

GEOSPATIAL DATA INTEGRATION USING GIS-CAD SOFTWARE

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Abstract: *In the technological age, computerization becomes a key factor, both in the rationalization of the work schedule and in the provision of services and information, factors that help to achieve as efficiently as possible the ongoing projects. GIS technology is increasingly becoming a necessity for a number of companies and institutions working with geospatial data. CAD projects are also currently helping to develop each industrial sector with more accurate data, depending on their requirements, including architectural and construction companies, installation management, utilities. These two technologies, viewed in a unitary way, largely complement the need for information when drawing up a work plan. From this point of view, it is quite clear from the last few years that the interconnection of GIS and CAD data demonstratively improves the operability and elimination of errors at the level of projects of great importance, and not only.*

In this article it is aimed to highlight how to use and integrate 2D and 3D data with the help of GIS-CAD technologies. It was chosen a dataset related to the cadastral plan of the intravilan of Ceamurlia de Jos, Tulcea county, a dataset that was imported into GIS and CAD software products.

Keywords: *GIS, query, CAD, geospatial data, 3D modeling*

1. Introduction

The integration of cadastral data into GIS technology is possible both at conceptual level and in terms of data, this fact being useful for the organizations dealing with cadastral data management. BIM and GIS models can be easily combined by exchanging information, which facilitates a better representation and visualization of 3D cadastral boundaries. [3]

Properties have the limits represented, in most countries, by two-dimensional dimensions and textual descriptions. [5] This approach is limited to represent the real footprint of complex 3D property units, especially in city centres. The construction information model (BIM) and geographic information system (GIS) could be used to accurately identify the property, leading to a better representation of cadastral boundaries and detailed visualization of complex buildings.

3D real estate is the basic legal unit of a 3D cadastre and can be limited both horizontally and vertically as a closed volume, for example a residential apartment building or part of a historic building, office building or mall.

The 3D cadastre involves a significant number of relationships between different stakeholders, such as the municipality, land inspectors, architects, contractors, owners. [5]

However, the current 3D-delimited units of ownership are still registered using 2D representation in most countries, as well as the representation of legal property boundaries that are presented in a textual description based on 2D maps and drawings.

In order to generate 3D cadastral models, BIM-GIS-CAD data and models can be shared and interrogated.

2. Materials and Methods

In order to better highlight the use and integration of 2D and 3D data with the help of GIS-CAD technologies, it was chosen a dataset related to the cadastral plan of the Ceamurlia de Jos intravilan, Tulcea County, a dataset that was imported into GIS and CAD software products.

Data Integration in ArcGIS Pro and AutoCAD

A first step is the import of geospatial data into the ArcGIS Pro and AutoCAD software products, for which the coordinates of the buildings and the textual data were taken over, entered in a *.dwg file, and integrated into the GIS environment.

The result is a series of layers related to each date time in the plane, such as polygons, polylines, texts, and points, so that all layers are aggregated by geometry types, annotations, and more. These layers require export as Shapefile file, a step that resulted in the following layers in the final stage: "Buildings", "Constructions", "Tarlale", "Plots", "Text", "Cadastral sector".

Various interrogations were carried out, including on the number of plots that have the destination "construction yards", the result being 341 CC plots (n.r. construction yards).

As can be seen in the images above, queries can be performed based on attributes, but also on the basis of location, as indicated in Figure 1.

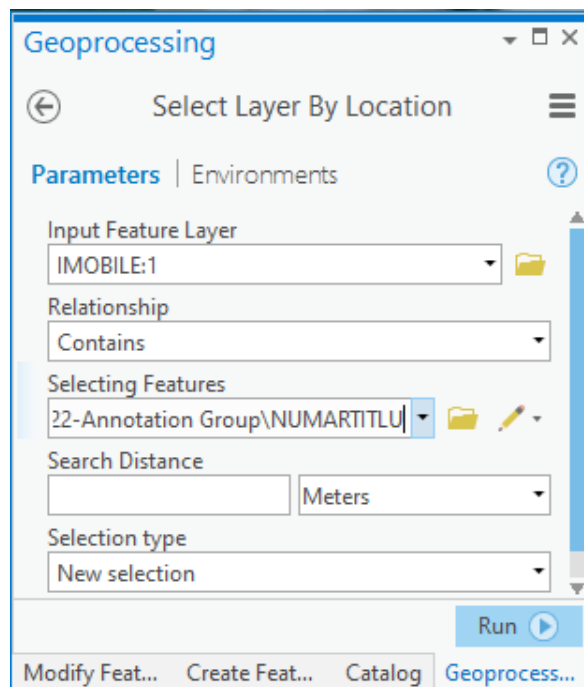


Figure 1 - Selection b Location of the Buildings that Have a Property Title

Taking into account the fact that certain buildings have a property title as a proof of ownership, this information being placed inside each building, in the form of text, the query can be formulated using the location-based selection function available in ArcGIS Pro software, in the "Geoprocessing" tab.

