<u>ISTANBUL TECHNICAL UNIVERSITY ★ CIVIL ENGINEERING FACULTY</u>

DESIGN AND IMPLEMENTATION OF ITU-CAMPUS INFORMATION SYSTEM – ABOVEGROUND INFRASTRUCTURE EXAMPLE WITH OPEN SOURCE GIS SOFTWARE (QGIS)

UNDERGRADUATE DESIGN PROJECT

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PROLOGUE

In this thesis, the foundations of Istanbul Technical University Campus Information System (ARIGIS) were laid.

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Elif Şevval Taştan
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ABBREVIATIONS

GIS	**:** Geographic Information System
CIS	**:** Campus Information System
İTÜ	**:** İstanbul Technical University
CGI	**:** Computer Generated Imagery
ESS	**:** Extended Service Set
GARCH	**:** Generalized Autoregressive Conditional Heteroskedasticity
GIS	**:** Geographic Information Systems
HCA	**:** Hierarchical Cluster Analysis
Mbps	**:** Megabits per second
SWAT	**:** Soil and Water Assessment Tool
UMN	**:** University of Minnesota
ARI GIS	**:** İTÜ Campus Information System
OSM	**:** Open Street Map
TUREF	**:** Türkiye Ulusal Referans Sistemi

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DESIGN AND IMPLEMENTATION OF ITU-CAMPUS INFORMATION SYSTEM – ABOVEGROUND INFRASTRUCTURE EXAMPLE

WITH OPEN SOURCE GIS SOFTWARE (QGIS)

SUMMARY

Campus Information System (CIS) provides easy access to up-to-date and accurate information for the use of university students, lecturers and other users who may need it. In this project, a Campus Information System (ArıGIS) was developed through QGIS software, which covers the entire Istanbul Technical University (ITU) Maslak-Ayazağa Campus. In this context, a PostgreSQL database that can be used by people in different disciplines through their own private passwords was created and integrated into the QGIS program with the PostGIS extension. It was also backed up and stored in the Amazon AWS database. The data to be used while creating the Campus Information System were obtained from the field studies carried out on the campus, the Department of Construction Affairs and some online data resources (e.g., OpenStreetMap), and were organized and developed with the studies carried out. The data obtained were divided into two groups as infrastructure and superstructure, in this way a more effective work was achieved. Then, various analyzes were carried out with the help of the generated data. As a result, ArıGIS was created and a Campus Information System was created on the web, which can be used by administrative units for various purposes and accessed by students and other users who may need it. With this project, the foundations of a forward-looking Campus Information System that are open to development were laid.

1. INTRODUCTION

Information is one of the most important resources for surviving and continuing to live in today's world. Obtaining, producing, processing and storing data is critical in the steps towards the future. With the acceleration of technological developments, technology is also advancing rapidly. Every step from obtaining information to processing information takes less time as a result of technological developments. The fact that the data is fast has made it easier to process with larger and more comprehensive data. The development of technology leads to an acceleration of data processing and perception, but also makes a great contribution to development in all areas. Developments in different fields also enable more data production and data to be changed in a more serial manner. These changes also highlight the issue of the topicality of the data.

Universities are institutions that should be pioneers in the fields of science and technology, first in their own countries and then around the world. One of the most urgent problems facing today's organizations is to provide access to information when necessary. Existing information archived without a regular organization can cause problems. In addition, today's institutions are willing to produce new information from current information at the right time to have the right information at the right time. These standards apply to universities and various other institutions (Geymen et al., 2008). Istanbul Technical University (ITU) is also a reputable institution that has signed many valuable studies both in our country and internationally. It requires the university to produce, store and process information in the administrative, academic and social fields and that this information is available to the necessary people and institutions. The necessity of a system where these data will be connected and presented with spatial dec and where they are accessible to everyone cannot be ignored. Istanbul Technical University, where there is an active campus life, needs a campus information system (CIS) that will serve in all areas. As Sarı, Erdi, and Kırıloğlu have mentioned, this concept, also known as the Campus Information System (CIS), can basically be defined as a system that provides access to all organs, geographical assets, and also attribute data of a university campus.

In today's conditions, where the existence of data, as well as its topicality, is of critical importance, the task of this system will be, first of all, to accelerate and facilitate the development of the university. Then, using the system, keeping it up-to-date, improving it, its shortcomings and benefits will be observed. In the light of this information, it will first be an example for other universities and institutions in our country, and then it will be an important study on the development of the information system in the international area.

With the help of geographic information system (GIS) techniques, operations such as collecting, storing, updating, controlling and analyzing and viewing information about the earth for a specific aim can be easily performed. According to Kahraman, Karas and Rahman (2011), the GIS-based Campus Information System exists in many universities to serve various aims. This integrated system for the collection of spatial and non-spatial data at the university and its subunits consists of 4 organs: hardware, software, data and users. These spatial and non-spatial data can be stored, researched, processed and presented to decision makers using technologies.

For this reason, GIS techniques are very effective for creating a Campus Information System. This campus information system, which will be created, will provide services for students, staff, academicians and visitors. With open source software (QGIS), it is easy to deliver spatial and non-spatial data to users. A system should be created that is accessible to everyone via the internet and convenient for updating the data belonging to the ITU campus.

1.1 Definition of the Problem

In many areas in Turkey in conjunction with a technical college, and the college that accept students from abroad, which is internationally recognised and preferred in the ITU as well as for students and academic staff to meet the needs of visitors there is a lack of administrative and campus Information System. The construction, enrichment and updating of such a system with data from different fields will be used and benefited by different people in different fields. Geymen, et al. (2008) stated that Geographic Information Systems (GIS) is a technology used to solve such problems in Turkey and around the world. As a result of these factors, the use of Geographic Information Systems is increasing rapidly all over the world, including Turkey. Universities are the first institutions that come to mind when it comes to information. In order for universities to provide the services they need, it is necessary to establish an information system within the university.

Users can be divided into 4 main groups. One of these groups is the group of students. When spatial problems and solutions are mentioned, the first problem that comes to mind is the transportation problem. Creating a route to the point that is intended to be reached can be given as an example of one of the transportation problems. This problem can be solved with a campus information system, where a solution will be established. First of all, when transportation is considered, it is necessary to define the bus and metro lines that will be used to reach the campus into the system. Public transportation routes are recorded in the system by defining the ring routes and routes within the campus. In addition to adding vehicle paths within the campus, pedestrian and bicycle paths should be defined. Adding the locations of vehicles such as bicycles and electric scooters that are rented on campus to the system and keeping them updated is one of the solution ways.

After the transportation roads and vehicles, the definition of parking places for cars, bicycles and rental vehicles and the determination of transportation places to these areas, as well as showing them on the map, also defining the transportation routes to these specific areas and accessing all these on a single map and system will be thanks to the campus information system.

After the main transportation problems, the problem of the accessibility of the places that students need academically by the students and the ability to reach the spatial locations of these places can be emphasized. The most practical way would be to use the campus information system for this. Because in this system, where a lot of data is collected from different fields, there is a school student system and information that will come from there. Where and when academic pursuits can be solved, who the relevant people are should be accessible through a single system.

