that enables us to run GIS is called hardware. Today, many GIS software runs on different hardware. These can vary from centralized computer systems to desktop computers and from personal computers to network-equipped computer systems.

2.2.3.2 Software

GIS software should provide needs and functions such as storing, analyzing, and displaying of geographic information to the user.

The basic elements that should be in software are:

- To have the necessary tools to access and process geographic information
- To have a data base management system
- To support spatial query, analysis and display
- To have interface support to link with additional hardware

2.2.3.3 Data

Data, which is one of the most important aspects of GIS, is the component to be the most difficult to obtain. The achievements of the weak points of data are data accuracy, neutrality, and suitability for the time.

The data obtained sometimes from scratch, and sometimes descriptive nature or attribute data table with graphic structure of geographic data can be collected from the resources required or the data available can be purchased in the market. GIS can combine spatial data with other data sources. Thus, data from many institutions and organizations can be organized and integrated with spatial data.

2.2.3.4 People

A structure would be limited without people in GIS technology. Because people manage the necessary systems and prepare development plans to apply to real-world problems. GIS users are a wide range of audience from the expert technicians who design and protect the systems, to the people who improve the performance of daily tasks.

2.2.3.5 Methods

A successful GIS operates according to very well-designed plan and business rules. These kinds of functions are models and applications are unit-specific to each institution.

2.2.4 Data Collection in Geographic Information System

2.2.4.1 How GIS Works?

GIS stores the information about the earth associated with each other geographically by accepting them as thematic map layers. This is a simple but extremely powerful approach for the evaluation of spatial information. This approach allows for the solutions of many real-world problems such as optimal load distribution of transport vehicles or detailed records of planning-based applications or even modeling of atmospheric changes.

2.2.4.2 Geographic References

Geographic Information contain exact values such as geographic coordinates in the form of latitude-longitude or referenced information such as address, area name, road name. These geographic references allow providing positioning of objects. Thus, commercial areas, forests, earth crust movements and surface shapes can be determined by the analysis of position.

2.2.4.3 Vector and Raster Models

GIS basically works with spatial model forms, which have two different structures. These are “vector model” and “raster model”.

2.2.4.3.1 Raster Model. A raster data type is, in essence, any type of digital image represented by reducible and enlargeable grids. Anyone who is familiar with digital

photography will recognize the raster graphics pixel as the smallest individual grid unit building block of an image, usually not readily identified as an artifact shape until an image is produced on a very large scale. A combination of the pixels making up an image color formation scheme will compose details of an image, as is distinct from the commonly used points, lines, and polygon area location symbols of scalable vector graphics as the basis of the vector model of area attribute rendering. While a digital image is concerned with its output blending together its grid based details as an identifiable representation of reality, in a photograph or art image transferred into a computer, the raster data type will reflect a digitized abstraction of reality dealt with by grid populating tones or objects, quantities, co-joined or open boundaries, and map relief schemas. Aerial photos are one commonly used form of raster data, with one primary purpose in mind: to display a detailed image on a map area, or for the purposes of rendering its identifiable objects by digitization. Additional raster data sets used by a GIS will contain information regarding elevation, a digital elevation model, or reflectance of a particular wavelength of light, Landsat, or other electromagnetic spectrum indicators (Environment & Ecology, 2012).

Raster data type consists of rows and columns of cells, with each cell storing a single value. Raster data can be images (raster images) with each pixel (or cell) containing a color value. Additional values recorded for each cell may be a discrete value, such as land use, a continuous value, such as temperature, or a null value if no data is available. While a raster cell stores a single value, it can be extended by using raster bands to represent RGB (red, green, blue) colors, color maps (a mapping between a thematic code and RGB value), or an extended attribute table with one row for each unique cell value. The resolution of the raster data set is its cell width in ground units (Environment & Ecology, 2012).

Raster data are stored in various formats; from a standard file-based structure of TIF, JPEG, etc. to binary large object (BLOB) data stored directly in a relational database management system (RDBMS) similar to other vector-based feature classes. Database storage, when properly indexed, typically allows for quicker

retrieval of the raster data but can require storage of millions of significantly sized records (Environment & Ecology, 2012).

2.2.4.3.2 Vector Model. In a GIS, geographical features are often expressed as vectors, by considering those features as geometrical shapes. Different geographical features are expressed by different types of geometry:

- **Points**

Zero-dimensional points are used for geographical features that can best be expressed by a single point reference—in other words, by simple location. Examples include wells, peaks, features of interest, and trailheads. Points convey the least amount of information of these file types. Points can also be used to represent areas when displayed at a small scale. For example, cities on a map of the world might be represented by points rather than polygons. No measurements are possible with point features (Coppock & Rhind, 1991).

- **Lines or Polylines**

One-dimensional lines or polylines are used for linear features such as rivers, roads, railroads, trails, and topographic lines. Again, as with point features, linear features displayed at a small scale will be represented as linear features rather than as a polygon. Line features can measure distance (Coppock & Rhind, 1991).

- **Polygons**

Two-dimensional polygons are used for geographical features that cover a particular area of the earth's surface. Such features may include lakes, park boundaries, buildings, city boundaries, or land uses. Polygons convey the most amount of information of the file types. Polygon features can measure perimeter and area (Coppock & Rhind, 1991).

2.2.4.4 Data Collection and Digitizing in Geographic Information System

To perform data to the system; maps, air photographs, satellite images and other resources must be collected. This geographic collected data must be digitized to use in GIS. The transformation of the paper or map-based data, which is used in the computer environment, is called digitizing. Digitization is made with scanning technique in the large projects and with table-type digitizers in the small projects. These data are also being sold as ready by various firms.

2.2.4.4.1 Data Processing. When it is required to examine the relationships between the data obtained from different sources, consequences arising from the different data structures may be encountered. For example, a different format or scale maps can be encountered. These must be transformed into the same format and brought to the same scales. Therefore, the transformations must be made available on maps. In this way, data analysis and modeling can be made easily.

2.2.4.4.2 Database Management Systems. In GIS projects, as the amount of data increases the storage and retrieval of them start to become complicated. Therefore, while in small projects to store the files are enough, in the comprehensive projects, on the other hand, it is required to utilize from database management system to use data groups. With the created database management system data storage and querying will be easier. GIS databases establish relationships between different information and therefore, repetition of data is prevented.

2.2.5 Software and Hardware in Geographic Information Systems

Geographic Information Systems in general are designed and carried out by the practitioners according to the purpose of the applications. However, in all these applications, there is a need of software and hardware that can fulfill the need of data collection, storage, processing, and displaying in a fast and healthy way.

2.2.6 Spatial Information Management Systems for Universities

Spatial Information Management Systems for Universities are a whole consisting of hardware, software, personnel, and data. These systems intend to create the spatial information management belonging to campus and to collect the spatial and non-spatial data of university and academic sub-units such as faculty, department, and divisions. These also intend to transfer those data into a computer and store, query, analyze them and prepare the visual and graphical presentations for the users.

Information system belonging to universities' campus is a land information system with its land use and land-editing features. In addition, it is also a Geographic Information System with its health services, environmental planning and facilities management features and its aim of making decisions in a fast and healthy way about the future of universities.

2.2.6.1 Examination of Spatial Information Management Systems

A spatial information management system, which is created, should be capable of responding to the needs of academic and administrative services offered on campus. Academic needs generally include qualitative and quantitative information such as faculty, department, classrooms, laboratories, etc. On the other hand, administrative needs include basic service information such as location of the campus infrastructure and superstructure facilities, maintenance and repair, cadastre of green space, personnel movements, artificial and natural conditions and quantities, transportation, parking area and size, resident status, planning, etc.

In addition, basically a spatial information system must provide the following functions:

- a. Querying of the graphic and non-graphic information by password, key code, or via a computer screen,
- b. Creation of appropriate interfaces to update the existing information,

- c. Correlation of data and database with each other in an interactive way,
- d. Generating of products in accordance with the output formats (table, maps in all scales),
- e. Planning functions:
 - Indicators of the information for the analysis of the internal structure of the university places,
 - Spatial and thematic generalization.

2.2.6.2 The Users

Users of the information system established under the campus are divided into 5 classes.

These are:

1. University Administrative Units
2. Hospital Directors and Officers
3. Education and Teaching Officers
4. Students
5. External Users

The system contains detailed information on campus so the data must be organized by the responsible persons. The control of system should not be influenced in any way except for the purpose to obtain information from the outside.

2.2.7 Advantages of GIS

The utilities that the Geographic Information System brings are listed below:

- Through GIS, geographic data analysis and maps can be made more accurate and faster way.
- Using GIS as a decision-making provides important benefits on decision-making. It is possible to obtain continuous maps of visual data.
- Important factors can be determined by producing large number of scenarios, (Terzi & Karaşahin, 2002).
- With GIS, data can be updated continuously and it can be shared with other organizations on the internet. Therefore, both repetitions can be avoided among the institutions that provide the same facilities and transparency can be increased. Acting in this way, the number of staff may be lessened, the cost is reduced, and the production rate increases. In addition, and perhaps the most important, the quality of the work increase, (Terzi & Karaşahin, 2002).
- With GIS, data obtained from different institutions, can be combined under one roof.
- With GIS technologies, using a common field is provided for the studies prepared in different parts of the world by different coordinate systems.

2.2.8 Geographic Information Systems Based Spatial Information Management for the Health Campus

“Spatial Information Management for Health Campus” should answer all the questions asked by potential customers. It should make needed spatial analysis and be open to multi-user. It should be able to provide current and detailed information. It is expected to be fast, be able to give output (print) and be open to updates. It should include user interfaces that allow people who are not high-level computer

users to use the system. These expectations are at the same time the general expectations of a GIS.

In recent years, the use of Geographic Information Systems is increasing rapidly in the field of health care as in every field. The use of computer software and advances in graphics as well as GIS-based spatial analysis models and methods encourage innovations in health applications. GIS is preferred by decision-makers as the most effective tool particularly because of processing large volumes of data quickly during the data analysis and the visualization of data in planning studies. In other words, GIS provides us method and technology about the analysis of data and spatial information (Karakuyu, 2004).

There are also problems about accessing information in health campuses like in many institutions. This problem encountered in results from not saving and storing information on a regular basis. In addition to these, information belonged to campus can't be updated due to new buildings and units in developing campuses. Therefore, a spatial information system, which was created, is able to take current situation and changes quickly and by this way an effective use of information was provided. For these reasons, the main purpose of this study is the digitalizing Dokuz Eylül University Inciraltı Health Campus site plan and transmission of them to computer. Thus, storing information in computer is possible with making classifications like green areas, sports fields, building areas. By this way, a more convenient database is emerged and it is possible to produce information for different purposes with this kind of database, which gives opportunity to geographic inquiry and analyses. It also provides an accurate transmission of information by updating the changes in the campus area quickly. In this context, Geographic Information Systems will be used in the creation of spatial information management system in health campus.

2.2.9 Analysis of the Examples of Spatial Information Systems

Today, many agencies and organizations working to create information systems for their own areas and for this purpose, they utilize from the opportunities provided

by Geographic Information Systems. Whether the institutions taking or not taking advantage of GIS technology, can be understood from the information that they presented on their internet web pages. For this purpose, it is tried to obtain information about the general structure by examining web sites of the institutions from various countries.

2.2.9.1 Examples around the World

Many examples can be found on spatial information system in the world. One of them is the campus information system. Information systems relating to universities, which are accessible via internet, usually come up in different ways. One of them is campus maps. For many universities, a map-based campus information system is perceived as just create a campus map. In addition, information system is created at only universities' own database and not provided for any information sharing. In the following examples the through internet what made various universities within the scope of the campus information system are given. Some of the examples given consist of interactive maps and others consist of explanatory maps (non-interactive). Interactive map is a map that gives information of an object when it is selected in the map or in a separate window. On the other hand, explanatory map is a map, which gives explanations around or the corner of the map, by giving symbols or numbers on the buildings.

2.2.9.1.1 Berkeley University of California. It is available to make queries in two different ways with this system that has both explanatory and interactive maps. One way is to obtain information by selection of the required building in the interactive map and have the information on the right side of the map both as non-graphic data and also its photo.

Other way is to select the required building from the list at the lower-right corner and have the information. Place of the selected building in the interactive map, its non-graphic data and photos can be reached. General view of Berkeley University

Campus is shown in Figure 2.3. Interactive campus map of Berkeley University is shown in Figure 2.4.

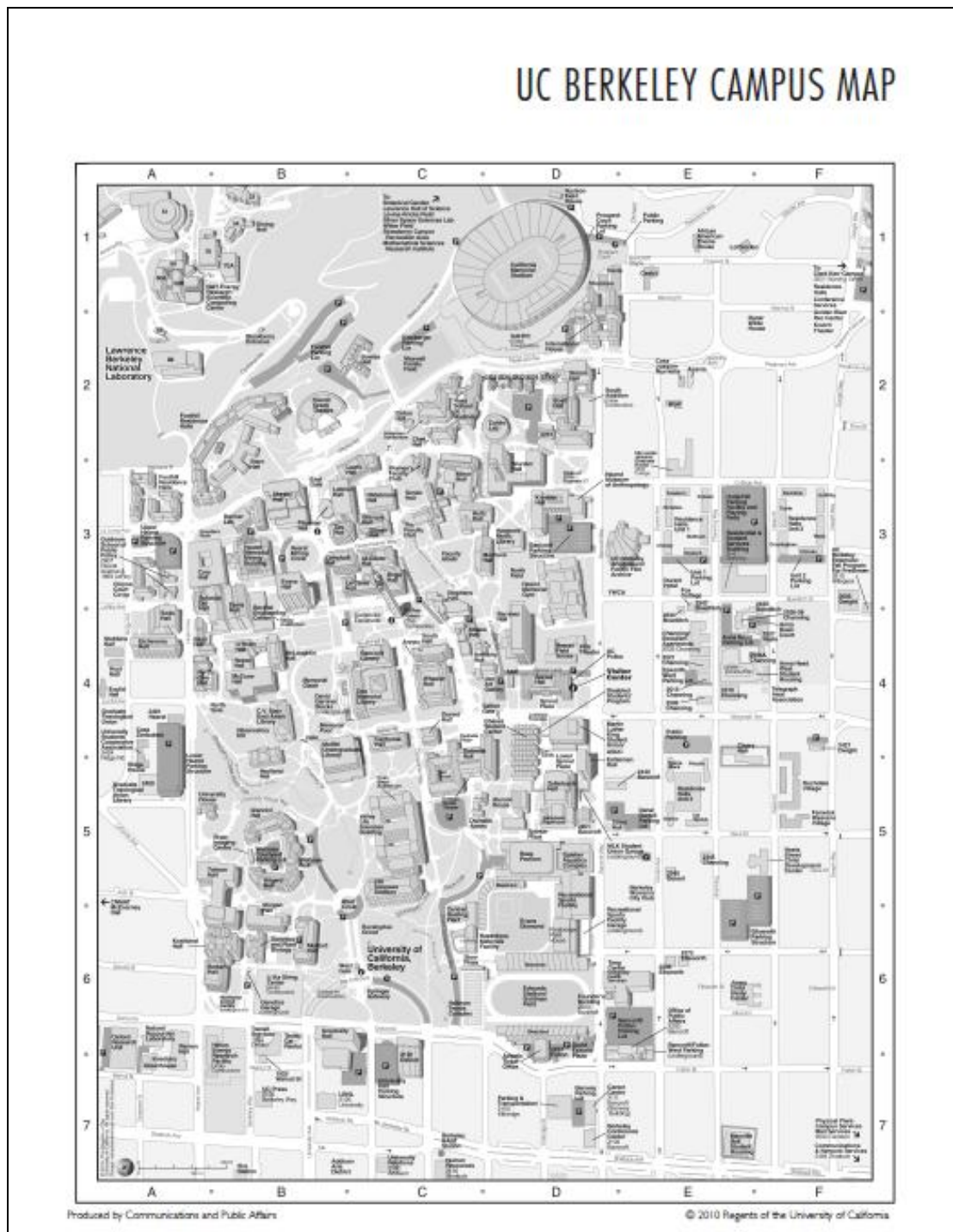


Figure 2.3 General view of Berkeley University Campus (Berkeley University, 2012)

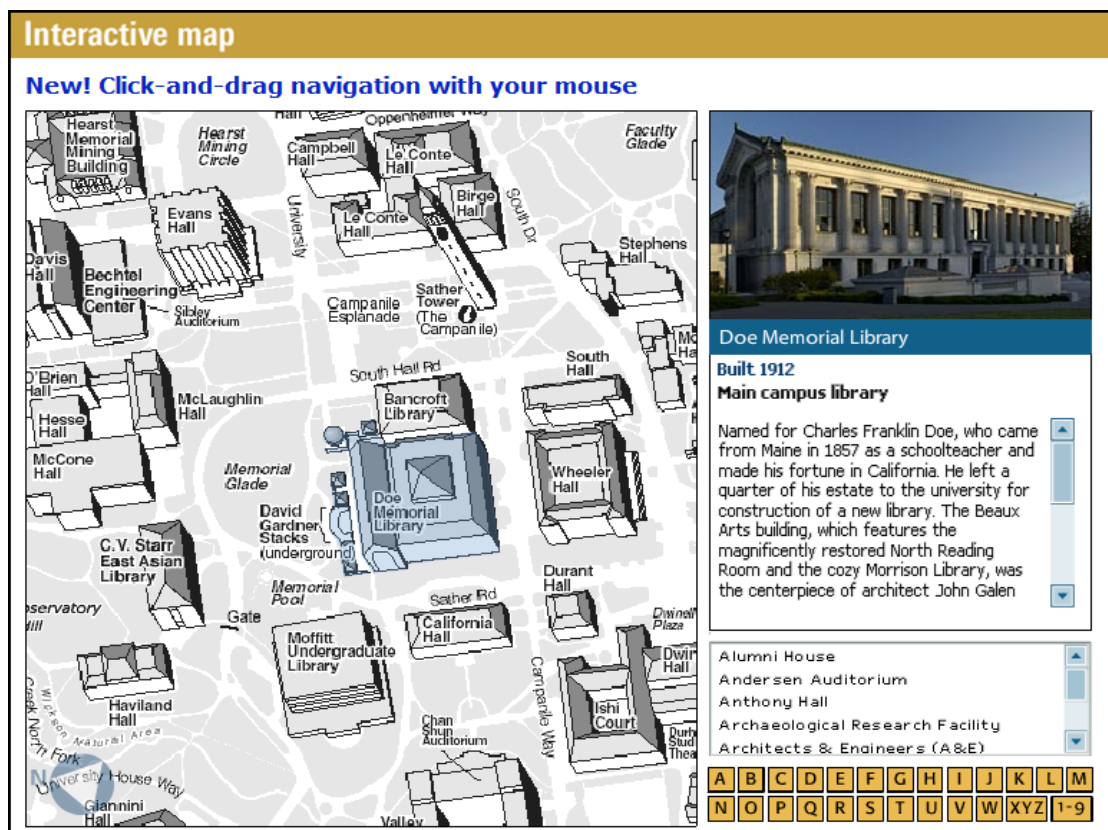


Figure 2.4 Interactive campus map of Berkeley University (Berkeley University, 2012)

2.2.9.1.2 *California State University, Chico*. This system has both two-dimensional and three-dimensional campus maps. 2-dimensional campus map shown in figure 2.5.

When any building on the campus map is selected, the departments in the building can be reached. (Figure 2.6)

After selecting one of these buildings, the information about this department, related web page and related programs can also be reached. (Figure 2.7)

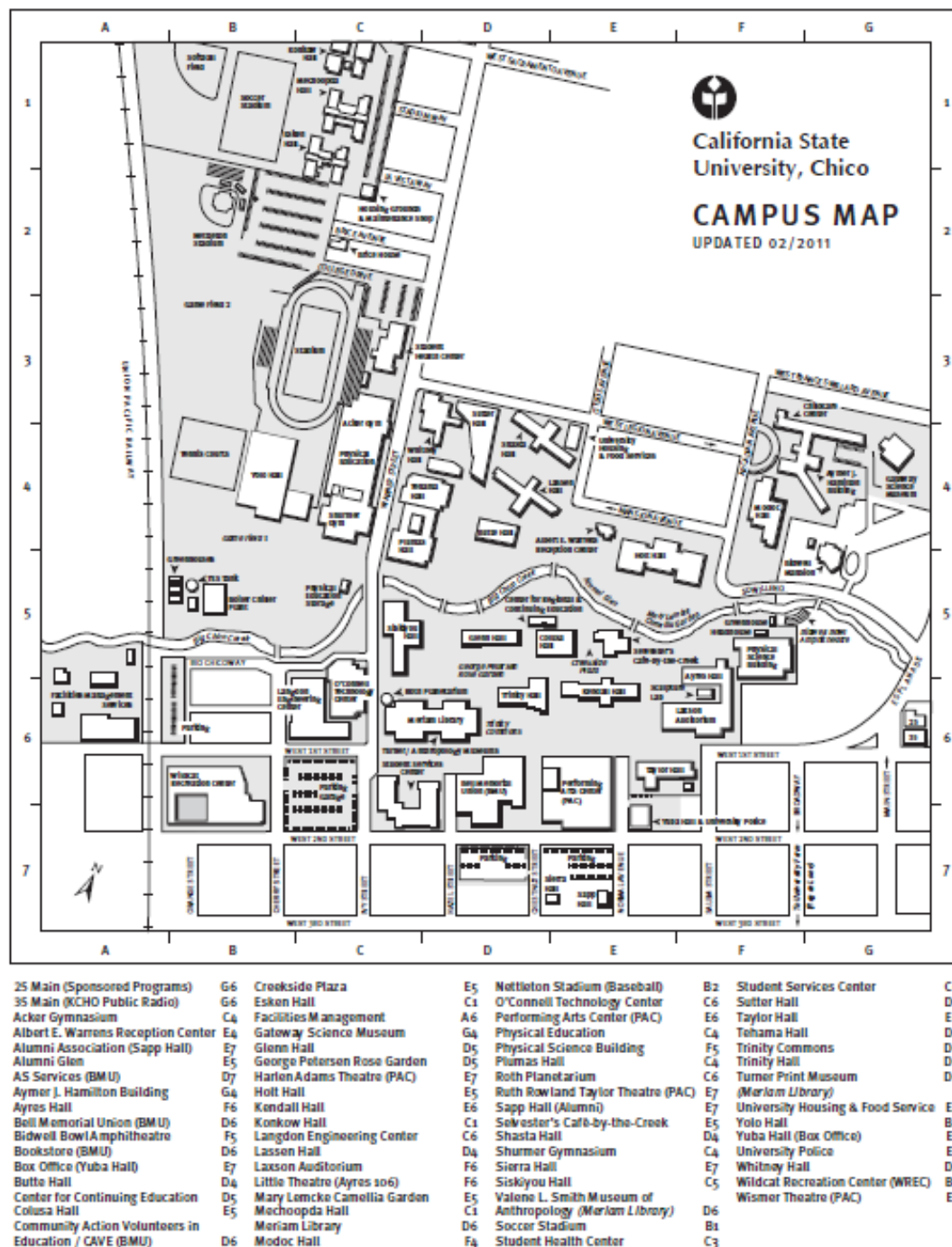
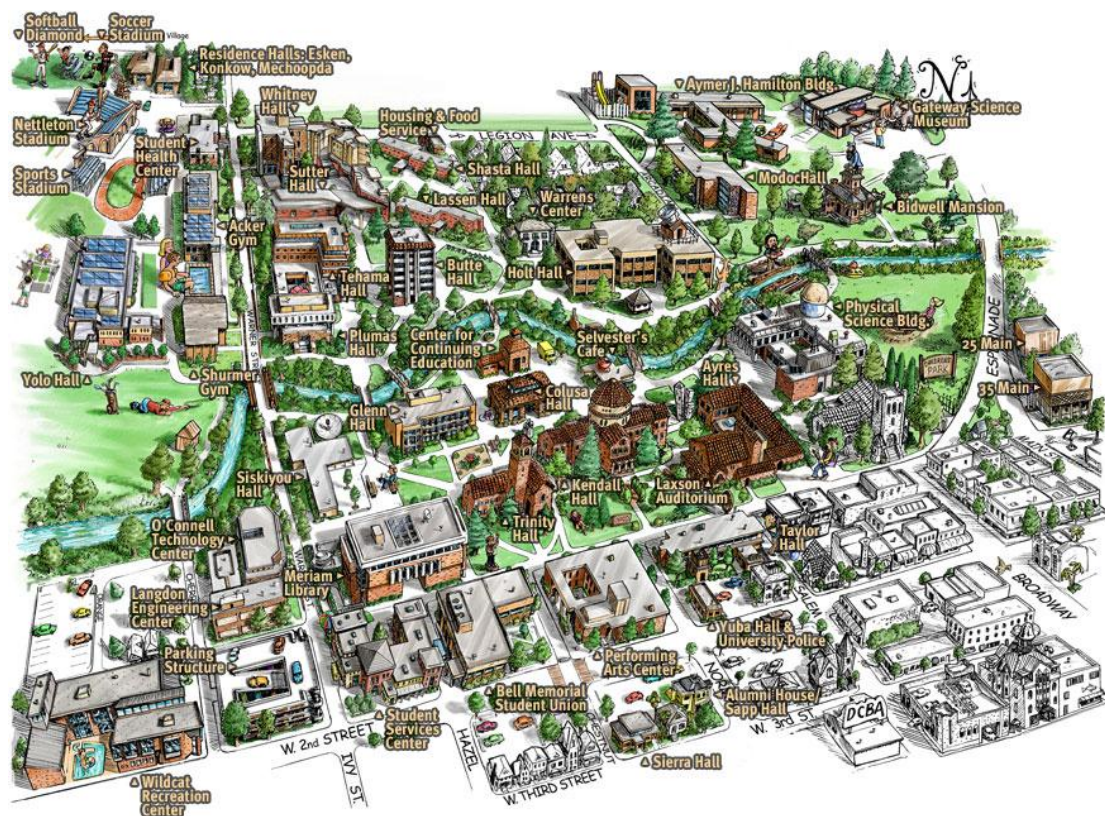


Figure 2.5 Two-dimensional campus view of California State University, Chico (California State University, 2012)



Buildings/Places on the CSU, Chico Campus

[25 Main Street](#)

[35 Main Street](#)

[Acker Gymnasium \(AGYM\)](#)

[Alumni House \(ALUM\)](#)

[Aymer J. Hamilton \(AJH\)](#)

[Ayres Hall \(AYRS\)](#)

[Bell Memorial Union \(BMU\)](#)

[Bidwell Mansion](#)

[Butte Hall \(BUTE\)](#)

[Colusa Hall \(CLSA\)](#)

[Gateway Science Museum \(GSM\)](#)

[Glenn Hall \(GLNN\)](#)

[Holt Hall \(HOLT\)](#)

[Kendall Hall \(KNDL\)](#)

[Langdon Hall \(LANG\)](#)

[Lassen Hall \(LASS\)](#)

[Laxson Auditorium \(LAXS\)](#)

[Meriam Library \(MLIB\)](#)

[Modoc Hall \(MODC\)](#)

[Netleton Stadium \(KNDL\)](#)

[O'Connell Technology Center \(OCNL\)](#)

[Performing Arts Center \(PAC\)](#)

[Physical Science Building \(PHSC\)](#)

[Plumas Hall \(PLMS\)](#)

[Regional and Continuing Education \(RCE\)](#)

[Mechoopda, Esken and Konkow Halls \(MECH, ESKEN, KONK\)](#)

[Roth Planetarium \(ROTH\)](#)

[Selvester's Cafe \(SELV\)](#)

[Shasta Hall \(SHAS\)](#)

[Shurmer Gymnasium \(SGYM\)](#)

[Sierra Hall \(SH\)](#)

[Siskiyou Hall \(SSKU\)](#)

[Student Health Center \(SHC\)](#)

[Student Services Center \(SSC\)](#)

[Sutter Hall \(YUBA\)](#)

[Taylor Hall \(TALR\)](#)

[Tehama Hall \(THMA\)](#)

[Trinity Hall \(TRNT\)](#)

[University Housing and Food Service \(UHFS\)](#)

[Albert E. Warrens Reception Center](#)

[Whitney Hall \(WHIT\)](#)

[Wildcat Recreation Center \(WREC\)](#)

[Yolo Hall \(YOLO\)](#)

[Yuba Hall \(YUBA\)](#)

Off-Campus

[Butte Creek Ecological Reserve](#)

[Facilities Management & Services](#)

[University Farm](#)

Quick Links

[Building Access Guide](#)

[Parking Lot Map \(pdf\)](#)

[Transportation & Parking Services](#)

[Parking Information](#)

[Getting Around—Driving to Chico & Public](#)

[Transportation](#)

[Maps & Directions](#)

For information about accessibility, contact

[Accessibility Resource Center](#), 530-898-5959.

Figure 2.6 Three-dimensional campus view of California State University, Chico (California State University, 2012)

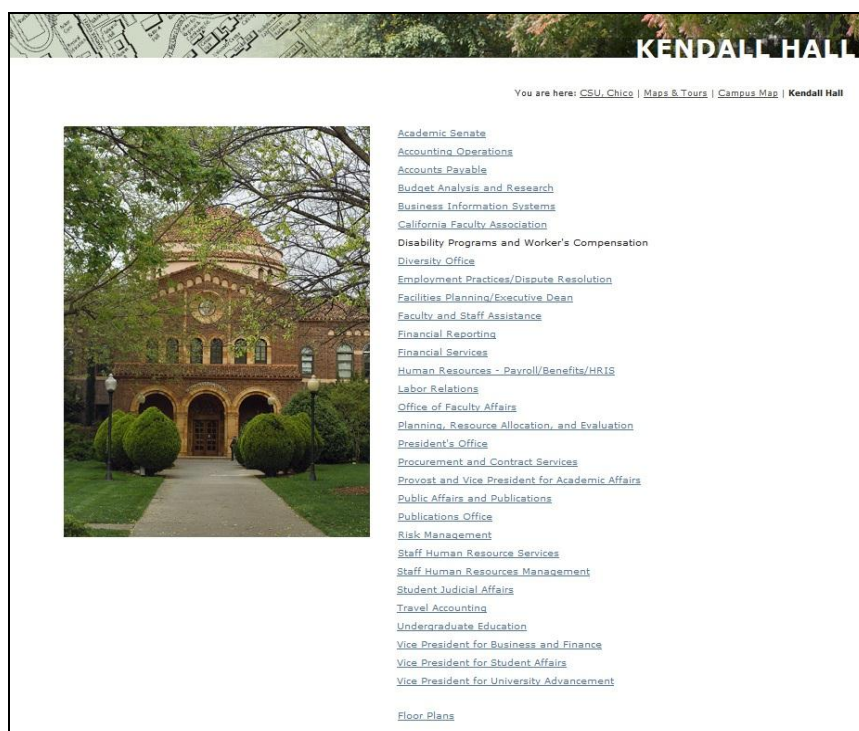


Figure 2.7 California State University, Chico (California State University, 2012)



Figure 2.8 Campus map of Clayton State University (Clayton State University, 2012)

2.2.9.1.3 Clayton State University. Clayton State University has a non-interactive campus map. The map divided to 5 parts as main campus area and other 4 campuses. The buildings in the main campus map are numerated. These numbers and the names of the buildings are explained at the bottom of the campus map. (Figure 2.8)

2.2.9.1.4 Rice University. Rice University has a non-interactive campus map. Numbers are given on the map of the campus buildings. The numbers, names of the buildings and the legend are given at the bottom of the map. Selection can not be made on the map.

RICE UNIVERSITY CAMPUS MAP

6/2011



Figure 2.9 Campus map of Rice University (Rice University, 2008)

2.2.9.1.5 Cambridge University. In the campus map of Cambridge University, buildings are shown with numbers. The number appears when the mouse over the building. By clicking to the building the users are directed to the bottom part of the map has the building number and name. From this part, to see the details of building,

the user must enter the “info” part. The user can reach from info part the name of the selected building, address and telephone information and related web pages. The campus map is shown with the road information of the city and important buildings. The information about access to campus is given with routes.

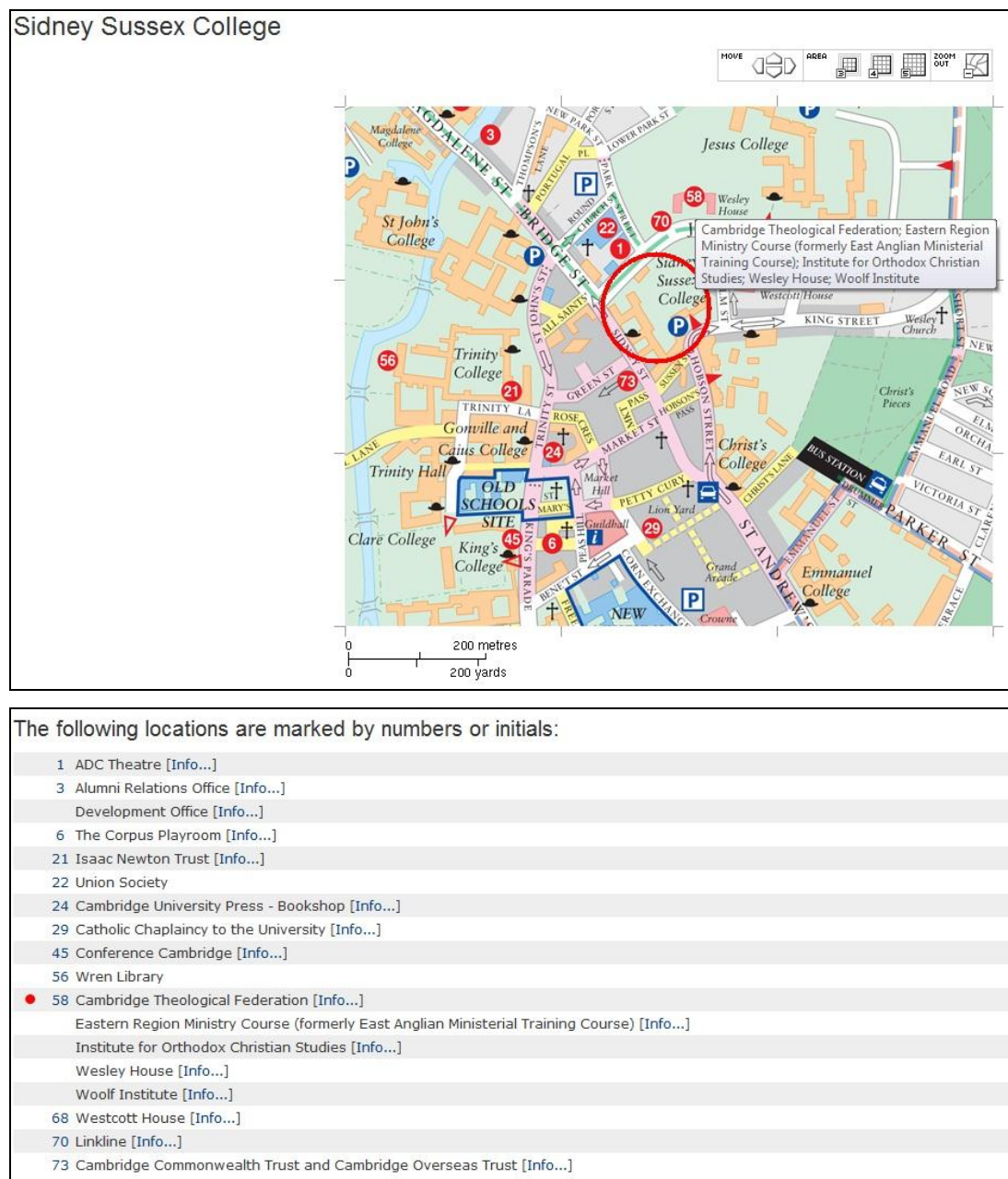


Figure 2.10 Cambridge University (Cambridge University, 2012)

2.2.9.1.6 *Youngstown State University*. Youngstown State University has both two-dimensional and three-dimensional campus maps.

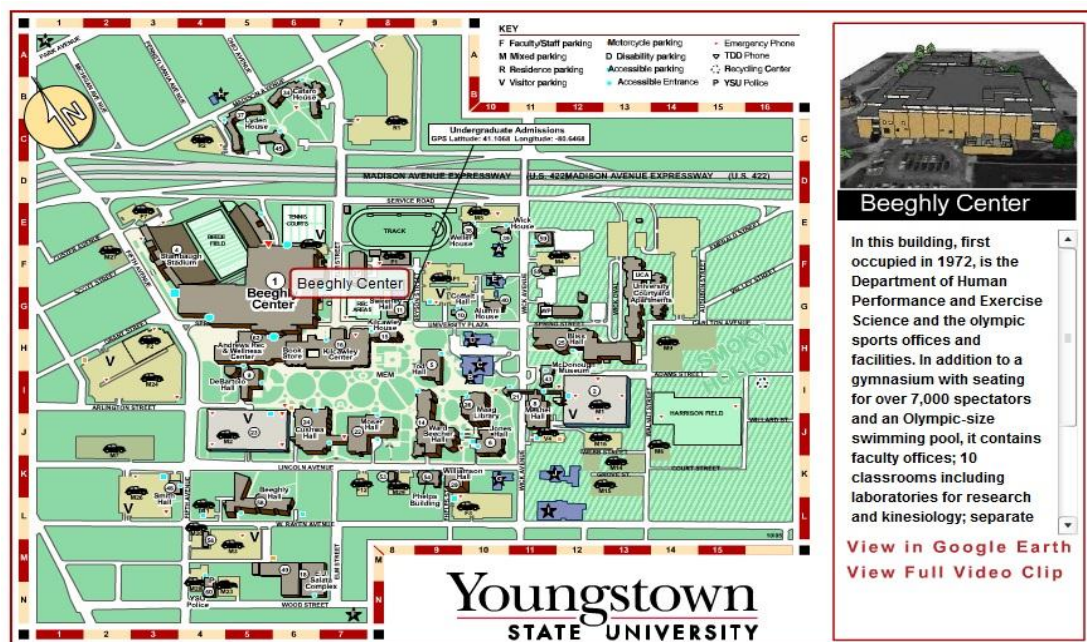


Figure 2.11 Youngstown State University 2D Campus Map (Youngstown State University, 2012)

When one building is selected on the interactive map, the photo of this building, its parts, information about these parts, data about personnel and other information are given. By following these steps the web pages of departments can be reached.

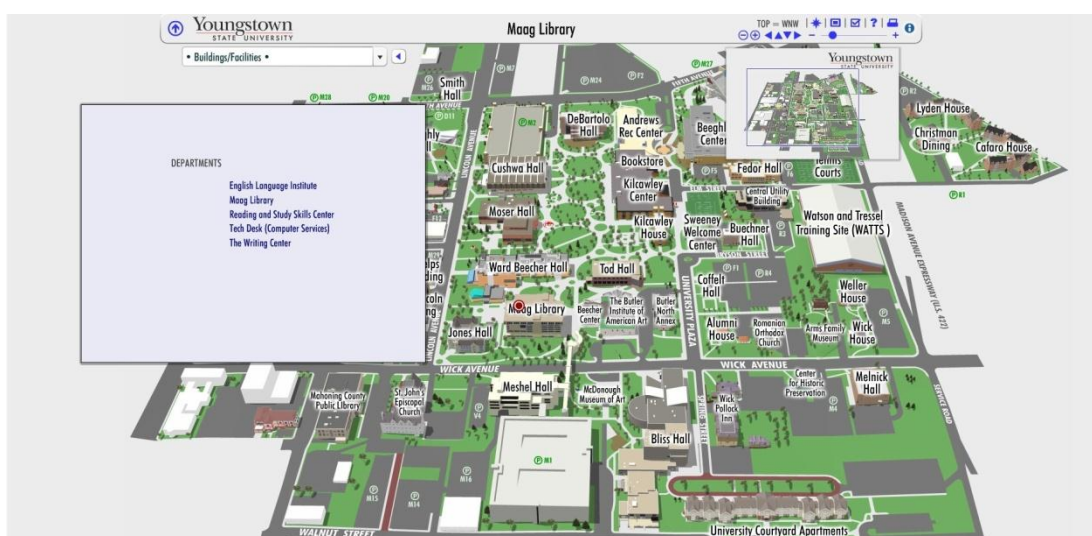


Figure 2.12 Youngstown State University 3D Campus Map (Youngstown State University, 2012)

2.2.9.2 Examples from Turkey

2.2.9.2.1 *Anadolu University*. Anadolu University has a Campus Information System and an interactive campus map. Campus Information System shown in figure 2.13.



Figure 2.13 Campus Information System of Anadolu University (Anadolu University, 2012)

In interactive map, if mouse came to one building, name of this building appears on the screen. Buildings' photos appear in the side of the interactive campus map with selecting the buildings. Beside, certain areas can be searched by categories.

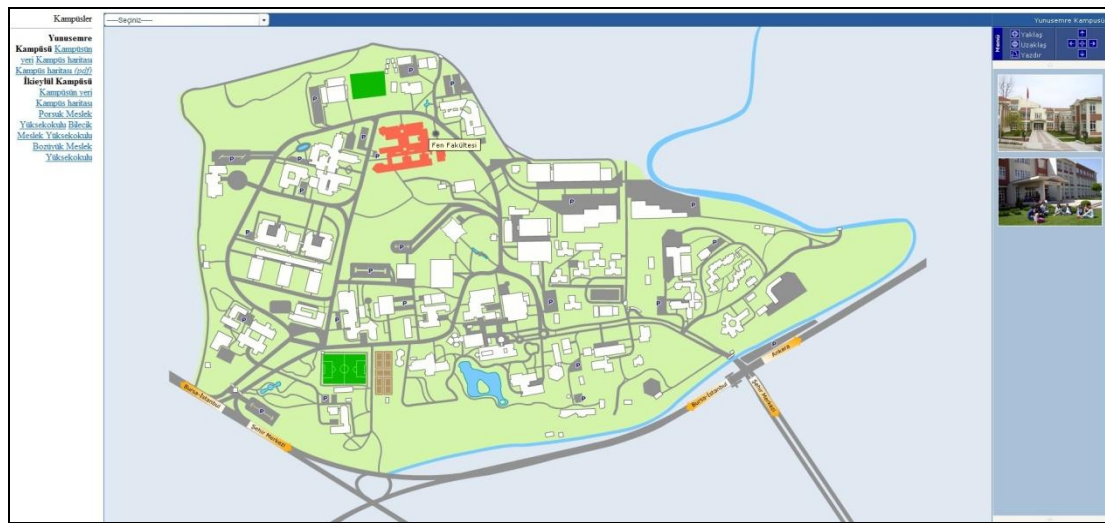


Figure 2.14 Campus Map of Anadolu University (Anadolu University, 2012)

2.2.9.2.2 *Middle East Technical University (METU)*. METU has an interactive campus map. By selecting the building on the map, data and photos of buildings can be reached. In addition, it can be provided that appear or not according to categories on the map.