A query was carried out in Figure 2 to obtain the number of parcels for arable use.

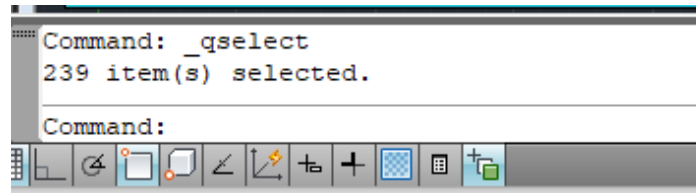


Figure 2 - Number of parcels for arable purposes

Another query made is the one in Figure 3, in which it was intended to be selected according to the area of the plots, provided that the area of the plot is less than 200 sqm.

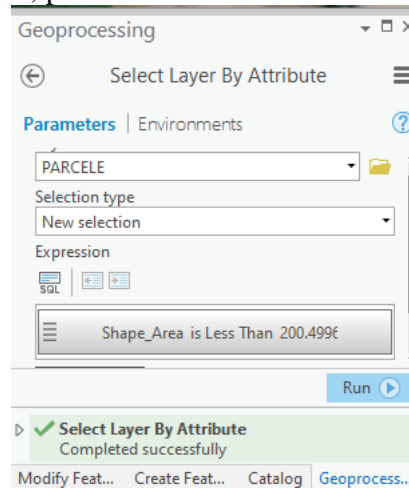


Figure 3 - Selection of Parcels with an Area of Less than 200 Sqm

Another example in which the query function was used is shown in Figure 4, where it was determined the the properties registered in the Land Book. In order to achieve this, there were selected from the map the text on the real estate layer registered in the land register.

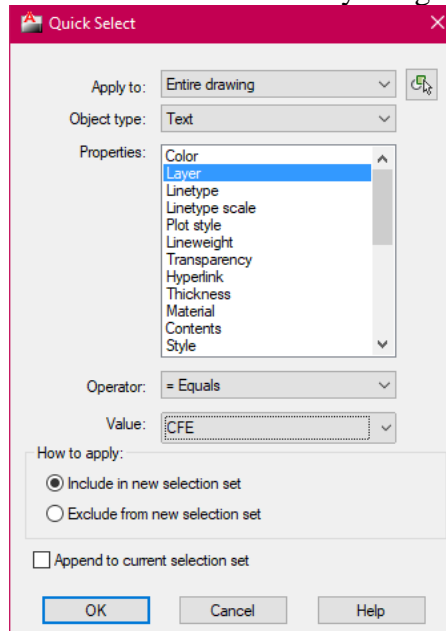


Figure 4 - Selection of buildings that have land register

The result obtained from the previously exposed query is visible in Figure 5.

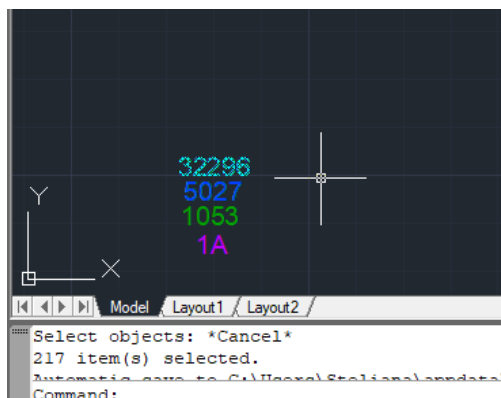


Figure 5 - Displaying the number of buildings with CF

Another method of analyzing the data network is the graphical representation of the result related to the query performed, this method being available in ArcGIS Pro, under the "Create Chart" function.

An example in which this function was used is shown in Figure 6, where a query was made referring to the category of use of the parcels but also to the destination of the land.