In addition to academic work, the locations of places that require urgent transportation, such as hospitals, should be accessible as quickly as possible. The collection of this information under a single system will facilitate this work. It is very important that the information mentioned is up-to-date, because incorrect or incomplete information in an emergency situation can lead to negative consequences.

Grocery stores, shopping venues, coffee shops, dining halls and restaurants, and locations, and information systems and the data to the host with this place-to-date campus information, students do not lose time with information about the whereabouts of where they would meet the requirements.

Speaking of the student group, one of the most important needs is the location and timeliness of the faculties and classrooms. After the course selection is made, only the name of the classroom and the name of the faculty building. their information will be available. But there will be no route showing how to get there. Thanks to the campus information system, information on how to access classrooms will be easily accessible. The changes made by the person giving the course related to the course, especially the change related to the location of the place where the course will be processed, will be accessible firsthand. Transportation of courses to the laboratory in application courses or surveys on campus, etc. in case of classes, location information will be easily shared and students and lecturers will be provided with convenience.

In addition to such tasks as informing about the place of processing of courses, students can easily be reached thanks to the information system of exam places. In fact, grievances can be eliminated because last-minute changes can be easily entered into the system and the student can also reach them.

The mentioned transport-related problems are a general problem. The proposed system solutions are suitable for everyone's use and are accessible.

The needs of lecturers for the system are similar to those of students. The two groups have common problems such as difficulty in getting to shopping places or getting to hospital locations. On the other hand, there is a student-course system currently used in universities. There is a lack of a system containing spatial data due to this. Thanks to this spatial system, classrooms, exams, etc. such problems can be solved.

From an administrative point of view, additions can be made regarding the necessity of the system. The administrative has to decide on technical processes such as infrastructure and superstructure works, structures to be built or demolished, the newly opened shops, dining hall, student affairs and access to roads, issues such as new roads. These decisions should be made in the most effective way and the problems should be solved in the most effective way. Having a system which the highest benefit will be provided and the price / performance ratio can be observed will pave the way for initiatives and projects to be carried out on campus. All this chain reaction will benefit both students and lecturers. With the benefit provided by the system to these units, the university will be developed and it will be ensured that exemplary steps will be taken.

In general, the display of deficiencies in technical works and the studies carried out through a single system will also facilitate the decision of which areas to invest in. In infrastructure studies, having location-based information of infrastructure units will ensure that these areas will be put to work quickly when work will be done.

Visitors can be considered as the end user group. As mentioned before, ITU is a large university that receives applications in bachelor's, master's and doctoral fields both from home and abroad. For this reason, there is no doubt that there is a need for a system where people who want to get information about the university can obtain this information. Information such as places to stay, transportation to classrooms, meals and visits, especially transportation to the campus, should be accessible through the campus information system. With the campus information system, the work of foreign students will be accelerated and they will get accurate and up-to-date information.

On the other hand, the campus information system can be used not only for those who want to study at the university, but also for people who want to visit research laboratories or units such as incubation centers on campus. People working in venture offices can benefit from this system.

Nowadays, it is quite necessary that the data becomes of great importance and that the data be kept organized and up-to-date. Otherwise, technological change may lose momentum. In order not to fall behind in this technological race, it is necessary to establish a campus information system.

1.2 Aim of the Study

The aim of the study is to create a Campus Information System belonging to the Ayazaga Campus of Istanbul Technical University. It is planned that this Campus Information System, which is intended to be created, will have a database that contains all kinds of data in the structure and infrastructure of the campus. By organizing, processing and analyzing these data, it is aimed to design a campus system that all users can easily access online. This system will be easily updatable.

1.3 Methodology

The development of the Campus Information System on QGIS consists of several stages. The first step of the study is to obtain data from various literatures and previous studies. The next step is to collect datas about the Ayazaga Campus of Istanbul Technical University. These include DEM data, topographic data, superstructure and infrastructure data, road, building, bridge, green area, sports field, etc. data can be given as examples. The next step is to transfer the collected data to the open source GIS software (QGIS) and analyze it with the help of the PostgreSQL database, which can be spatially characterized with the PostGIS plugin. The data is processed and analyzed with the help of QGIS software. The last step is to create a Campus Information System which can be accessed online by everyone at the Ayazağa Campus, and put it at the service of the users..

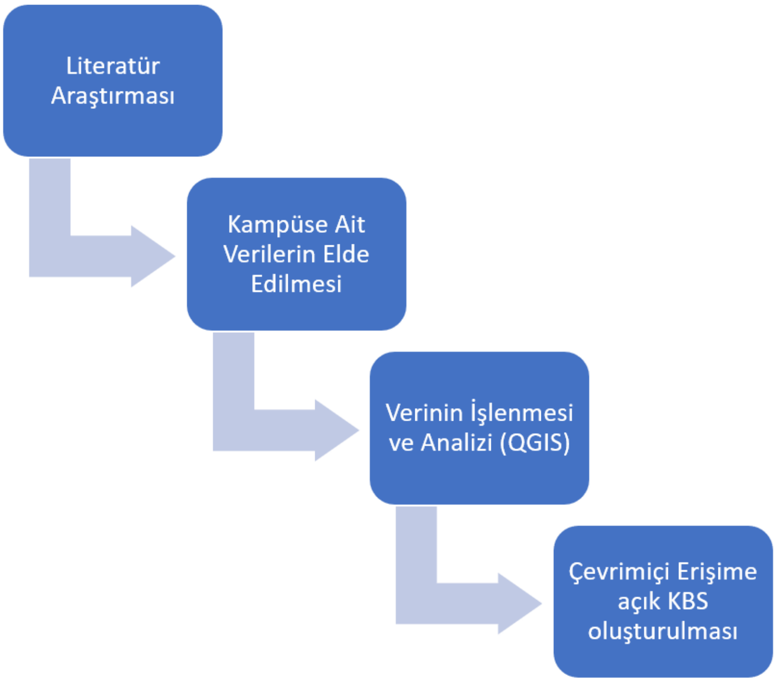

Figure 1.1: Methodology of the study (Bi, 2016).

1.4 Literature Research

Universities located in cities are the most effective institutions in the development of this city, and it is extremely important that these institutions use information in the most efficient way. GIS-based campus information systems are being developed and used in many advanced universities around the world (Bilgilioglu et al., 2011).

The use of internet cartography has become more and more heard in Turkey and has been adopted by people. New application areas have emerged. In particular, the use of institutions in applications and projects has increased and there is a need for competent people in this field. Internet-based geographic information systems are of critical importance in terms of being a solution tool, since it has become very easy for the public to access these maps with the Internet. Internet applications of campus information systems, with their easy accessibility, guide students from various cities and attract great attention. (Sarı, Erdi, and Kırtıloğlu, 2011).

Bassam et al. (2017), as mentioned by smart campus, is the product of the rapid development of GIS technology, computer network technology and internet of things technology. At the same time, they also stated that the three main elements of the smart campus system are personalized services, information services, and environmental platforms. In addition, they have also schematized the spatial database content.