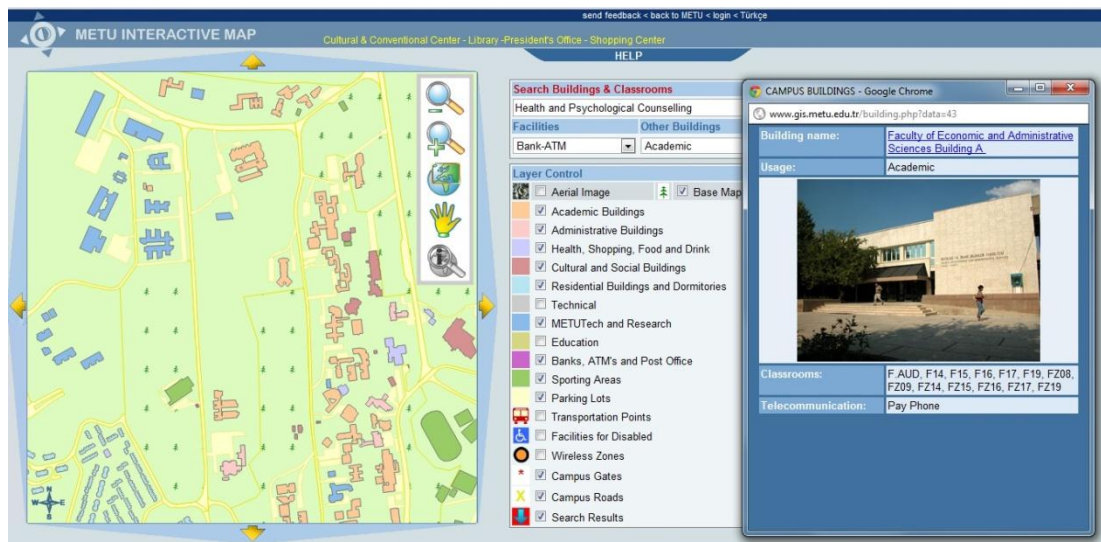


Figure 2.15 METU Interactive Campus Map (Middle East Technical University, 2012)

2.2.9.2.3 *Yıldız Teknik University*. In the campus map of Yıldız Teknik University, satellite photos are used as base map. On the interactive map, it is possible to make queries by selecting any building from categories. After making

query, drawings of the building that selected on the map appear. Detailed information about building can be also reached.



Figure 2.16 Yıldız Technical University Davutpaşa interactive campus map (Yıldız Technical University, 2012)

2.2.9.2.4 İzmir Two-Dimensional City Guide. Two-dimensional and three-dimensional city guides, which are prepared by İzmir Metropolitan Municipality, consist of all buildings in the authority borders of municipality.



Figure 2.17 İzmir two-dimensional city guide (İzmir Metropolitan Municipality, 2012)

It provides making queries of usage of buildings, names of the businesses, official/private institution information (health, education etc.), and pharmacies on duty, transportation points, important historical buildings, cultural & tourism facilities and it also provides photos of these features.



Figure 2.18 İzmir 3D city guide (İzmir Metropolitan Municipality, 2012)

2.2.9.2.5 İstanbul City Guide. İstanbul city guide has satellite photos of different years and also topographic maps and it is possible to make various queries on these maps. By querying from buildings, detailed information can be reached.

CHAPTER THREE

DESIGN OF THE SPATIAL INFORMATION MANAGEMENT SYSTEMS:

SPATIAL INFORMATION MANAGEMENT FOR DOKUZ EYLÜL

UNIVERSITY İNCİRALTI HEALTH CAMPUS

3.1 History and Location

Dokuz Eylül University (DEU) is a state university established in İzmir on 20 July 1982. About 3000 academic staff trains 44000 students (Wikipedia 2011).

Today, Dokuz Eylül University keeps training in ten different settlements of İzmir as Alsancak, Balçova, Bornova, Buca, Buca-Tınaztepe, Foça, Hatay, Narlıdere, Seferihisar, Torbalı, İnciraltı and Urla with 10 faculties, 10 institutes, 9 graduate schools, 1 conservatory, 27 research and application centers.

İnciraltı Campus of Dokuz Eylül University, which located in Narlıdere, includes two faculties, a Vocational School, a Sports Hall, a Library and a Dokuz Eylül University Hospital.

İnciraltı Campus of Dokuz Eylül University was selected as a study area in this thesis because of this thesis's related to the health campus and this is the only one campus has a hospital in Dokuz Eylül University.

3.2 Settlement Plan

İnciraltı Health Campus has Faculty of Fine Arts, Health Services Vocational School, Faculty of Medicine and Dokuz Eylül University Hospital, which is the main factor that makes this campus a health campus in this thesis.

There are also an indoor sports area, lecture hall, classroom buildings, nursery, library, dining hall and several dining areas in health campus.

In addition to these, there are repair and maintenance buildings within the university. Figure 3.1 shows the footprint of İnciraltı Health Campus in satellite Photograph. The campus is within the area designated by the red line.



Figure 3.1 Satellite photo of İnciraltı health campus (İzmir Metropolitan Municipality, 2011)

3.3 Goal and Objectives of Spatial Management for İnciraltı Health Campus

Within the scope of this work, a target is identified to achieve Health Campus Information Management System. Desired goals and objectives are listed below.

3.3.1 Goal

After reviewing of existing structures of different faculties, vocational schools and hospital in İnciraltı Health Campus, it is intended to provide the Health Campus Information Management System to the defined users by accepting the campus as a whole structure and gathering all data under the umbrella of an information system. In order to achieve this goal, the desired objectives are as follows.

3.3.2 Objectives

Objective 1: Creation of databases of departments across health campus, hospital and related sub-units and the usage of them for administrative purposes.

- Collection of data on room number, room type, the responsible person, in-room telephone number of campus buildings,
- Collection of data on faculty and school names,
- Collection of data on conference room, library, reading rooms, eating-drinking areas located within the campus.

Objective 2: The creation of digital maps by using graphic data of the faculties, schools and other buildings of the Campus.

- Reaching the satellite photograph of campus and charting campus plan by using it,
- Getting floor plans and drawing floor and room plans,
- Identifying green areas, sports fields and car parks located within the campus.

Objective 3: Merging graphic and attribute data.

- The combination of information of campus buildings and their names, floor numbers,
- Adding attribute room data of gathered to computer based attribute table.

Objective 4: Making queries to get required information in Health Campus Information Management System.

- Reaching rooms and room numbers according to room types,
- Reaching location information via faculties, vocational schools and hospital data,
- Specifying the distribution of particular room types by grouping,
- Making queries to reach conference room, library, reading rooms, eating-drinking areas.

Objective 5: Producing physical maps of health campus in the desired formats and keeping them in updatable conditions.

Objective 6: Opening to usage Spatial Information Management System to users which is prepared for them.

- Putting maps in the entrances of campus and hospital.
- Publication of spatial information management system on the Internet

Objective 7: Reaching health campus related information quickly and easily.

3.4 Determination of Method for Developing the Spatial Information Management of İnciraltı Health Campus

Determination of a methodology is required in the beginning for a project created with Geographic Information System. With this principle, for the development of Spatial Information Management System in the Health Campus a determination of method also should be made. To design the system and for the implementation, a few basic steps must be followed. Identification of needs is at the beginning of these steps

and other ways to be followed described in the following sub-headings.

3.4.1 Identification of Needs

Before the establishment of the targeted system, the information system should be evaluated, which intended as economically, functionally and physically. The studies of the spatial information management system in the health campus have shown that for fast and healthy development of the university campus layout, a spatial information system should be made.

When there is a need for information technology economically, also there is a need to transition to the production of knowledge within a particular organization with the automation of the current system working in the classical terms functionally.

When necessary and appropriate examines made, it was seen that while today in Dokuz Eylül University Inciraltı Campus, operations of personnel and students are done on computer, other regulations such as campus planning, landscape, upper and lower building, etc. are done by classical methods completely independent from computer environment. This approach is very inconvenient for both the dynamic planning and in the economic terms. Thus, first of all, topographic structures and other spatial details of campus must be transferred to computer as location-based.

Campus plans and satellite photos, which can be seen as visual elements, will ensure the sharing of information in a different environment. Through an information system that supported by visual elements, both it can be provided easily to access to information and also spatial data will be available easily that form the information. From this perspective, there is a need to benefit from the Geographical Information System and the conveniences that it brings.

3.4.2 Use of the System

In the event of the fulfillment of Dokuz Eylül University Spatial Information Management for Inciraltı Health Campus, if the demands of system users will be

taken into account, then the following basic functions will be expected to achieve by usage of the system.

These are;

- Spatial Information Management System will be a dynamic tool to decide. Thus, it will be an important assistant for planners and manager,
- Users are able to produce maps for different purposes,
- The relations of existing spaces with their surroundings will be seen easily,
- The system will serve to physical, environmental, and financial planning and investments,
- It will allow to obtain information, adding information to the system databases and archiving them for the Spatial Information Management for İnciraltı Health Campus,
- In addition to renovation of existing documents, the modern understanding will come to documentation procedures.

3.4.3 Products

Although the main goals of Spatial Information Management for Health Campus are to collect, store and query the information of planning and land use, it is also to product the map and table information toward these goals.

Beside base maps for the entire health campus, such as topographic maps, also maps must produced for special zones (hospital, faculties, administrative regions, parking areas, etc.).

3.4.4 Application Tools

While forming Information Management System for Health Campus, to realize the objectives it is required to utilize from adequate hardware and software. Different types of software needed to create Information Management System for Health Campus with;

- Formation of database,
- Digitization of graphical data (maps, satellites),
- Merging the database with the graphical data.

Recently, many application tools, in other words, the software, are available to help the formation of GIS. In the implementation of Spatial Information Management for Health Campus, AutoCAD Map, which is Cad software, and ESRI's products, ArcMap and ArcCatalog software will be used.

3.4.4.1 AutoCAD Map 3D

AutoCAD Map 3D mapping software is a model-based infrastructure planning and management application that provides broad access to CAD and GIS data. Use the intelligent industry data models and tools to apply regional and discipline-specific standards. These technologies help you to improve data quality, support productivity and better manage infrastructure assets. While working in a single, familiar AutoCAD-based environment, you can:

- Access and edit more information directly
- Integrate and analyze asset information
- Communicate more effectively (Autodesk, 2012)

3.4.4.2 *ArcMap*

ArcMap is the most complete and extensible GIS available. Professional GIS users use ArcMap for all aspects of data building, modeling, analysis, and map display for screen and output.

A complete GIS out of the box, ArcMap provides all the functionality for creating and managing an intelligent GIS. This functionality is accessible via an easy-to-use interface that is customizable and extensible through models, scripting, and applications (GIS Data, 2012).

With ArcMap you can;

- Build powerful geoprocessing models for discovering relationships, analyzing data, and integrating data,
- Perform vector overlay, proximity, and statistical analysis,
- Generate events along linear features and overlay events with other features,
- Convert data to and from many formats,
- Build complex data and analysis models and scripts to automate GIS processes,
- Publish cartographic maps using extensive display, design, printing, and data management techniques (GDI, 2012)

ArcMap is a comprehensive map authoring and data analysis component of ArcGIS Desktop. It is the application that use for querying, analyzing, editing and mapping data (ESRI, 2008). GIS professionals need tools to gather data, build data, analyze geographic relationships, and discover new information.

ArcMap supports the requirements of the professional GIS user by providing tools to build and manage a complete, intelligent GIS that includes maps and globes, data models, metadata, geodata sets, and work flow models.

ArcMap software's geoprocessing framework and data management environment includes tools to perform data conversion, generalization, aggregation, overlays, buffer creation, statistical calculations, and much more (ESRI, 2008).

The standard for GIS, ArcMap is the most complete and extensive GIS used by hundreds of thousands of users around the world.

- Why Use ArcMap?

ArcMap software's extensive tools, models, and applications help users in many aspects of their work.

- Discover new relationships between disparate data sets to help answer questions such as, Who is at risk for flooding?, Where are crimes occurring in relationship to freeways?, What is the demographic profile of the neighborhood around my hospital and is it changing over the next 10 years? And where should I locate my new store?
- Model linear features (e.g., streets and pavement types) for generating events (e.g., accidents) from features and for overlaying events (e.g., accidents and pavement types). This type of analysis could answer questions such as; on what type of pavement do traffic accidents mostly occur?
- Convert data to and from various formats; for example, convert GIS data to (CAD) features and back,
- Increase productivity by automating GIS processes with scripts and data models,

- Display and communicate results through high-quality cartographic output,
- Automate and simplify processes for developing high-quality maps and presentations,
- Edit and maintain GIS data for the enterprise or individual project,
- Develop complex models for research and scientific discovery of complex geographic systems,
- Work with coverage data using the environment designed for managing coverage —ArcMap Workstation (GDI, 2012).

- Who Uses ArcMap?

Hundreds of thousands of people worldwide use ArcMap in thousands of applications from locating new stores and finding the most efficient routes for a fleet of delivery trucks to managing the assets and operations of entire cities and utility companies.

- GIS professionals who build and maintain comprehensive GIS processes,
- Cartographers who need to use advanced tools for map layout, labeling, and symbology,
- Scientists who need geographic model tools to discover new processes and relationships,
- Data administrators or data providers who need a complete set of tools for managing GIS data,

- GIS network analysts who need to edit routes and use tools for dynamic segmentation and linear referencing analysis,
- GIS professionals and administrators who import and export data between many sources,
- GIS professionals who perform extensive creation and editing of coverage data (GIS Data, 2012).

3.5 The Steps of Establishing Spatial Information Management for Health Campus

3.5.1 Design of the System

What are the expectations from Spatial Information Management for Health Campus are mentioned in the previous sections. Spatial Information System must be designed to meet these expectations. In this Spatial Information System, which will be formed, all kinds of spatial information located in health campus are required to reach depending on the map.

One of the most important steps of the design of Spatial Information Management for Health Campus is to determine that under which titles the data will be classified. The system will be created needs to be designed according to the intended use of it. Before data collection, it must be decided under which titles the data will be collected. Collected data in the Spatial Information Management for Health Campus will be used as a tool for decision-making in this area. For this purpose, data to be obtained in the Spatial Information Management for Health Campus are classified before collecting.

The data is divided into graphic and non-graphic data. The graphic data are classified under the titles of rooms, buildings, health areas, building common areas, sport areas, green areas, parking areas. Non-graphic data consist of information

types, capacities, unit and the information that the numerical data contain.

3.5.2 Data Collection

After the determination that under which titles the data will be collected, the data collection stage starts. In Dokuz Eylül University Inciraltı Health Campus, the method at the data collection stage is identical observation or interview with authorized persons of hospital, faculty and graduate schools.

All the data required from outside areas of the health campus are collected by the direction of authorized persons. In addition, floor plans of each storey of hospital and every room's information are collected by the observation method by walking around one by one.

While the buildings' datas are collecting, on each floor, an ID number has been assigned to rooms, starting from one. With the possibility of confusion, both the room number and the door number are processed. Sport area, green area, parking area, building common areas and other buildings are also assigned with ID number to create the database.

3.5.3 Data Classification

The graphical data required for Spatial Information Management for Health Campus are obtained by updating the layout plan; the data of outside of the campus are obtained by updating the floor plans using ArcGIS and the data of indoor areas are obtained by digitizing using AutoCAD Map 3D.

Basic layers of geographical information collected in the project designed for Spatial Information Management for Inciraltı Health Campus are;

- Structure (Building, Hospital Area, The off Campus, New Building, Additional Building, Ruin, Empty Area, Sport Court) [Polygon]

- Car Parking, Green Area [Polygon]
- Pavement , Bicycle Path [Polygon]
- Retaining Wall, Fence [Polyline]
- Stream, Splay [Polygon]
- Street Furniture (Illumination, Garbage Can, Pay Phone, Fire Tap, Seating Unit, Tree, Bus-Stop, Flag Pole, Fountain, Advertising Billboard, Security Camera) [Point]
- Indoor Areas (Room, Corridor) [Polygon]
- Building Common Areas (Stairs, Lift, Air Well) [Polygon]
- Door [Polyline]
- Window [Polyline]
- Indoor Data (Emergency Button, Heating Cooling, Fire Sensor, Fire Panel, Fire Extinguisher, Seating Unit, Pay Phone, Camera, Liquid Hand Gel, Switch) [Point]
- Medical Zone Gas Control Panel [Polygon]

CHAPTER FOUR

IMPLEMENTATION: SPATIAL INFORMATION MANAGEMENT FOR HEALTH CAMPUS

4.1 Creation of Campus Maps

To create the map of Health Campus, first a scaled map is needed, which will be the base for the project. During the project, ArcGIS is used that allows computer-aided design and drawing. As base maps, satellite photo of 2010, DXF files of satellite photo, which is drawn as vector and the site plan of health campus, are used.

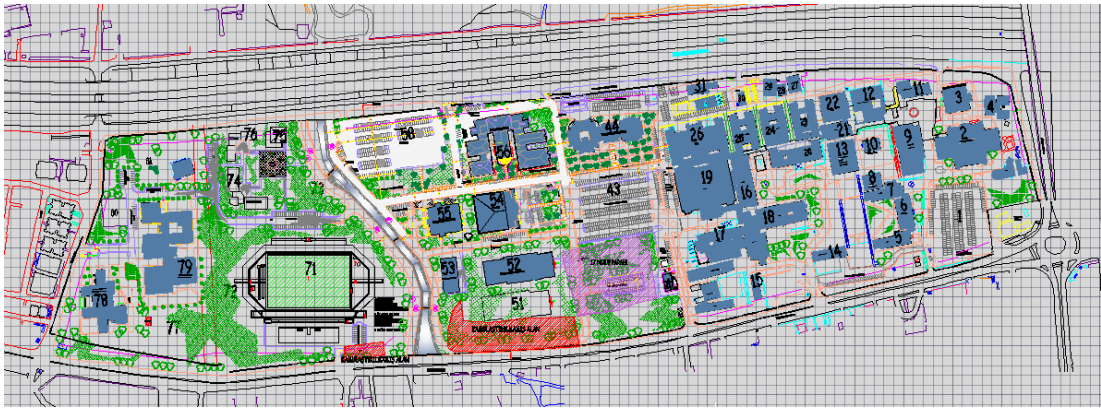


Figure 4.1 The site plan (Rectorate of Dokuz Eylül University, 2011)



Figure 4.2 Satellite photo of the year 2010 (İzmir Metropolitan Municipality, 2011)

In the second step, vector data in DXF format is combined with the satellite photos that have correct coordinates.

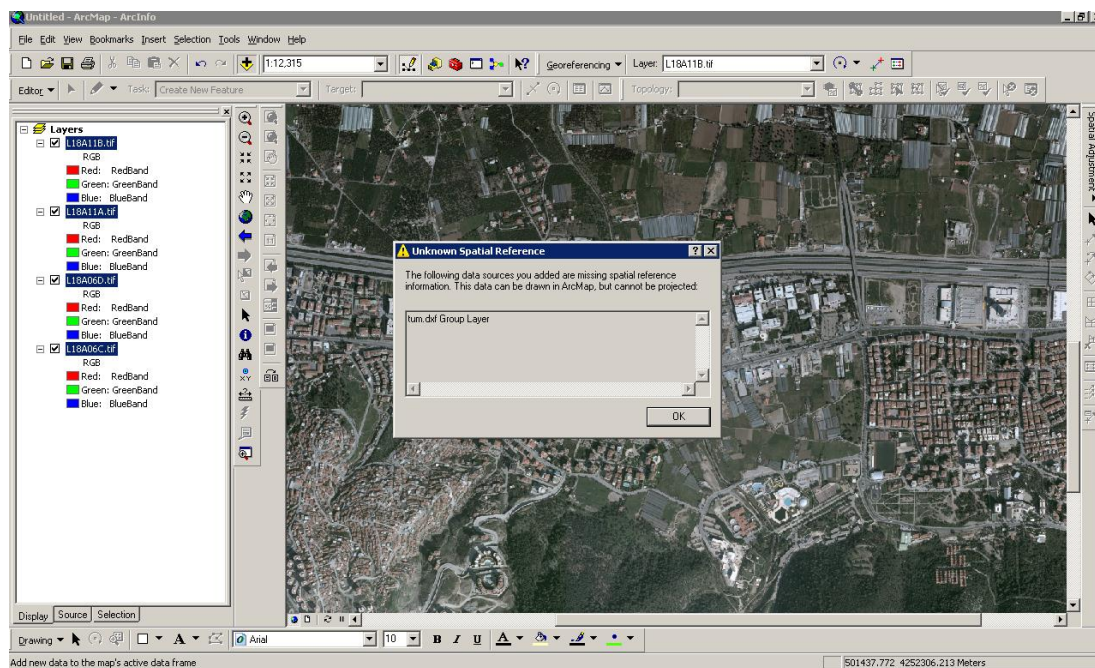


Figure 4.5 Data adding process of vectoral DXF file

These vector data that has no coordinates are geo-referenced by satellite photos.

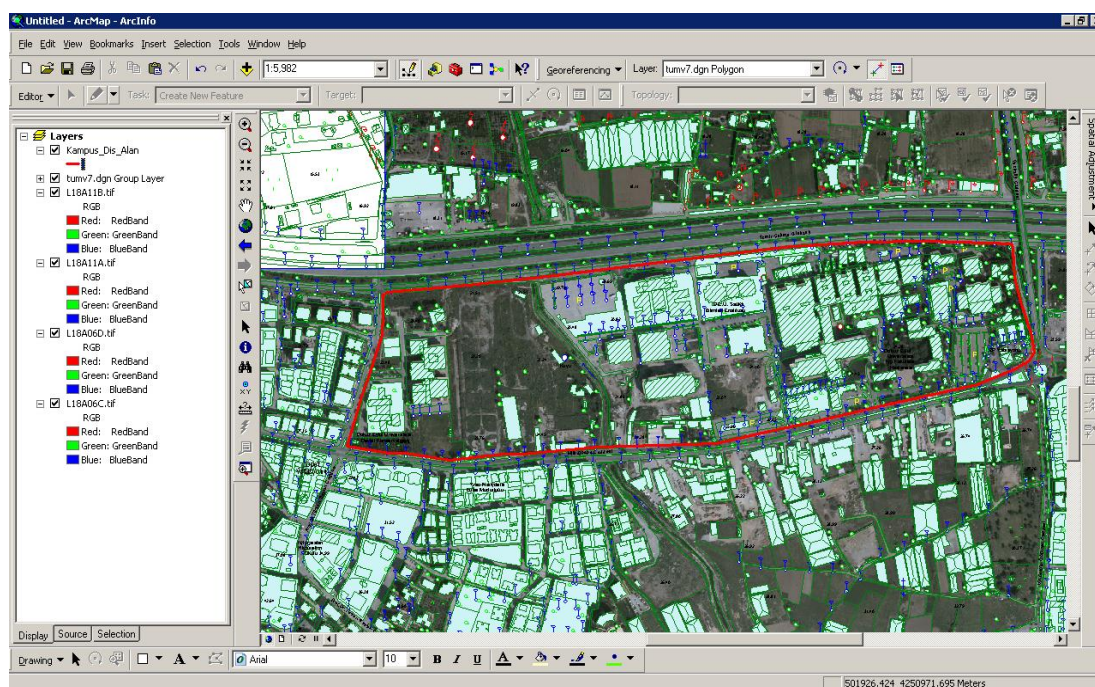


Figure 4.6 The view of the health campus in satellite photo and vectoral drawings

The site plan, which is a DXF file, is also geo-referenced by satellite photos using ArcGIS.

Before starting to draw, the layers, which are need to be digitized, must be created in Arc Catalog as shape files. Shape files are added by given name one by one with import of the coordinate system and the line types are determined as point, polyline or polygon according to their features.

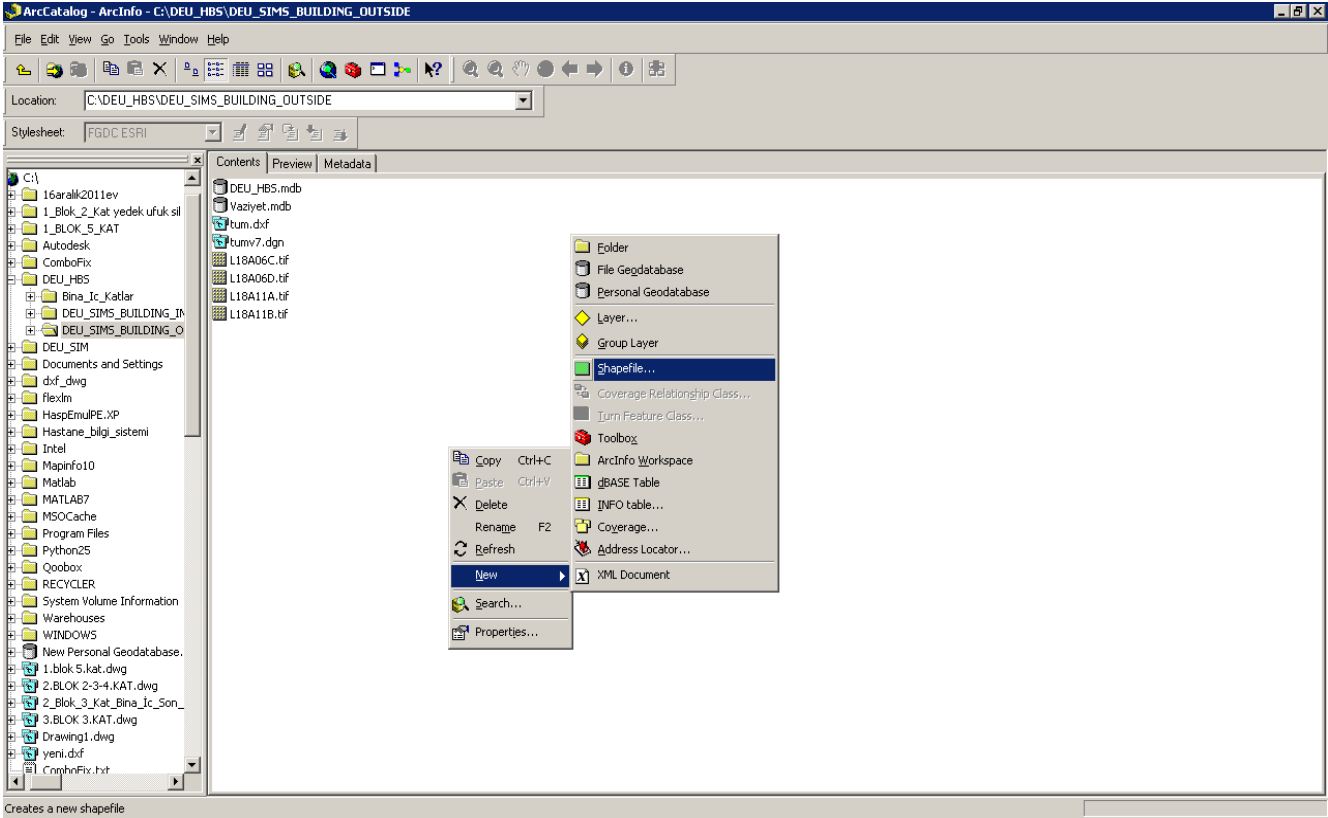


Figure 4.7 Creating a new shapefile in ArcCatalog

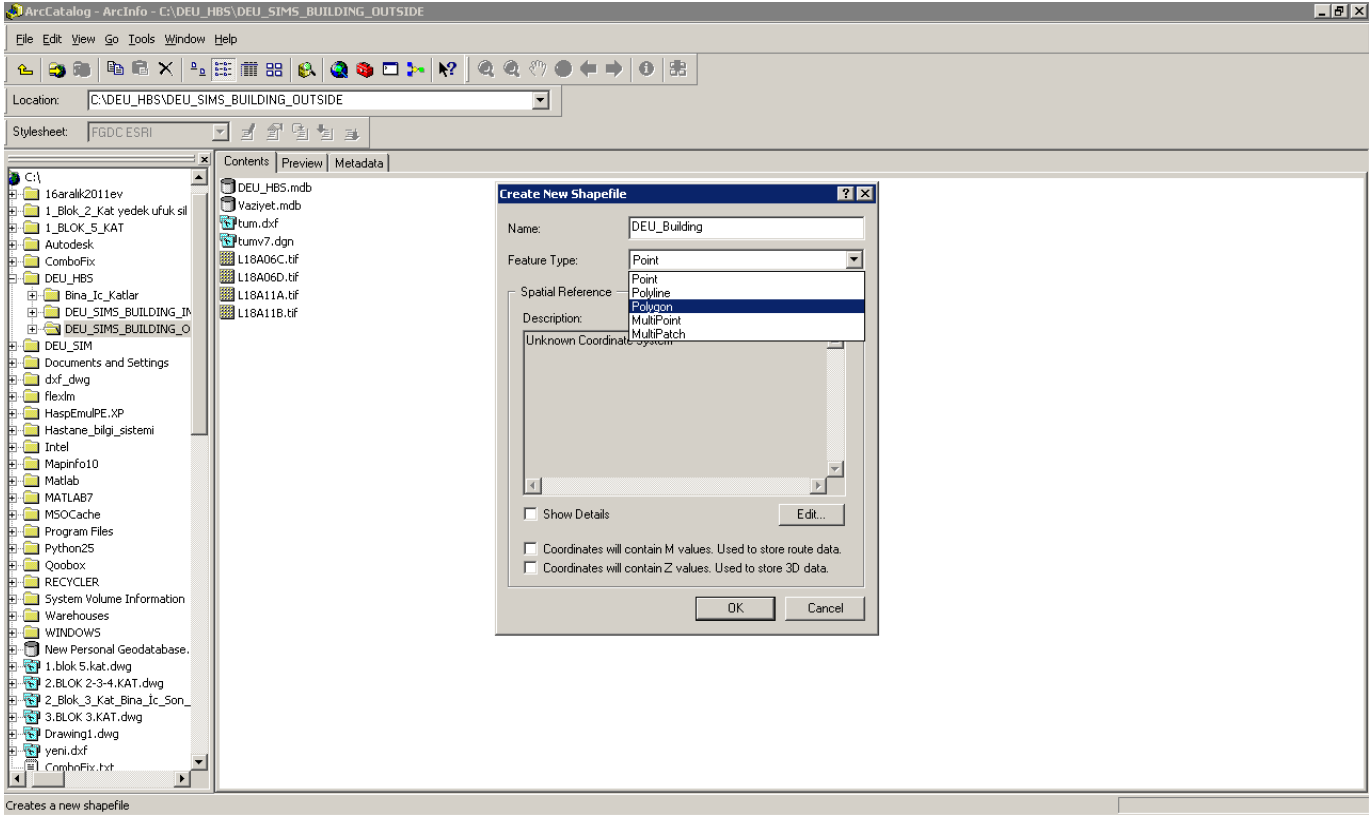


Figure 4.8 Determination of line type of the building layer

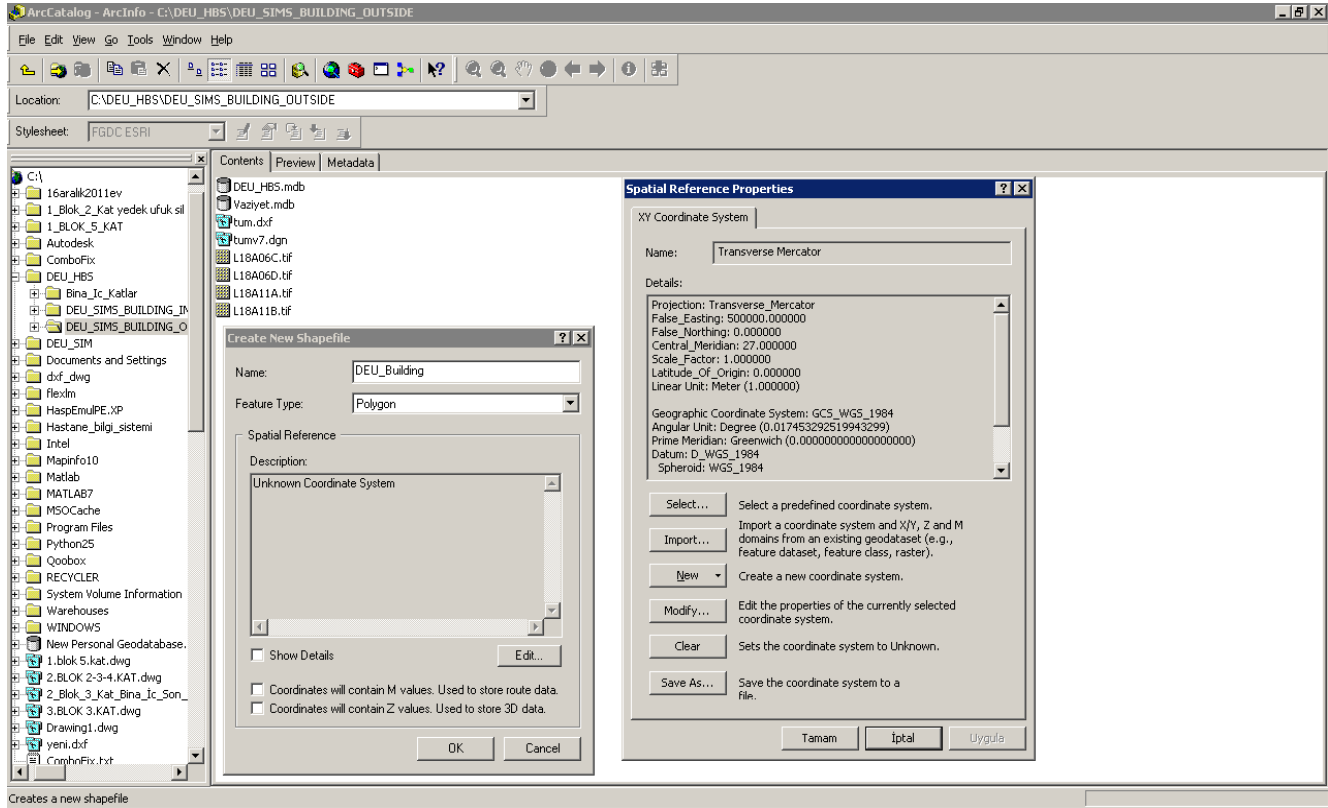


Figure 4.9 Determination of coordinates of the building layer

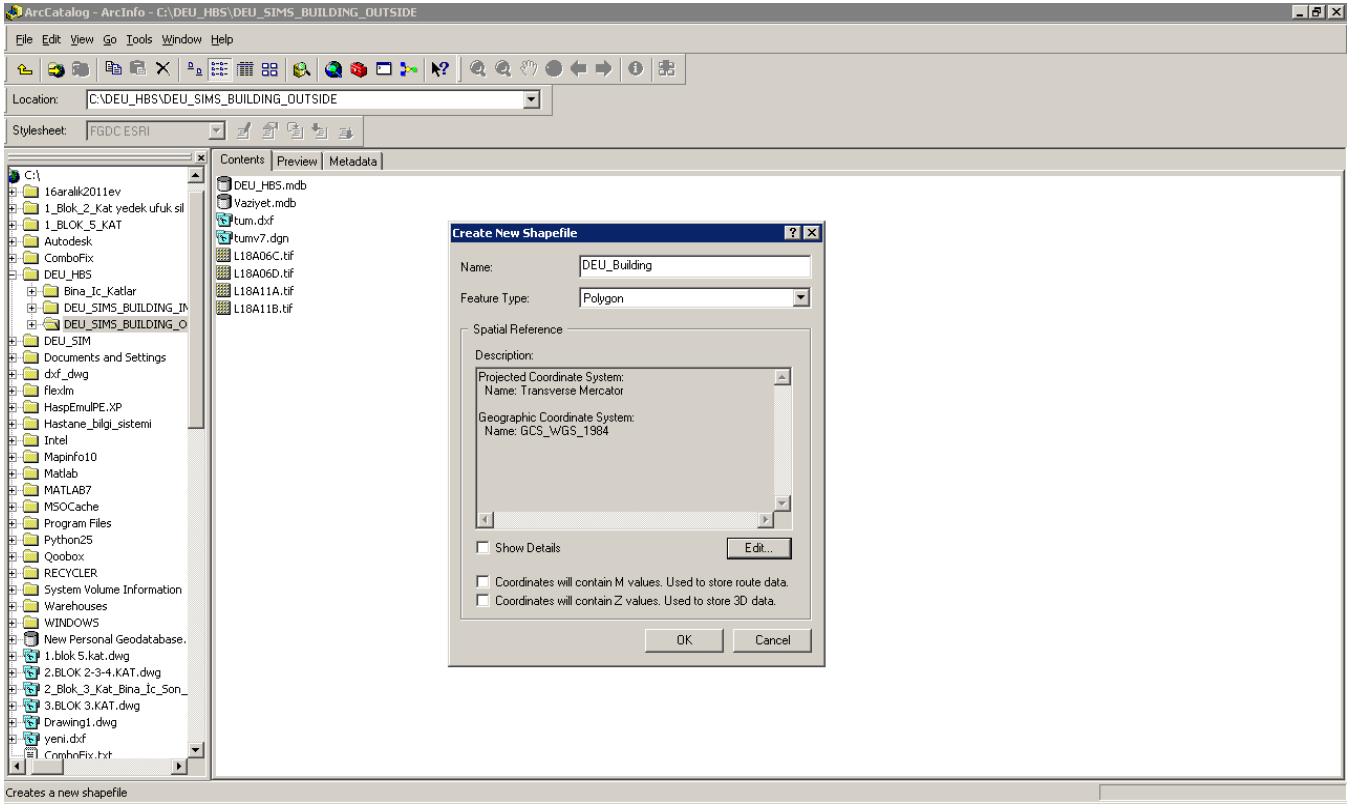


Figure 4.10 Final stage of the creating of building layer

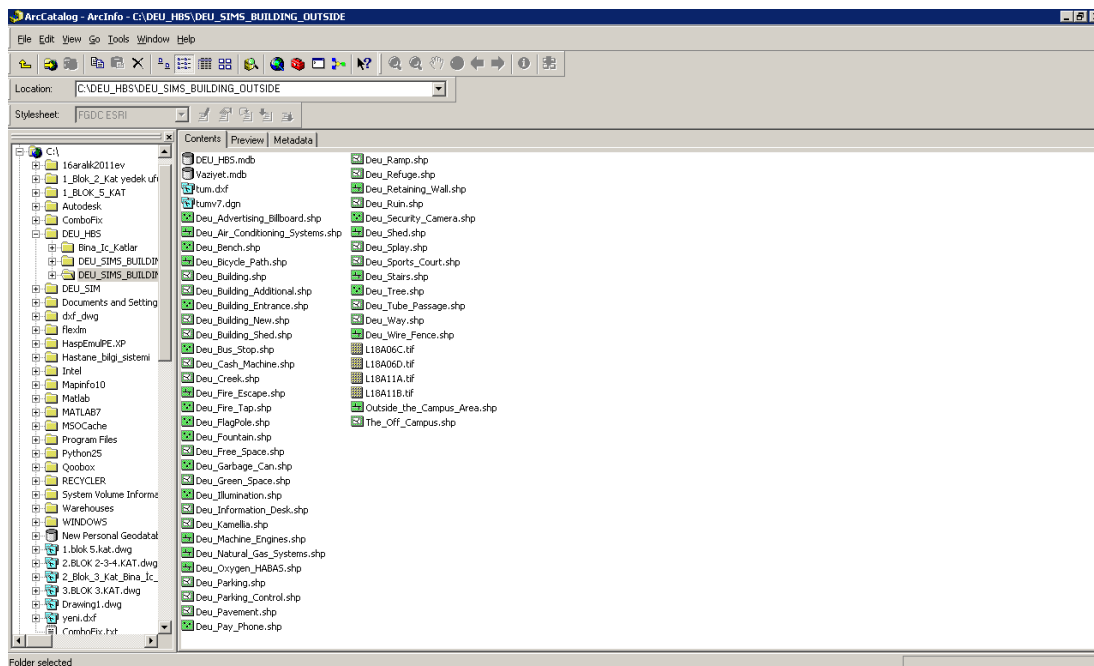


Figure 4.11 The form of the layers of outer areas created in ArcCatalog

Afterwards, the created files are opened on the satellite photos and vector data in ArcMap software and the digitizing operations are started. To start these digitizing operations, the start editing button in the editor tool must be active. In this tool, the layer, which will be digitizing, must be selected and then the digitizing operation starts.