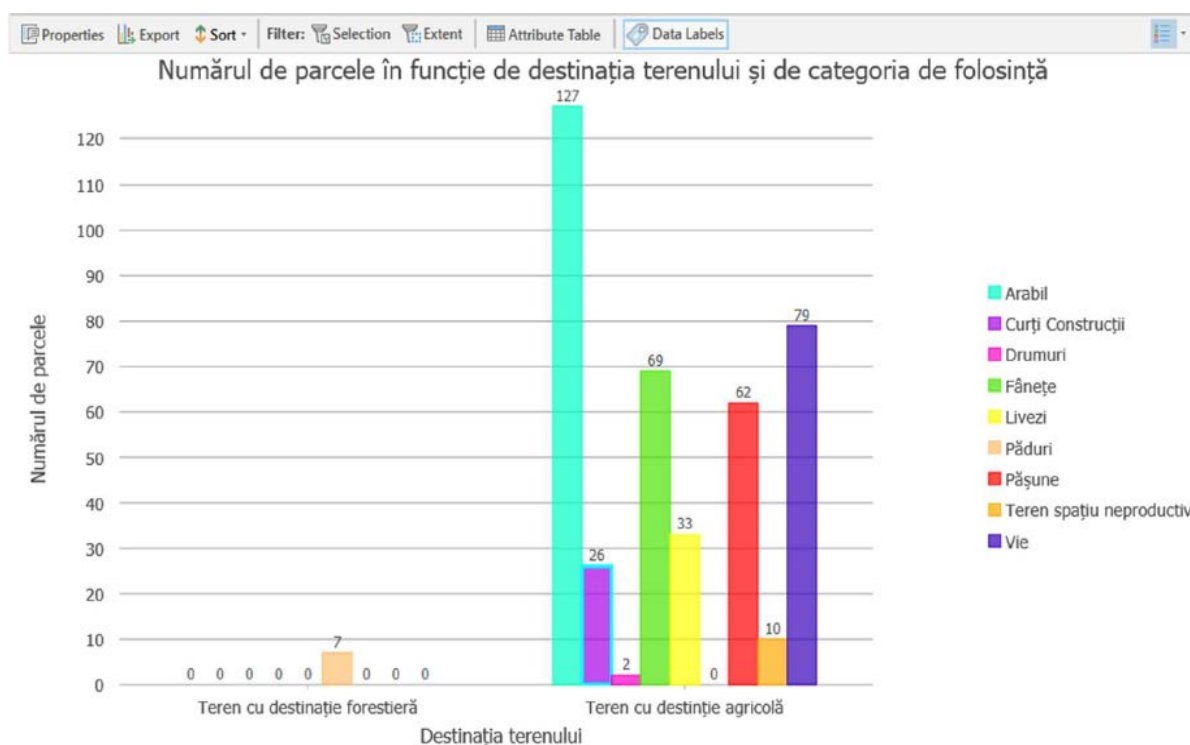


Figure 6 - Graphical Representation of the List of Parcels According to the Destination and the Category of Use

In the resulting graph, it is the vertical axis that quantifies the parcels according to the category of use, and the horizontal column indicates that most parcels have agricultural purposes and the rest are for forestry purposes.

Another graphic representation was made on the areas of the constructions, in this case being a representation made for the purpose of metering the constructions with an area of less than 90 sqm. (Figure 7)

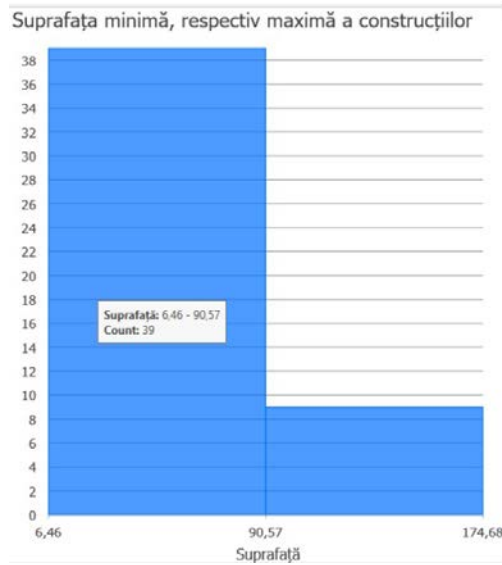


Figure 7 - Graph reporting the minimum and maximum area of constructions

As it can be seen in Figure 7, a number of 39 constructions with an area between 6-90 sqm have been identified, the rest having an area of over 100 sqm.

In addition to counting items, this function can also represent a classification, depending on the chosen field for each start in the database.

The graph illustrated in Figure 8 is related to constructions, and the field chosen for the query is "Resistance Structure".