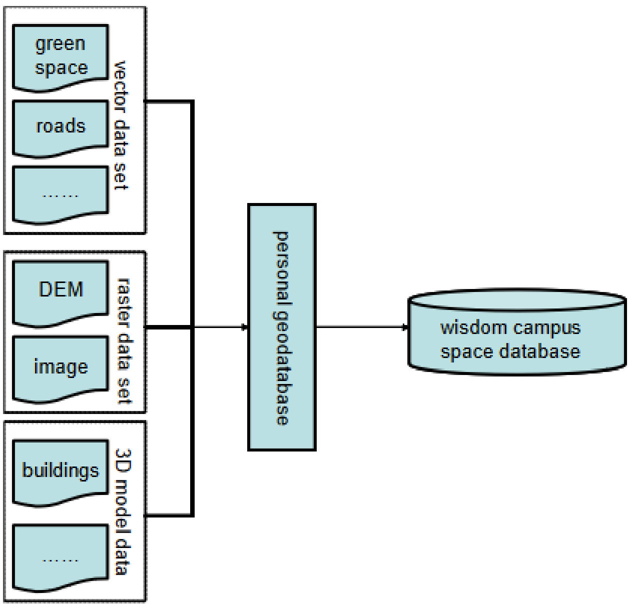

Figure 1. 2: Spatial database scope (Bi, 2016).

2. BASIC CONCEPTS AND DEFINITIONS

2.1 Basic Concepts

Geographic Information System: A geographic information system (GIS) is a system for creating, managing, analyzing, and mapping various types of data. GIS connects data to a map by combining location data with other types of descriptive information. Geographical information systems provide a basic science of mapping and analysis. People can understand linkages and spatial situations more easily with the help of GIS. Higher efficiency, better management, and more precise decision-making are all advantages of better communication. According to Bilgiliolu (2011), GIS, is a technological system that allows for the inquiry, analysis, and storage of both geometric and non-geometric data according to specified standards.

Campus Information System: It is a system that allows all functions on any university campus to query their spatial and non-spatial assets, geographic information, and characteristics. Thanks to this system, students or academic staff from outside the city can be questioned in spatial or qualitative terms via the universities website (Sarı, Erdi and Kırtioğlu, 2011)

Data Dictionary: A set of names, properties, and definitions for data stored in a database, as part of a project, or as part of an information system. It describes the meanings and purposes of data elements in the context of a project and gives advice on how to understand, accept, and represent them. Metadata about data objects is also provided via a Data Dictionary. The scope and attributes of data components, as well as the rules for their usage and application, can all be defined using metadata in a Data Dictionary.

QGIS: It is a free and open-source geographic information system (GIS) program that includes data display, editing, and analysis capabilities, as well as cross-dec support. It was previously known as "Quantum GIS."

Data: It is the name given to a piece of raw data that has not been processed. Measurement, experiment, observation, counting, and study are all methods for collecting data. It is developed as a consequence of a topic's research, discussion, collecting of knowledge, and reasoning. It is raw data that has not been processed or systematized to the point where it cannot be interpreted.

Database: It is a collection of data that is saved and retrieved electronically on a regular basis. Small databases can be stored in a file system, while large databases are hosted in computer clusters or cloud storage. The design of databases, data modeling, representation and efficient data storage, query languages, and the security and privacy of sensitive data, including formal techniques to support concurrent access to distributed computing and fault tolerance issues and practical issues, including the covers.

Spatial Database: It is any kind of data that directly or indirectly refers to a particular geographical area or location. Spatial data, also known as geospatial data or geographic information, can represent a physical object numerically in a geographic coordinate system. Spatial data includes location, shape, size and orientation.

Vector Data: It is vector data that are defined as graphical representations of the real world. There are three main types of vector data. These are points, lines and polygons. The connection points form lines, and the connection lines that form a closed space form polygons.. Vectors are used in the figure to present generalizations of objects or features on the Earth's surface. Vector data and shapefiles (.the file format, known as shp), is mostly vector data.since it is stored in shp files, it is sometimes used interchangeably.

Raster Data: These are the data presented in a pixel grid. Each pixel in a raster has a value, such as a color or a unit of measure, to convey information about the item in question. Rasters typically refer to images. However, in the spatial world this may refer specifically to orthoimages, which are photographs taken from satellites or other weather devices. The raster data quality varies depending on the resolution and the task to be performed.

Non-Spatial Data: Non-spatial data is information that is not constrained by any geometric constraints.

Qualification Data: It contains the definition or measurement of a geographical feature on a map. It refers to detailed data combined with spatial data. Attribute data helps to obtain meaningful information of a map. For example, the name of the building, the area of the building, the number of floors, the number of rooms, etc.

2.2 Concepts Related to the Functions of GIS

Data Storage and Management: The database created with GIS can be stored in different media such as hard disk, DVD, USB drive, online drive, as well as in the cloud. The spatial database can be updated regularly, acquiring new sources of input from time to time. This is the most advantageous function, since all the data is in digital form, so it is very easy to update the data and reduces the data redundancy.

Data Integration: The use of a geographic information system (GIS) allows to connect and combine data from many sources. As a result, GIS may be used in combination with other methods to map variables and evaluate new variables and factors.

Data Conversation: It is a very important function, as it facilitates better analysis of data collected from different sources. It can be converted to tiff format like jpeg file, converting the projection through geo-referencing so that all the data is in the same projection system. The data can be converted from raster to vector, such as image to polygon/line, or vice versa from vector to raster, such as polygon to raster format. The data can also be converted from raster to raster or vector to vector data according to the need for software and analysis.

Data Analysis: The data can be analyzed by applying appropriate mathematical or statistical algorithms on the data to create new information/maps. Buffer analysis, proximity analysis, and interpolation process to generate DEM, etc. as it depends entirely on the requirements of the users.

Data Modelling: Many simulation models on data may be generated using GIS functions to generate relevant information for planning, such as flow modeling, urban growth forecasting, and so on. In order to properly evaluate the property, it also includes tools for constructing 2D and 3D models of the earth's surface.Many mathematical and statistical methods can be used for modeling in GIS.

Display: It is the function of presenting the results in various forms, such as numerical maps, printed maps, tables and graphs. It completely depends on the user's need to view the data in different formats.

3. APLLIED STUDIES

3.1 Preparation of the Database

Before starting the studies, there is a need for a common database that is easy to access, view and update data quickly. The QGIS software we used in the ArıGIS project also supports many spatial formats, including PostGIS. This extension provides convenience in the execution of the project. In the ArıGIS project, a connection to Amazon's cloud system was provided with PostGIS as a database extension. The data to be worked on started to be stored in the database created over Amazon's cloud system, via the QGIS program.

3.2 Layers

In QGIS program, different types of data are stored in different layers. There are three types of data types. These are: point, polygon and line. Spatial data are divided into these three categories according to their properties. For example, data such as road and wastewater line are stored in layers with line data type, data such as building and pavement are stored in layers with polygon data type, data such as valve and poi are stored in layers with point data type. The coordinate reference system of the project is determined as TUREF/TM30 EPSG:5254. All generated data are defined in this reference system. A study area including ITU Ayazağa campus has been determined for the ArıGIS project. Corner coordinates of the working area: 417033.772 - 4551425.371: 419682.169 - 4553536.987. The campus data is divided into two groups as superstructure and infrastructure. The data layers in the superstructure are: buildings, open spaces, monument-sculpture, point of interest and technokent boundary layers. Data layers in the infrastructure: transportation, transportation-buffer, pavement, wastewater line, wastewater manhole, bicycle park, parking lot, natural gas, power line-transformers, fiber cable, drinking water-potable valve, irrigation line, storm water, heating layers.