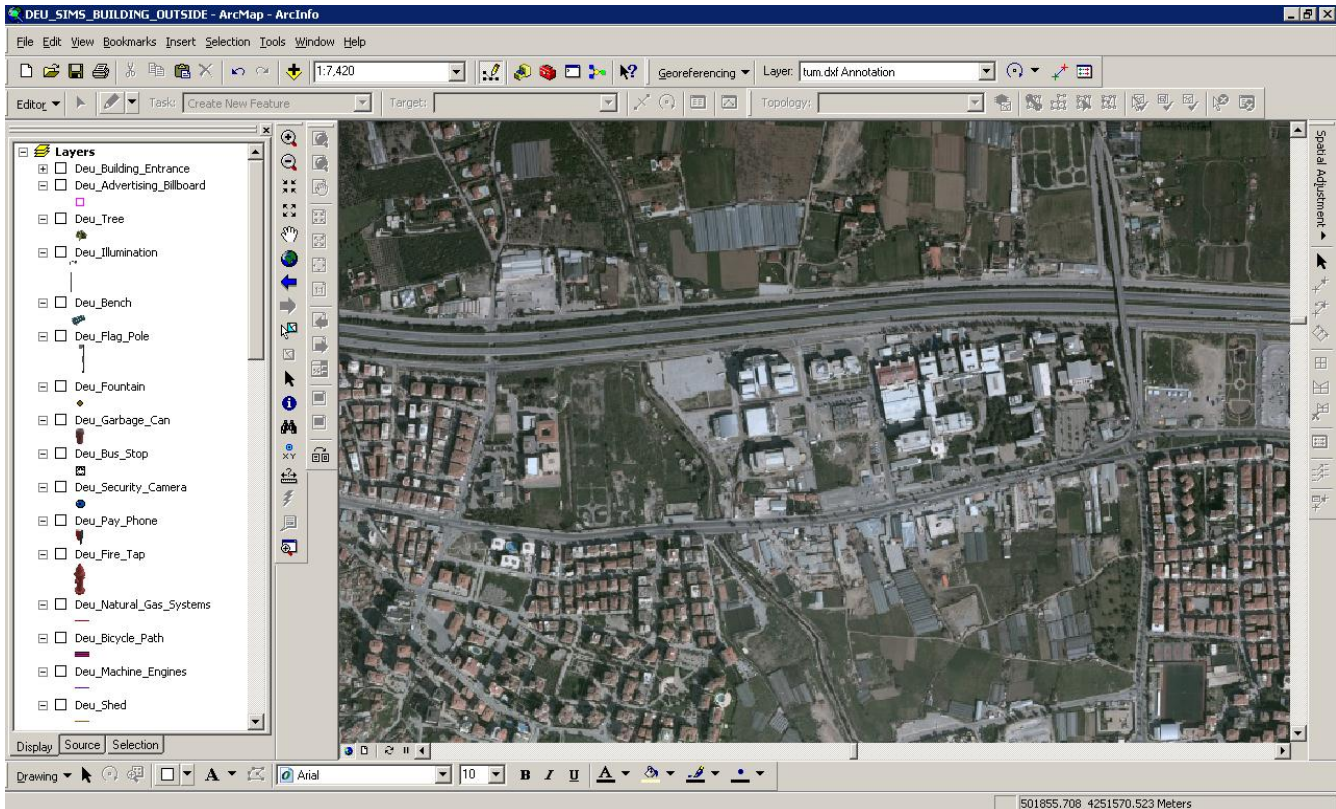


Figure 4.12 Digitizing operations, step 1

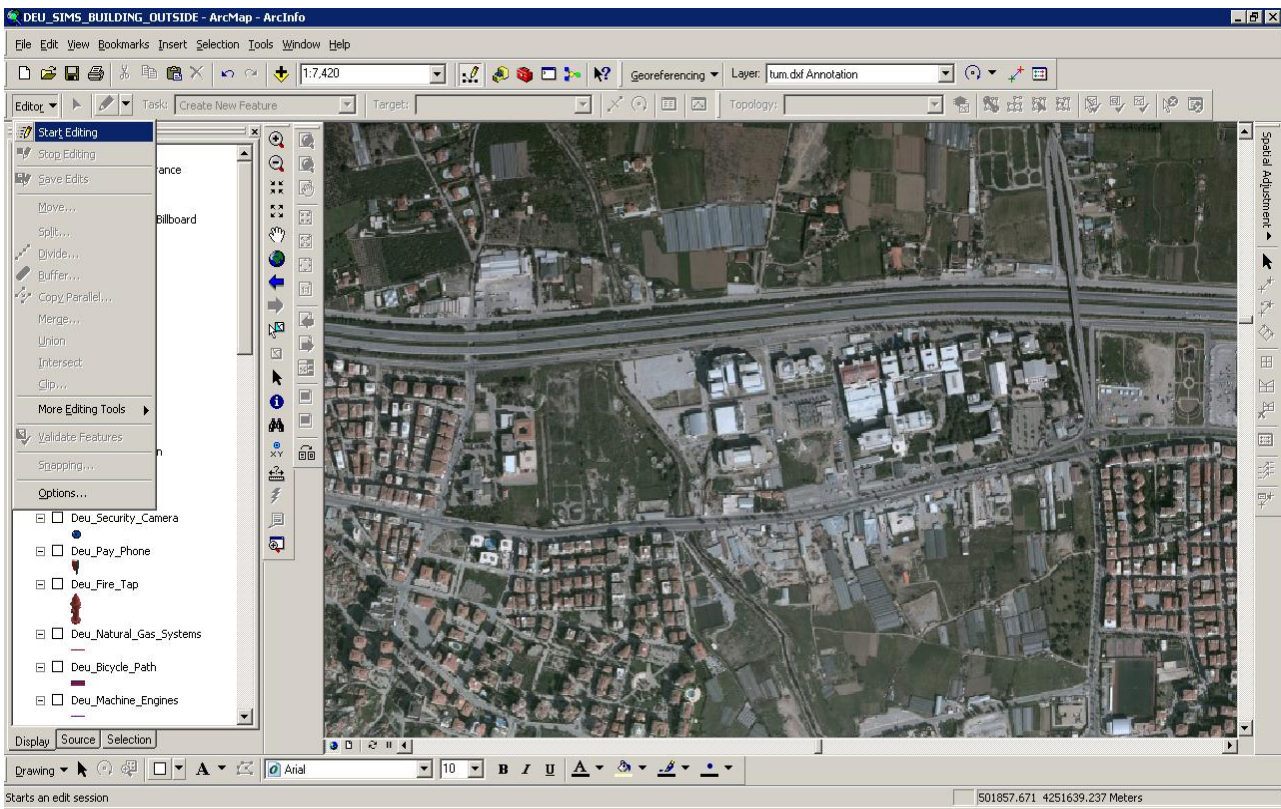


Figure 4.13 Digitizing operations, step 2

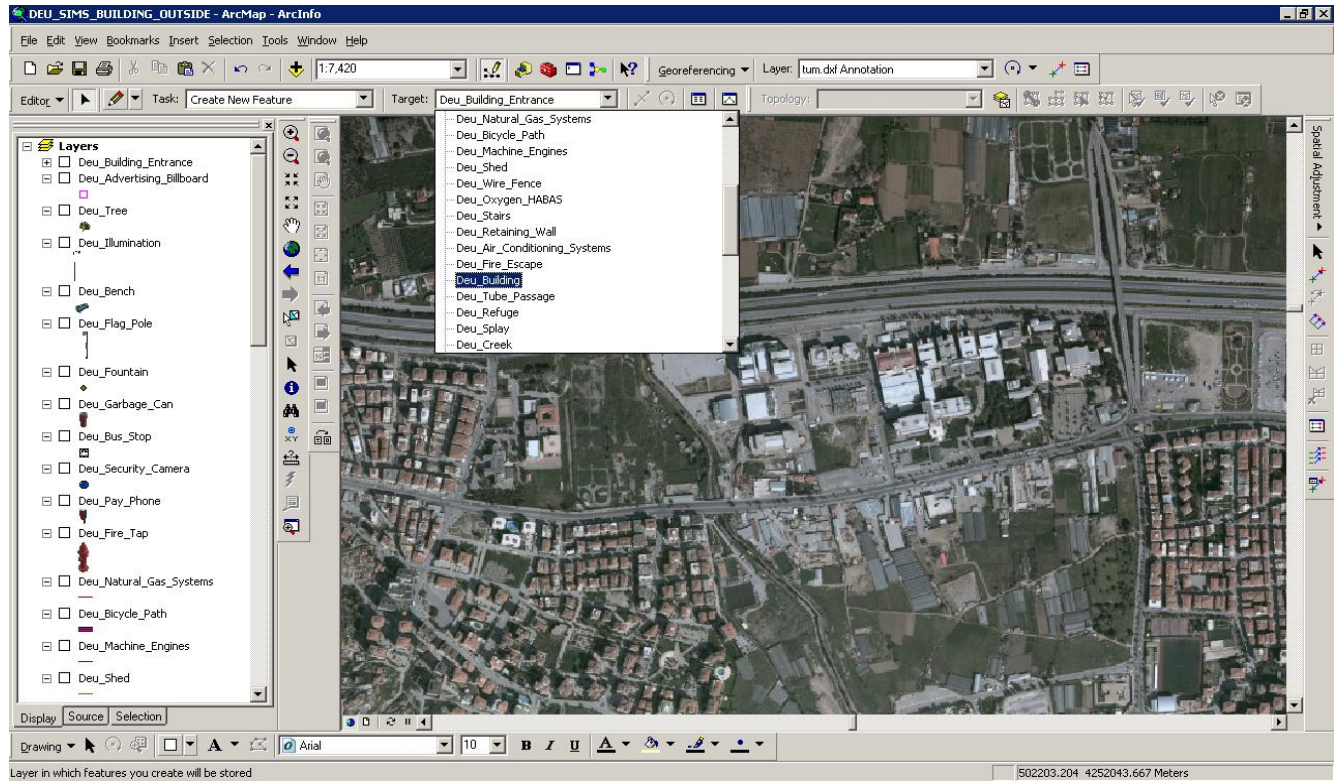


Figure 4.14 Digitizing operations, step 3

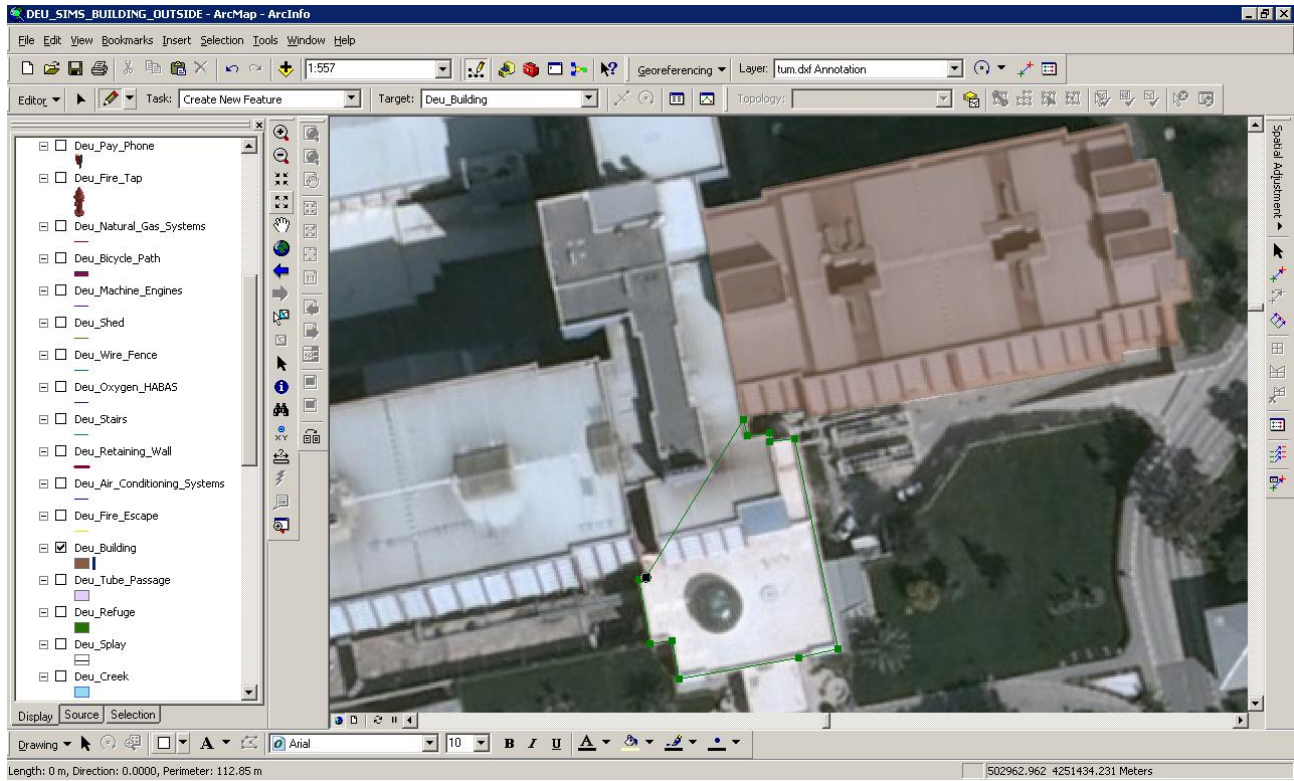


Figure 4.15 Digitizing operations, step 4

Overlapping the satellite photo of 2010 with its vector data and current site plan, the area that Health Campus covers and the objects in the campus are created with their outlines. Using ArcGIS, first, the buildings, empty areas, the off campus and ruins in Health Campus are created properly.

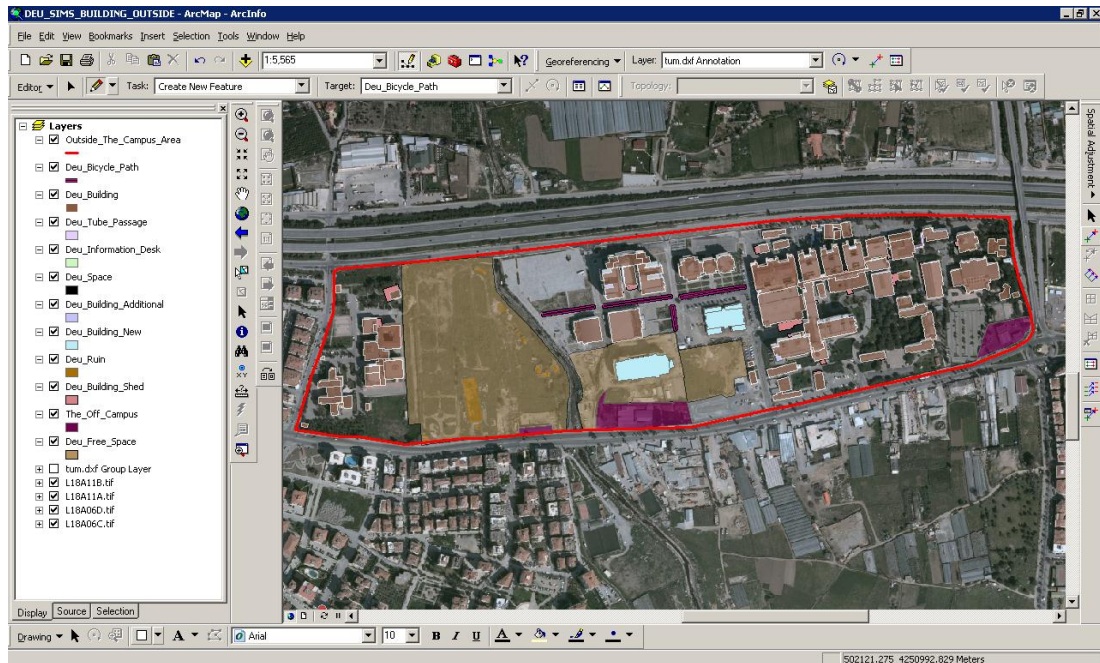


Figure 4.16 Creation of campus buildings from satellite photos

Drawings, specified the green areas, sport areas, roads, parking areas, stream and slope areas of campus are prepared. In Figure 4.17, the drawings of these areas are shown.

After drawing the buildings (education buildings and hospital), sport court, green areas and parking areas in Health Campus, street furniture such as illumination, garbage can, fire tap, seating units, trees, flag pole, advertising billboards, bus-stops, pay phones, security cameras, natural gas systems, machine engines, sheds, fire escapes, air-conditioning systems, fences, retaining walls, ramps, refuges, parking control, information desk and security points, pergolas and ATM points are also added to the drawing. (Figure 4.18)

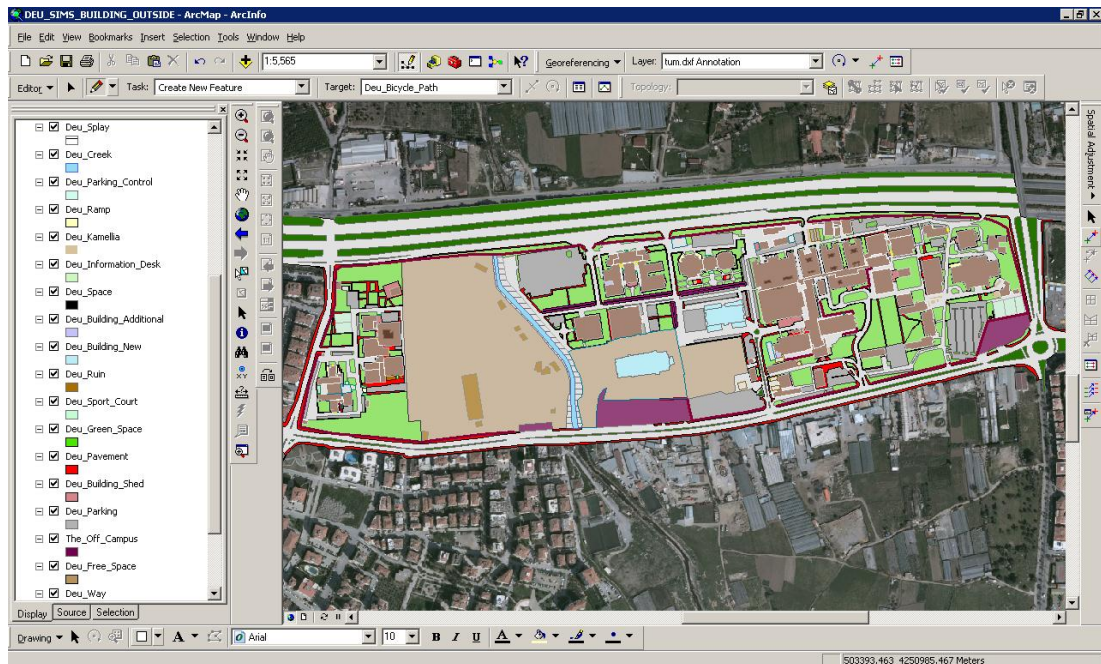


Figure 4.17 Creation of the general shape of the campus area

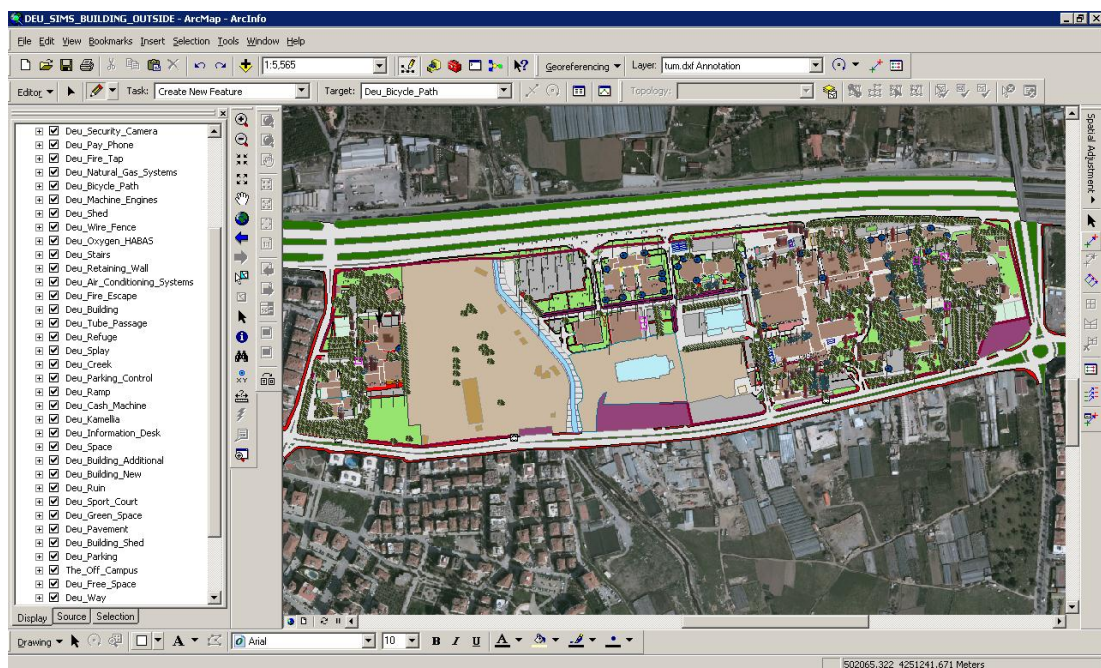


Figure 4.18 The final version of the digitized campus area

4.2 Creation of Database

After creation of Health Campus area and obtaining of the graphic data, next process is inserting the attribute data into the topological data table, which created in

ArcMap. For this, the attribute data collected must be related with the graphic data that formed before.

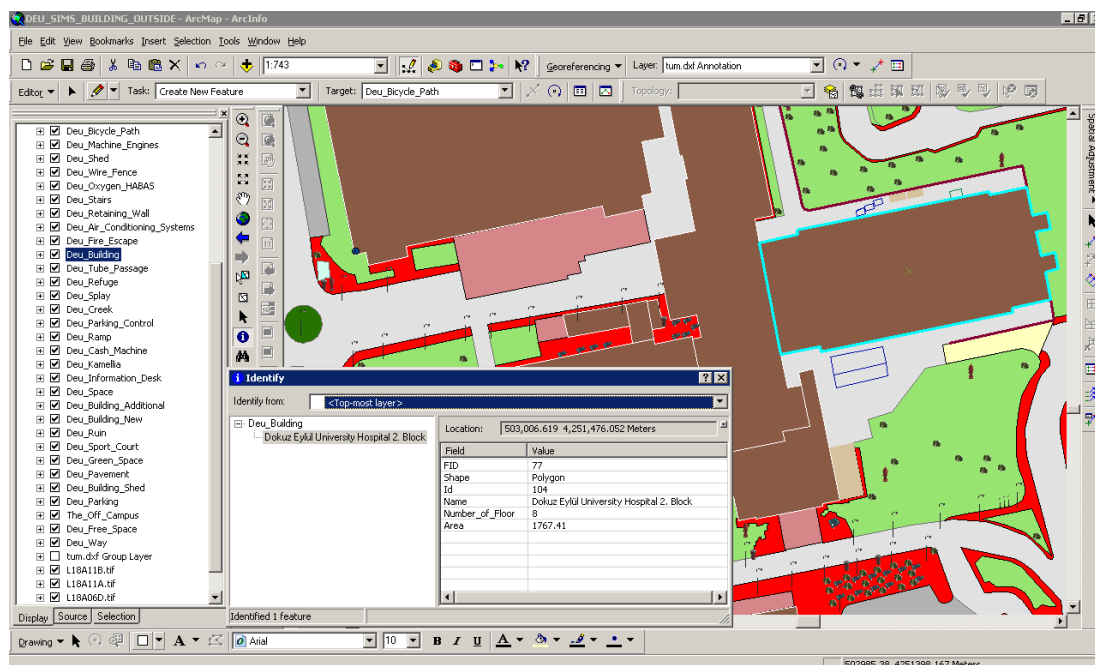


Figure 4.19 Creation of the attribute information of the buildings

Data layers, which created for this purpose and their links to databases, are achieved by dynamic power of data editing of ArcMap. For each graphic data of layers, attribute data of each layer collected and processed to attribute tables.

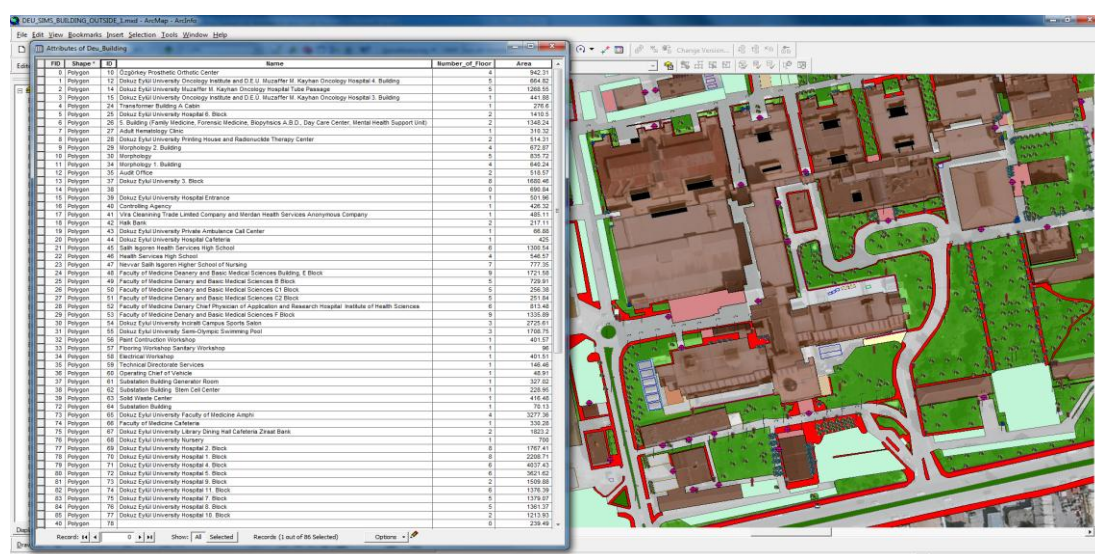


Figure 4.20 Attribute table of the building layer

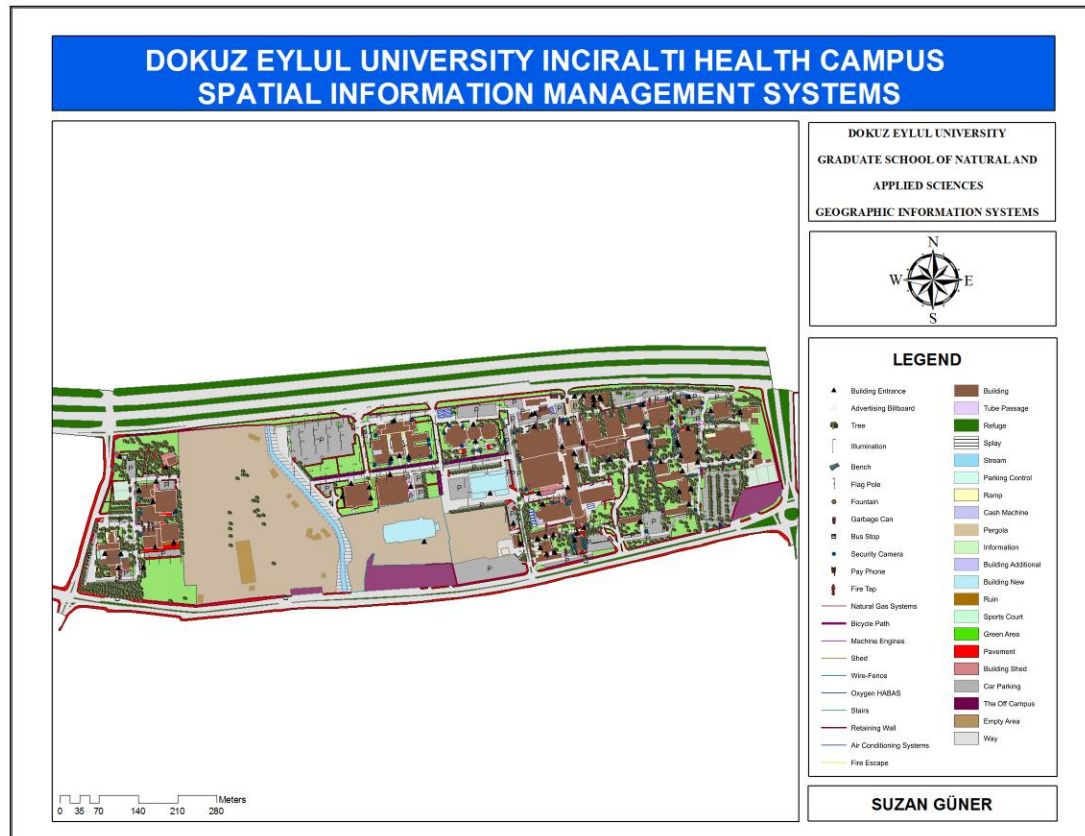


Figure 4.21 Dokuz Eylül University İnciraltı Health Campus Spatial Information Management System (Larger version of the map at the Appendices part.)

After the completion of the drawings of campus outside, drawings of buildings' inside (floor plans) were made at Dokuz Eylül University Hospital. Dokuz Eylül University Hospital was chosen for floor plans because of the thesis's main subject is spatial information management in health campus.

First, a scaled map is needed for the formation of the base map of Health Campus and also there is a need for base maps to draw the floor plans. The plans, which obtained from Dokuz Eylül University Hospital, are not scaled and don't have correct coordinates.

Because the drawings will be made in AutoCAD, the layer of the outer area of building from the drawings, which created at the former step, are transferred into AutoCAD environment so the scale, the direction and the coordinates of the floor plans, in DXF format, are adjusted.

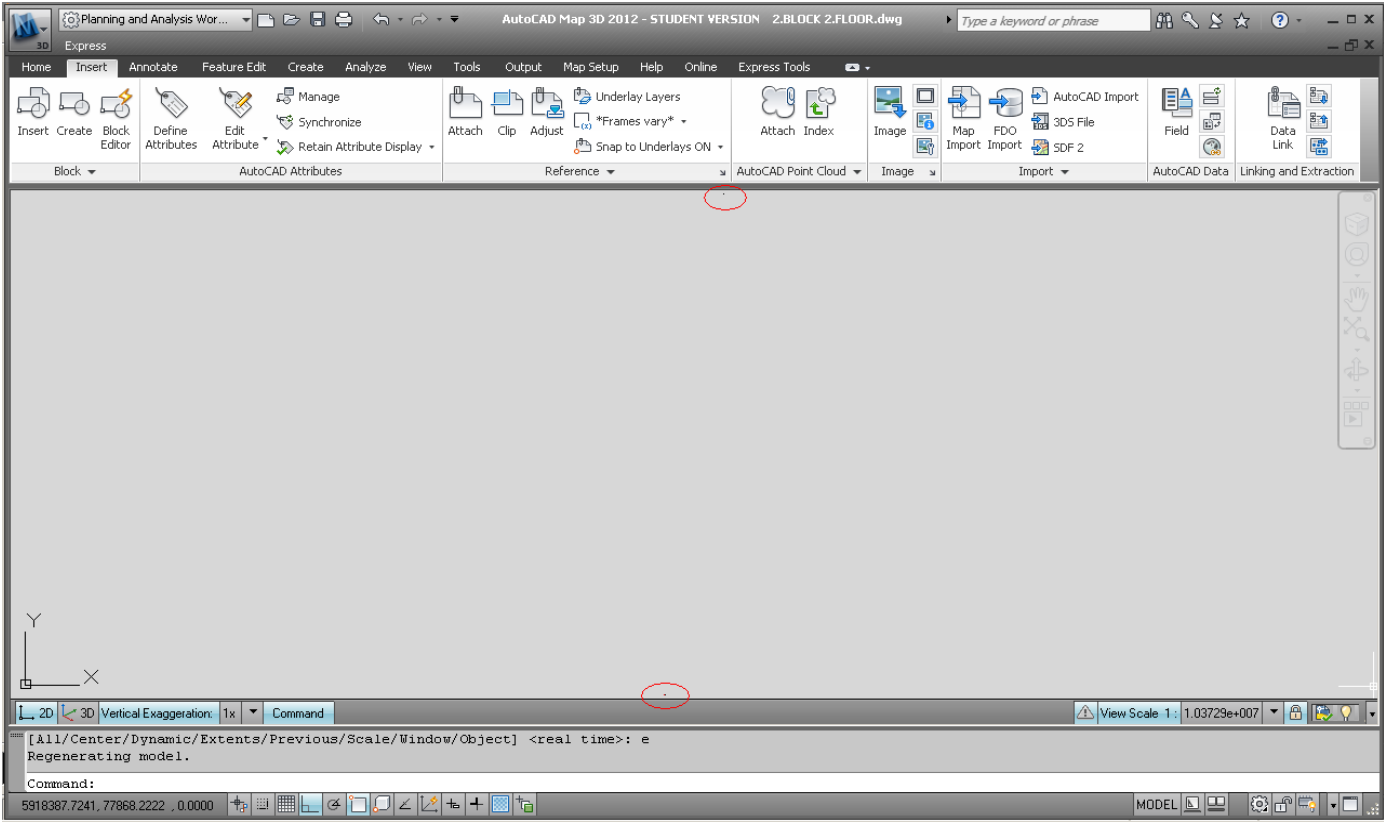


Figure 4.22 Opening the digitized building layers and floor plans of health campus in AutoCAD

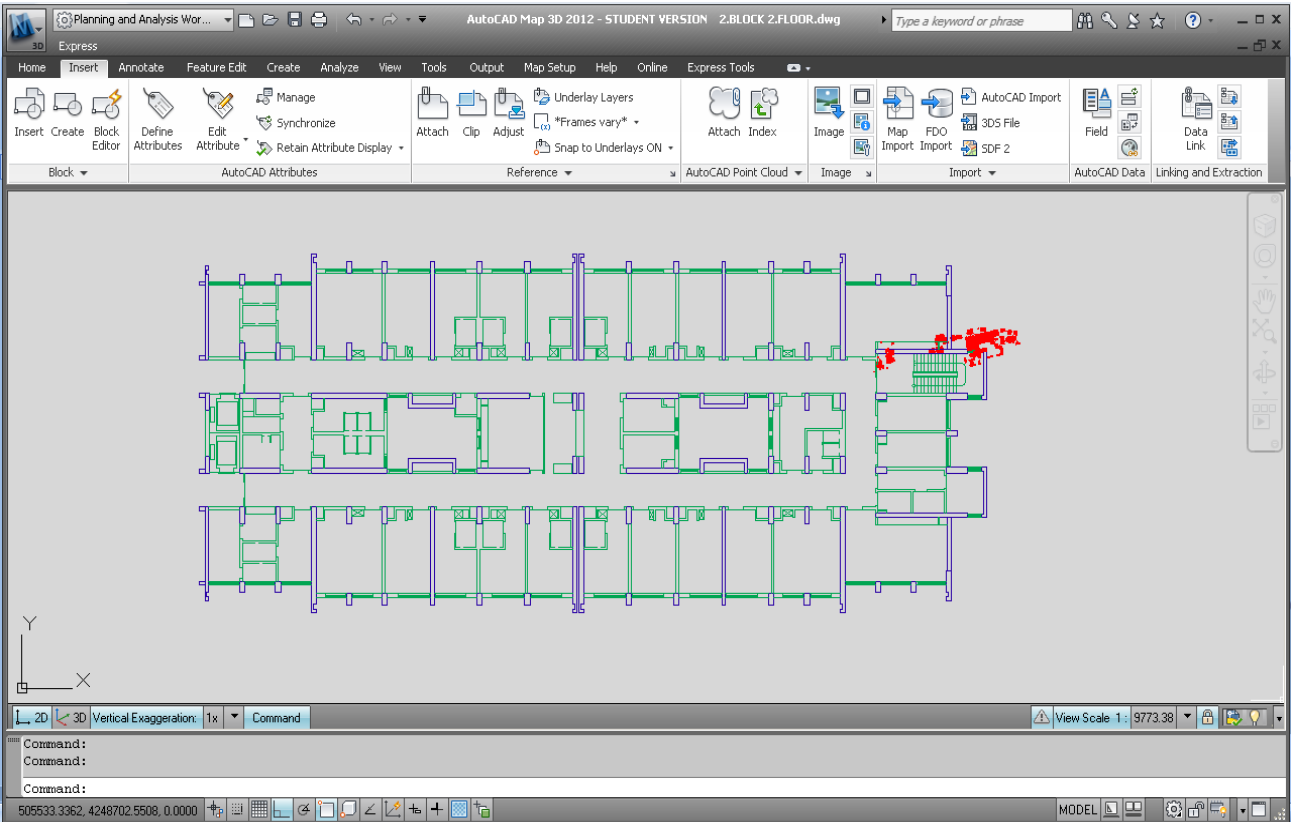


Figure 4.23 The scaling of the floor plan according to the building layer

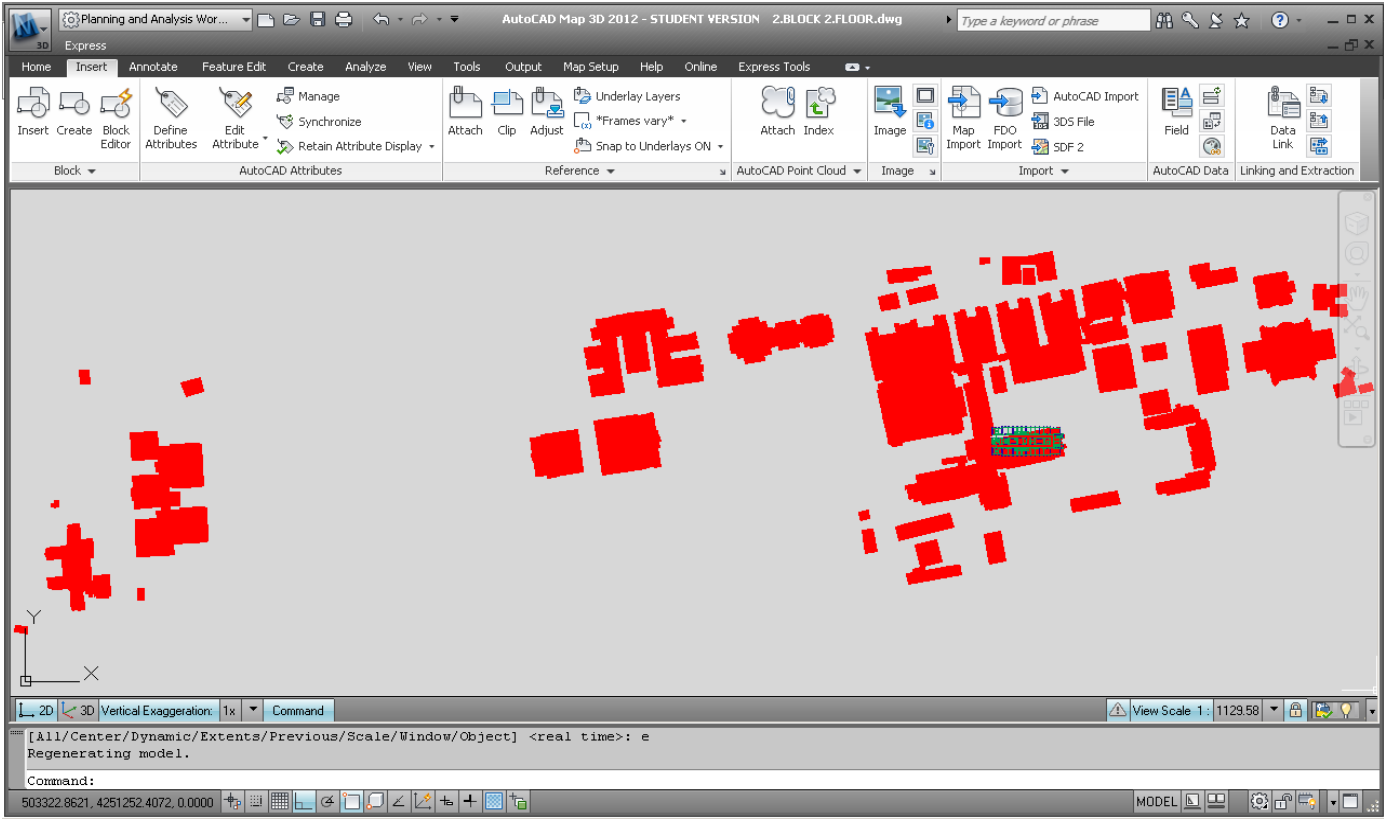


Figure 4.24 Rotation of the floor plan according to the building layer

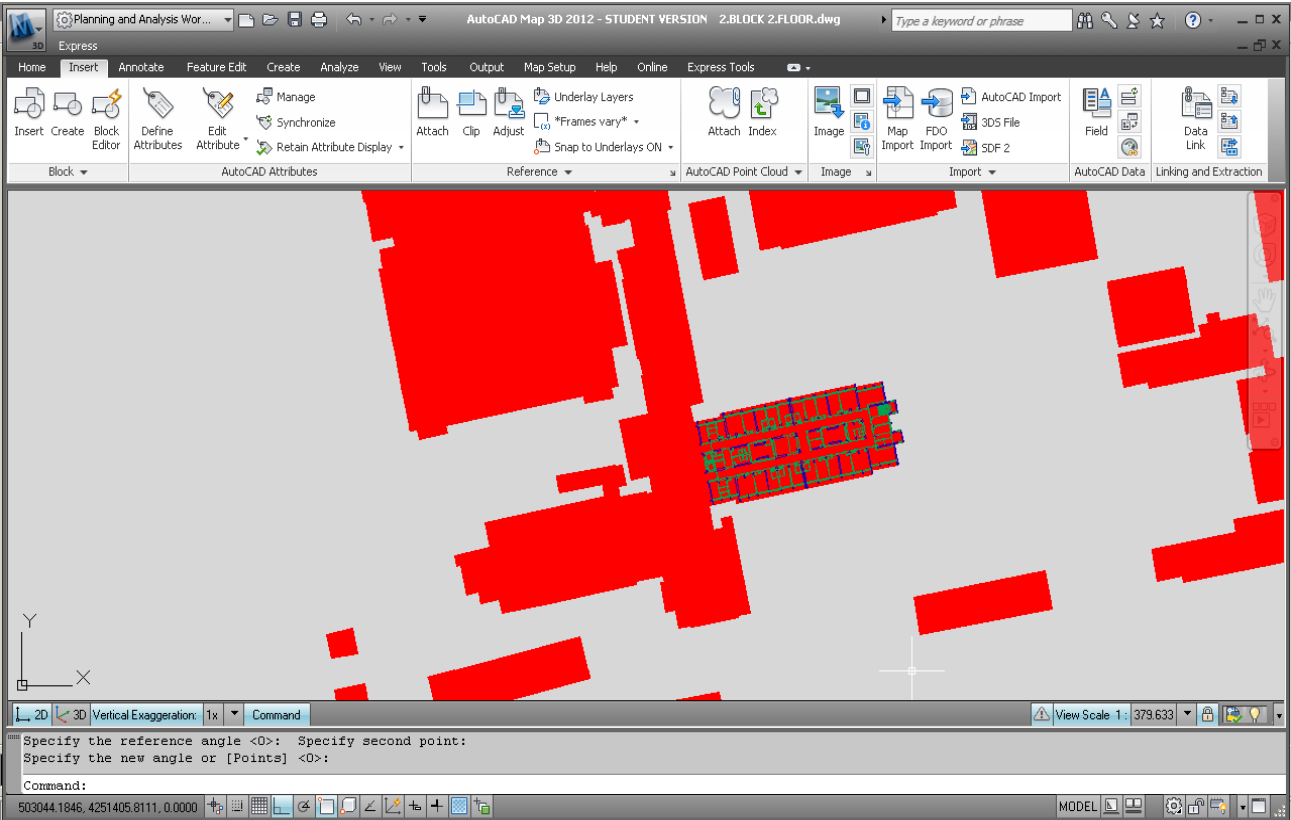


Figure 4.25 Final version of scaled floor plan

Following the completion of rotation and georeferencing operations, digitizing processes start. To achieve this, the layers, which will be drawn, are created in AutoCAD environment. Necessary layers for drawing are listed below.

- Column
- Wall
- Room
- Window
- Door
- Stairs
- Lift
- Corridor
- Equipment Cabinet
- Air Well
- Balcony
- Hatch

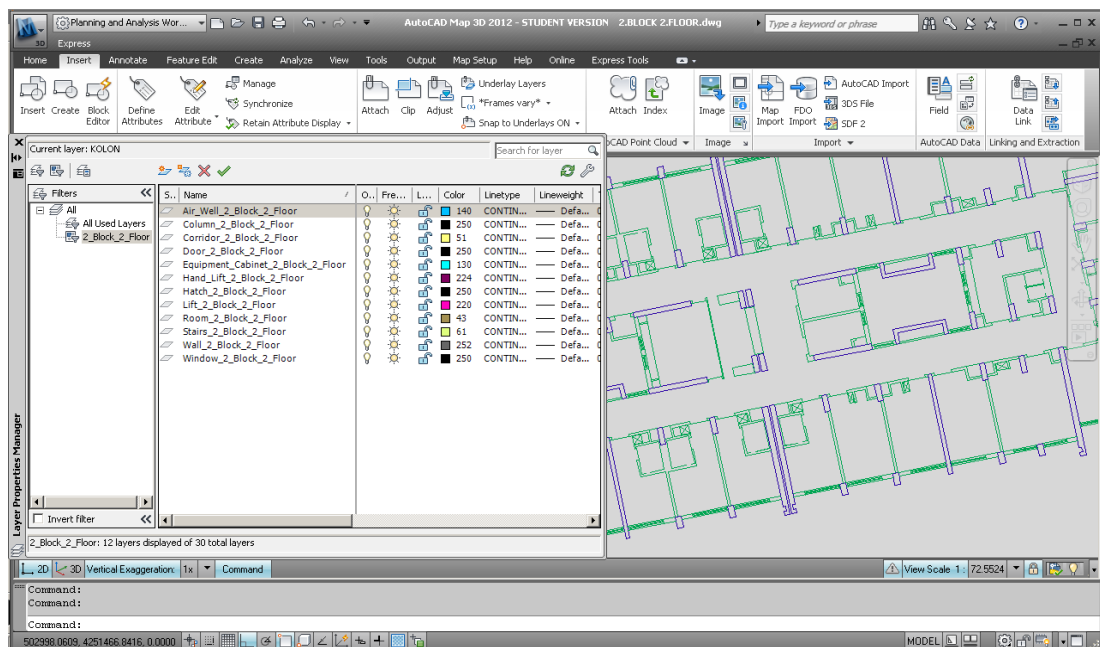


Figure 4.26 The necessary layers created in AutoCAD

After creating all the necessary layers in AutoCAD, next, the digitizing is started. Each layer is established by processing the updates upon that layer.