3.2.1 Superstructure

3.2.1.1 POI Layer

A Point of Interest or POI is the location of a particular point that a person may find useful or interesting. All data of the POI layer were obtained from ITU Construction Department. These point-type data were brought together in NETCAD software to cover the entire campus. POI layer includes id, type, name, usage type and purpose, and ownership data.

Table 3.1 : Data Dictionary of POI Layer.

Id	Name	Alias	Tip	Type name	Length	Precision
0	Fid		Qlonglong	Int8	-1	0
1	Poi_id		int	Int4	-1	0
2	Poi_turu		QString	varchar	-1	0
3	Poi_ismi		QString	varchar	11	0
4	Kullanım_turu		QString	varchar	16	0
5	Kullanım_amacı		QString	varchar	16	0
6	Poi_saahiplik		QString	varchar	30	0

Notation and symbology are of great importance for POIs. Symbols were created in accordance with cartographic representation techniques. For example, the tree symbol was used for single trees, and the ATM symbol in the program was used for ATMs.

Figure 3. 1 : Examples of Using Symbols.

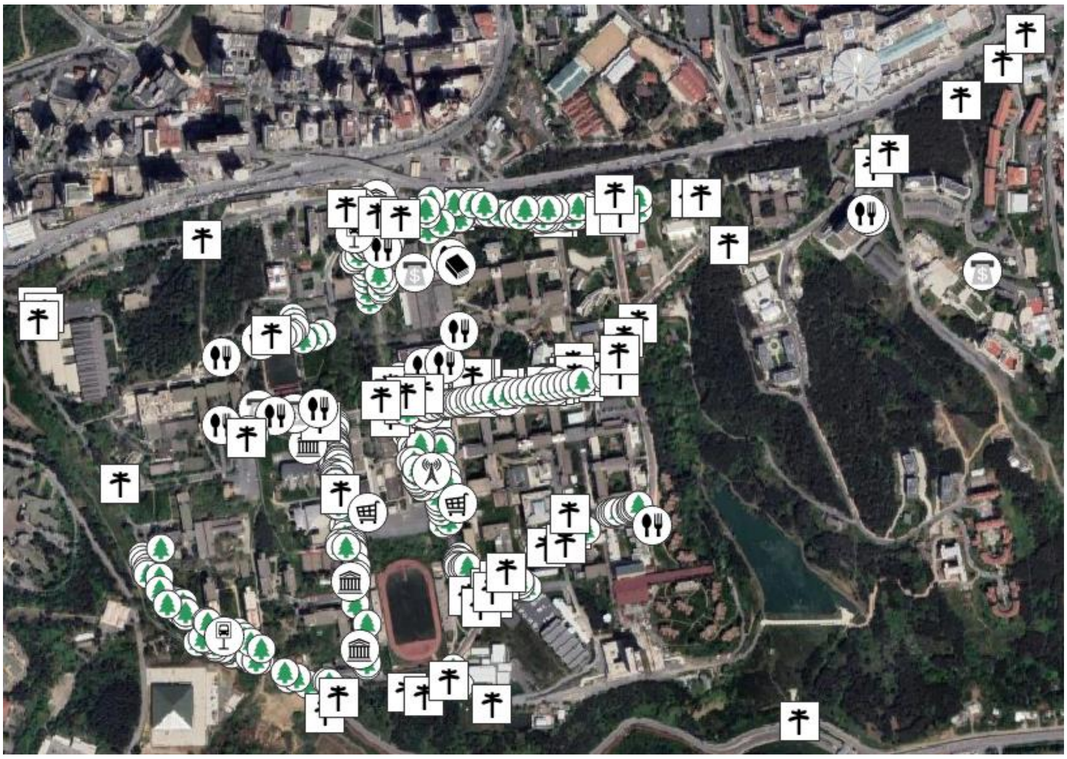

Figure 3. 2 : General view of POI layer.

3.2.1.2 Buildings Layer

In the studies carried out, the second step was to create the "BUILDINGS" layer. First of all, data from OSM (OpenStreetMap) was obtained. However, due to the lack of spatial sensitivity and deformities of these data, up-to-date and location-accurate data about buildings were obtained from ITU Construction Department. Then, the data in line type with high position precision were converted into polygons, and digitization was started on it. Afterwards, the joint boundaries and sections of the buildings such as the Faculty of Civil Engineering, the Faculty of Arts and Sciences, and the Central Classroom were separated with the help of the maps obtained from the relevant authorities. A joint is the part that connects two or more elements and allows them to rotate in all directions.

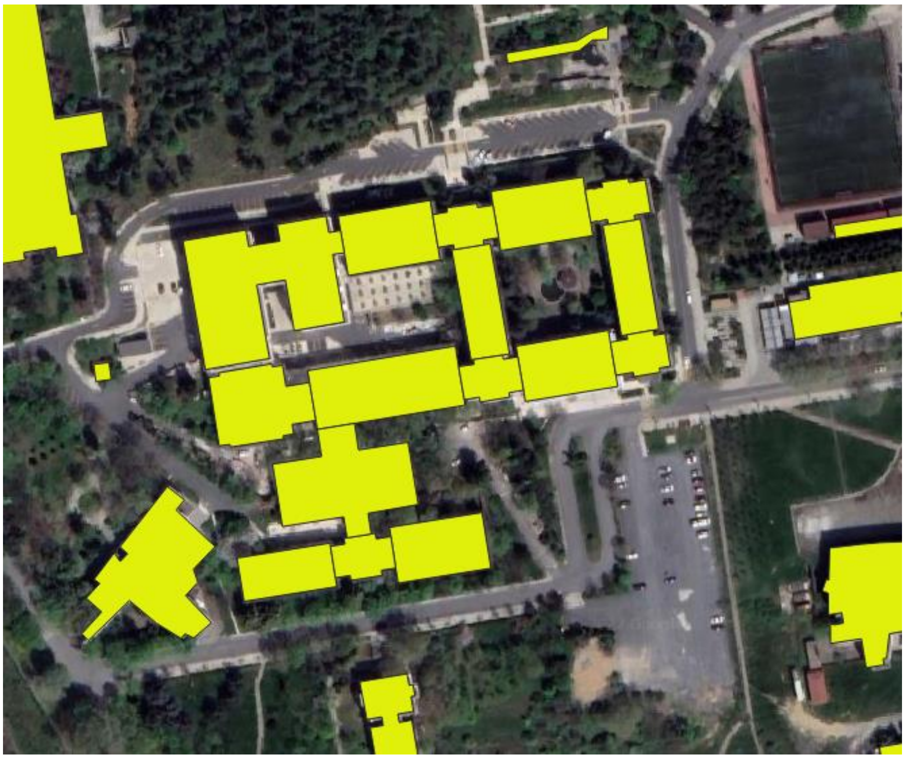

Figure 3. 3 : Joints of the faculty of civil engineering.

The building layer includes fid, ID number, exterior door number, apartment/block name, photograph, architectural project, purpose of use, number of ownership floors, joint blocks, building class, building age, heating system, access between floors and area information.

Table 3. 2 : Data dictionary of buildings layer.

Id	Name	Alias	Tip	Type name	Length	Precision
0	Fid		Qlonglong	Int8	-1	0
1	Kimlik_no		int	Int4	-1	0
2	Dış_kapı		QString	varchar	-1	0
3	Apartman/blok_adı		QString	varchar	-1	0
4	Fotograf		QString	varchar	-1	0
5	Rapor		QString	varchar	-1	0
6	Mimari_proje		QString	varchar	-1	0
7	Kullanım_amacı		QString	varchar	32	0
8	Sahiplik		QString	varchar	32	0
9	Kat_adedi		Int	Int4	-1	0
10	Mafsal_blok		QString	varchar	-1	0
11	Yapı_sınıfı		QString	varchar	-1	0
12	Bina_yaşı		Int	Int4	-1	0
13	Isıtma_sistemi		QString	varchar	-1	0
14	Katlar_arası_erişim		QString	varchar	-1	0
15	Alan_m^2		double	Float8	-1	0

Data dictionary of buildings layer "ID_ID" / "outer_door" / "apartment/block_name" / "use_purpose" / "ownership" columns are filled with the help of the MAKS system of the General Directorate of Population and Citizenship Affairs.

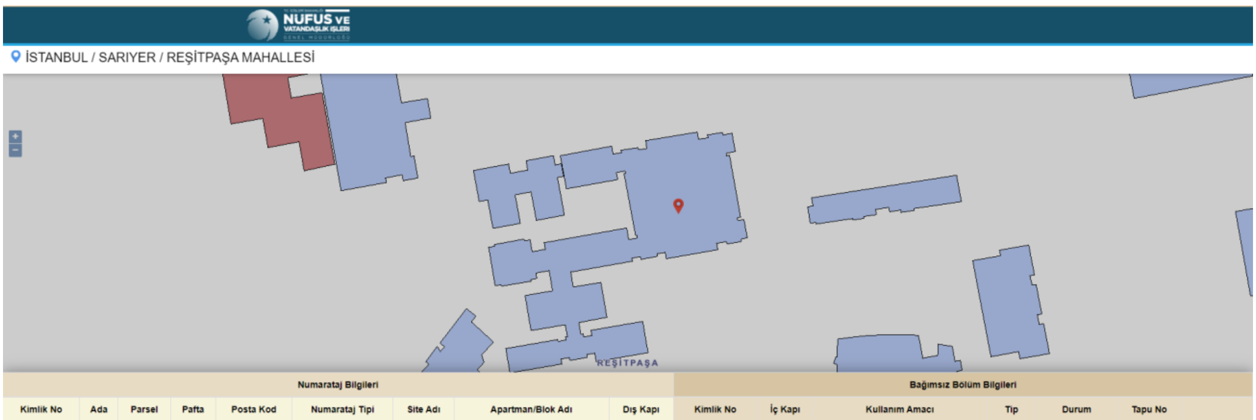

Figure 3. 4 : MAKS System.

In addition, columns (number of floors, joint_block, building_class, building_age, heating_system,_interfloor_access) were formed for use in future studies and their final shapes were given.

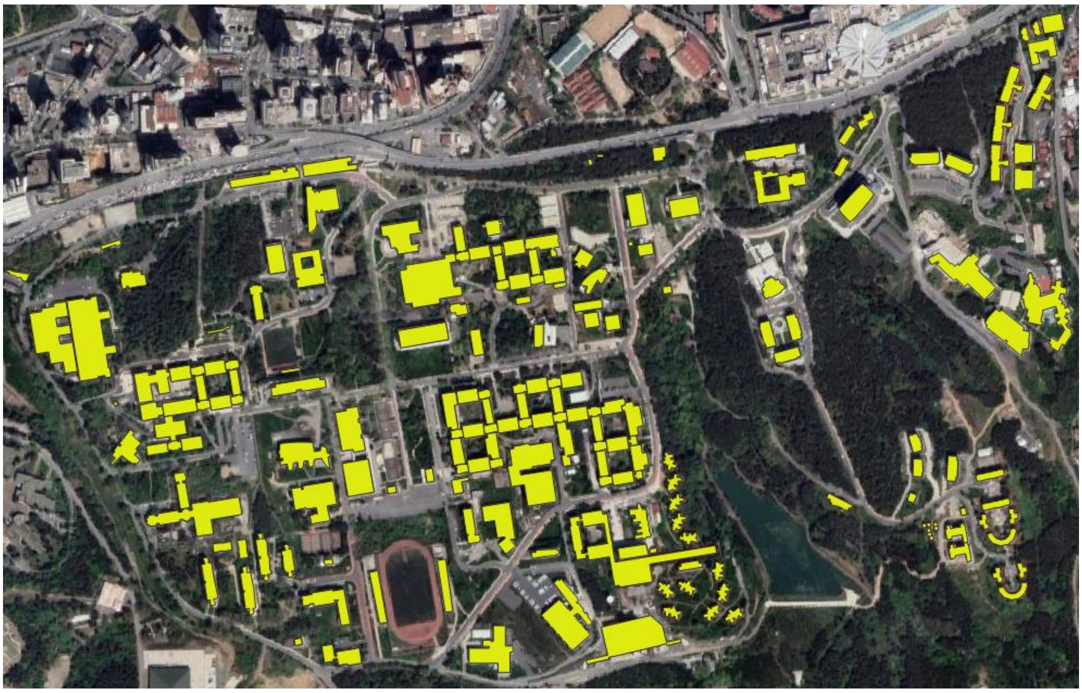

Figure 3. 5 : General view of building layer.

3.2.1.3 Open Fields Layer

High-accuracy data from the Construction Department was brought together and an overall view was obtained. Then the digitization process was carried out. open spaces; According to the purpose of use, they were gathered under 3 main headings as sports fields, green areas and water areas. The Open Fields layer contains intent and space data.

Table 3. 3 : The data dictionary of the open fields layer.