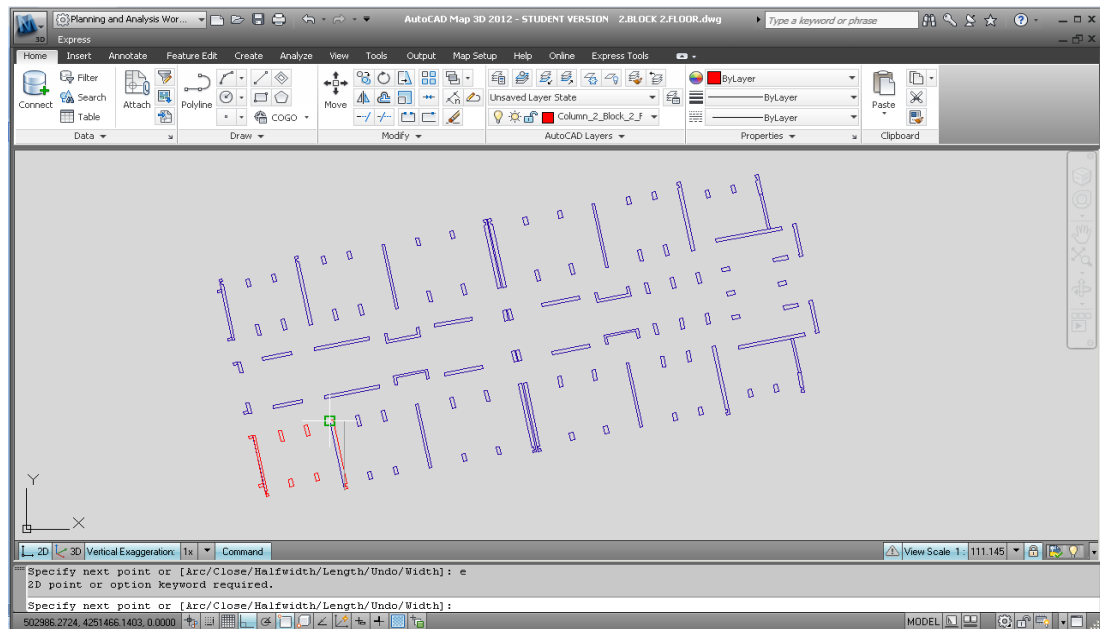


Figure 4.27 The digitizing process in AutoCAD

The image of the floor plan is given below which is formed after finishing drawing all the layers.

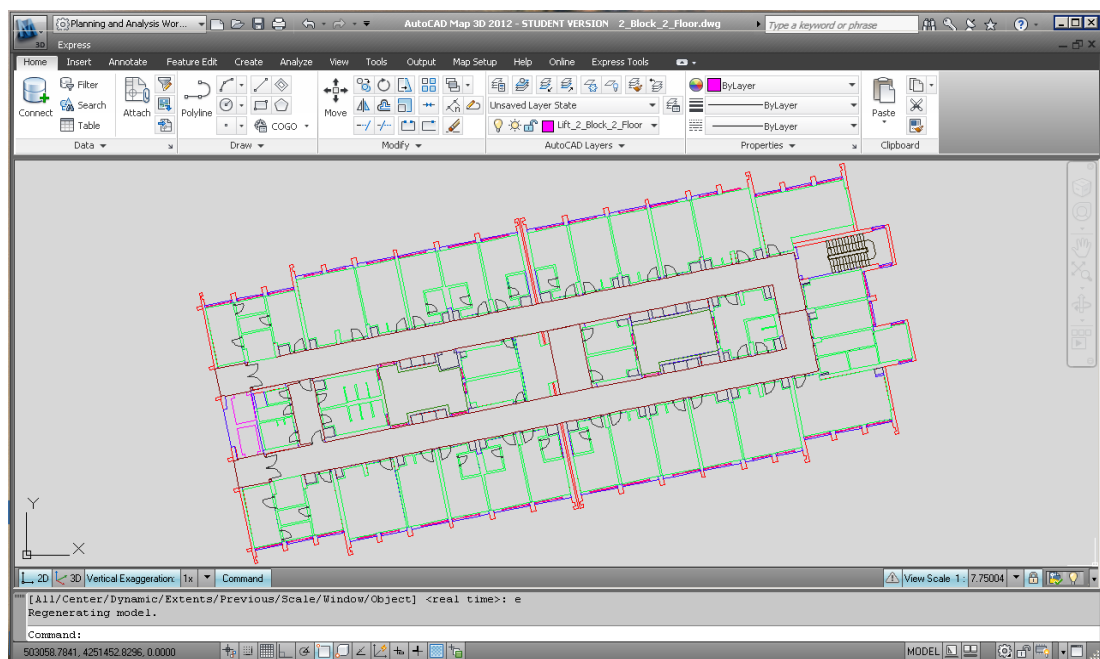


Figure 4.28 The digitized version of floor plans

After finishing drawing all the floor plans, to open those drawings on the buildings drawings, to be able to process the data and to prepare for the queries, it is required to transfer floor plans from AutoCAD to ArcGIS. To achieve this, the “output” command is used in AutoCAD Map 3D software. Each layer is saved as shapefiles separately. While saving, the issue about which layer must be in which line type is also decided.

Every layer is opened in ArcMap without any problem, following saving them as shapefile. At this stage, there must be another process for the layers that have their line type as “line” instead of “polygon” because the closed area could not be created before.

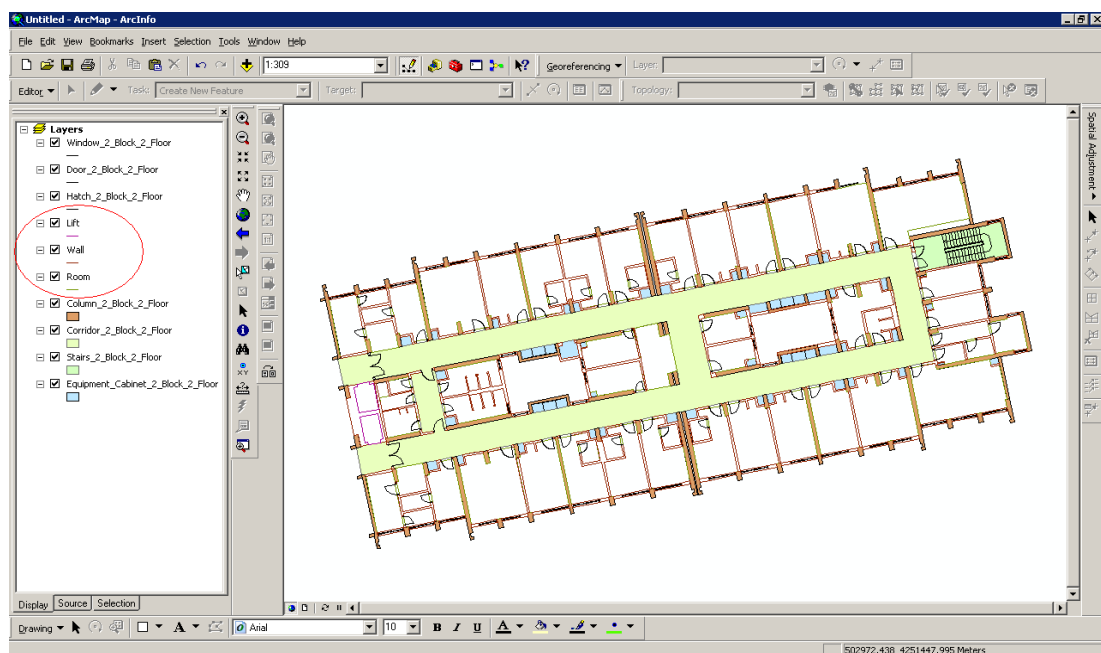


Figure 4.29 The view of the layers in ArcGIS that have incorrect line types

To achieve this process, first, new shapefiles should be established according to the line types of layers in ArcCatalog.

Subsequent to creation of new layers, these layers are opened in ArcMap. Using the “topology” command, the layers, which must be in “polygon” line type but instead are in “line” line type, are transferred to the “polygon”.

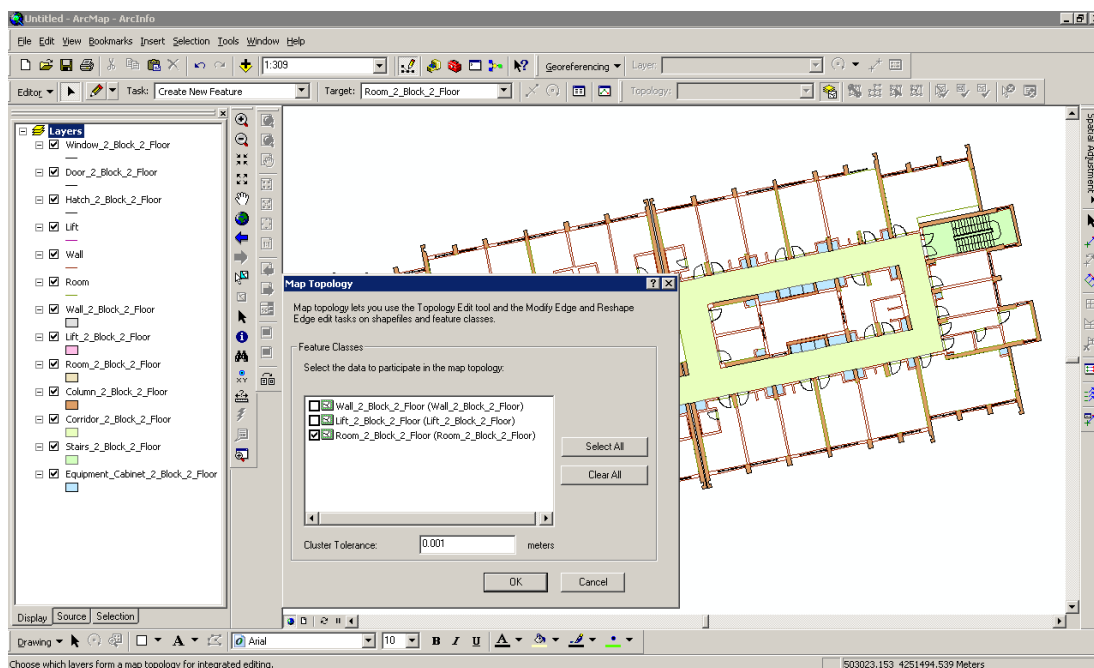


Figure 4.30 Using of the “map topology” command for transferring the line type of room layer from “line” to “polygon” type.

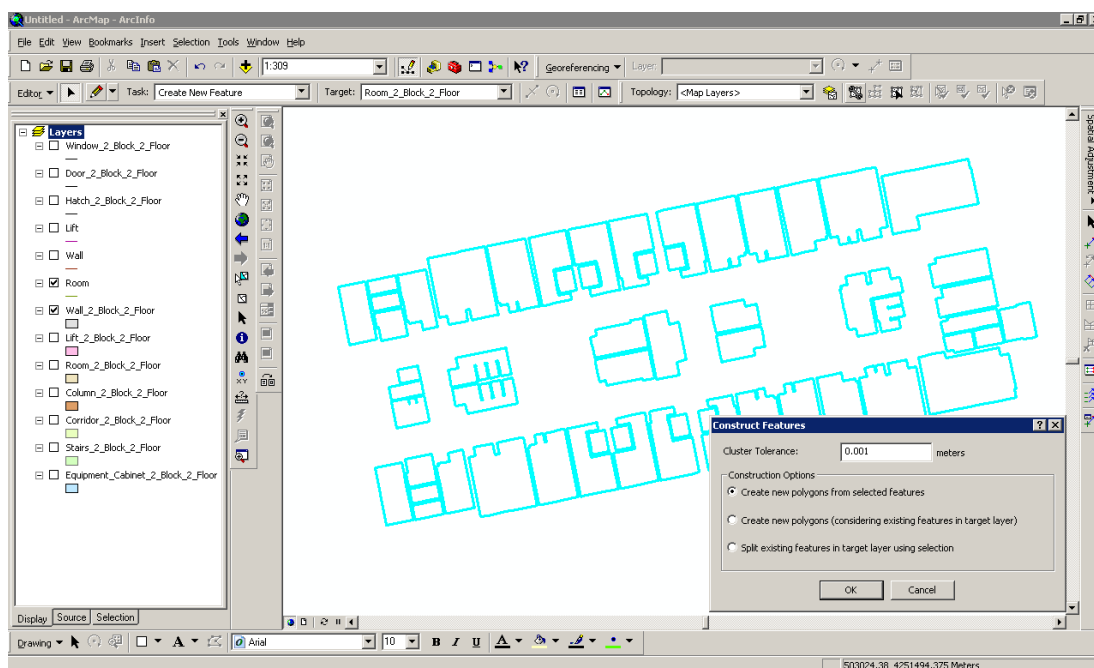


Figure 4.31 Transferring the line types from “line” to “polygon” by selection of drawings with “line” types

Graphic data can be used following these operations, in other word, it has become to ready to be integrated with attribute information.

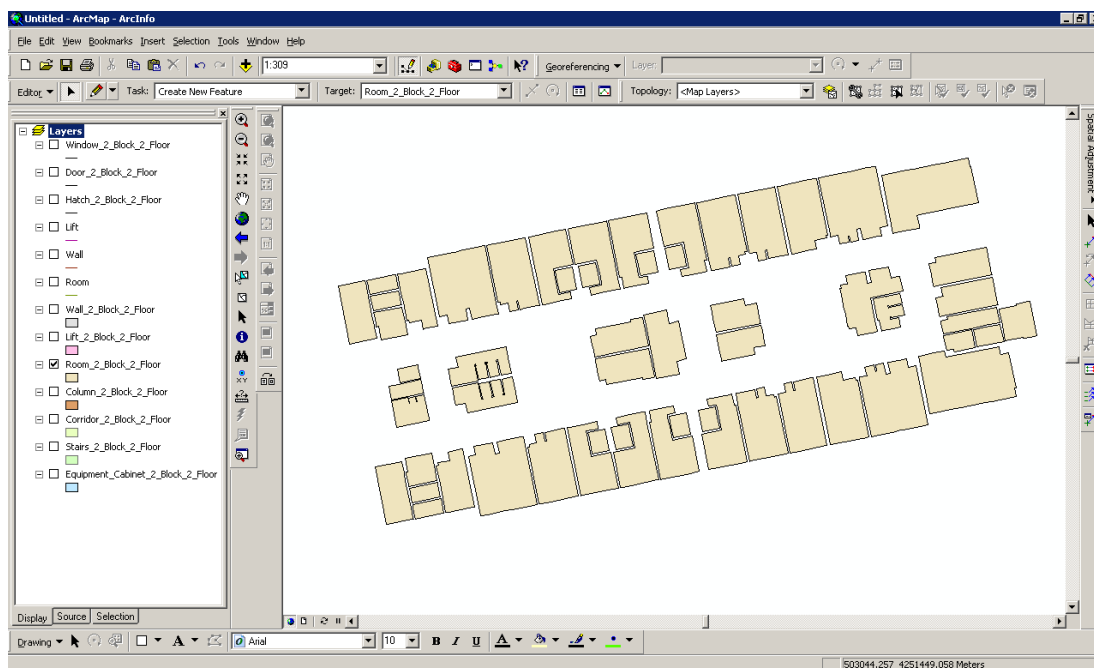


Figure 4.32 Digitized room layer with “polygon” line type

Creation of database is the process of adding the attribute data to the topological data table that created in ArcMap after obtaining the graphic data. After editing all layers in this way, next stage is adding the data of inside the building that collected one by one through observation.

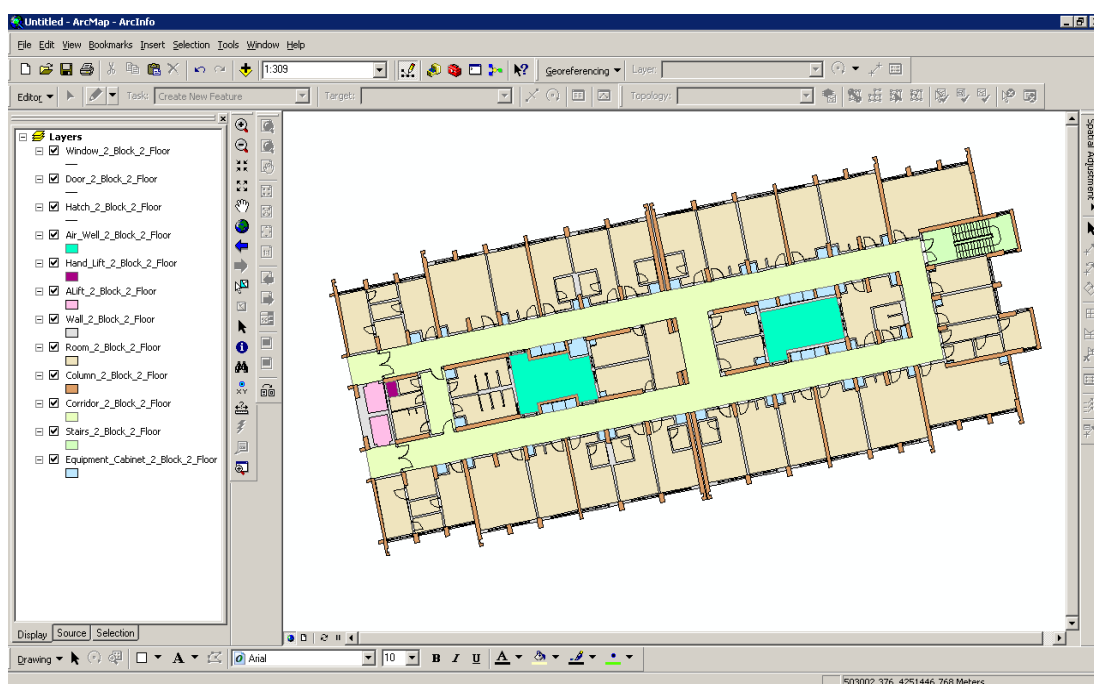


Figure 4.33 Digitized floor plan

Each layer in the floor plan and attribute information gathered has become questionable by processing to the tables.

Figure 4.34 displays three attribute tables from ArcMap, showing data for 'Block 2 Floorplan'. The tables are 'Attributes of Window_2_Block_2_Floor', 'Attributes of Door_2_Block_2_Floor', and 'Attributes of Room_2_Block_2_Floor'. Each table lists various attributes like ID, Shape, ID, Glass_Type, Usage, Direction, and Department, along with their values.

Figure 4.34 Attribute tables of the layers in the floor plan

New layers created in ArcCatalog for each data added. These new layers are opened upon the other drawings and their data are processed for every layer.

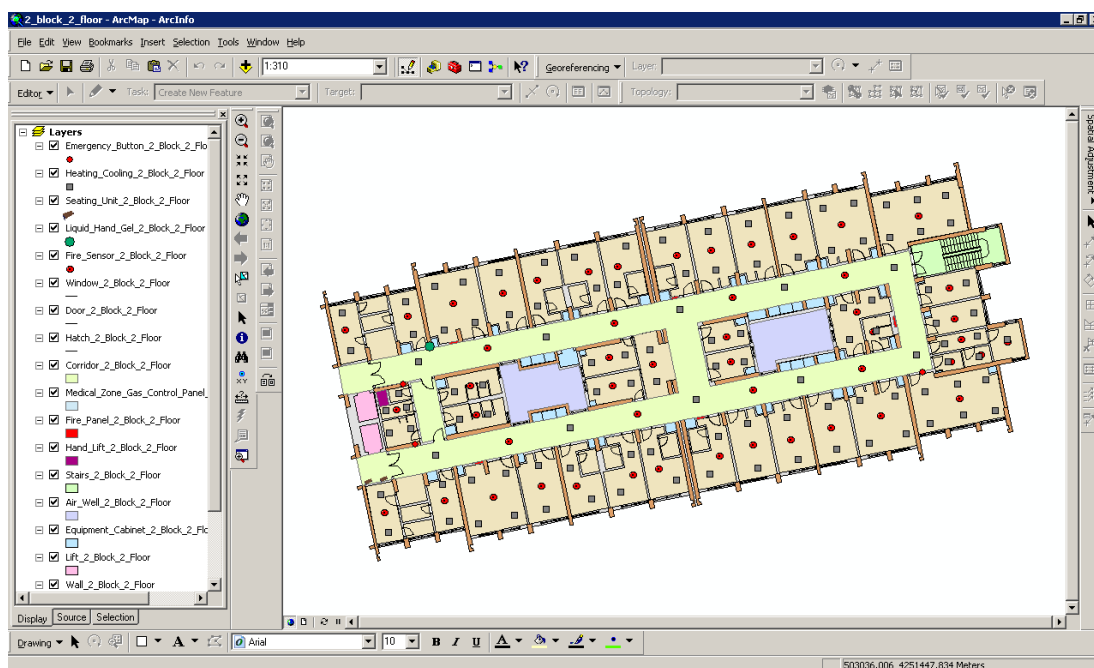


Figure 4.35 Processing of data of the newly created layers on floor plans

After the completion of drawing of all the layers, attribute table of these layers are filled in. To achieve this, first, the titles of required information are formed. Next, these titles are added to the attribute tables. Afterwards, attributes of points are related with graphic data by “editor” tool.

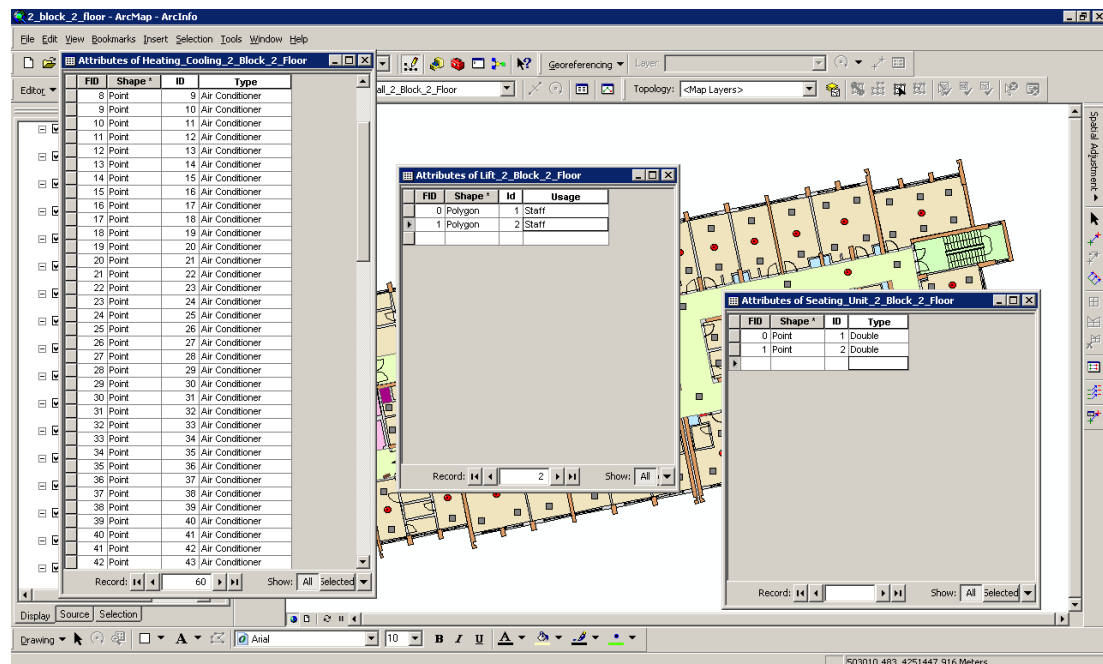
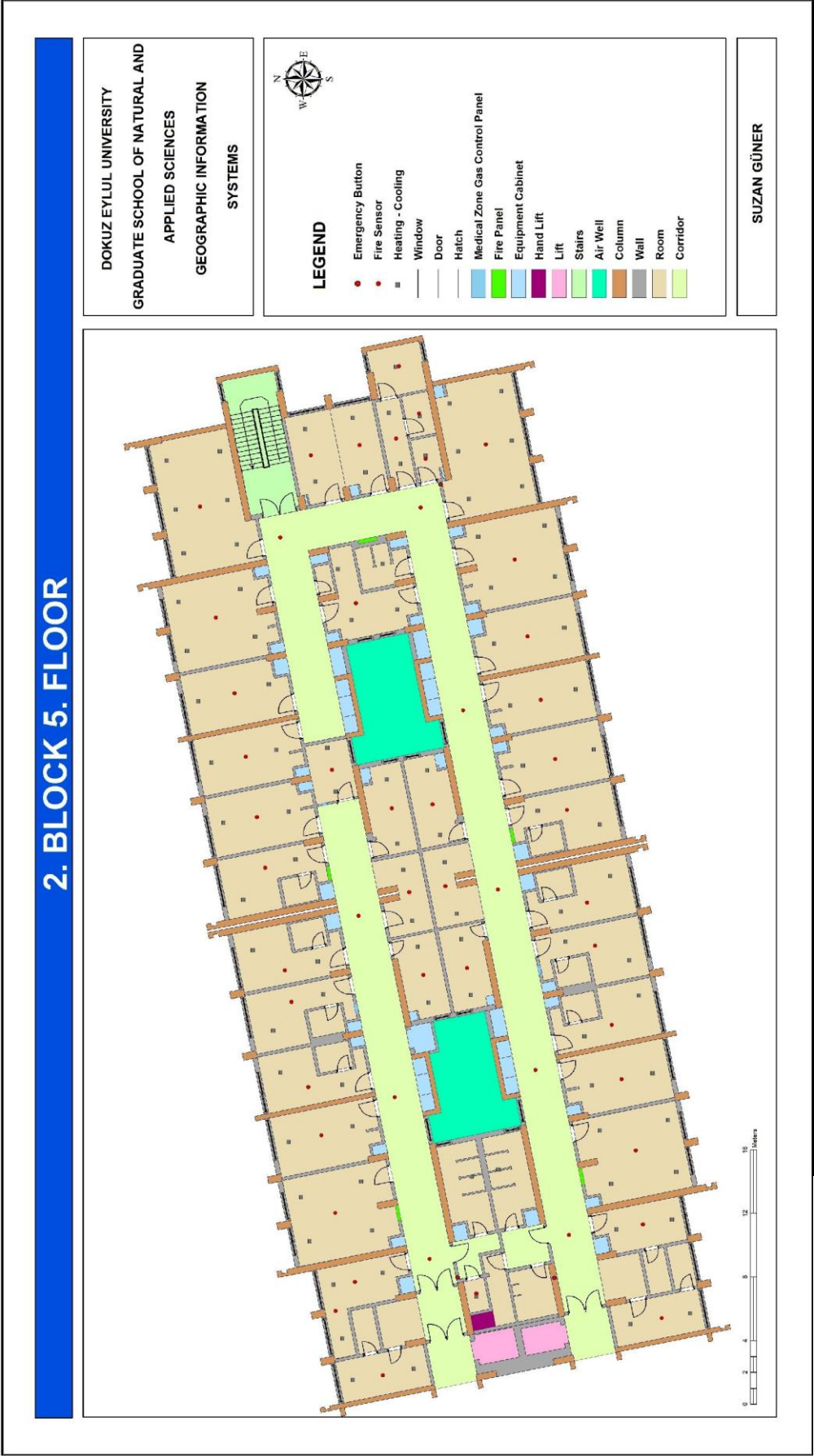


Figure 4.36 The view of the attribute tables of data are processed on floor plans

After the following the same operations for each floor in 3 blocks, the data has become to be used and querying.

Drawing of the floor plan of the 2nd block 5th floor is shown below in Figure 4.37. Other blocks' floor plan drawings are shown in the Appendix chapter.



4.3 Queries

Primarily, arrangement of data is required to perform spatial queries by the system users identified at the first stage of the thesis. Arrangement will be prepared by using data collected through observation, in accordance with the aims and objectives of the system of Health Campus. To organize the data Arc Catalog is used at this stage. The data generated at Arc Catalog are divided into two categories as outside and inside, which formed two different personal geodatabases and new layers, are opened in these personal geodatabases. The reason of division of data as outside and inside is; there are two different type of data structure. The outside geodatabase has exterior building components, so has more general data, and cannot touch directly the detailed data inside the building. Inside geodatabase has floor plans, so more details about building are manipulated. In this context, there are no common components between these data and this requires generating data into two different categories.

After arrangement of data as two different categories, next, the data is divided into categories within itself and the query titles are prepared. To make queries clear and regular, layers related to each other are gathered under the identified main titles. The main titles determined according to subject of the Thesis are:

OUTSIDE

- General Query
- Detail Query
 - Whole Campus
 - Building
 - Street Furniture
 - Sports Complex
 - Transportation
 - Car Parking
 - Area

INSIDE

- Blocks
- Floors
- Departments
- Whole Hospital
- Rooms
 - According to Type of Room
 - According to Number of Room
 - According to Number of Door
 - Other Queries
- Keeper
- Service Secretary / Nurse Station

After determining the query titles, disorganized data are transferred into personal geodatabase by export command in the ArcCatalog.

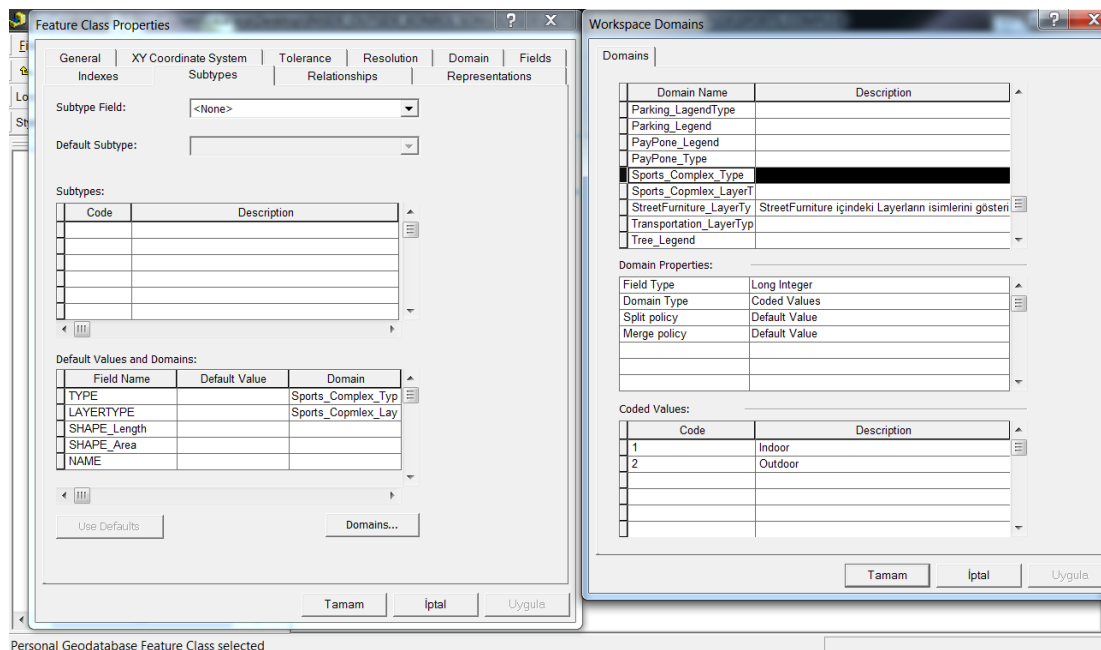


Figure 4.38 The image of layers with domain and subtypes in Arc Catalog.

Next stage is the layer arrangement. During the arrangements, constant titles are generated for type values and categories. Domain and subtype values are given to these constant titles to make queries. For example, for the type column under Sports Complex layer, domain values are given and these domain values are determined as indoor and outdoor, as layer types. The attributes of data are determined as given the code 1 for indoor and given the code 2 for outdoor. These processes are also done for the data of other layers according to their query types. The reasons of doing these processes are to ensure regularity of data and to make queries more convenient. Figure 4.38 shows the finished form of the processes mentioned above.

After all this data manipulation operations, writing the code stage is started by the C# language Arcobject extension attachments in Visual Studio 2008. All query menus, which are created, are prepared for only this thesis.

During the software stage, first the CAMPUS menu for the exterior building queries and the HOSPITAL menu for the interior building queries are created. After, the query forms are designed according to the determined titles. Some of those query forms are used to general queries; on the other hand some of them are used to generate new forms for detailed queries.

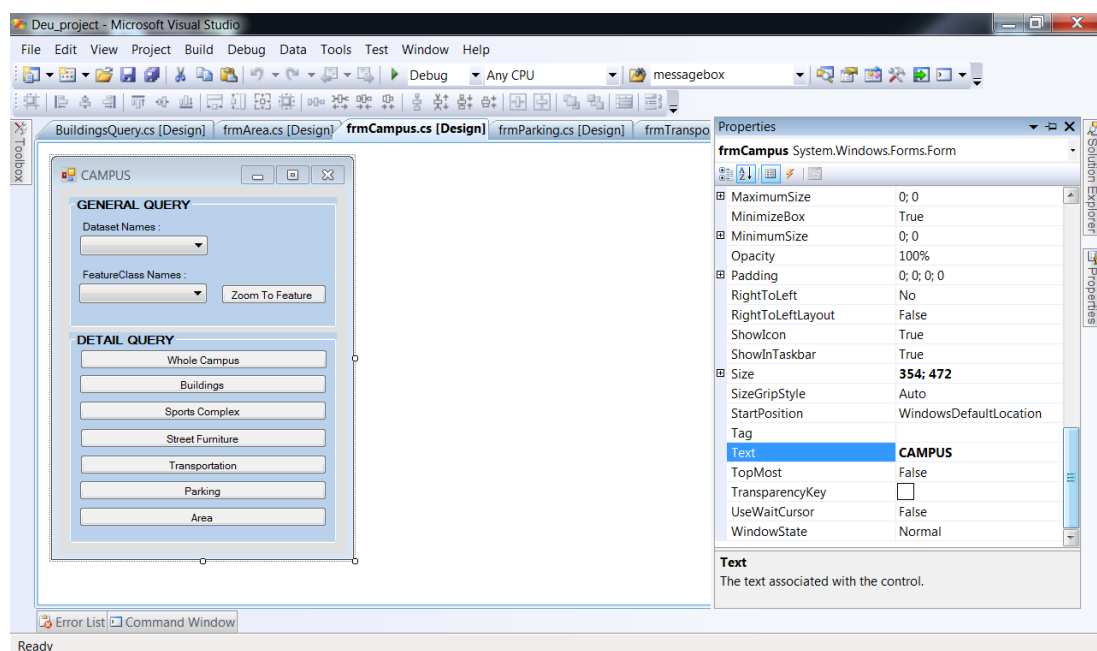


Figure 4.39 The image of query form at Arcobject in Visual Studio 2008.

After completion of the query software, symbologies in the layers of inside and outside mxd format are organized and data becomes a queryable system.

The system becomes questionable with the creation of a database, which is regular and accordance with the requirements of the system. On the system, spatial queries suitable for specified goals and objectives can be performed. As its structure, the system divided as building exterior and building interior, it provides to perform separated queries for campus area and for hospital by different query menus.

4.3.1 Campus Queries

CAMPUS menu title, which has been shown within the red circle in Figure 4.40, symbolizes commands created within this study by Visual Studio 2008 with the extension of ArcObjects. CAMPUS menu will be used to perform the queries of Campus Area as building exterior.

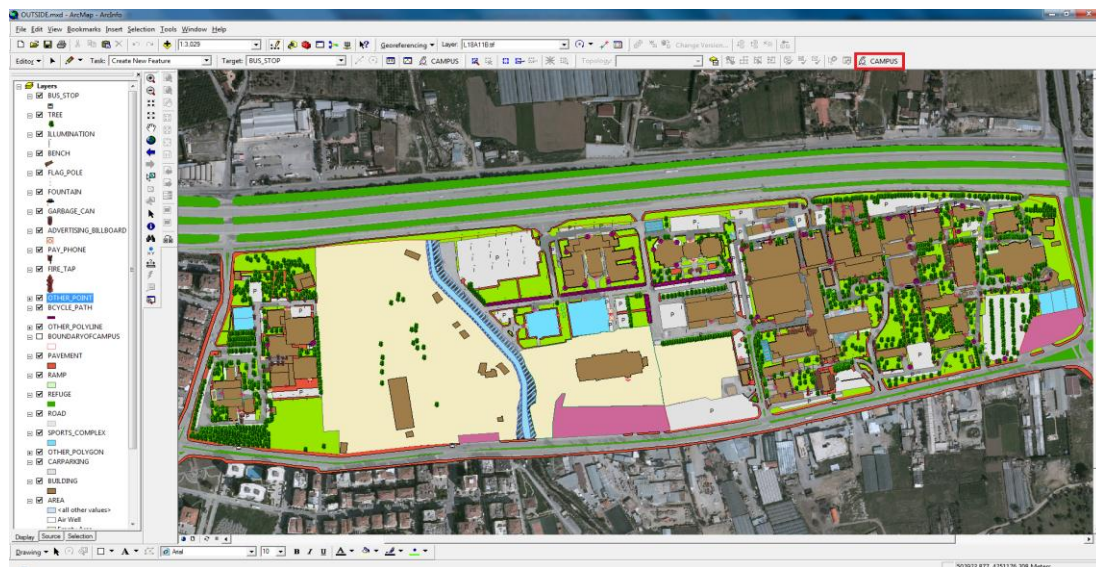


Figure 4.40 The campus menu created in ArcGIS.

CAMPUS menu established under the Dokuz Eylül University Spatial Information Management for İnciraltı Health Campus is divided into two parts as general and detail queries. Sub-titles under the Campus menu are shown in Fig. 4.41.

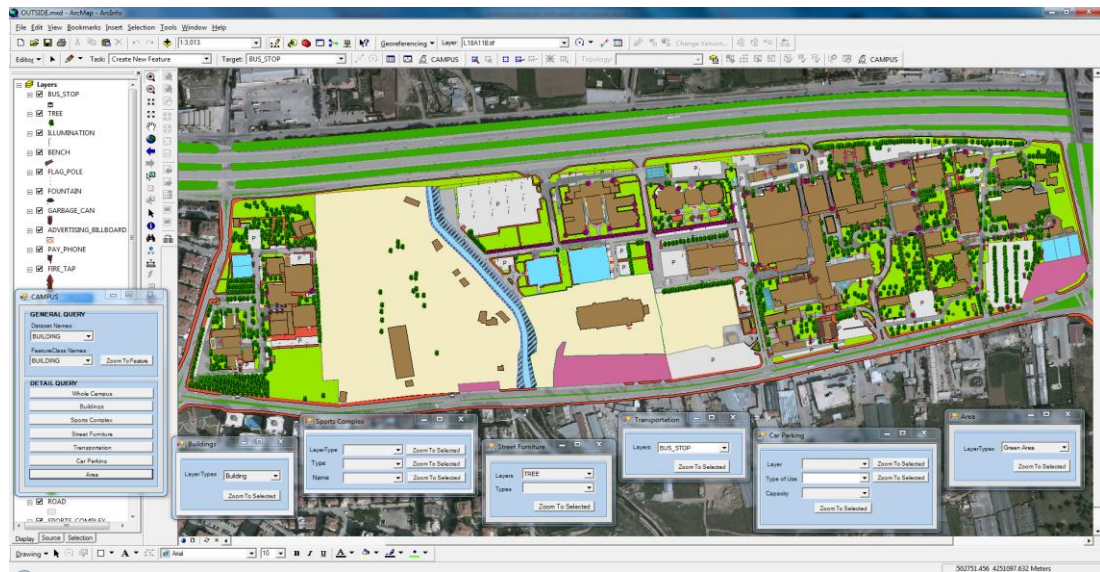


Figure 4.41 Sub-titles under the Campus menu.

Explanations of the sub-titles of the Campus menu:

4.3.1.1 General Query

This section called general query provides to make queries according to the dataset names and future classes without further details.

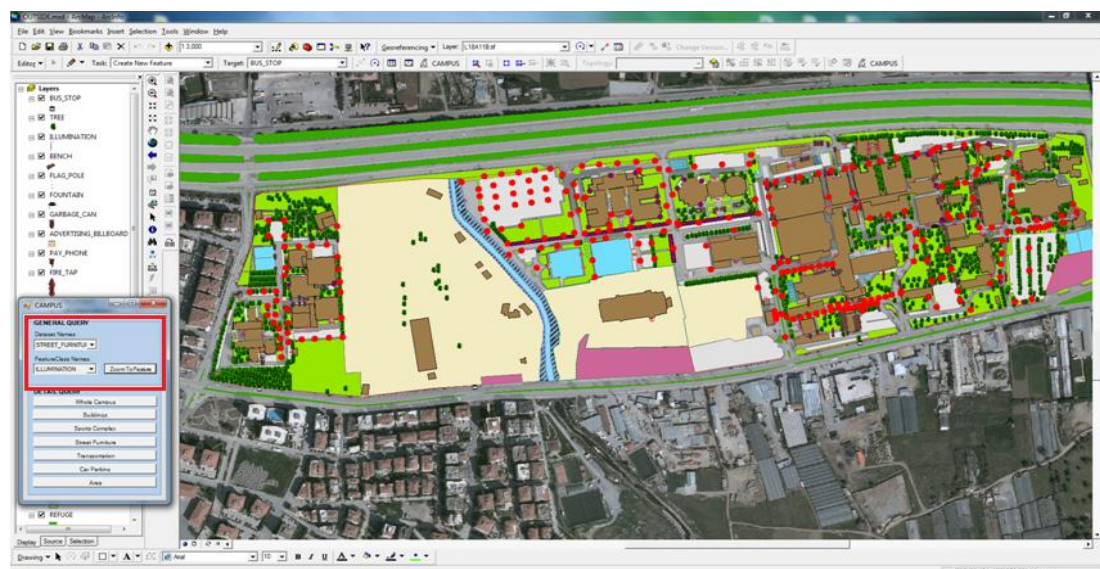


Figure 4.42 The result image of the querying of lighting from street furniture by the general query command.