Id	Name	Alias	Type	Type name	Length	Precision
0	fid	Sistem tarafından otomatik atanır.	qlonglong	int8	-1	0
1	kullanım_amacı	Alanın kullanım amacını belirtir.	QString	varchar	10	0
2	Alan_m^2	Alanı m^2 cinsinden gösterir.	double	float8	-1	0

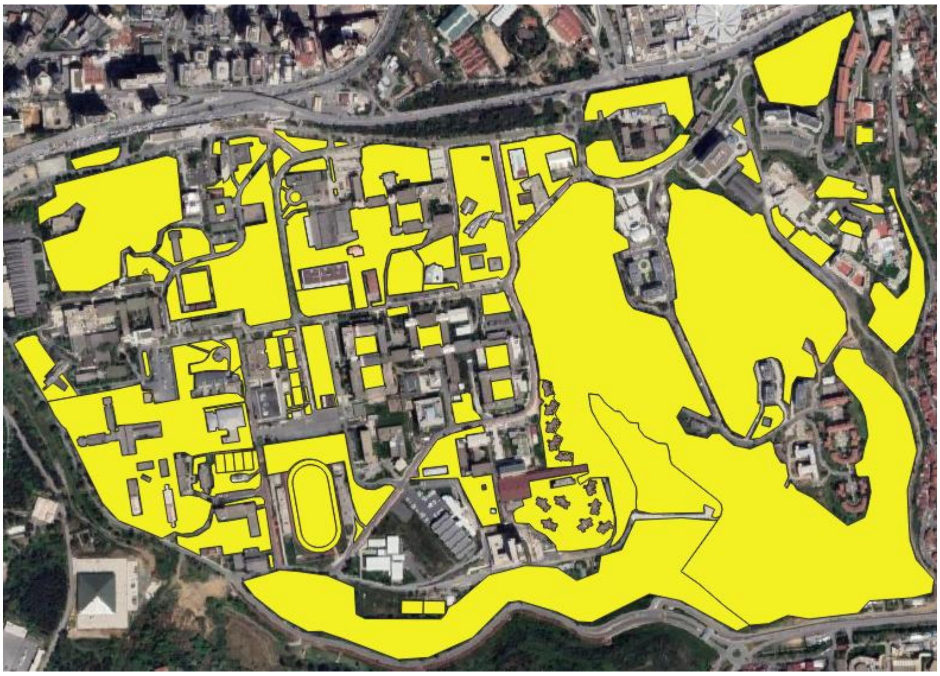

Figure 3. 6 : General view of open field layer.

3.2.1.4 Technocity Boundary Layer

Boundary means the line that divides a place into two parts. Boundaries have been determined to separate the areas belonging to the technocity and the areas belonging to the school. As in the previous steps, the data in line type taken from the relevant unit of the rectorate were turned into a single closed polygon. Teknokent Boundary layer; It contains fid and id information.

Table 3. 4 : The data dictionary of the Teknokent boundary layer.

Id	Ad	Alias	Tip	Type name	Length	Precision
0	Fid		Qlonglong	Int8	-1	0
1	Id		int	Int4	-1	0

Figure 3. 7 : General view of technocity boundary layer.

4. ANALYSES

Analyzes can be made using the data in the layers of the superstructure and infrastructure produced in the ArıGIS project. Besides being open source, QGIS software is suitable for easy spatial analysis.

4.1 Analysis

The average area of open areas was found to be 7587.63 square meters from statistical information. As analysis, it was determined that the open areas with an area greater than 7500 were determined.

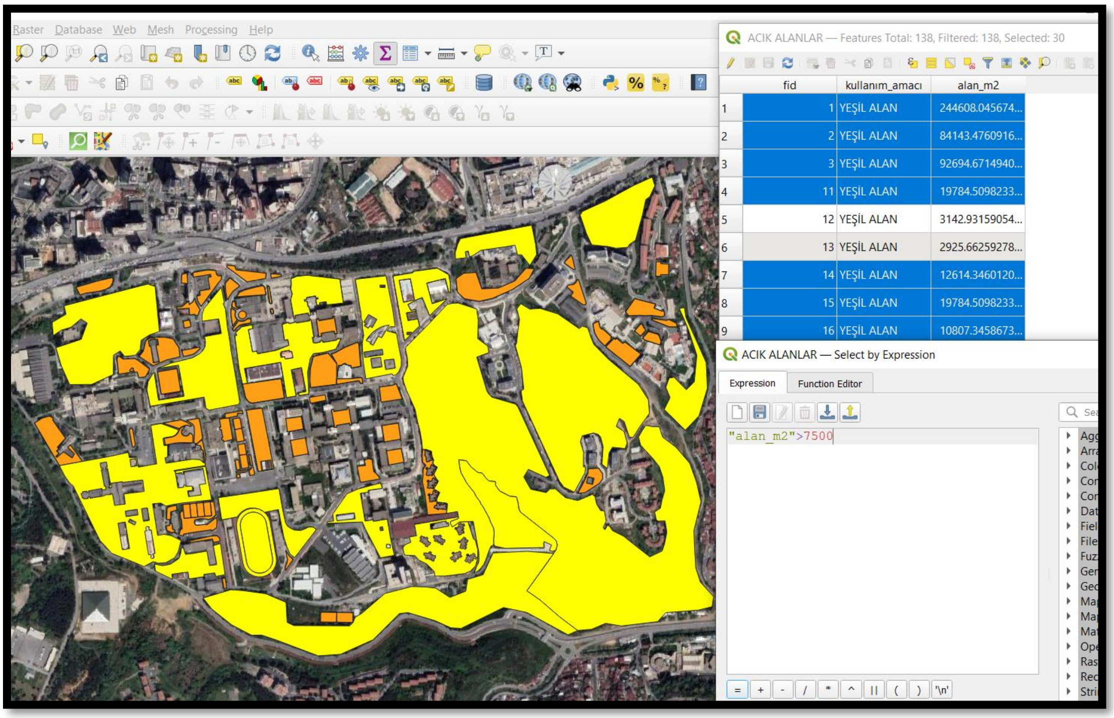

Figure 4. 1: Analysis of green areas larger than 7500 m^2.

This analysis method can be used to show the 'Faculty of Arts and Sciences' on the map.

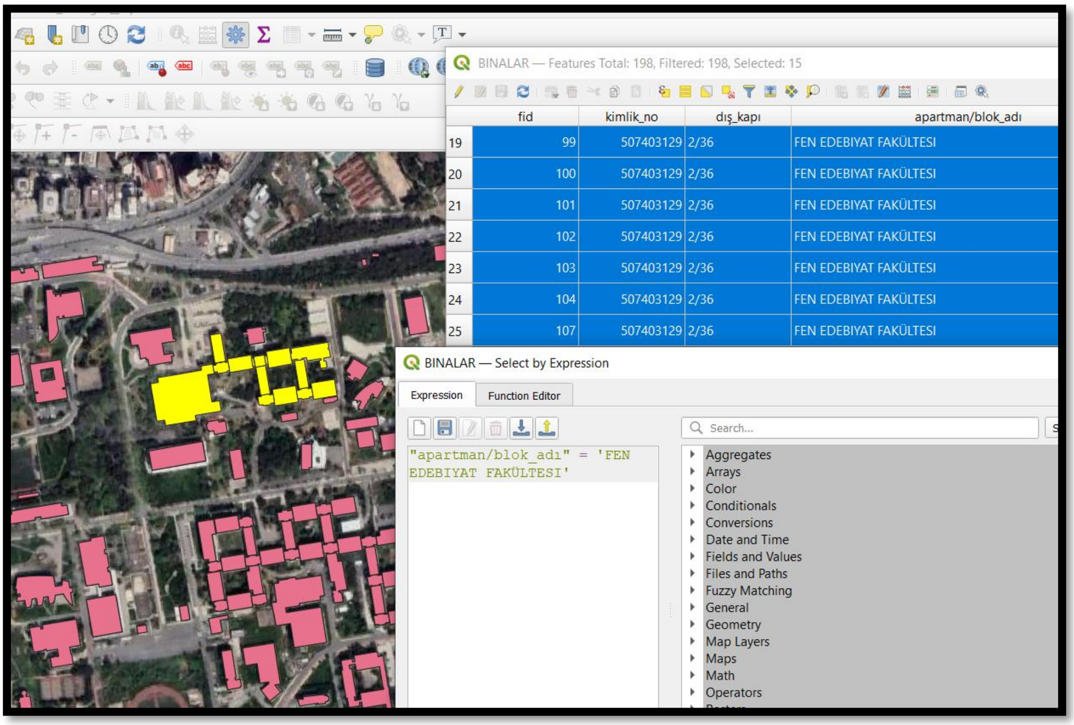

Figure 4. 2: Specific building analysis by block name.

This analysis method can be used to distinguish or mark all faculty buildings on campus. In this way, data with the desired features on the map can be easily accessed.

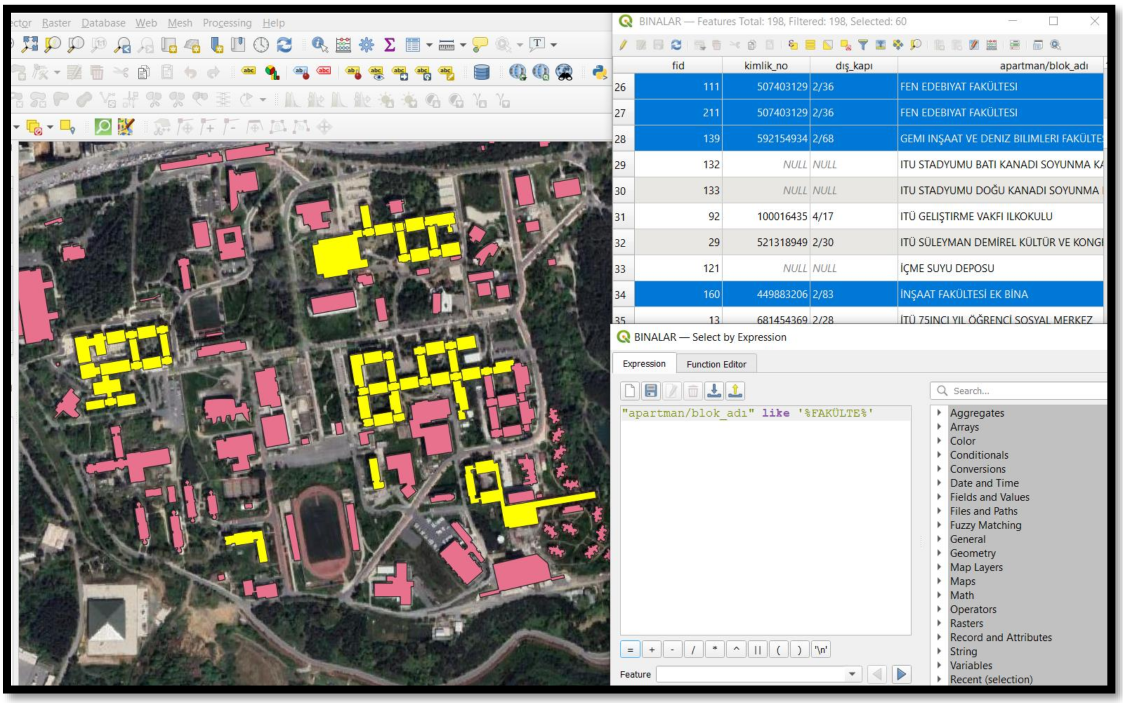

Figure 4. 3: Analysis of faculties.

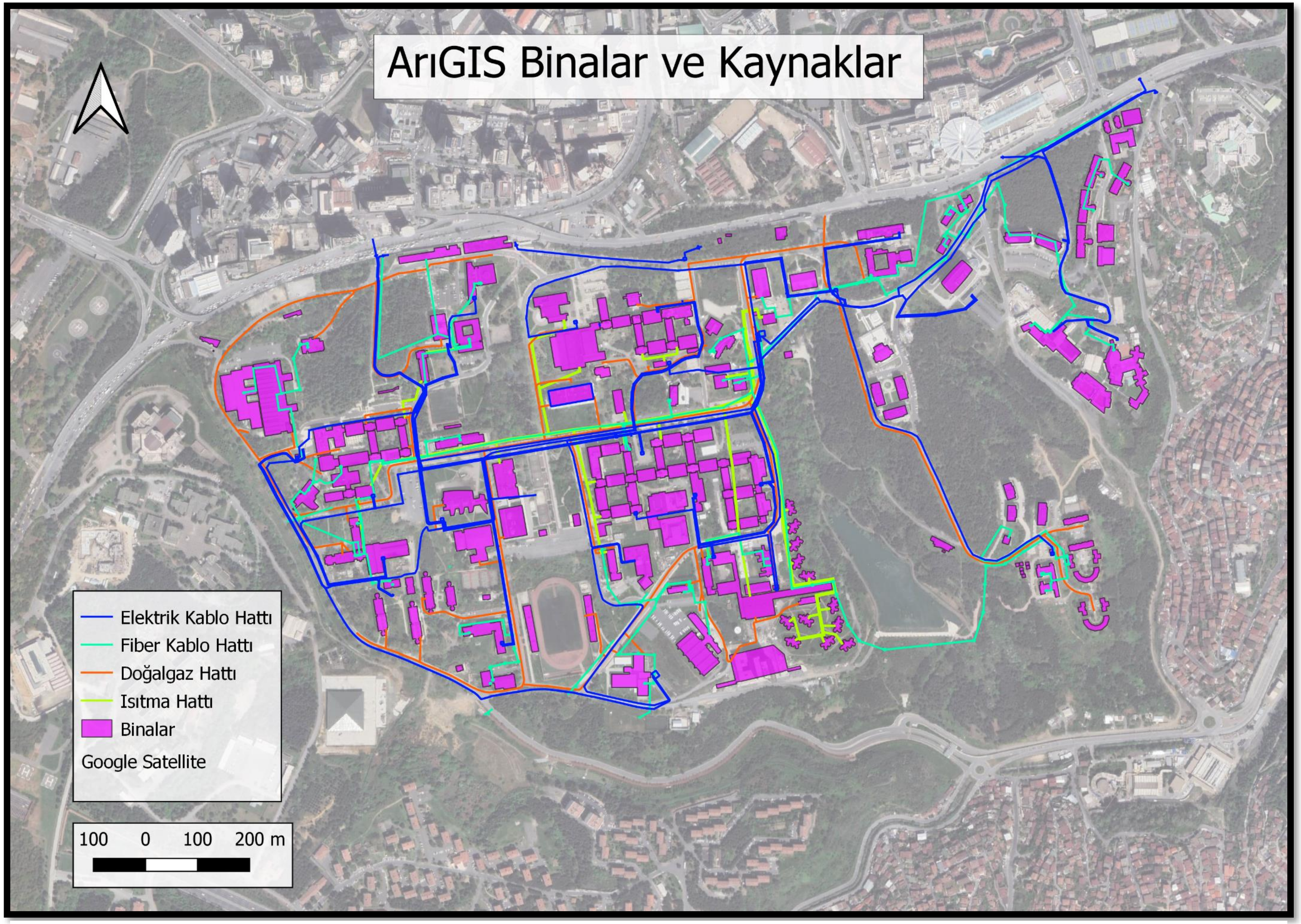

Figure 4. 4: Generel view of buildings and resources.