As it is shown in Figure 4.42, illuminations in the street furniture are questioning without details. In this section questioning is done as a whole without selecting any feature of illumination.

4.3.1.2 Detail Query

Another title under the Campus menu is “Detail Query” command. Detail query command is also divided into sub-titles.

4.3.1.2.1 Whole Campus. “Whole campus” command under the detail query provides to show the entire campus area map regardless of which map and table is opened at that moment.

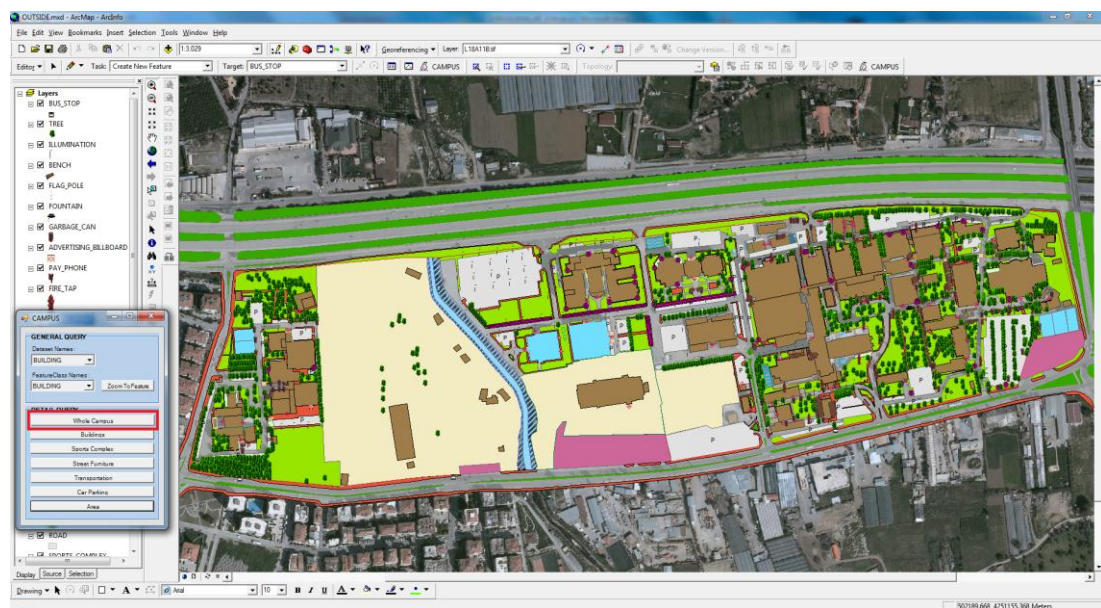


Figure 4.43 The result image of the “Whole Campus” command

4.3.1.2.2 Buildings. “Buildings” query command provides access to any building located in the health campus. The query options are; building, building new, building additional, building shed, cash machine, information, parking control, pergola, ruin, shed, sports complex and tube passage are shown in Figure 4.44.

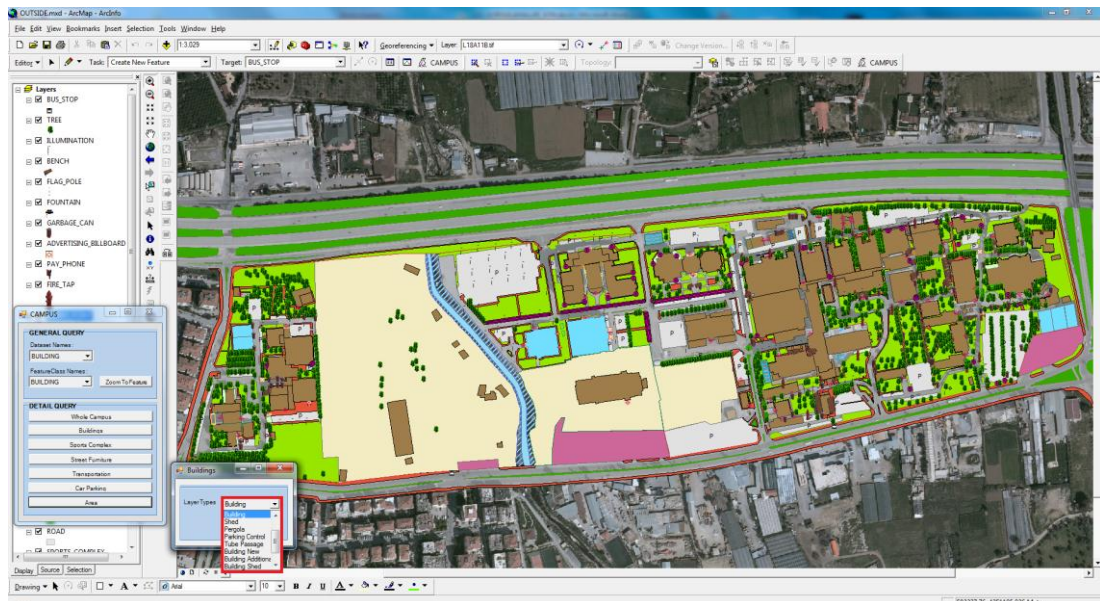


Figure 4.44 Options of layer types queries.

In the "Buildings" query command, the image of any selected buildings can be shown on the map. The image of selection of buildings by "Buildings" query command is shown in the Figure 4.45.

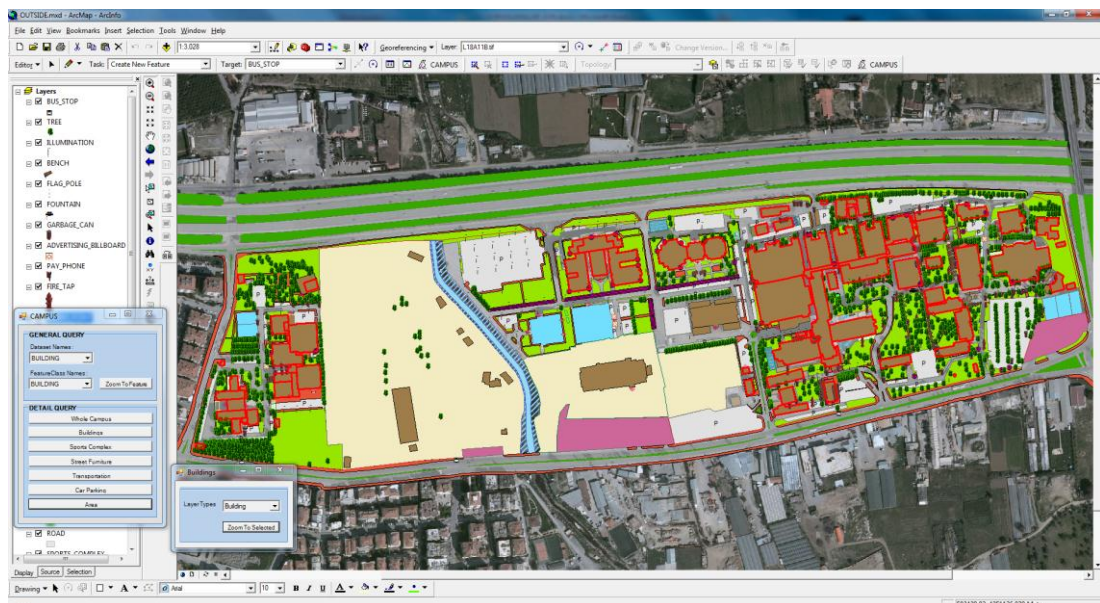


Figure 4.45 The result image of the query of buildings by "Buildings" command.

Other requested information about the building can be seen by Info Tool or the attribute table.

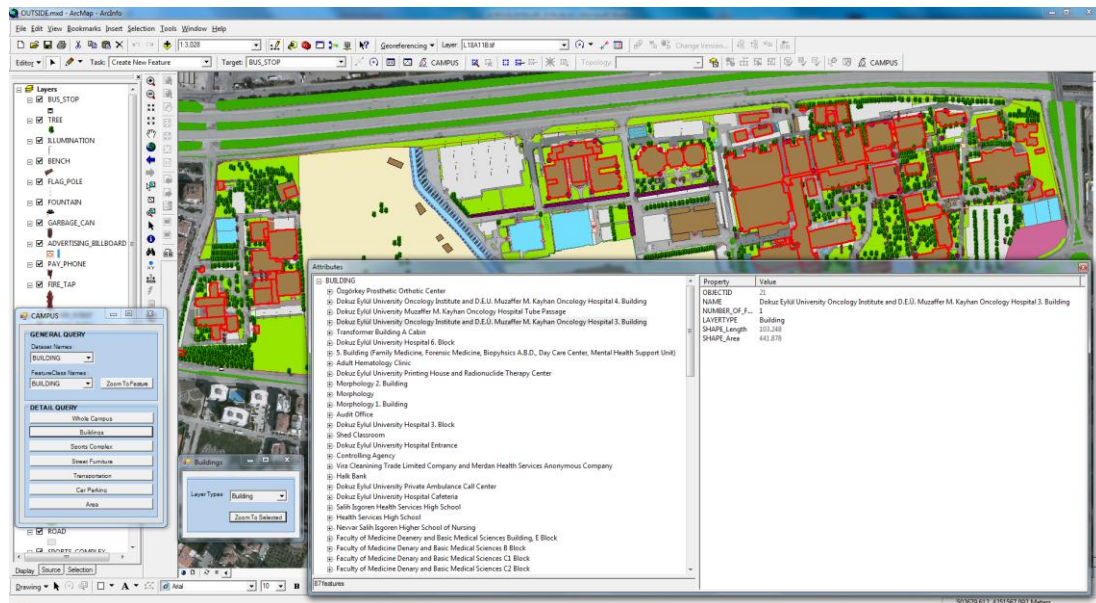


Figure 4.46 Showing the attribute data of buildings selected by buildings query.

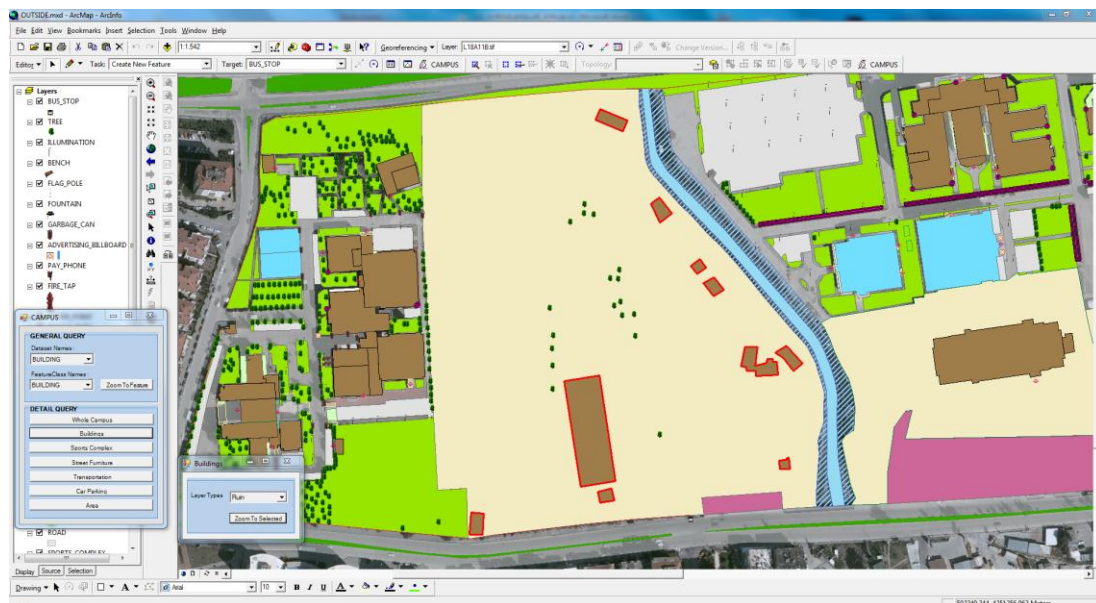


Figure 4.47 The result image of selection of “ruin” by buildings query.

4.3.1.2.3 Sports Complex. Another sub-title of Detail Query under Campus menu is “Sports Complex”. Sports Complex command can query according to layer types, types or layer names separately. As it is shown in Figure 4.48, all sport complexes can be reached by using layer types, on the other hand, it can be selected as outdoor and indoor sport complex according to its type.

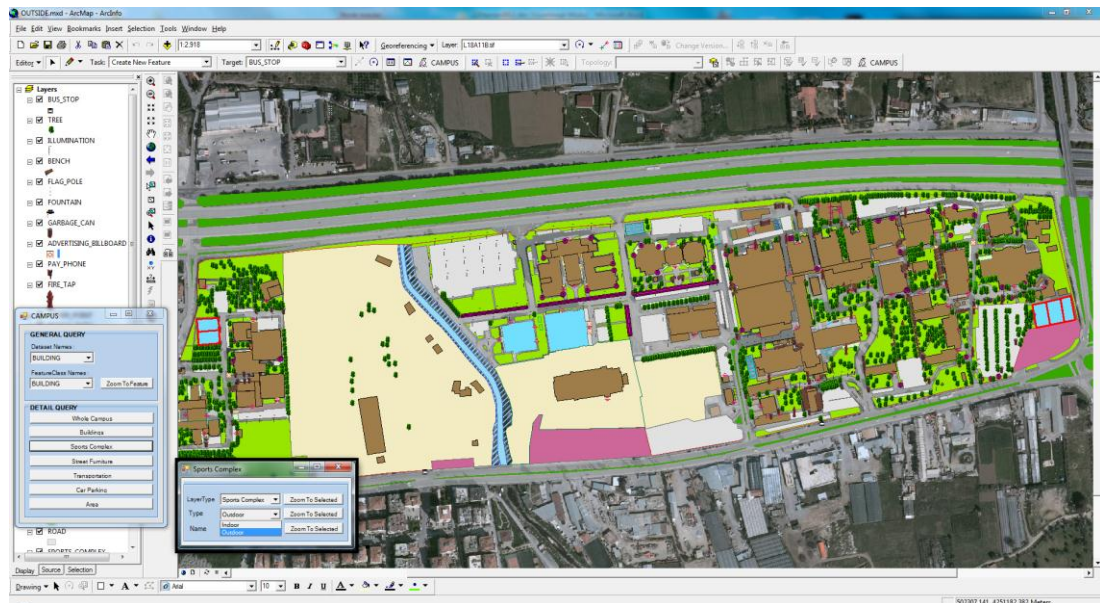


Figure 4.48 The result image of selection of outdoor sport areas by “Sports Complex” query.

In addition, sport complex can be selected according to their names as it is shown in Figure 4.49.

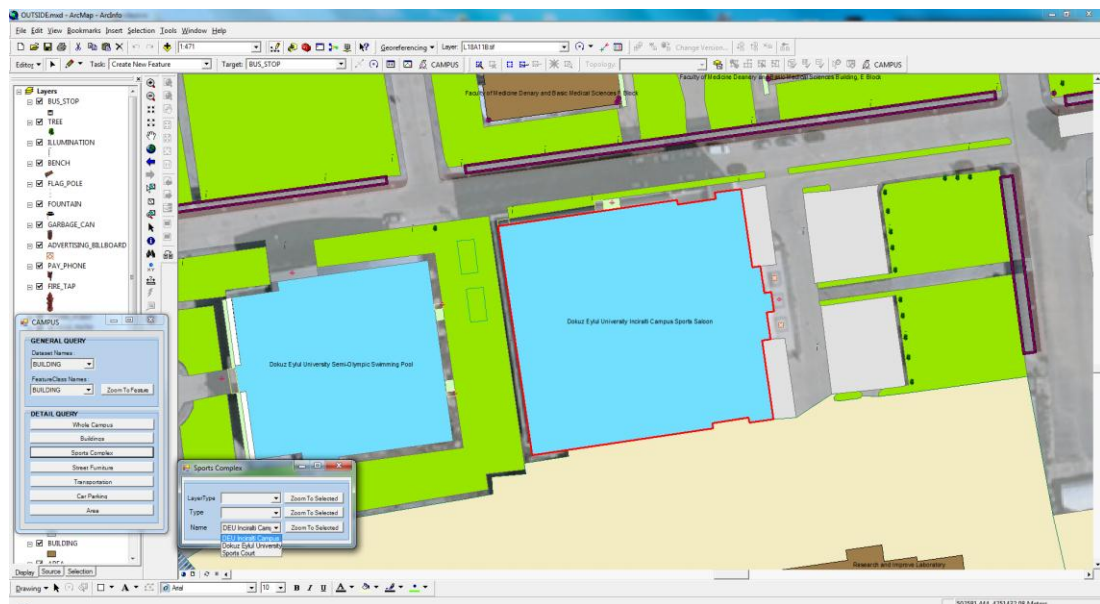


Figure 4.49 The result image of query of sport complex according to their names.

4.3.1.2.4 Street Furniture. As it shown in Figure 4.50, advertising billboard, bench, fire tap, flag pole, fountain, garbage can, illumination, pay phone and trees, which are the parts of the street furniture, can be queried according to types using by

“Street furniture” command.

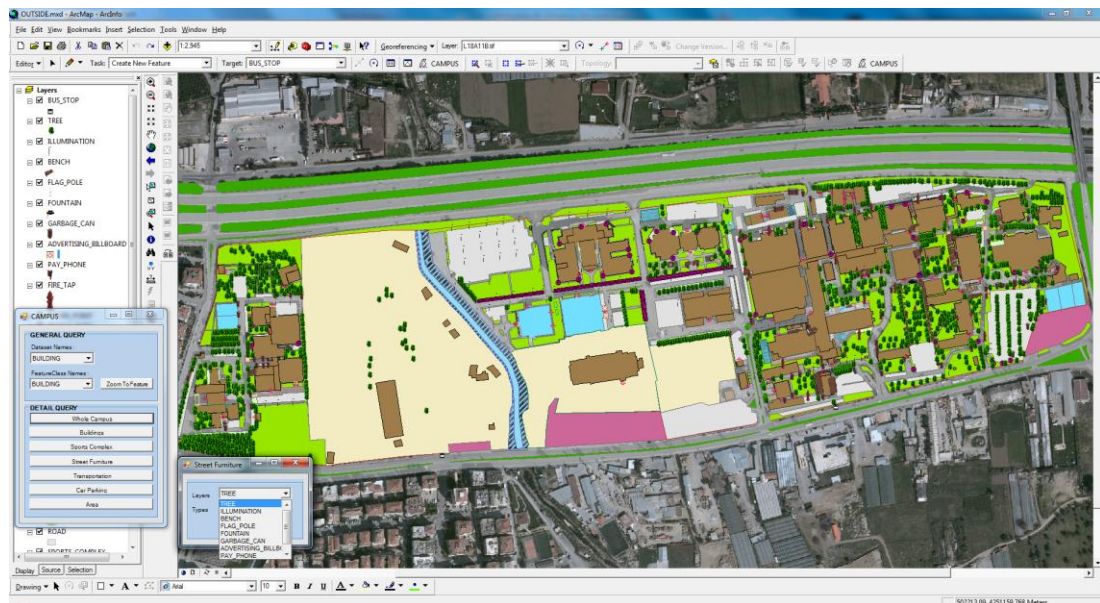


Figure 4.50 Sub-titles of “Street Furniture” command.

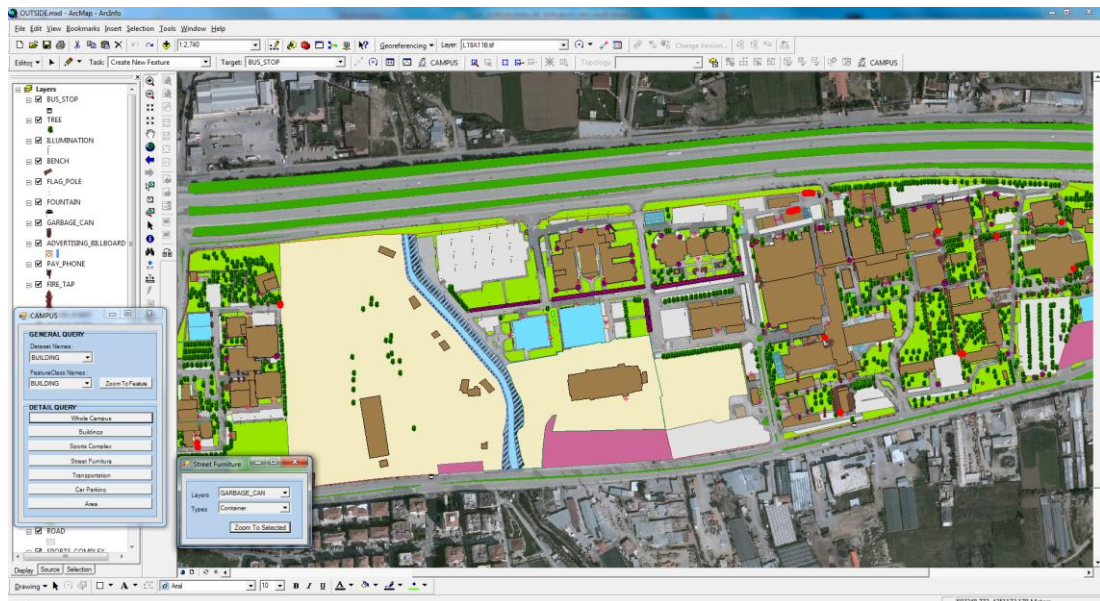


Figure 4.51 The result image of query of container type garbage can by Street furniture command.

Detail query according to the sub-titles, which are mentioned above, can be done using by “Street Furniture” command. The result image of the query of the long mast double sided types, which is the part of the illumination layer, is shown in Figure 4.51. The image of the query of garbage can which’s type is container can be shown

as another example.

4.3.1.2.5 *Transportation*. Bicycle path, bus stop, pavement, ramp, refuge and roads of health campus can be queried by “Transportation” query command.

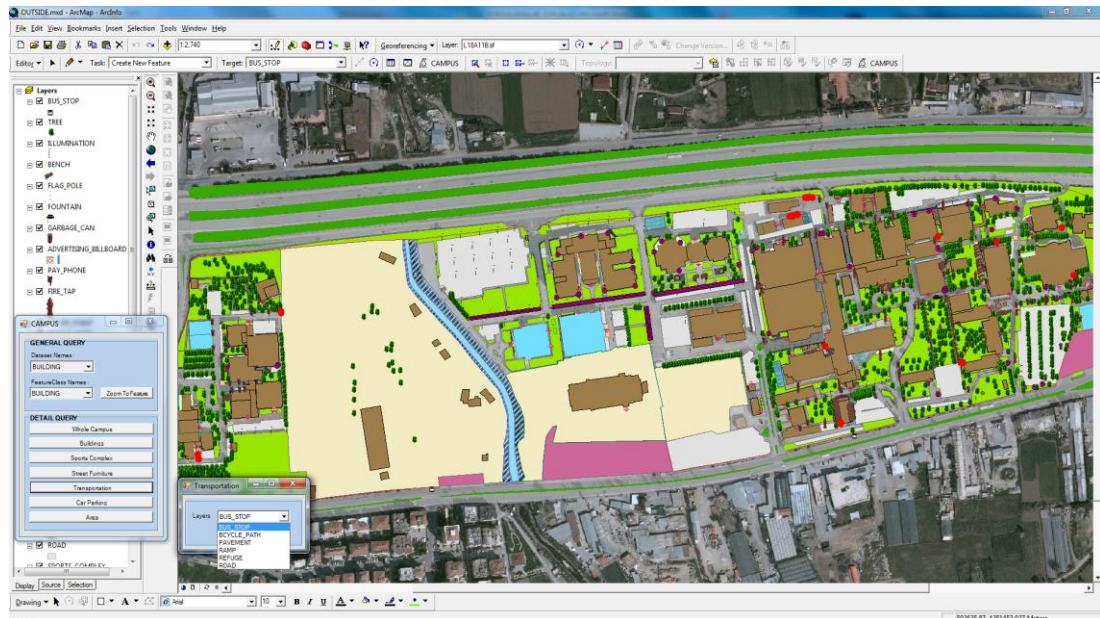


Figure 4.52 Sub-titles of “Transportation” query command.

Query of the bus stops around campus area are shown in Figure 4.53.

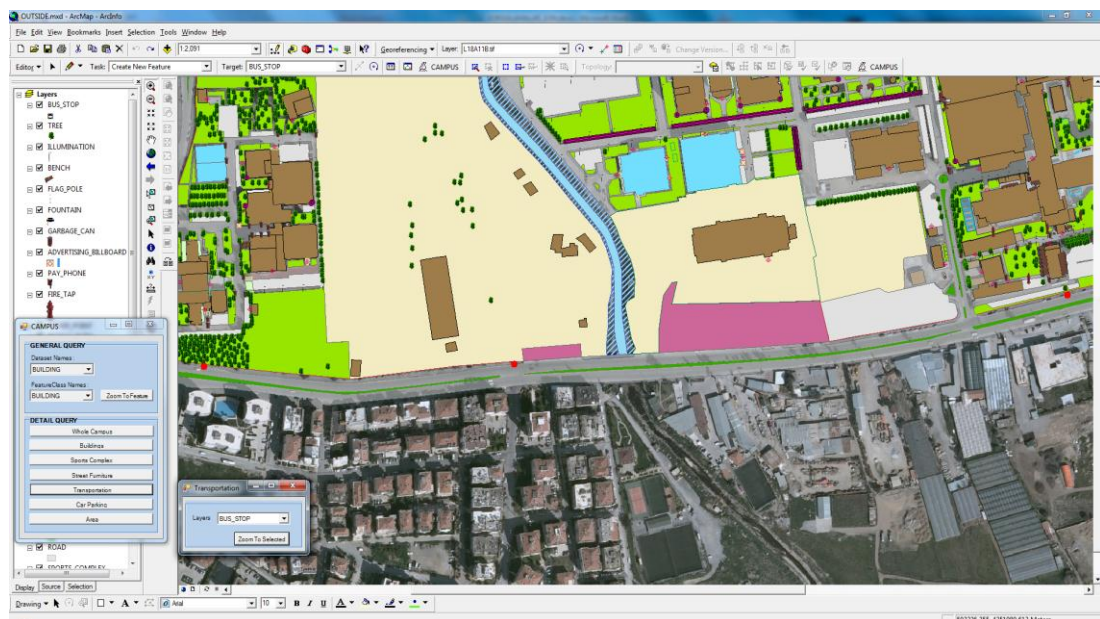


Figure 4.53 The result image of the query of the bus stops by transportation query command.

4.3.1.2.6 *Car Parking*. By “Parking” query command from the sub-titles of Detail Query, car parking areas in the campus area are questioned in detail. The questioning of all car parking areas can be done by selecting the layer at the parking query command.

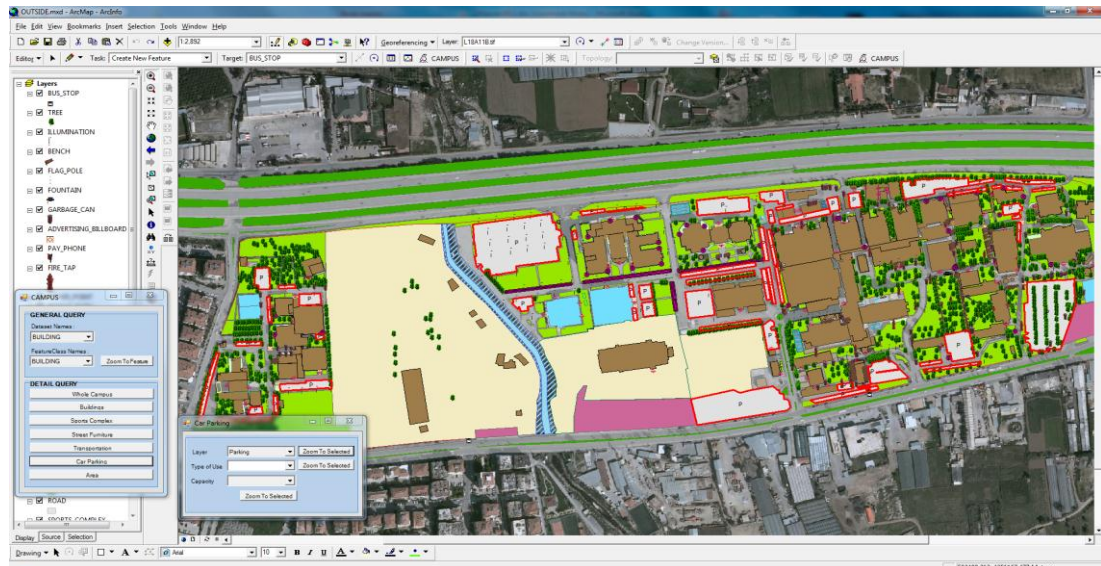


Figure 4.54 The result image of the query of car parking areas in the campus.

Car parking areas in the Health Campus can be questioned according to their type of usage as general and academic personal+student car parking. The query of car parking according to type of use is shown in Figure 4.55.

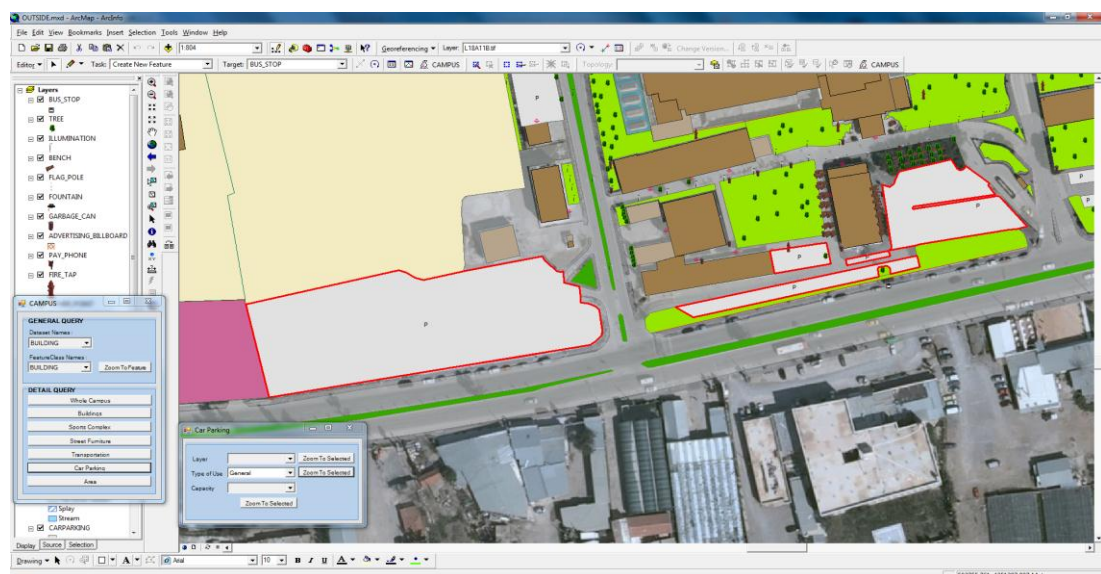


Figure 4.55 The result image of query of general parking by Car Parking query command.

Addition to questioning the car parking in the campus area, attribute data of selected car parking can be also seen at the attribute tables.

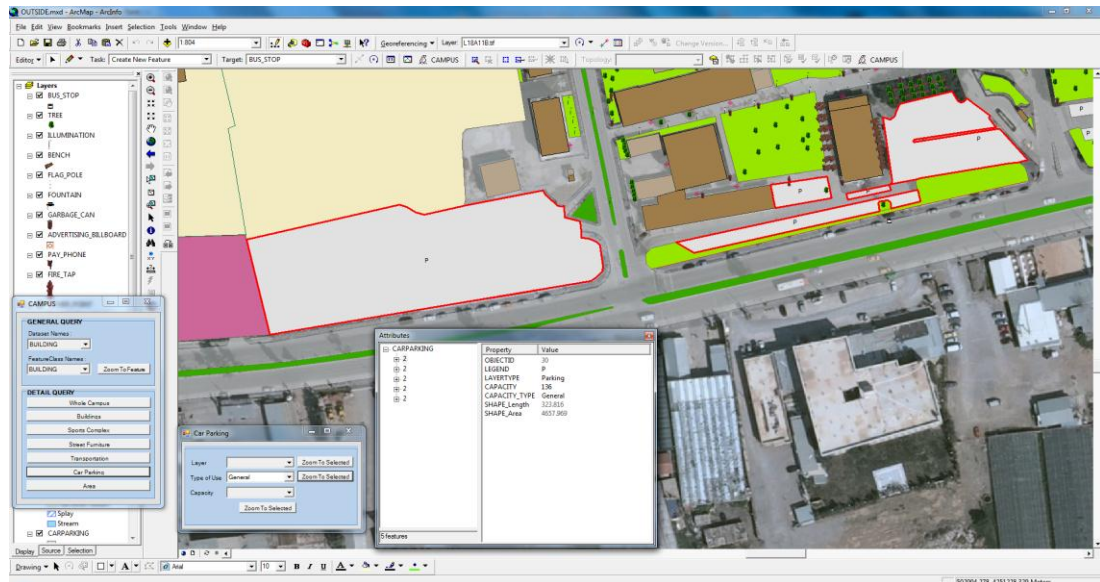


Figure 4.56 The image of the attribute data of general car parking areas.

In addition, the query according to capacity of car parking can be done by selecting any of the general or academic personnel+student car parking areas using “Parking” query command. Figure 4.57 and Figure 4.58 shows the query of the general car parking areas with 136 car capacity.

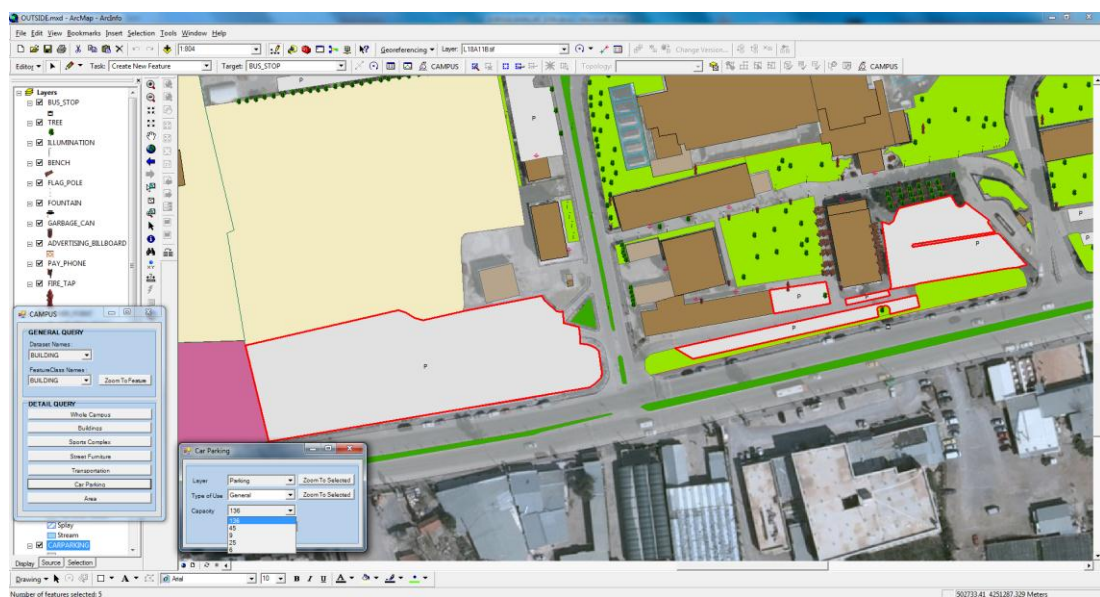


Figure 4.57 The query of car parking according to their capacities by “Parking” query command.

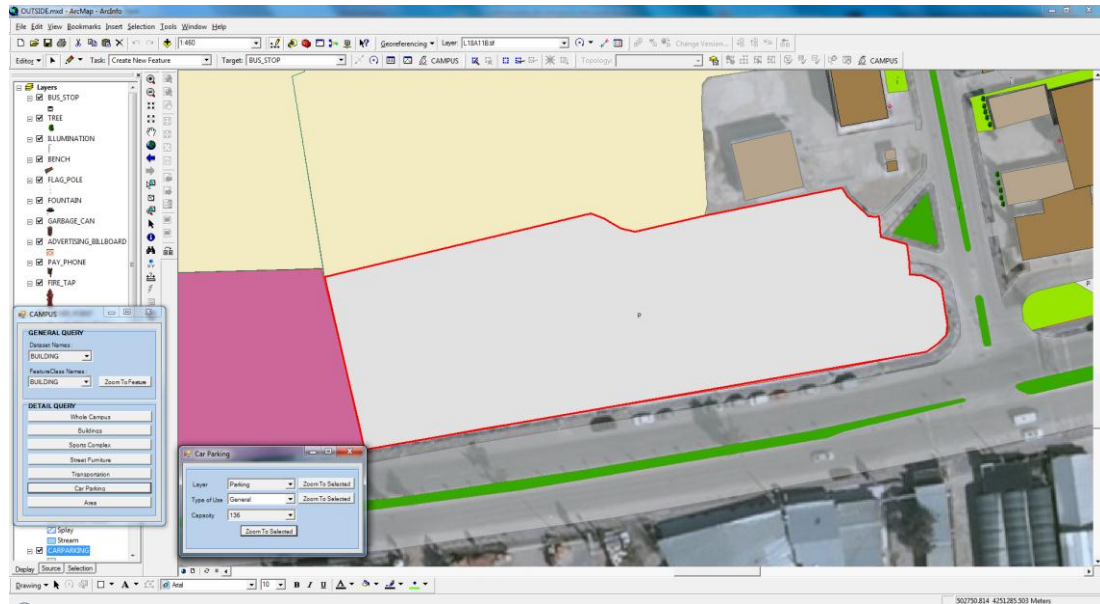


Figure 4.58 The result image of the query of general car parking with 136 car capacity.

4.3.1.2.7 *Area*. Air well, empty area, green area and off campus areas in the Health Campus can be questioned by “Area” query command.

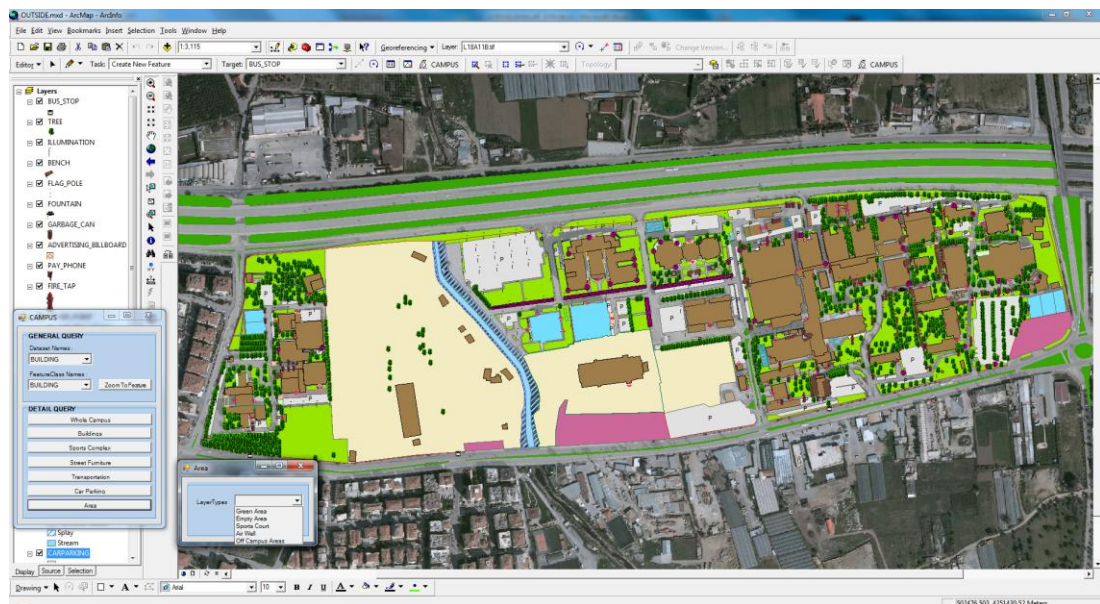


Figure 4.59 Sub-titles of “Area” query command.

Green areas in the Health Campus are questioned by “Area” query command are shown in Figure 4.60.

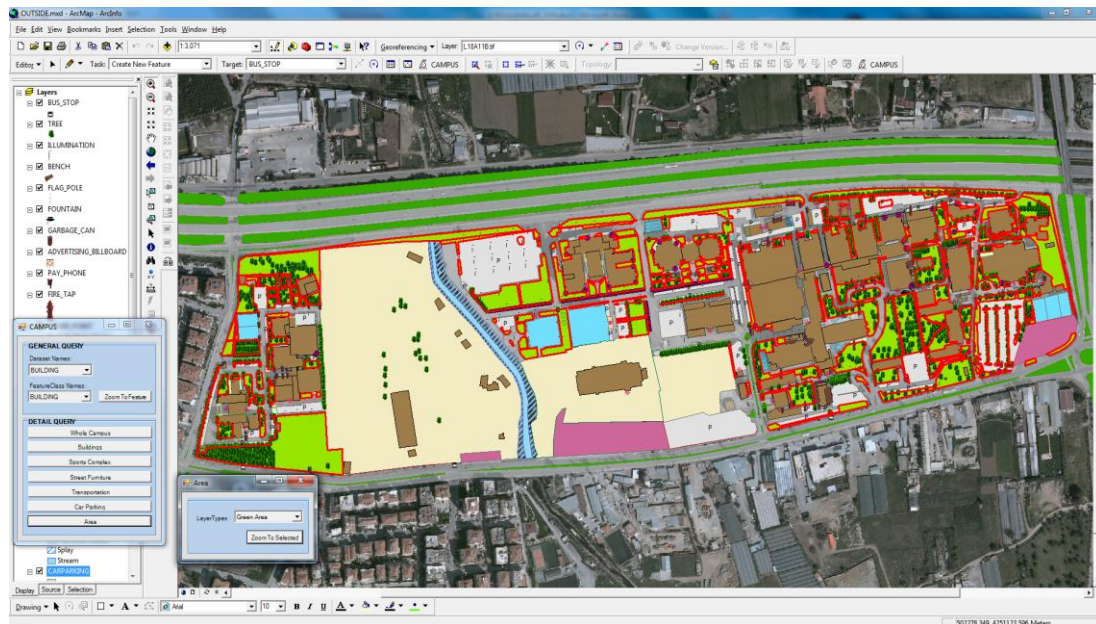


Figure 4.60 The result image of the query of green areas in the campus by “Area” command.

4.3.2 Hospital Queries

As it is mention before, while creating of Spatial Information Management for Dokuz Eylül University Inciraltı Health Campus, queries divided into two parts as building exterior and building interior. Under the chapter of queries, first building exterior queries were explained and then building interior queries will be explained.