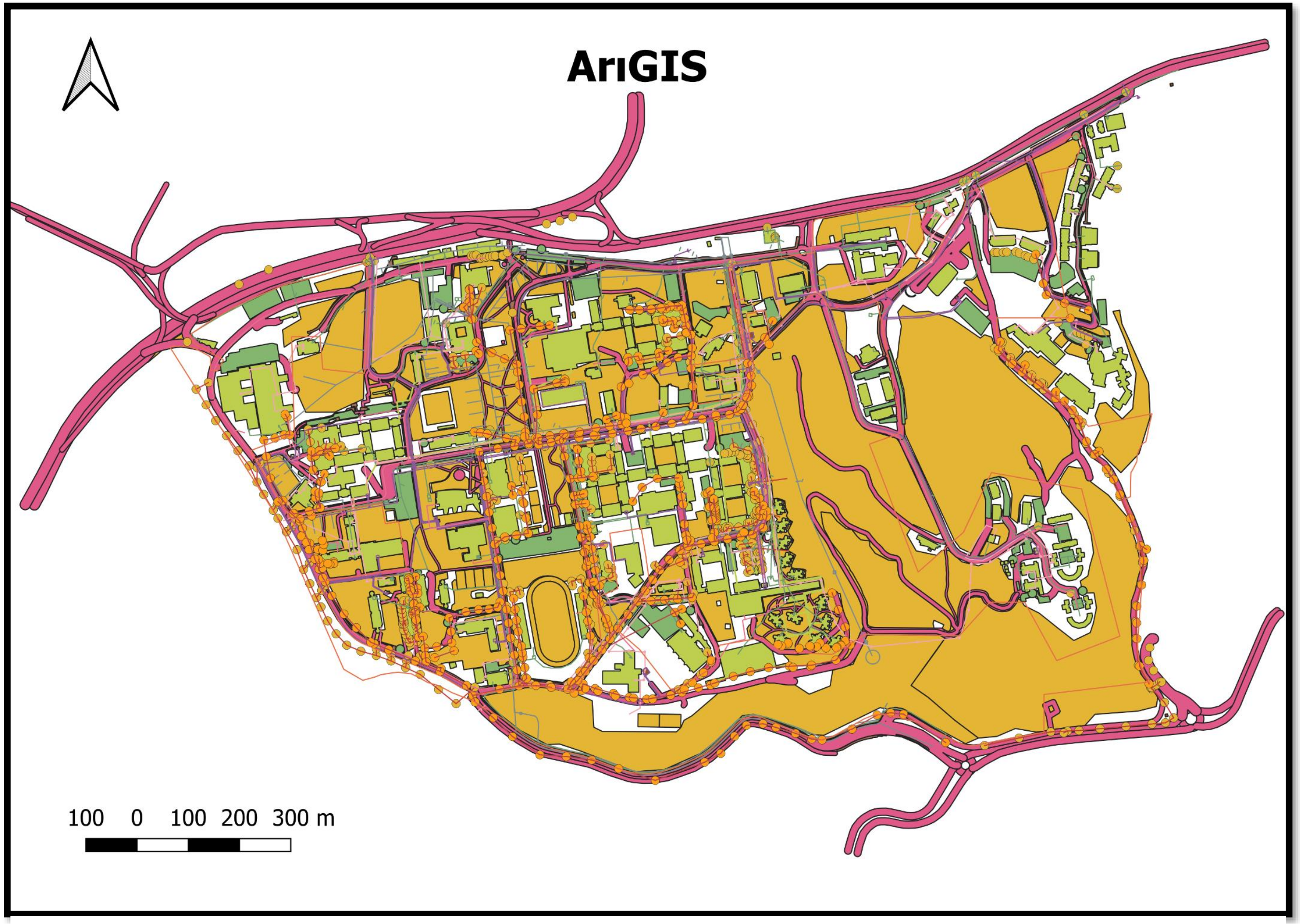

Figure 4. 5: General view of ARIGIS.

5. CONCLUSION AND RECOMMENDATIONS

Within the scope of the ArıGIS project, the foundations of the KBS of Istanbul Technical University were laid. During the project, the data obtained from various sources was developed and edited using QGIS software. The layers created with the edited data were stored in the Amazon AWS database with the PostGIS plugin. The layers classified as Superstructure and Infrastructure have been made easy for people with access to the database and able to edit the data. In total, 6 different layers were created for 17 superstructures for infrastructure.

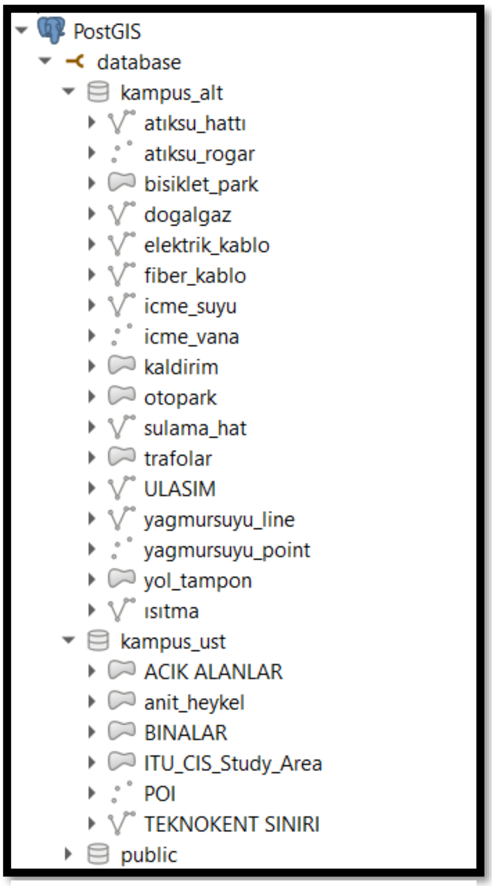

Figure 5. 1: All layers.

In this project, the foundations of ArıGIS CIS belonging to ITU Ayazağa Campus were laid. The data that has been organized and layered can be easily accessed by the relevant persons in the ITU Construction Department and can make improvements on this data. Infrastructural and superstructural changes in the real campus can also be applied to the layers in the ArıGIS database and the CIS can be kept up-to-date. This CIS created in 2D can also be a base for a KBS that can be created in 3D. This CIS can be developed with 3D indoor mapping methods.

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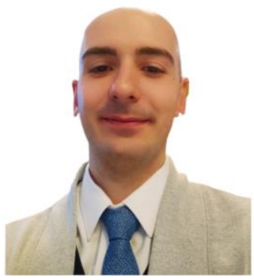

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