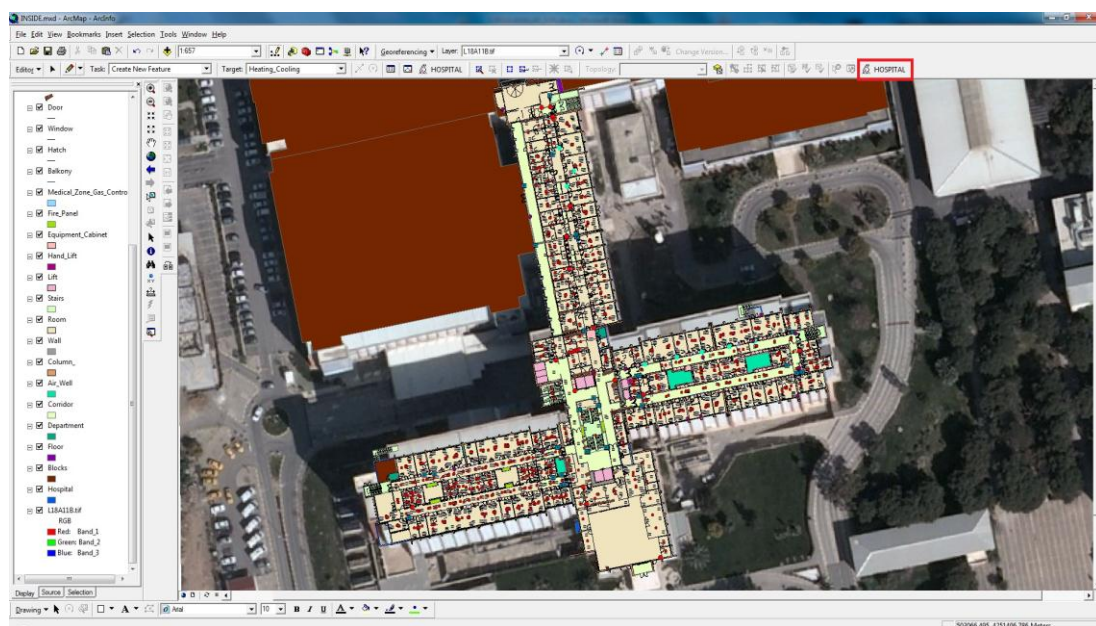


Figure 4.61 The image of the “HOSPITAL” menu created for the building interior queries in ArcGIS.

In order to perform queries HOSPITAL menu is created in Visual Studio 2008 by extension of Arcobject. Figure 4.61 shows the “HOSPITAL” menu created.

Building interior queries are also divided into two parts as it is done for building exterior queries.

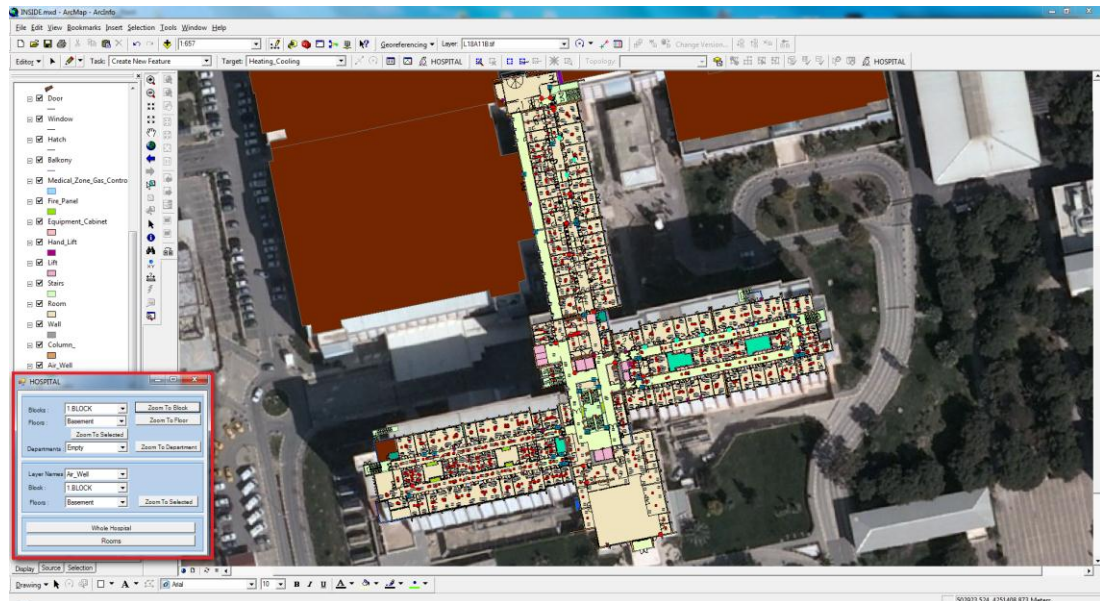


Figure 4.62 Types of queries under “HOSPITAL” query form.

Under the Hospital query menu, first, building interior query form appears that created for the queries for interior of hospital building and it also has multi queries under its own. The queries under this form will be briefly explained below.

4.3.2.1 Block Query

Dokuz Eylül University divided eleven blocks. For this reason, querying of blocks has become a necessity. To query blocks, a query command is created. To perform of query of the blocks of Dokuz Eylül University Hospital, “Block Query” is used.

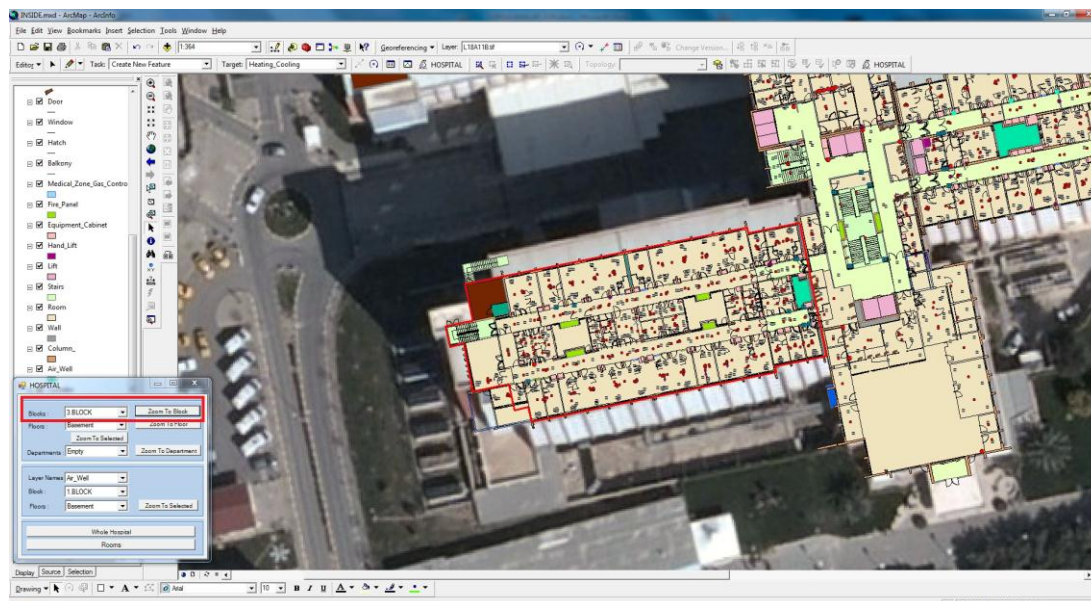


Figure 4.63 The image of the query of 3rd block by Block command which is the first query in the form under the Hospital query menu.

4.3.2.2 Floor Query

There are eight floors all blocks, which is studied, in study area. To query floors, a floor query command is created. Figure 4.64 shows the query of floors of Hospital by Floor Query command.

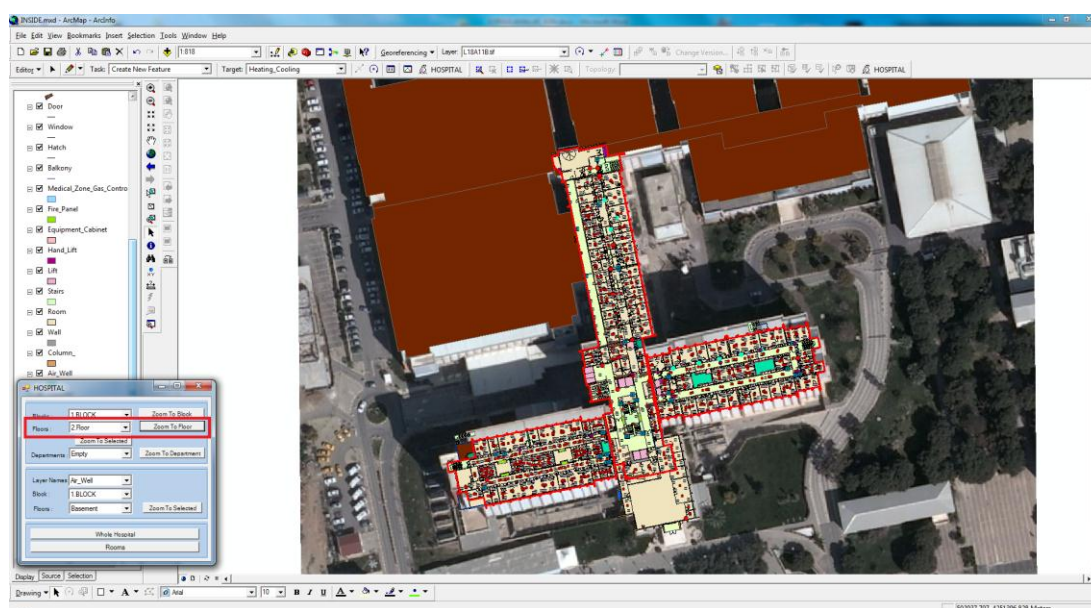


Figure 4.64 The result image of the query of 2nd floor of Hospital.

Block and floor queries can be performed separately or also one floor in a particular block can be questioned as double query. As an example, Figure 4.65 shows the result of the query of 6th floor at the 2nd block.

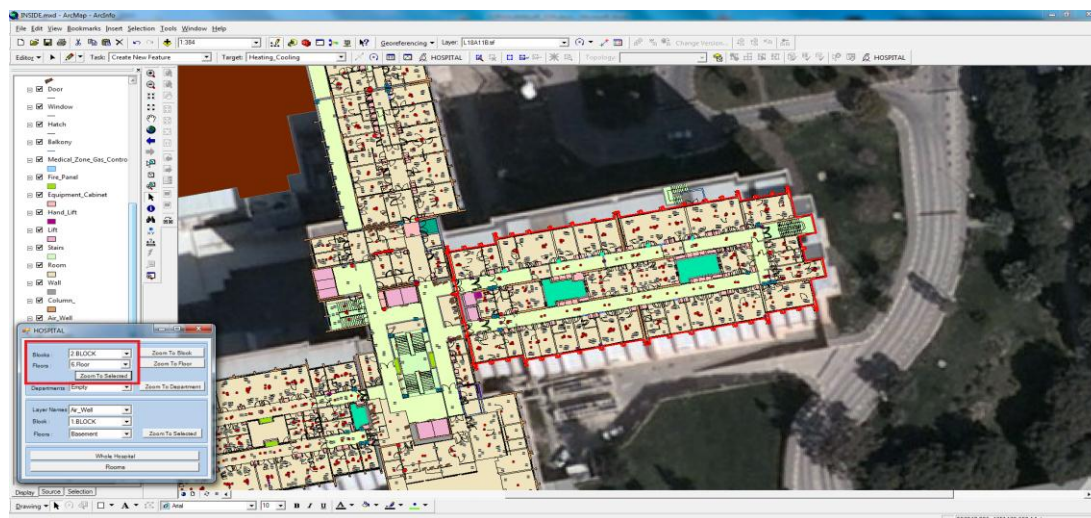


Figure 4.65 The result image of the query of 6th floor at the 2nd block.

4.3.2.3 Department Query

When intended to be reached any of the departments within the hospital, department query command will be used. Below, the query of the medical pathology department is shown.

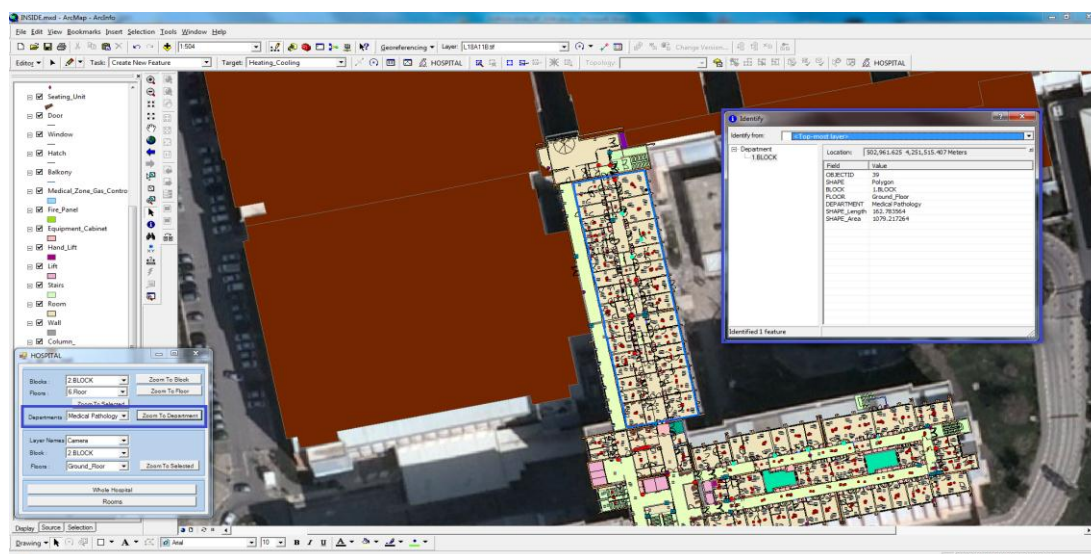


Figure 4.66 The result image of the query of medical pathology through hospital departments.

Building interior query form has also the command that provide to question the block and floor data of any of the layers. Figure 4.67 shows the query of the cameras which are in the ground floor of the 2nd block.

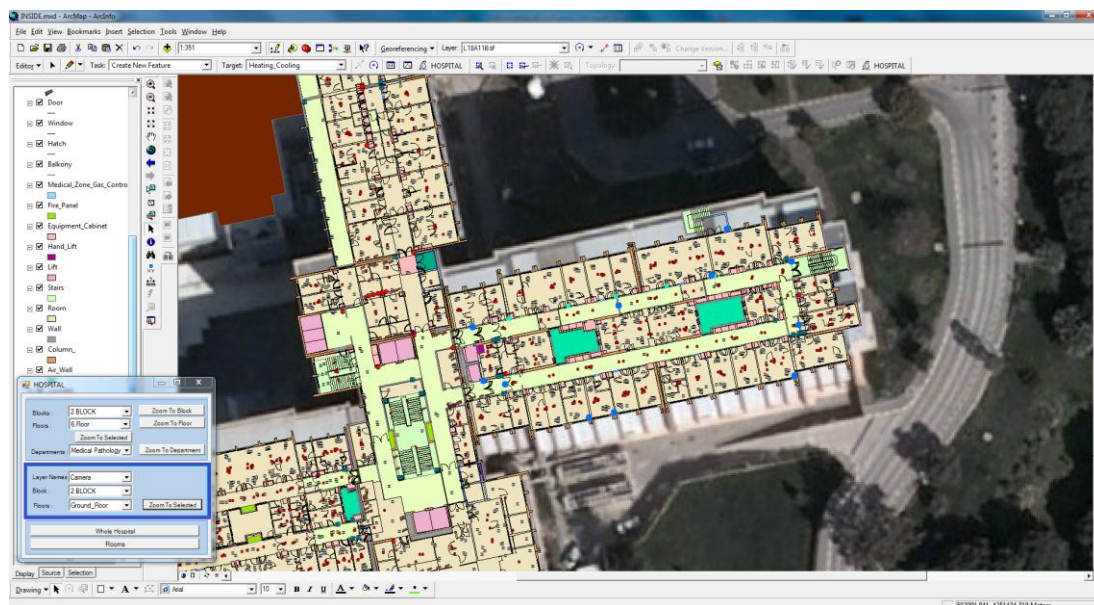


Figure 4.67 The result image of the query of cameras in ground floor of the 2nd block.

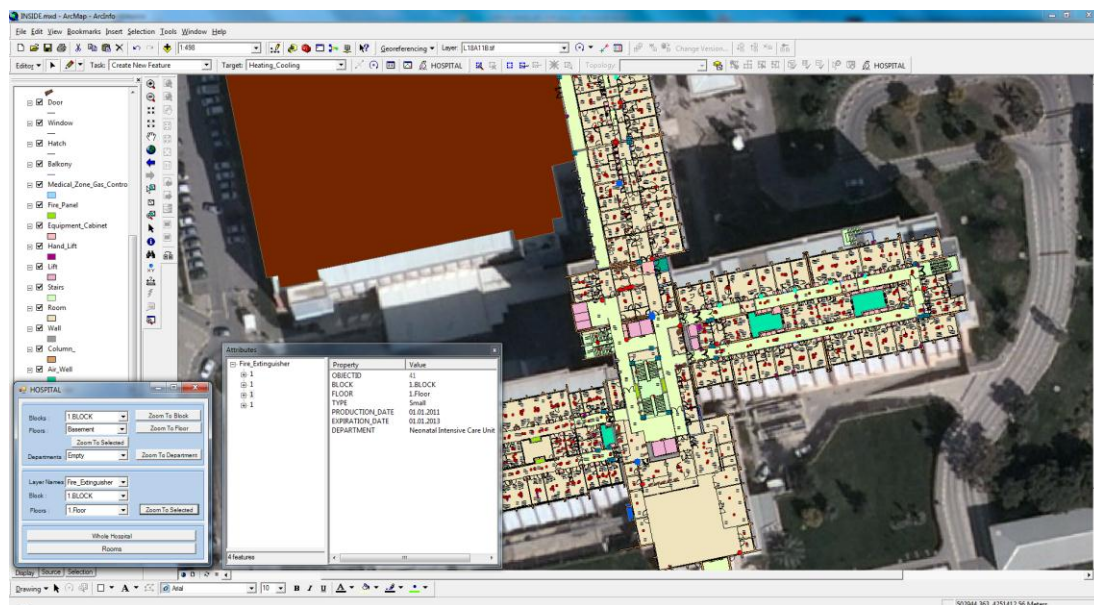


Figure 4.68 The result image of the query of fire extinguishers in the 1st floor of the 1st block and showing its attribute data.

4.3.2.4 Whole Hospital

Whole Hospital command provides to show the entire hospital in the screen regardless of which map or table is opened at that moment.

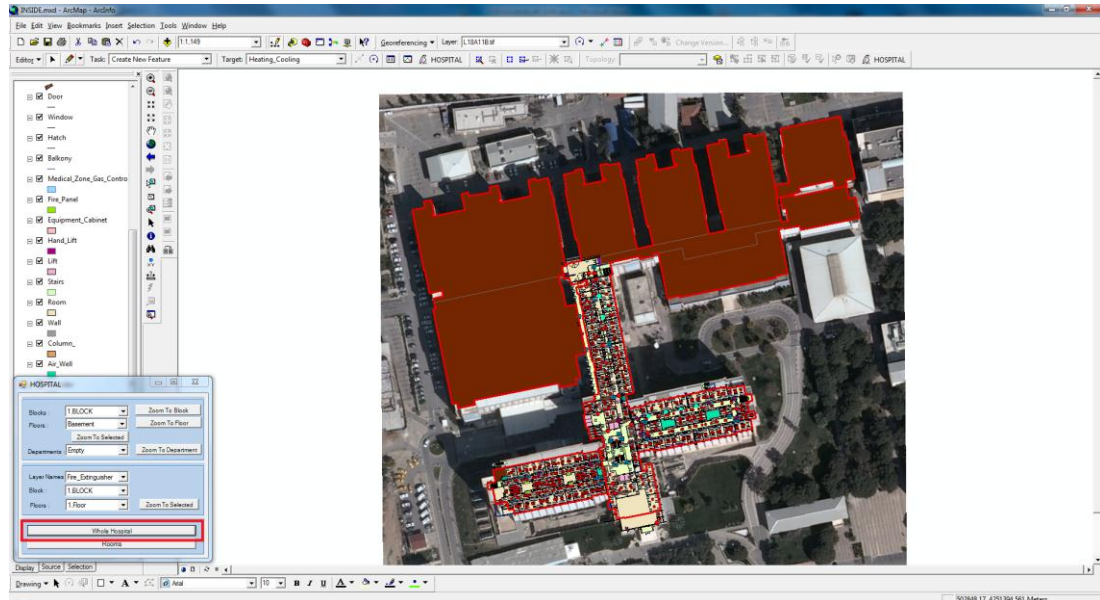


Figure 4.69 The result image of the query by “Whole Hospital” query command.

4.3.2.5 Rooms

The rooms query at the end of the Hospital query form contains another query form that provides to perform the queries about rooms of hospital. Rooms query is also divided into titles as; according to the type of room, according to the number of room, according to the number of door and other queries such as according to the keeper, according to the service secretary and nurse station.

4.3.2.5.1 According to the Type of Room. According to the type of room query command under the rooms’ queries perform by selecting the block, floor, room type and type of use features. Figure 4.70 shows the suite patient rooms in the 6th floor of the 2nd block of the hospital.

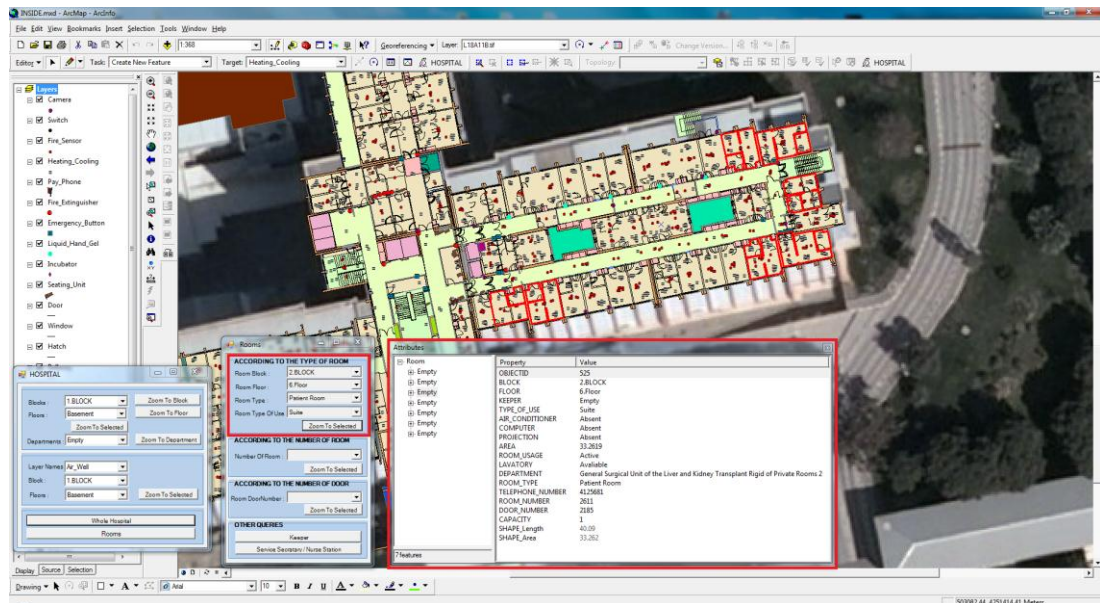


Figure 4.70 The result image of suite patient rooms in the 6th floor of the 2nd block.

In addition to the queries according to the usage types of patient rooms as general, special, suite, also the queries can be performed according to the room type as nurse room, storeroom, resting room, seminar room, doctor room, billing and other data that entered to the system as room type. Figure 4.71 shows the query of nurse rooms in the 3rd floor of the 3rd block of the hospital.

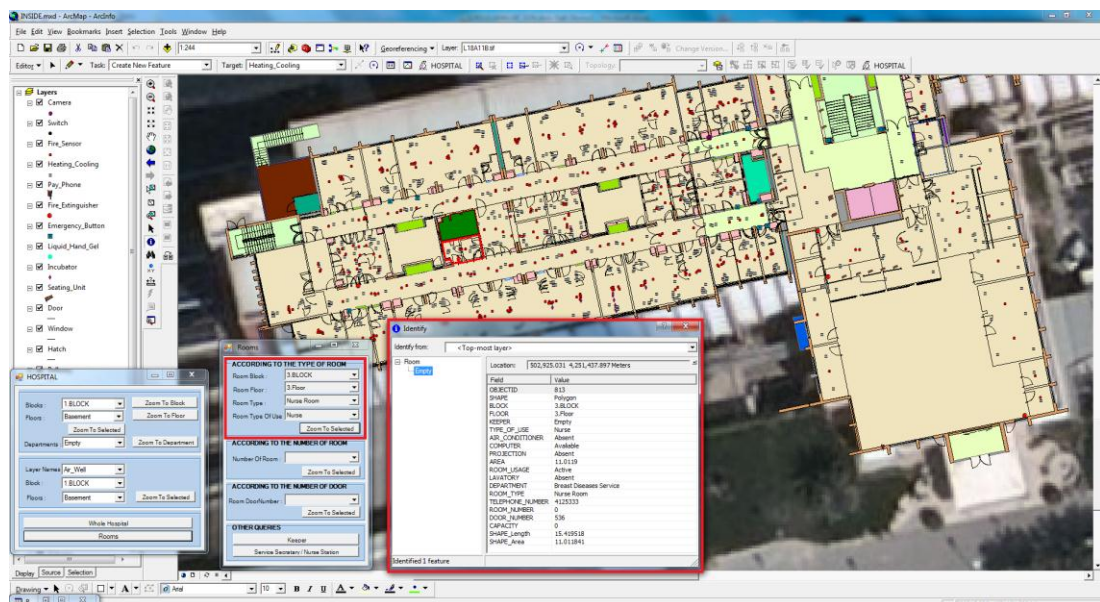


Figure 4.71 The result image of the query of nurse rooms in the 3rd floor of the 3rd block by according to the type of room query command under “Rooms” query form and showing its attribute data by info tool button.

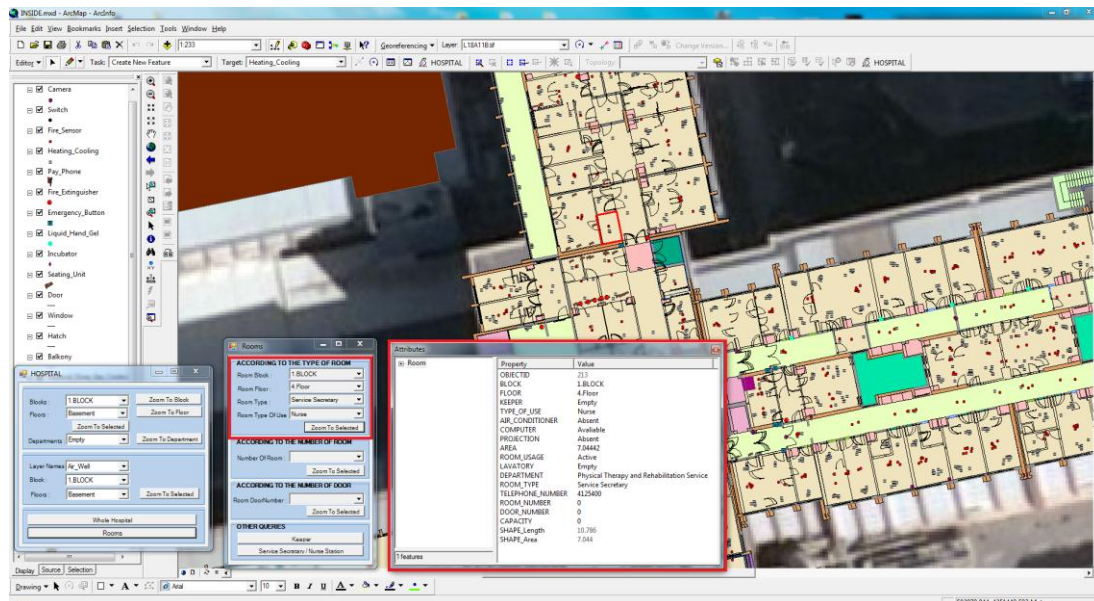


Figure 4.72 The result image of the query of service secretary room in the 4th floor of the 1st block of Hospital and showing its attribute data by attribute table button.

The room numbers of Dokuz Eylül University Hospital are given as two separate ways as patients' rooms and other rooms. Patient rooms have an adjacent number, which specify its block, floor and room number. For example, the patient room number 8 in the 2nd floor of the 1st block has the room number as 1208. "1" represents its block number, "2" represents its floor number and "8" represents its room number. One room, which was previously not a patient room but in time changed as patient room, has two types of numbers as room numbers and door numbers. Other rooms that not a patient room has door numbers only. The queries, which are performed according to this information, are shown below.

4.3.2.5.2 According to the Number of Room. Queries performed according to the number of room shows the block and the floor of the rooms selected and also all kinds of room features by attribute tables. Figure 4.73 shows the query of the room number 1208.

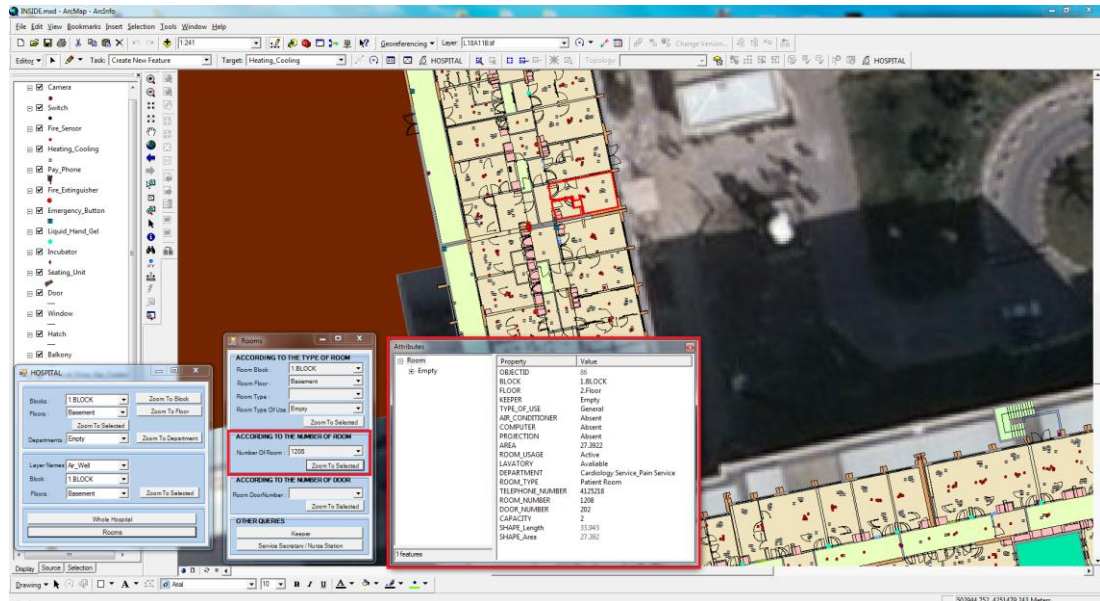


Figure 4.73 The result image of the query of the room number 1208.

4.3.2.5.3 According to the Number of Door. While the queries of the patient rooms are performing according to the number of room, on the other hand, room queries for the rooms of other usages are performed according to the door number. Doctor rooms, nurse rooms, seminar rooms, laboratory, examination rooms, treatment rooms, namely all types of rooms entered to the system as the type of usage can be questioned according to the number of door. Figure 4.74 shows the query of the door number 250 and its attribute table.

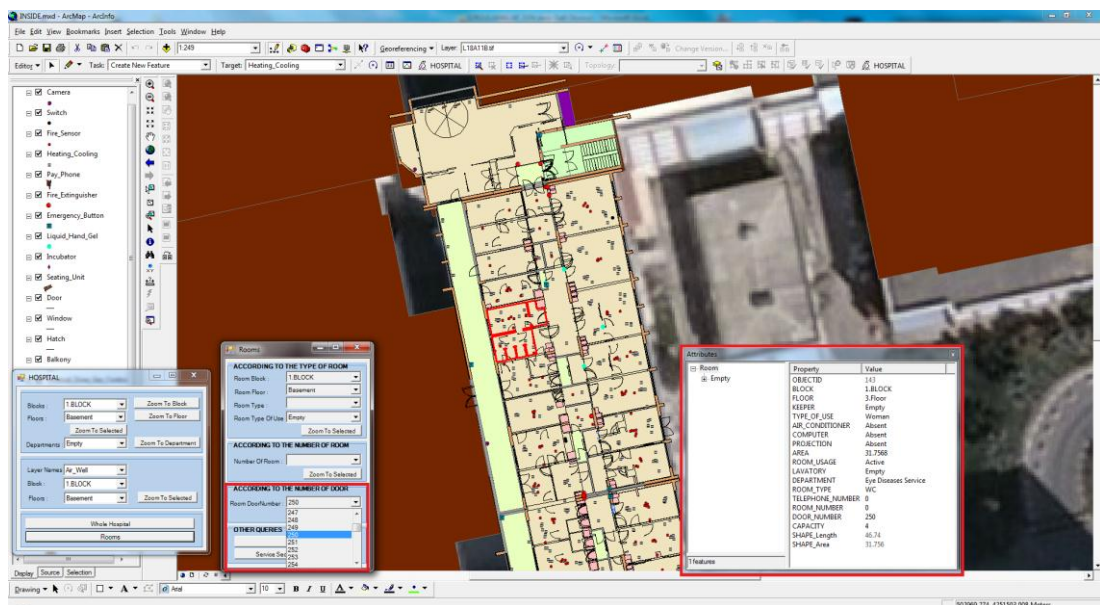


Figure 4.74 The result image of the query of door number 250 and its attribute data.

4.3.2.5.4 Other Queries. Other queries part of this study includes the query according to the keeper, according to nurse station and according to service secretary.

The query according to the keeper provides great convenience to find out the place of the room of someone known. While querying according to keeper the entire attribute data of the room layer are also shown. While the place of the room can be seen on the map, also the room's block and floor information can be learned and at the same time, the department of the room and if it is exist, the phone number are also shown. Figure 4.75 shows the query of room of Birsen Alptekin.

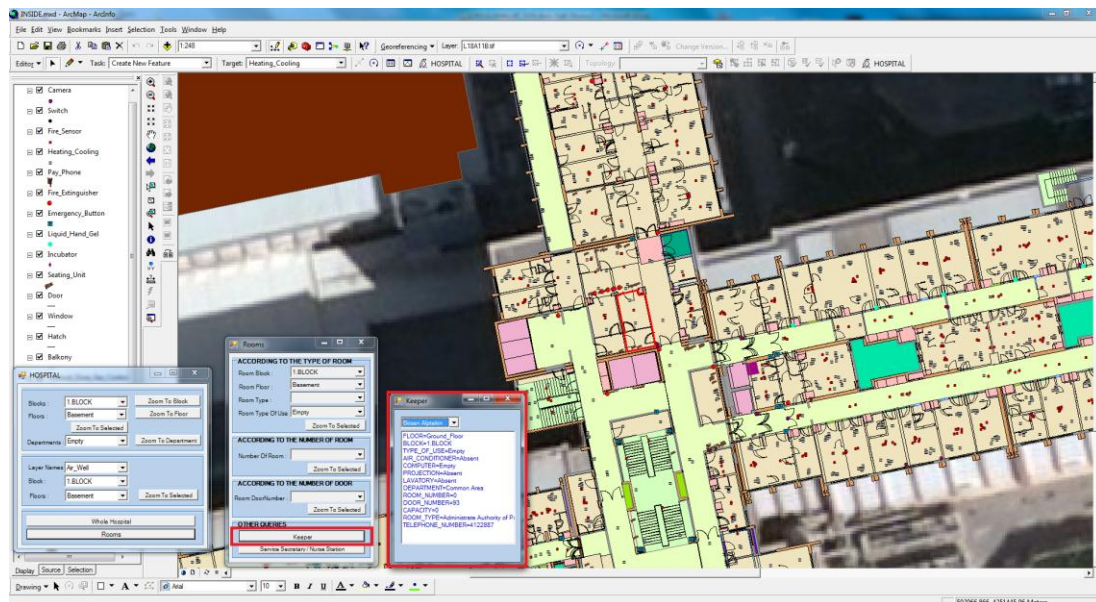


Figure 4.75 The result image of the query of the room which belonging to Birsen Alptekin by keeper query command.

There is a service secretary and a nurse station in every department in the hospital. To reach the service secretary or the nurse station of any selected department, Service Secretary/Nurse Station query window will be used. When running this query command, two options appear on the screen as service secretary and nurse station. When choosing one of these two options, for example service secretary, it shows the block name, floor and phone numbers of selected one. (Figure 4.76, 4.77, 4.78)

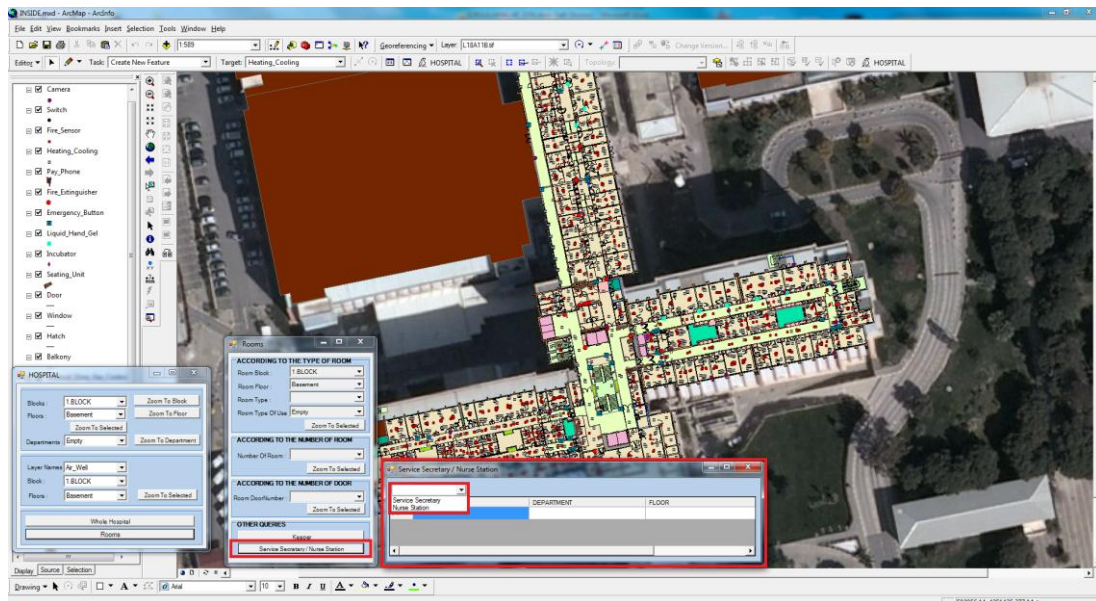


Figure 4.76 The query command window of service secretary/nurse station.

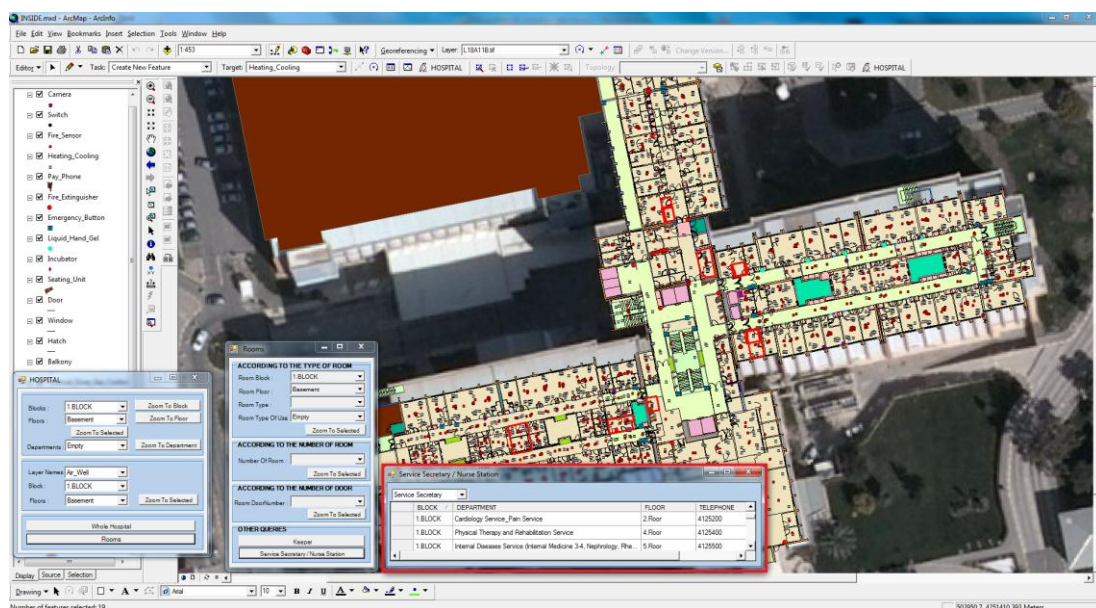


Figure 4.77 The result image of the query of service secretary.

Within Dokuz Eylül University Spatial Information Management for İnciraltı Health Campus, the querying can be performed by ArcGIS software without using the query commands which are created for the system. While questioning the data belong to one layer according to the one of the criteria as block, floor, department or types, Arc GIS Select by Attributes query command can be used. For example, Figure 4.79 shows the query of small fire extinguishers without depending on its block, floor and its department, just by choosing its type as criteria. (Figure 4.79)

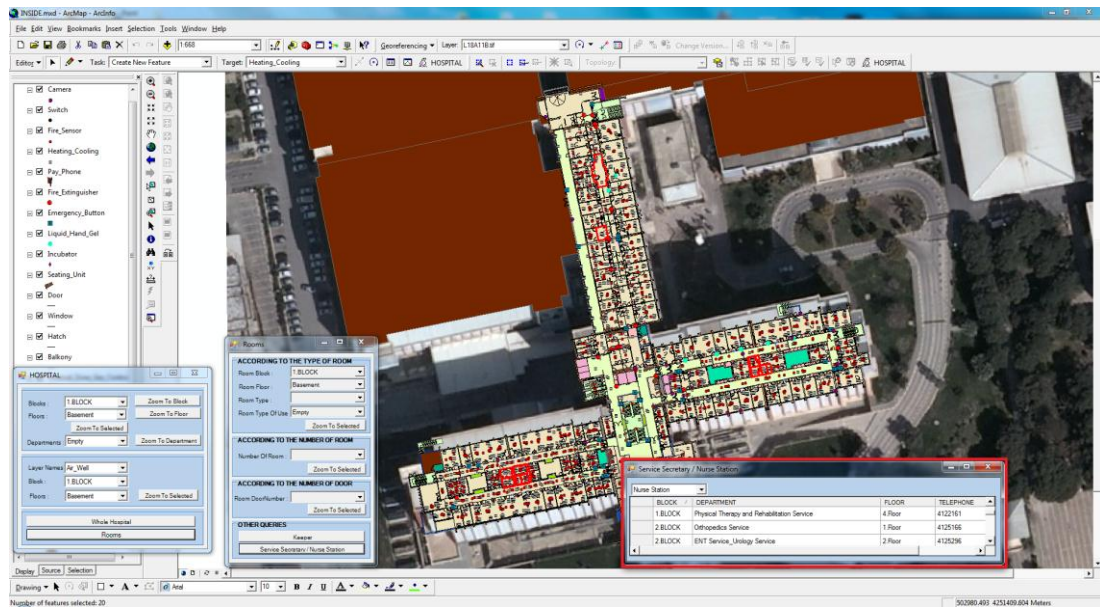


Figure 4.78 The result image of the query of nurse station.

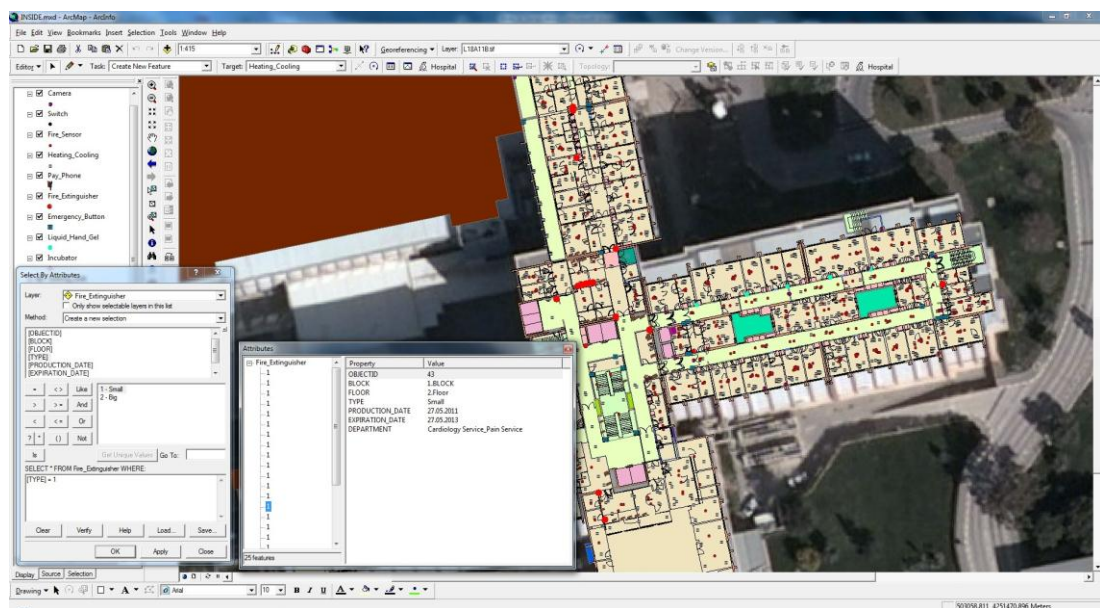


Figure 4.79 The result image of the query of small type fire extinguisher by the “Select By Attributes” query command and its attribute data.

Hospitalization and leaving hospital processes have a great importance because the services section of the hospital is studying in the scope of this thesis. Therefore, in this part, query of Patient Admission_Patient Stay-Exit Firm are included. All kind of data of any unknown location can be reached by the query according to the type of room usage.

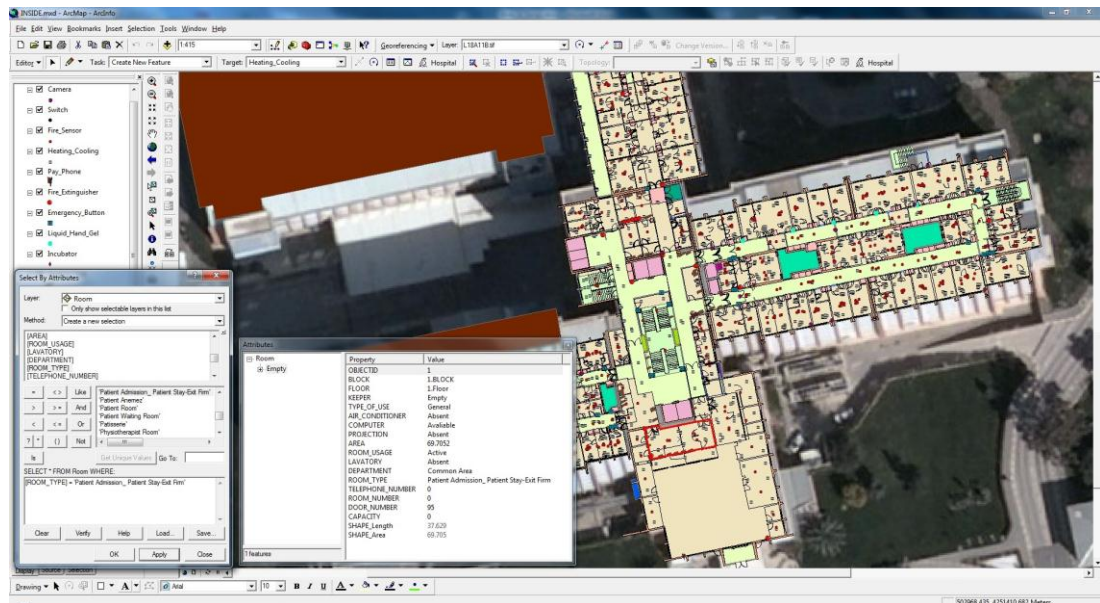


Figure 4.80 The result image of patient admission_patient stay_exit firm room query and attribute data of selected room.

Some objects in the hospital are placed according to patient or disease characteristics. For example, Figure 4.81 shows that cameras are placed according to areas need security. The result of the query shows the place of the cameras as inside the hospital, entrance of the hospital, in the medical equipment and psychiatry services.

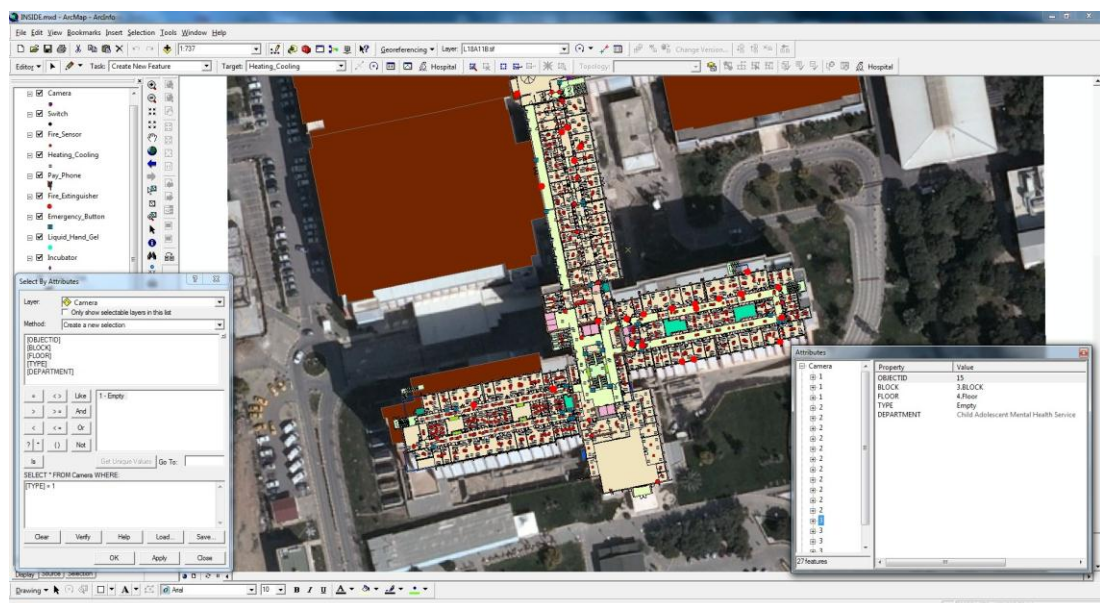


Figure 4.81 The result image of the query of cameras inside the hospital.

By the same way, Liquid Hand Gels inside the hospital can be questioned and the result in Figure 4.82 shows that liquid hand gels are placed around the areas has the risk of infection.

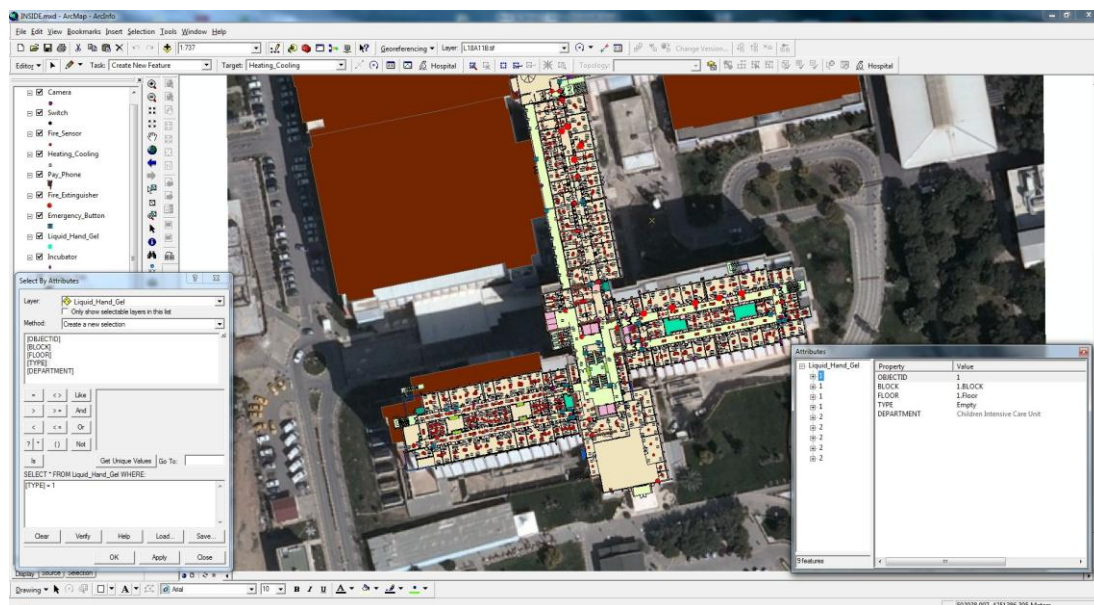


Figure 4.82 The result image of the query of Liquid Hand Gel inside Hospital.

CHAPTER FIVE

DISCUSSION

Today, information is now seen as an important resource. For this reason, a very rapid developments in information technology are recorded and investments made by many communities in this area. Especially million dollars of investments made in the field of computer software-hardware industry are seen in many areas from individuals to institutions. The purposes of all these investments are the necessary tools for optimal use of information.

Individuals of information societies live in much more welfare than others. One of the factors of this certainly is that these societies are much more intense and active in usage of information.

Today, spatial-based data collection in the required formats and even reproduction and sharing of data have become possible with developed techniques. The main goal of the most of the spatial-based information, including Geographic Information Systems, is establishment of the necessary mechanisms for collection, storage and presentation to the users of the data that obtained by location-based observations.

GIS is used by countries to recognize and identify the natural-resource potential, on the other hand, it is used by local governments to recognize the lower and upper structures of districts and to perform the maintenance and repairs of these structures. But addition to these, any institution, such as universities, also can have an information system design and implementation depending on the field of its activity.

As with universities in many countries, today, also in our country, universities are the most important education and training institutions. Lower-upper structures and related services of the university need to be done regularly. For this purpose, it is seen inevitable to use information system in the university, which will provide a planned development. Of course, such a system can be considered a broad range of associate properties such as planning, structuring, and so the information. However,

the first there is a need to recognition of the physical environment and obtaining of the information such as university area, buildings, roads, sub-structures.

For this purpose, an information system was designed and with taking advantage of modern information technology, a spatial information management system realized for Health Campus of Dokuz Eylül University. Feature of designed system is to allow the collection, storage of spatial information within the scope of the health campus and presentation to the users.

By detailing the graphic data of health campus, especially building data (structure layer), the database that contains the information of the personnel and functions of the buildings have become the part of the system. So, the relationship of between the graphic and non-graphic data is provided and it becomes possible to make queries about personnel and buildings. All of these have shown that this system can assist in making decisions for planning and the information can be accessed quickly when it is needed. So, the decisions will be more close to the right one.

For Spatial Information Management System for Dokuz Eylül University Inciralti Health Campus, it is not sufficient to confine to the available data only. Gathering the required data and more important than this keep these data up to date is the most significant factor in terms of the system to be permanent. For this purpose, the personnel who is responsible is needed for the system for the functional processes and necessarily updates. At first, including system manager, other personnel also must be within a structure that allows the flow of data and information sharing.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

The education sector that has an important role in the development of societies, are expected to be the fastest sectors which is able to adapt to the era. Consequently, it is not possible to separate the field of education from the field of information technologies and information systems that contain them. Information systems can be used in every area of education.

Even if the universities in the structure of health campus have different purposes, in a sense, they perform as the small towns in structure. As well as existence of the required space for education and research, also they should be included in the required space for the health fields. Accordingly, student and staff services are also the functions are considered fundamental qualities. It is obvious that all of these activities must be committed by an organized structure throughout health campus. However, rapid and healthy development of a health campus depends on having information related to the campus in a healthy way. Especially in this information age, there is a absolute need of location-based information systems. In many universities around the world, studies on this subject show that there is a rapid development in this way.

Starting from this idea, an information management system for Dokuz Eylül University Inciraltı Health Campus is designed and implemented. This system is developed in parallel with the basic philosophy of Geographic Information Systems. First, required digitizing processing made by the help of Auto CAD Map 3D software, to have graphical data, then these graphical data are connected to the databases that consist of the attribute data collected through observations. Then, the layers, which topological structures are formed, location-based analysis and production of output products are provided by Arc Info software. The detailed studies have shown that, the system also allows hospital and personnel management and the ability to make decisions quickly and in a healthy way for the future, besides planning and obtaining inventories such as green space, roads, buildings, etc. within

the health campus.

Spatial information management system for health campus, which is designed, can't accomplish all the functions at the first stage. However, the first step for this work has been taken and the base maps are created. Besides the establishment of the system, its preservation is also important. When prompted to creation of such a system in the University, if current departments can not establish to perform this, then for management of this system a center must be installed. All authorized persons in the departments must be raised the awareness of this issue. Discussions with each department should be done individually, appropriate questions should be asked by questionnaire surveys and more detailed analysis must be done. Identification of the workflow diagram of the departments and their relations with each other must be identified by the determination of the current situation and needs analysis. This center installed for the management must provide the organization and security of the data and the distribution of the authority, which is necessary to update all the data, in connection with the departments of the university. This kind of Geographic Information System project should be made by a group work with an appropriate division of works.

Software will be used to perform Geographic Information Systems for Health Campus project must be identified according to the needs. Software must be appropriate to work with large data, easy to use, fast, and capable of processing different location-based data. It is also important that it must have a relation with other systems and must have a large capacity of querying and analyzing that consists of interfaces allows special queries. ArcMap, which is an ESRI product, seems to be appropriate software according to these criteria.

As a result, within this study, a pilot project was performed by creation and implementation of an Information Management System for a Health Campus based on Geographic Information Systems. Finally, efficiency of the system has been tested in terms of creation of the location-based health campus data, querying and management of these data.

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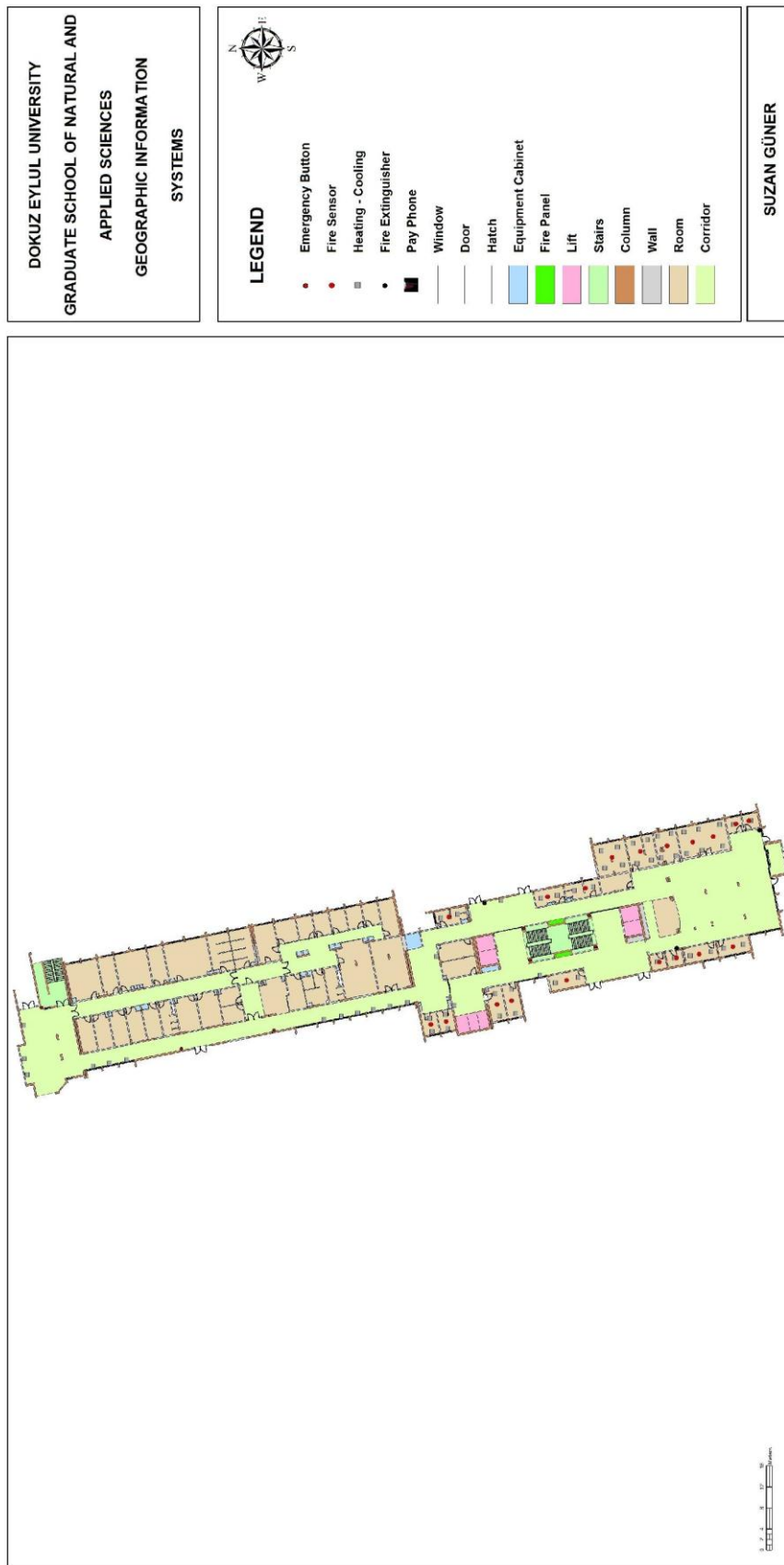
Yomralıoğlu, T., Bıyık, C., Akyol, N., (1999). *Kuzey Kıbrıs Türk Cumhuriyeti Coğrafi Bilgi Sistemleri Projesi Geliştirme Ön Raporu*, KKTC Başbakanlık, s.20, KTÜ, Trabzon.

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Appendix 2: 1. Block Ground Floor

1. BLOCK GROUND FLOOR

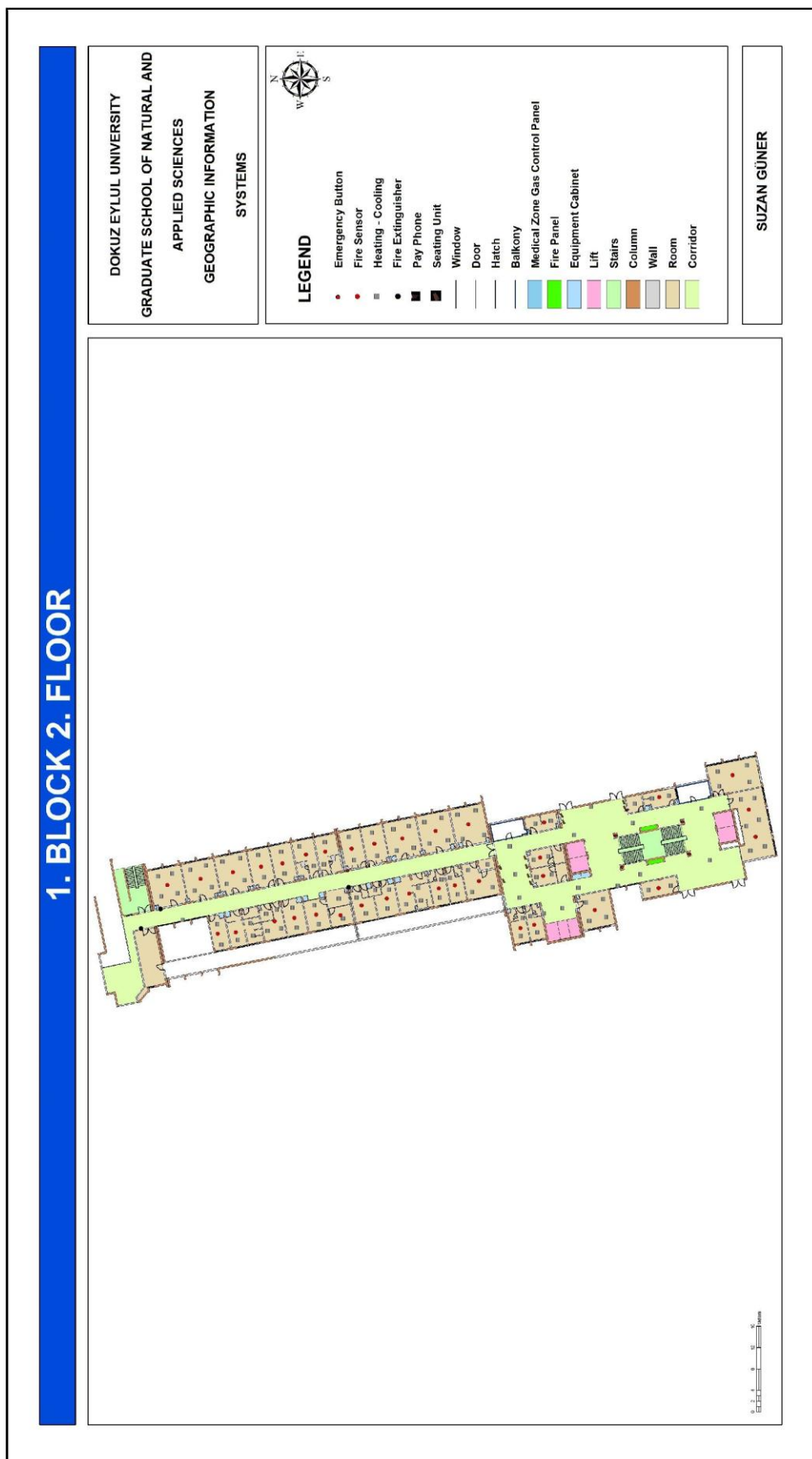


Appendix 3: 1. Block 1. Floor

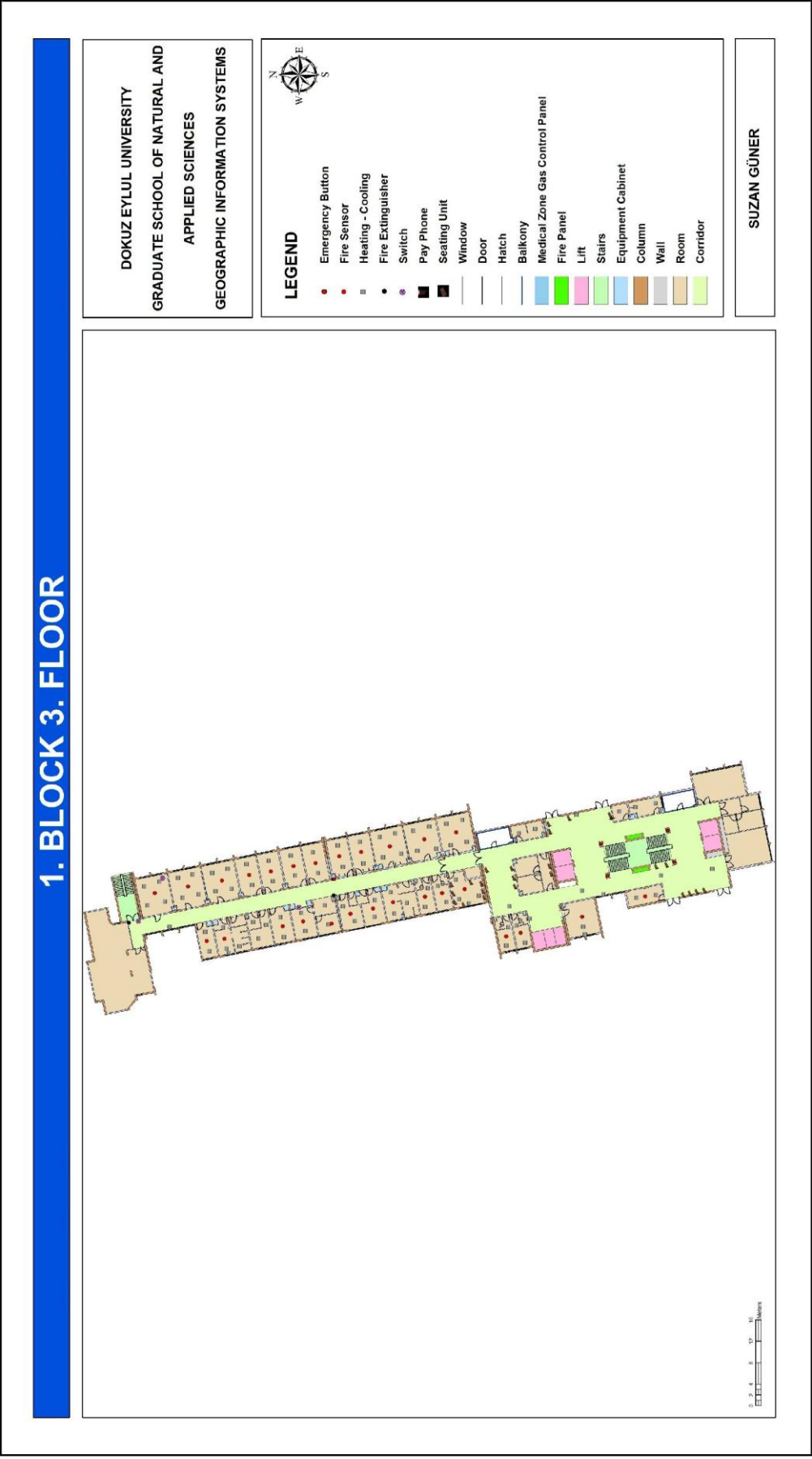
1. BLOCK 1. FLOOR



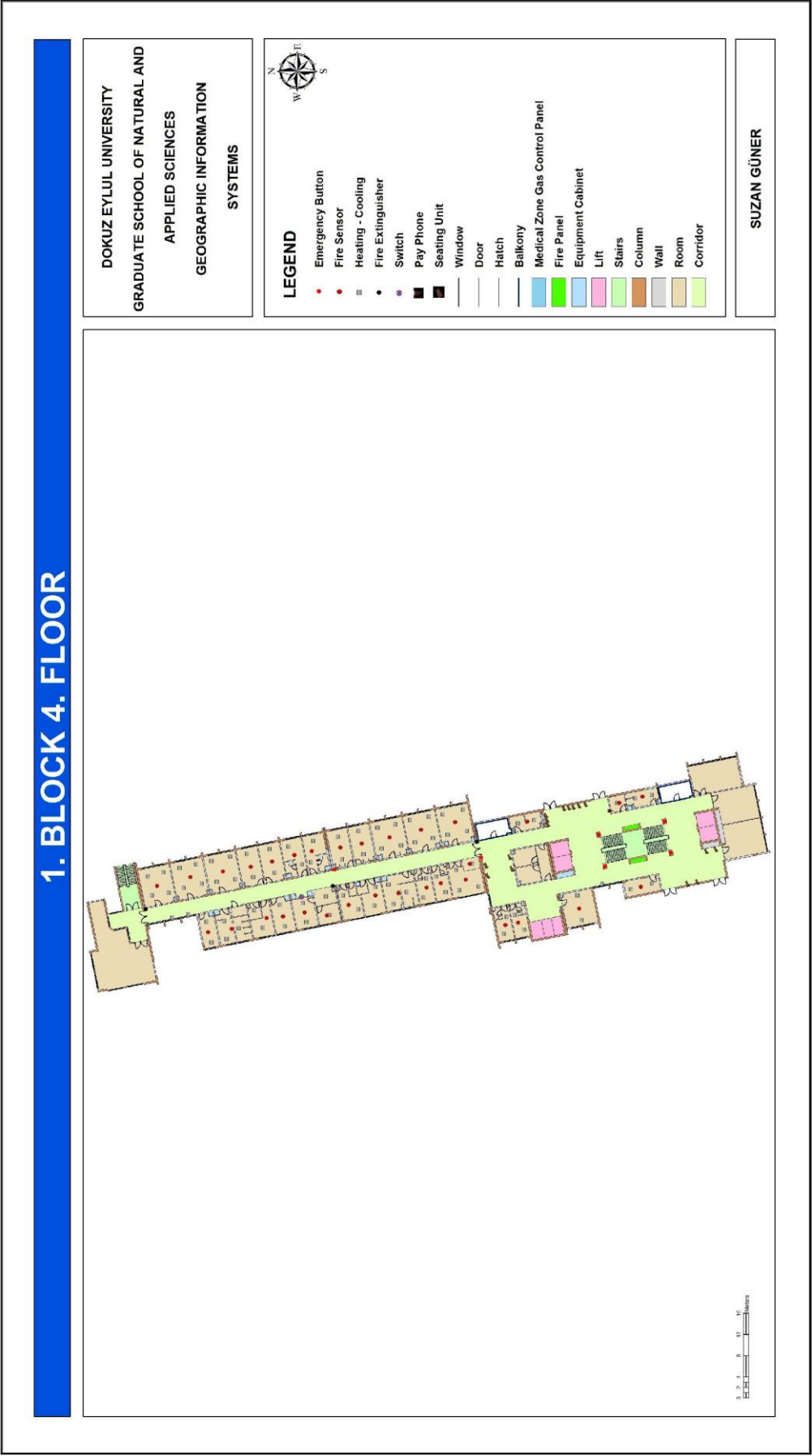
Appendix 4: 1. Block 2. Floor



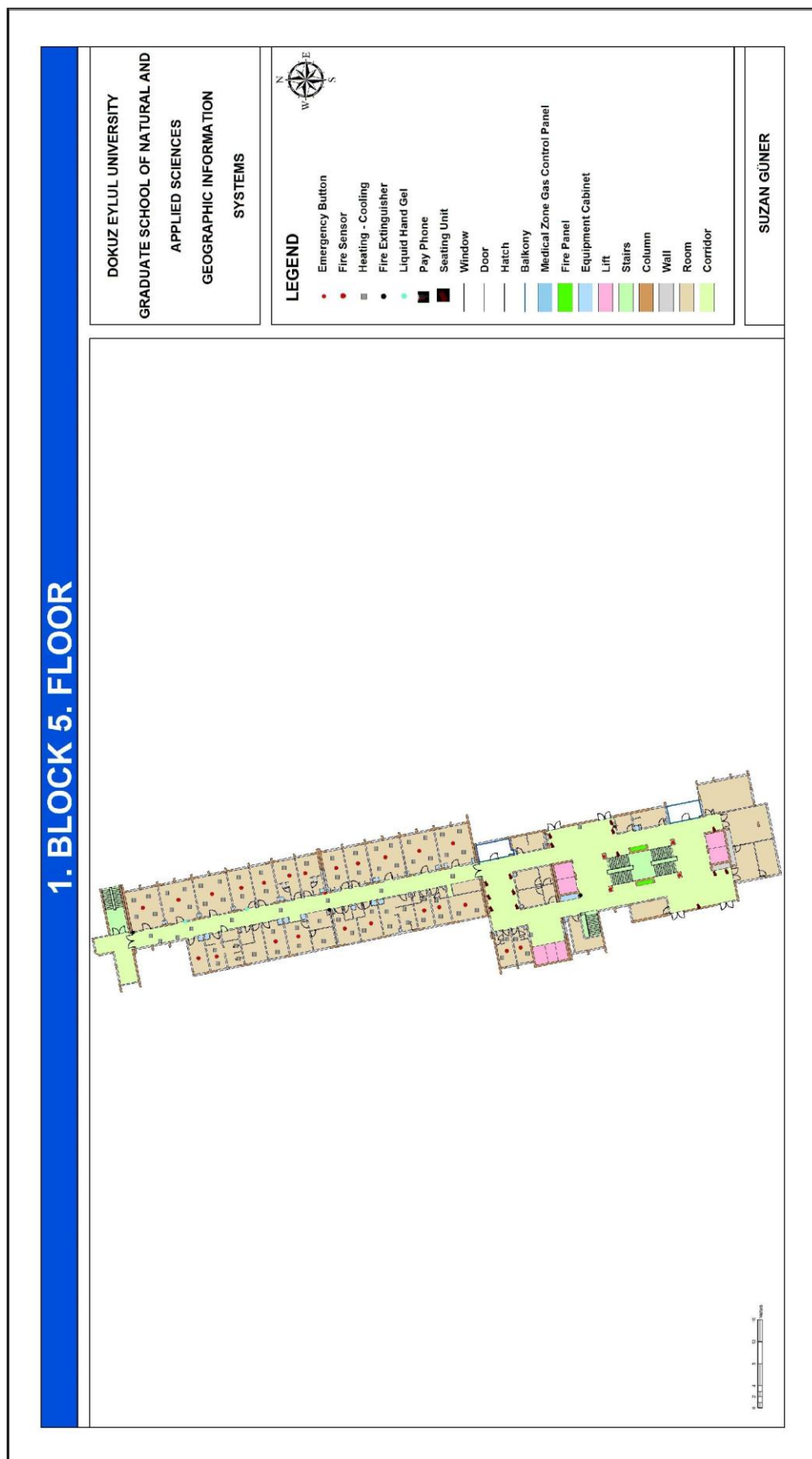
Appendix 5: 1. Block 3. Floor



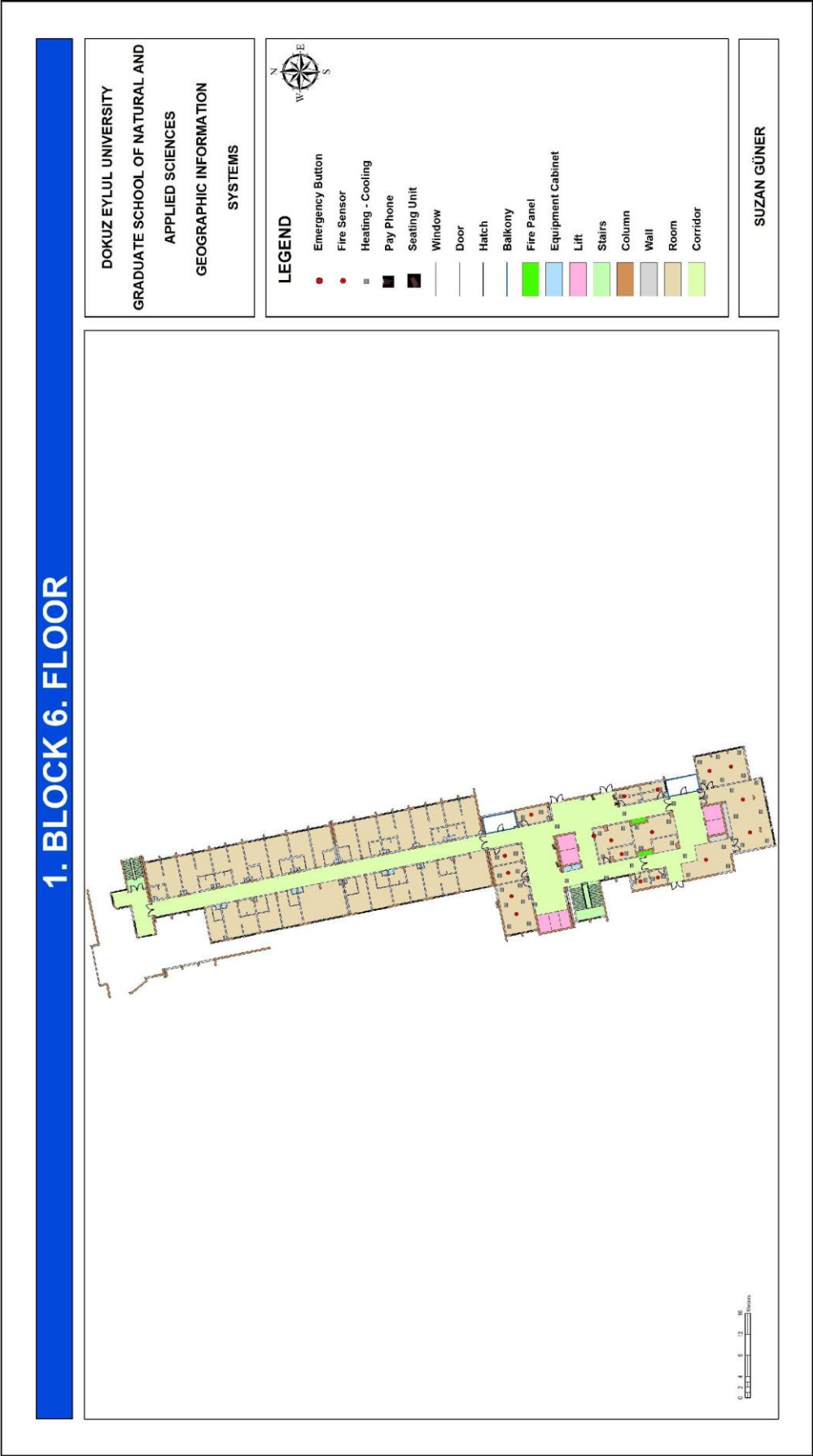
Appendix 6: 1. Block 4. Floor



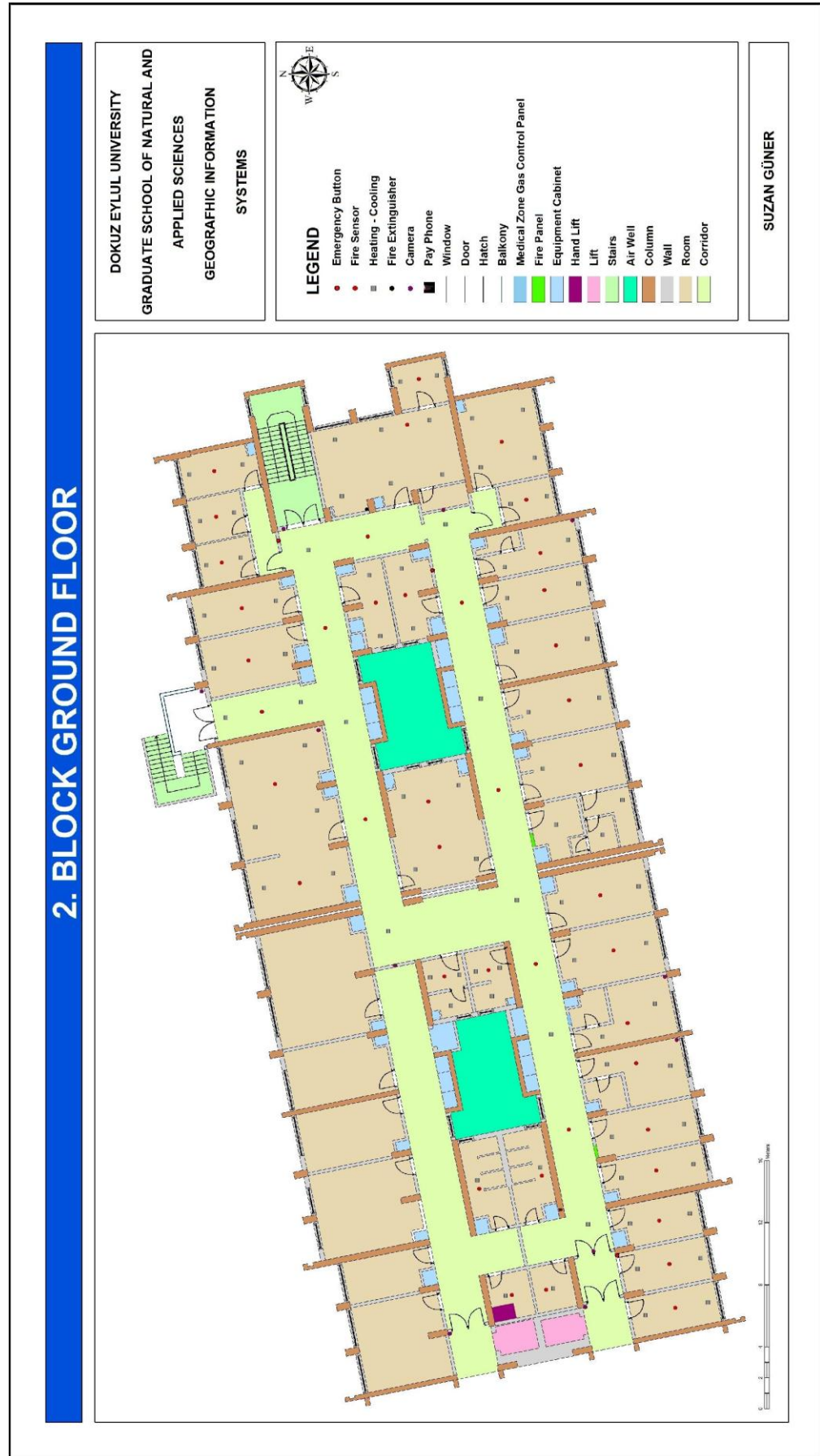
Appendix 7: 1. Block 5. Floor



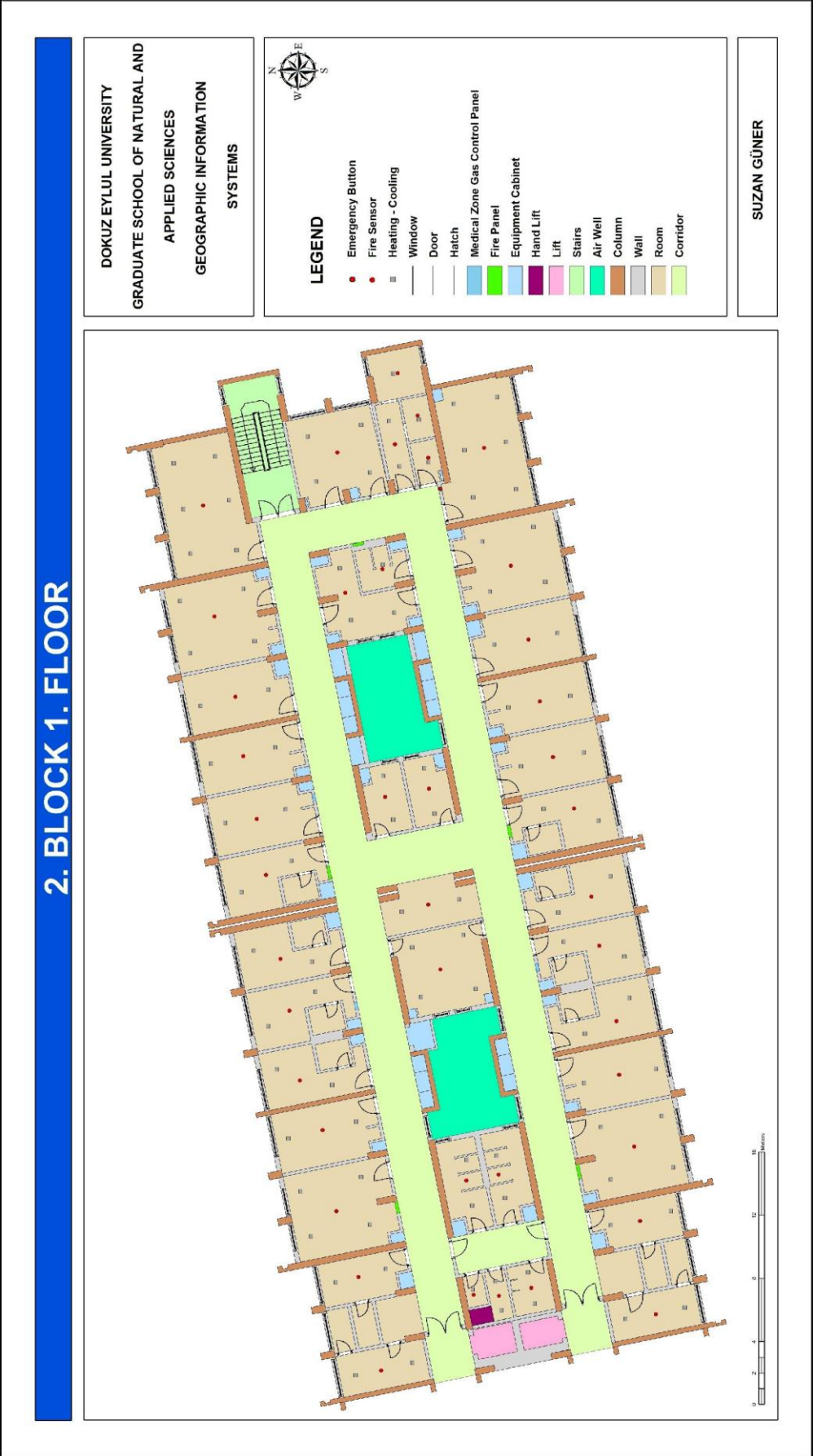
Appendix 8: 1. Block 6. Floor



Appendix 9: 2. Block Ground Floor



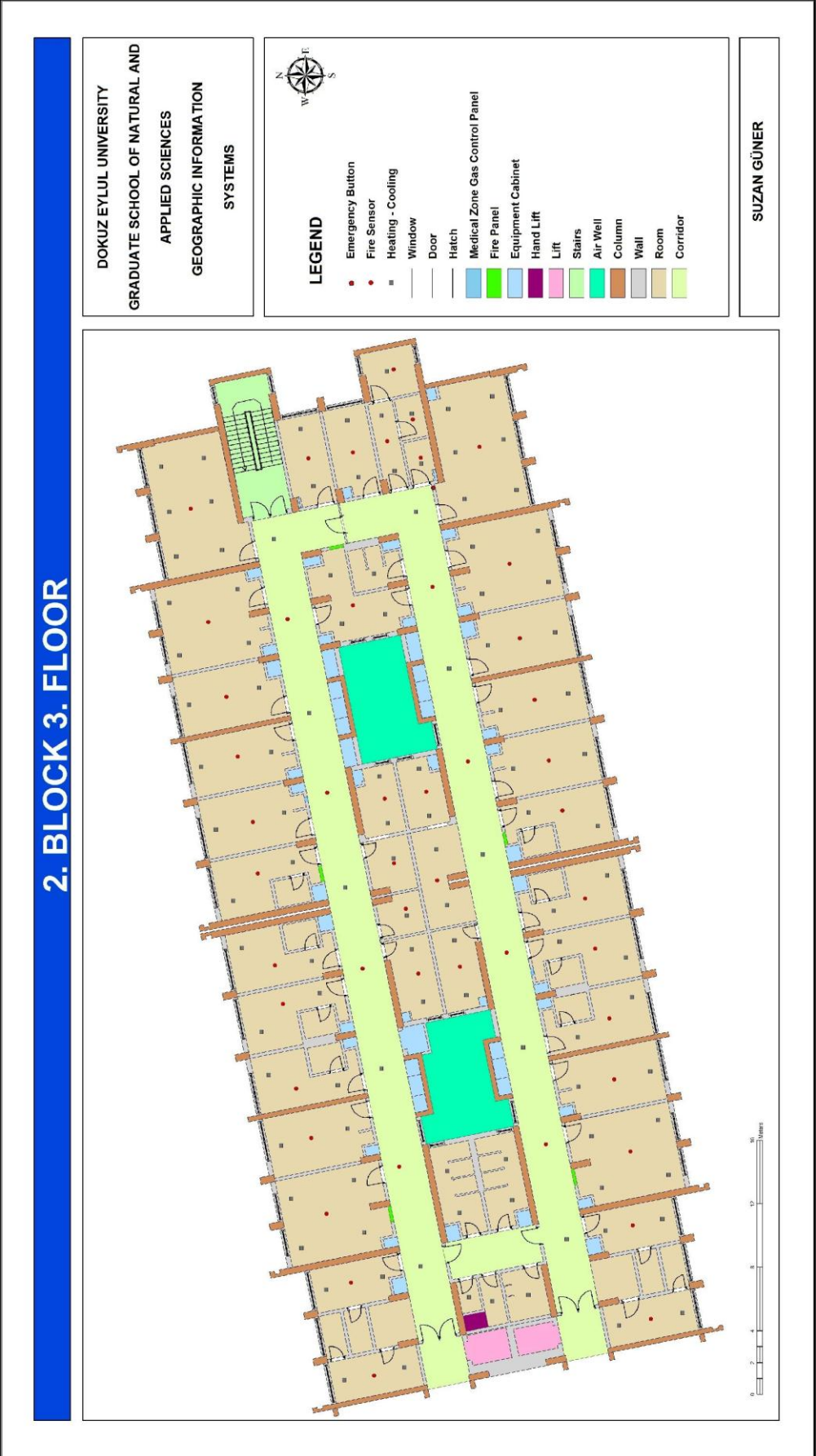
Appendix 10: 2. Block 1. Floor



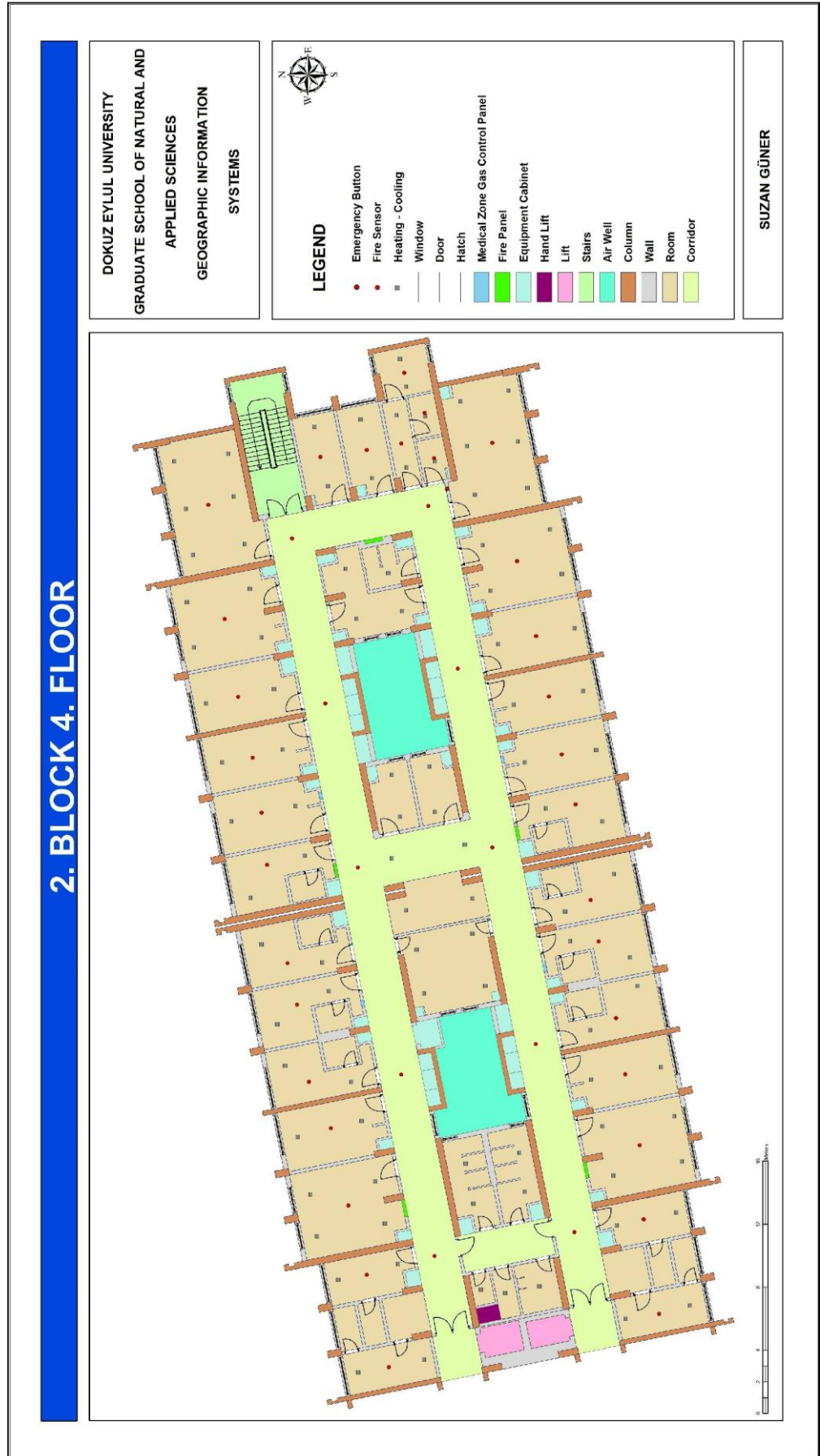
Appendix 11: 2. Block 2. Floor



Appendix 12: 2. Block 3. Floor



Appendix 13: 2. Block 4. Floor

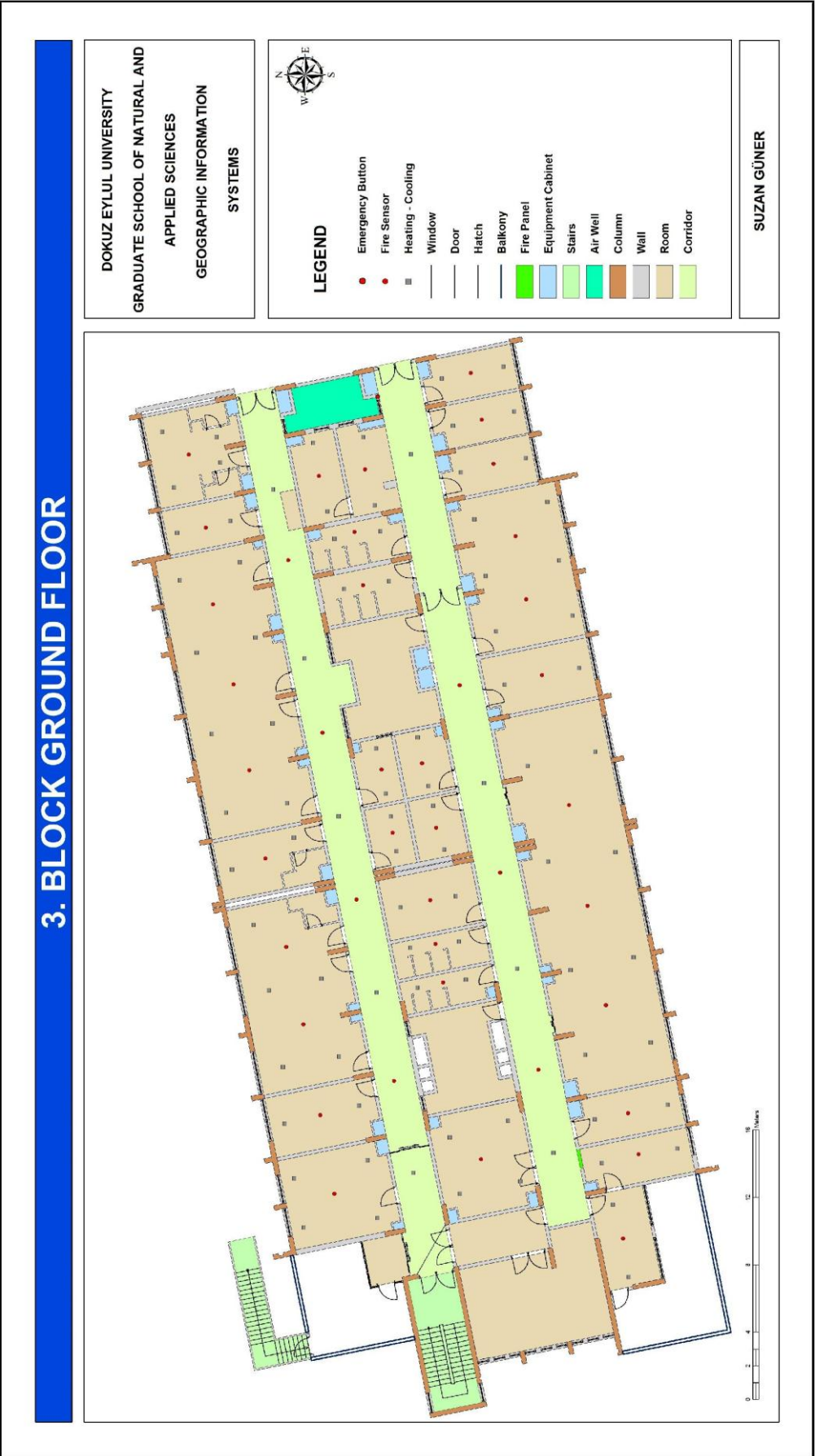


Appendix 15: 3. Block Basement

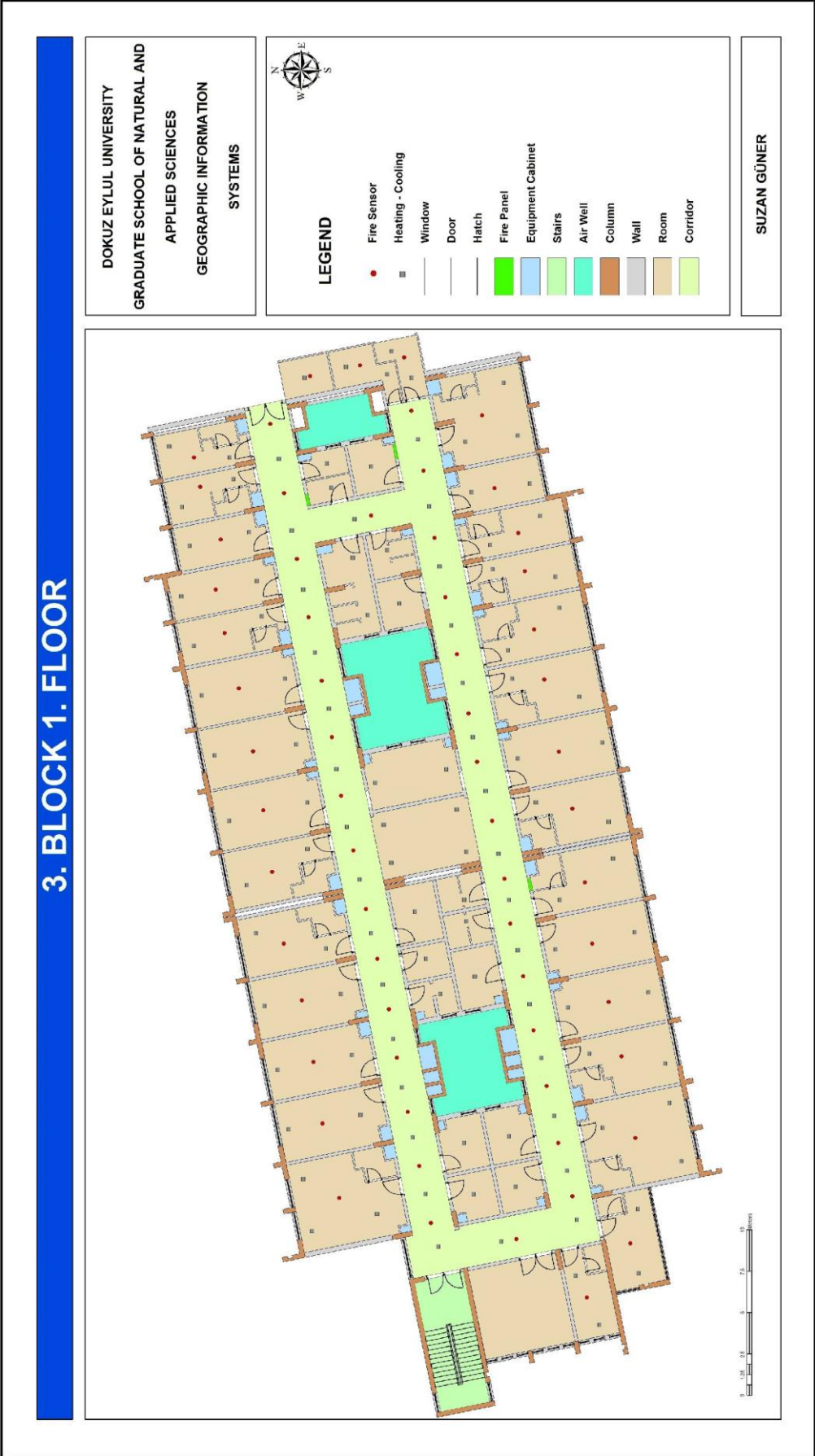
3. BLOCK BASEMENT



Appendix 16: 3. Block Ground Floor



Appendix 17: 3. Block 1. Floor

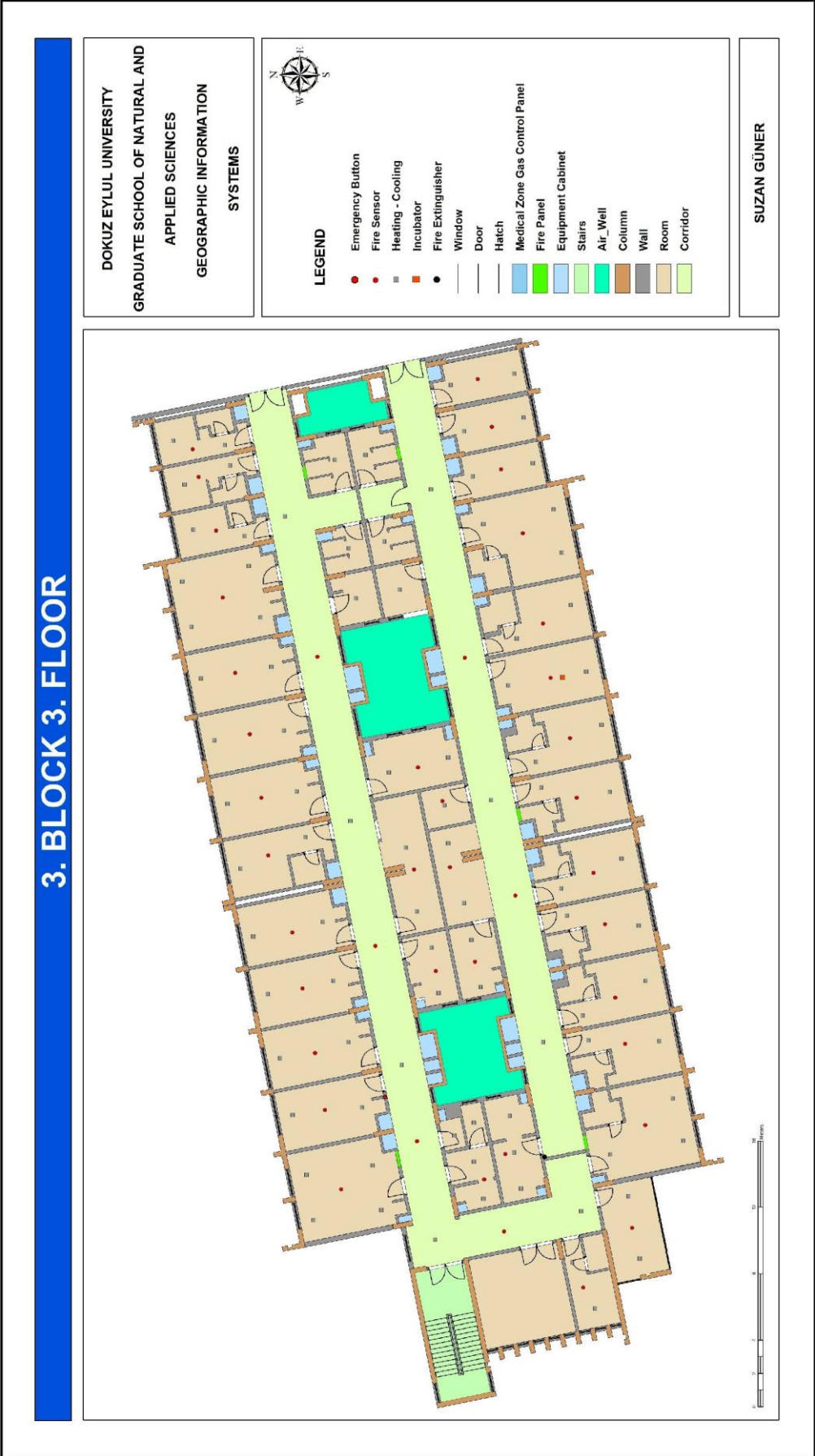


Appendix 18: 3. Block 2. Floor

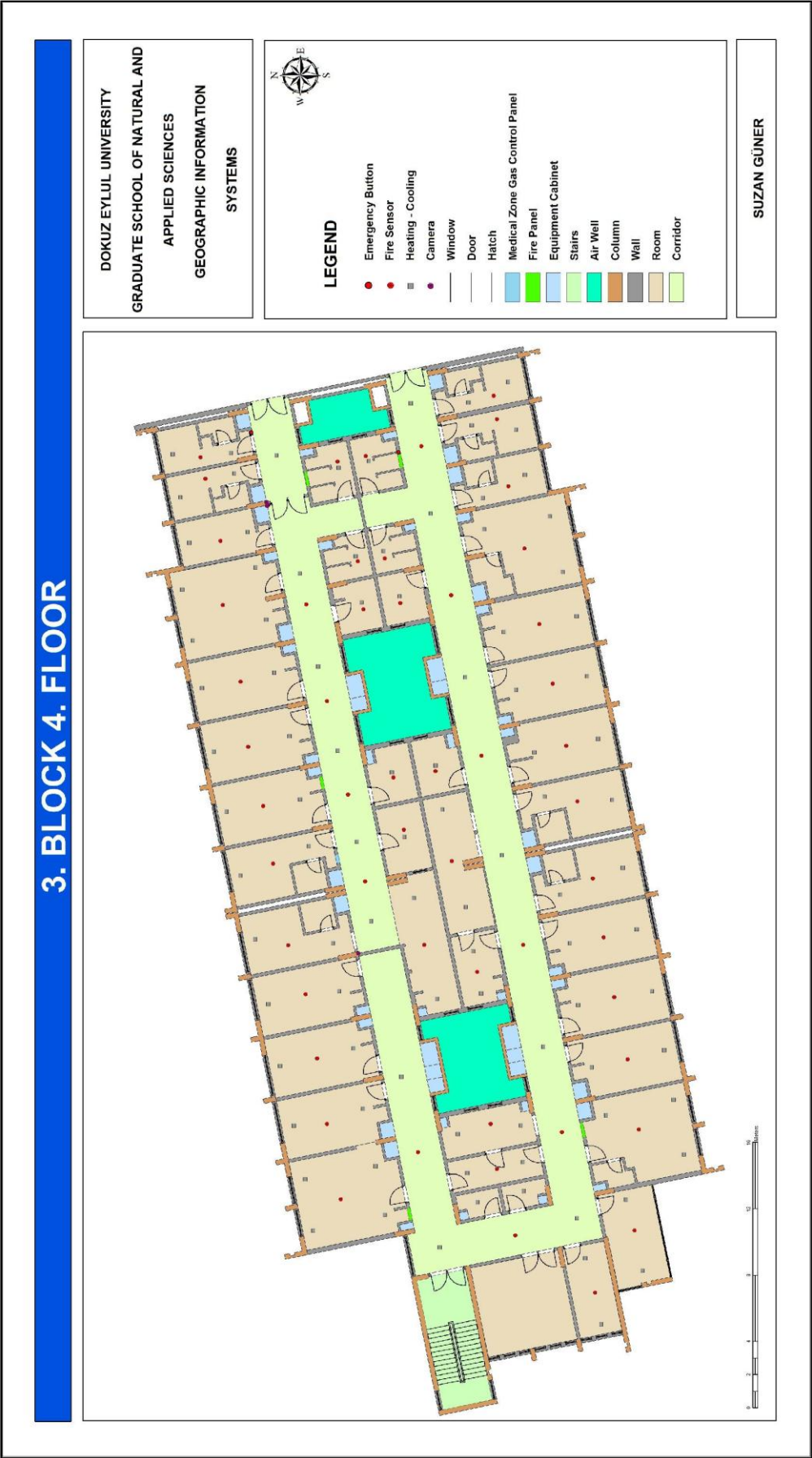
3. BLOCK 2. FLOOR



Appendix 19: 3. Block 3. Floor



Appendix 20: 3. Block 4. Floor

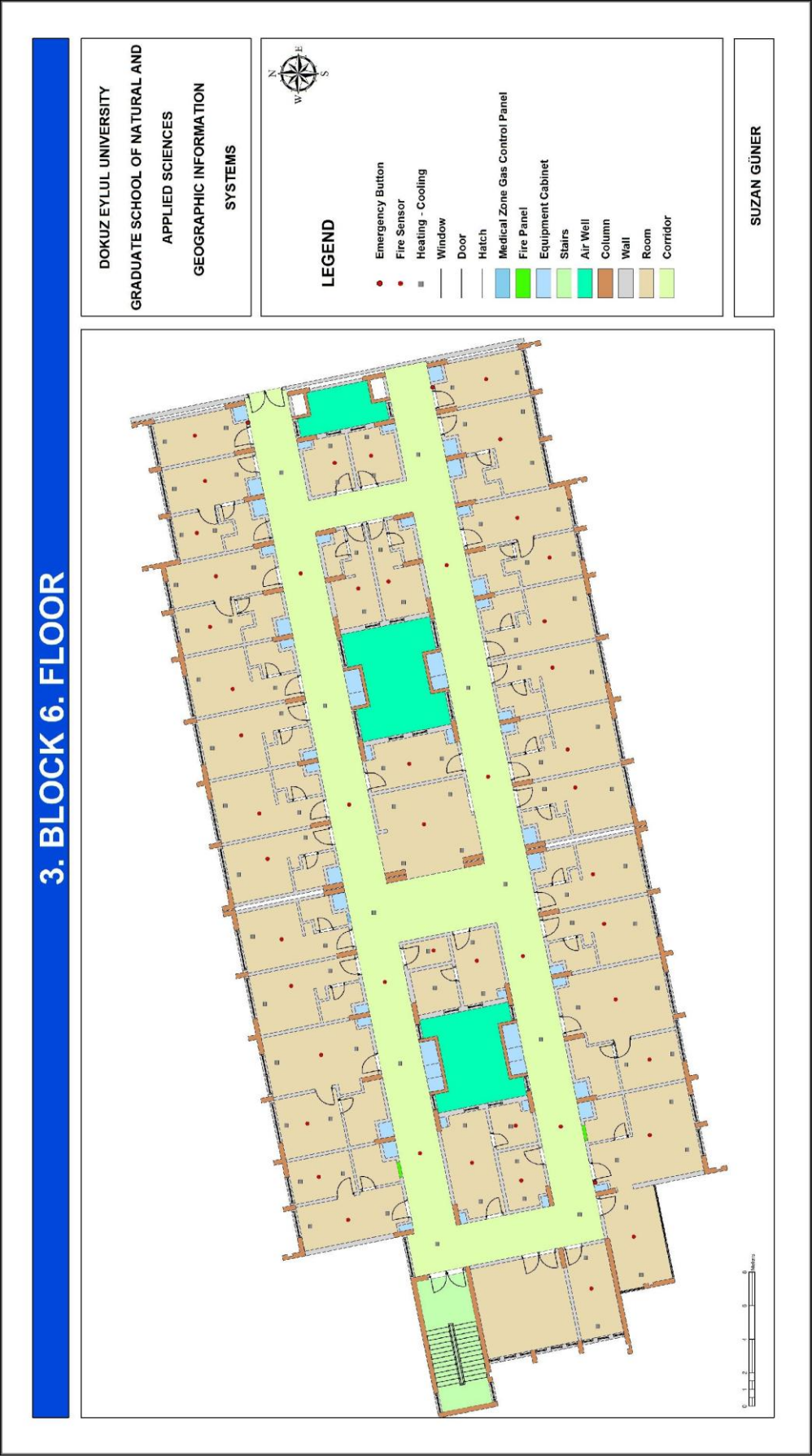


Appendix 21: 3. Block 5. Floor

3. BLOCK 5. FLOOR



Appendix 22: 3. Block 6. Floor



Appendix 23 Commands created for Building Interior and Building Exterior under Dokuz Eylül University Spatial Information Management System by Arcobject extension attachments.

OUTSIDE

```

using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Windows.Forms;
using ESRI.ArcGIS.Framework;
using ESRI.ArcGIS.ArcMapUI;
using ESRI.ArcGIS.Carto;
using ESRI.ArcGIS.Geodatabase;
using ESRI.ArcGIS.Editor;
using ESRI.ArcGIS.Geometry;

namespace Deu_project
{
    public partial class BuildingsQuery : Form
    {
        public IMap m_map;
        private List<domains> levhaYonkodulist = new
List<domains>();
        private static IWorkspace accessWks = null;
        private IEditor ed = null;
        string buildingsquery;
        private IApplication m_application;
        private IMxDocument pMx;

        public BuildingsQuery(IApplication map_ap)
        {
            ed = new Campus().getEditOperation();
            InitializeComponent();
            m_application = map_ap;
            if (ed.Map == null)
            {
                System.Windows.Forms.MessageBox.Show("Start
Editor for Querying");
            }
        }

        private void BuildingsQuery_Load(object sender,
EventArgs e)
        {
            accessWks = ed.EditWorkspace;
            IEnumDataset enumDS =
accessWks.get_Datasets(esriDatasetType.esriDTFeatureDataset);

```

```

        IDataset dataSet = enumDS.Next();
        if (enumDS != null) //if there are datasets, pick
out the featureclasses
        {
            while (dataSet != null)
            {
                if (dataSet.Name.ToString() == "BUILDING")
                {
                    IFeatureDataset      featDS      =
(IFeatureDataset)dataSet;
                    IEnumDataset      enumDSFeatClass  =
featDS.Subsets;

                    IDataset dataSetFC = null;
                    dataSetFC = enumDSFeatClass.Next();
                    if (dataSetFC.Name == "BUILDING")
                    {
                        ITable          featTable          =
(ITable)dataSetFC;
                        IRecordSetInit  recSetInt  =  new
RecordSetClass();

                        recSetInt.SetSourceTable(featTable, null);
                        IRecordSet      recSet      =
(IRecordSet)recSetInt;
                        IFields recFields = recSet.Fields;

                        for (int k = 0; k <
recFields.FieldCount; k++)
                        {
                            string      fieldsname      =
recFields.get_Field(k).Name;
                            IField      fieldlevha      =
featTable.Fields.get_Field(featTable.Fields.FindField("'" +
fieldsname));
                            IDomain      domain      =
fieldlevha.Domain;

                            if (domain != null)
                            {
                                if (domain.Type ==
esriDomainType.esriDTCodedValue)
                                {
                                    }
                                }
                            }
                        }
                        dataSet = enumDS.Next();
                    }
                }
            }
        }
    }

```

```

    private void button1_Click(object sender, EventArgs e)
    {
        IFeatureWorkspace      projefeatureWorkspace      =
(IFeatureWorkspace)accessWks;
        ITable      tablebuildings      =
projefeatureWorkspace.OpenTable("BUILDING");
        pMx = m_application.Document as IMxDocument;
        m_map = pMx.ActivatedView.FocusMap;
    }

```



```

pMx.ActiveView.FocusMap.ClearSelection();

IFeatureLayer featureLayer = findLayer("BUILDING")
as IFeatureLayer;
IDataset projds = (IDataset)featureLayer;
IFeatureSelection fSel =
(IFeatureSelection)featureLayer;
fSel.Clear();

IQueryFilter qfbuildings = new QueryFilterClass();
qfbuildings.SubFields = "";
qfbuildings.WhereClause = "LAYERTYPE = "+
buildingsquery+"";
ICursor cursorbuildings =
tablebuildings.Search(qfbuildings, true);
IRow rowbuildings = cursorbuildings.NextRow();
string whr = "";
if (rowbuildings != null || rowbuildings == null)
{
    while (rowbuildings != null)
    {
        string oid = rowbuildings.OID.ToString();
        whr += "OBJECTID = " +
rowbuildings.get_Value(rowbuildings.Fields.FindField("OBJECTID")) +
" OR ";
        rowbuildings = cursorbuildings.NextRow();
    }
}
if (whr != "")
{
    IQueryFilter qf = new QueryFilterClass();
    qf.WhereClause = whr.Substring(0,
whr.LastIndexOf(" OR "));
    fSel.SelectFeatures(qf,
esriSelectionResultEnum.esriSelectionResultAdd, false);

    ISelectionSet selset = fSel.SelectionSet;
    ICursor cur;
    selset.Search(null, true, out cur);

    IEnvelope bigenv = new EnvelopeClass();
    IFeature f = (IFeature)cur.NextRow();
    if (f != null)
    {
        while (f != null)
        {
            IEnvelope env = f.Extent.Envelope;
            bigenv.Union(env);
            f = (IFeature)cur.NextRow();
        }

        bigenv.XMax += 25;
        bigenv.YMax += 25;
        bigenv.XMin -= 25;
        bigenv.YMin -= 25;
    }
    else

```

```

        {
            MessageBox.Show("There isn't any Data");
        }
        pMx.ActiveView.Extent = bigenv;
        pMx.ActiveView.Refresh();
    }
    else
    {
        MessageBox.Show("There isn't any Data ");
    }
}

```

INSIDE

```

private void btnRoomNumber_Click(object sender, EventArgs e)
{
    IFeatureLayer featureLayer = findLayer("Room") as
IFeatureLayer;
    IDataset projeds = (IDataset)featureLayer;
    IFeatureWorkspace projefeatureWorkspace =
(IFeatureWorkspace)projeds.Workspace;
    pMx.ActiveView.FocusMap.ClearSelection();
    IFeatureSelection fSel =
(IFeatureSelection)featureLayer;
    fSel.Clear();

    IFeatureClass fclastargetboru = (featureLayer as
IFeatureLayer).FeatureClass;
    IFeatureSelection featurselectiontargetboru =
featureLayer as IFeatureSelection;
    IQueryFilter qftargetboru = new
QueryFilterClass();
    qftargetboru.WhereClause = "ROOM_NUMBER=" +
RoomNumberquery + "";

    IFeatureCursor fcrtargetboru =
fclastargetboru.Search(qftargetboru, true);
    IFeature feattargetboru = null;
    feattargetboru = fcrtargetboru.NextFeature();

    featurselectiontargetboru.SelectFeatures(qftargetboru,
esriSelectionResultEnum.esriSelectionResultAdd, false);
    ISelectionSet selset =
featurselectiontargetboru.SelectionSet;
    ICursor cur;
    selset.Search(null, true, out cur);

    IEnvelope bigenv = new EnvelopeClass();
    IFeature ftarget = (IFeature)cur.NextRow();

    while (ftarget != null)
    {
        IEnvelope env = ftarget.Extent.Envelope;
    }
}

```

```

        bigenv.Union(env);
        ftarget = (IFeature)cur.NextRow();
    }
    bigenv.XMax += 25;
    bigenv.YMax += 25;
    bigenv.XMin -= 25;
    bigenv.YMin -= 25;

    pMx.ActiveView.Extent = bigenv;
    pMx.ActiveView.Refresh();
}

private void btnDoorNumber_Click(object sender,
EventArgs e)
{
    IFeatureLayer featureLayer = findLayer("Room") as
IFeatureLayer;
    IDataset projeds = (IDataset)featureLayer;
    IFeatureWorkspace projefeatureWorkspace =
(IFeatureWorkspace)projeds.Workspace;
    pMx.ActiveView.FocusMap.ClearSelection();
    IFeatureSelection fSel =
(IFeatureSelection)featureLayer;
    fSel.Clear();

    IFeatureClass fclastargetboru = (featureLayer as
IFeatureLayer).FeatureClass;
    IFeatureSelection featurselectiontargetboru =
featureLayer as IFeatureSelection;
    IQueryFilter qftargetboru = new
QueryFilterClass();
    qftargetboru.WhereClause = "DOOR_NUMBER=" +
DoorNumberquery + "";

    IFeatureCursor fcrtargetboru =
fclastargetboru.Search(qftargetboru, true);
    IFeature feattargetboru = null;
    feattargetboru = fcrtargetboru.NextFeature();

    featurselectiontargetboru.SelectFeatures(qftargetboru,
esriSelectionResultEnum.esriSelectionResultAdd, false);
    ISelectionSet selset =
featurselectiontargetboru.SelectionSet;
    ICursor cur;
    selset.Search(null, true, out cur);

    IEnvelope bigenv = new EnvelopeClass();
    IFeature ftarget = (IFeature)cur.NextRow();

    while (ftarget != null)
    {
        IEnvelope env = ftarget.Extent.Envelope;
        bigenv.Union(env);
        ftarget = (IFeature)cur.NextRow();
    }

    bigenv.XMax += 25;
    bigenv.YMax += 25;

```

```

        bigenv.XMin -= 25;
        bigenv.YMin -= 25;

        pMx.ActiveView.Extent = bigenv;
        pMx.ActiveView.Refresh();
    }

    private void btn_typeofroom_Click(object sender, EventArgs e)
    {
        IFeatureLayer featureLayer = findLayer("Room") as
IFeatureLayer;
        IDataset projeds = (IDataset)featureLayer;
        ///         projeye         workspace         bağlantısı
oluşturuyoruzzz...
        IFeatureWorkspace         projefeatureWorkspace         =
(IFeatureWorkspace)projeds.Workspace;
        pMx.ActiveView.FocusMap.ClearSelection();
        IFeatureSelection         fSel         =
(IFeatureSelection)featureLayer;
        fSel.Clear();

        IFeatureClass fclastargetboru = (featureLayer as
IFeatureLayer).FeatureClass;
        IFeatureSelection         featurselectiontargetboru         =
featureLayer as IFeatureSelection;
        IQueryFilter         qftargetboru         =         new
QueryFilterClass();
        qftargetboru.WhereClause         =         "ROOM_TYPE='"         +
roomtypequery         +         "'"         AND         block="+RoomBlocksquery+"         AND
floor="+Roomfloorsquery+" AND TYPE_OF_USE="+RoomTypeOfUsequery+"";

        IFeatureCursor         fcrtargetboru         =
fclastargetboru.Search(qftargetboru, true);
        IFeature feattargetboru = null;
        feattargetboru = fcrtargetboru.NextFeature();

        featurselectiontargetboru.SelectFeatures(qftargetboru,
esriSelectionResultEnum.esriSelectionResultAdd, false);
        ISelectionSet         selset         =
featurselectiontargetboru.SelectionSet;
        ICursor cur;
        selset.Search(null, true, out cur);

        IEnvelope bigenv = new EnvelopeClass();
        IFeature ftarget = (IFeature)cur.NextRow();
        if (ftarget != null)
        {
            while (ftarget != null)
            {
                IEnvelope env = ftarget.Extent.Envelope;
                bigenv.Union(env);
                ftarget = (IFeature)cur.NextRow();
            }
            bigenv.XMax += 25;
            bigenv.YMax += 25;
            bigenv.XMin -= 25;

```

```

        bigenv.YMin -= 25;

        pMx.ActiveView.Extent = bigenv;
        pMx.ActiveView.Refresh();
    }
    else
    {
        MessageBox.Show("There isn't any Data");
    }
}

private void btnRoomNumber_Click(object sender, EventArgs e)
{
    IFeatureLayer featureLayer = findLayer("Room") as
IFeatureLayer;
    IDataset projeds = (IDataset)featureLayer;
    IFeatureWorkspace   projefeatureWorkspace   =
(IFeatureWorkspace)projeds.Workspace;
    pMx.ActiveView.FocusMap.ClearSelection();
    IFeatureSelection    fSel                    =
(IFeatureSelection)featureLayer;
    fSel.Clear();

    IFeatureClass fclastargetboru = (featureLayer as
IFeatureLayer).FeatureClass;
    IFeatureSelection featuresselektiontargetboru =
featureLayer as IFeatureSelection;
    IQueryFilter      qftargetboru              =      new
QueryFilterClass();
    qftargetboru.WhereClause = "ROOM_NUMBER=" +
RoomNumberquery + "";

    IFeatureCursor      fcrtargetboru           =
fclastargetboru.Search(qftargetboru, true);
    IFeature feattargetboru = null;
    feattargetboru = fcrtargetboru.NextFeature();

    featuresselektiontargetboru.SelectFeatures(qftargetboru,
esriSelectionResultEnum.esriSelectionResultAdd, false);
    ISelectionSet        selset                 =
featuresselektiontargetboru.SelectionSet;
    ICursor cur;
    selset.Search(null, true, out cur);

    IEnvelope bigenv = new EnvelopeClass();
    IFeature ftarget = (IFeature)cur.NextRow();

    while (ftarget != null)
    {
        IEnvelope env = ftarget.Extent.Envelope;
        bigenv.Union(env);
        ftarget = (IFeature)cur.NextRow();
    }
    bigenv.XMax += 25;
    bigenv.YMax += 25;
    bigenv.XMin -= 25;
    bigenv.YMin -= 25;

```



```
        pMx.ActiveView.Extent = bigenv;  
        pMx.ActiveView.Refresh();  
    }  
}
```