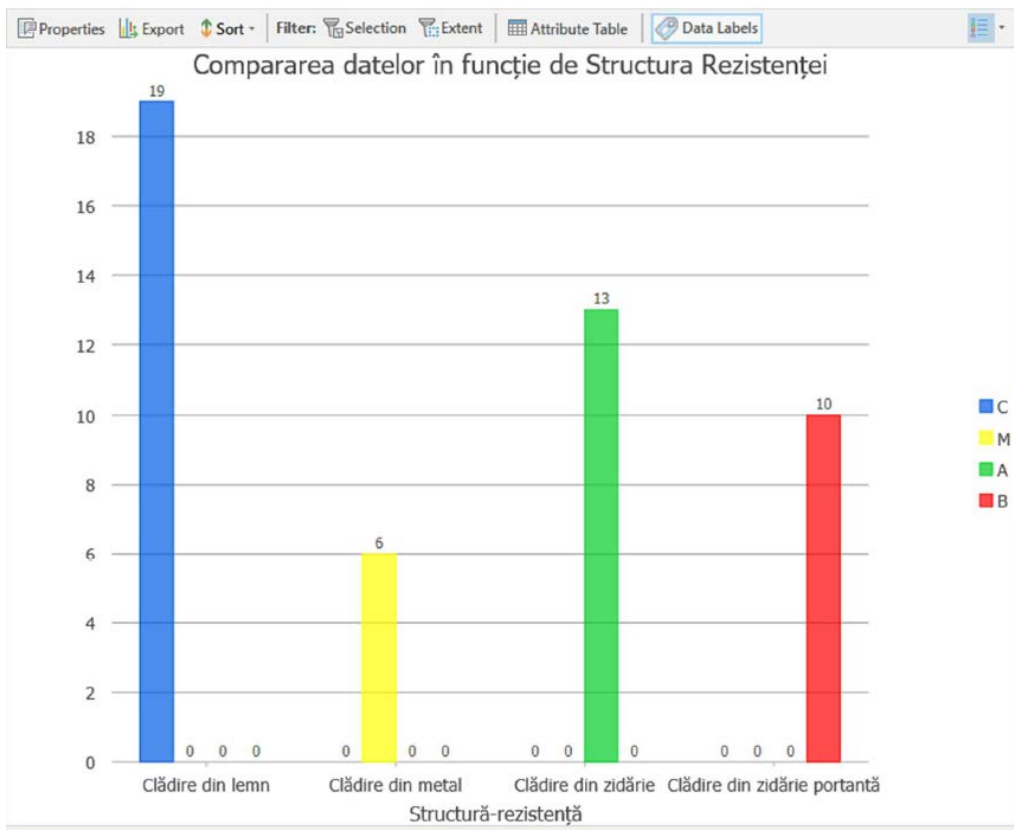


Figure 8 – Classification of Constructions according to Strength Structure

Topology Aspects in ArcGIS Pro and AutoCAD

The correctness of the geometry of the plane was verified, and this was made possible by creating a topology. Topology was defined by adding rules referring to buildings, texts of buildings, plots, and constructions. (Figure 9)

All the datasets were included in the topology in order to be able to make the connection with the topology rules. The imposed rules ensure that buildings, constructions and sectors do not contain gaps, also that there are no overlaps, and that there are no points that are not included in a closed polyline geometry, more precisely, each building contains a text, representing the name of the building. [7]

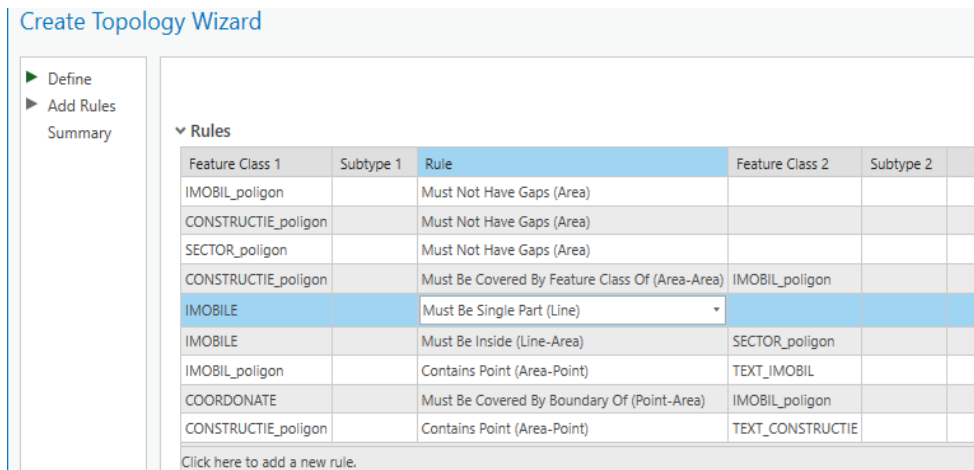


Figure 9 - Adding Rules and Datasets to Topology

After going through all the stages that build the topology, it was validated and run, and when the topology check became complete, errors were identified. There were identified buildings that overlapped, so that this problem was repaired, and in addition, several buildings that were not of closed polyline type, which makes the building to be perceived as a polygon with gaps. (figure 10, figure 11)

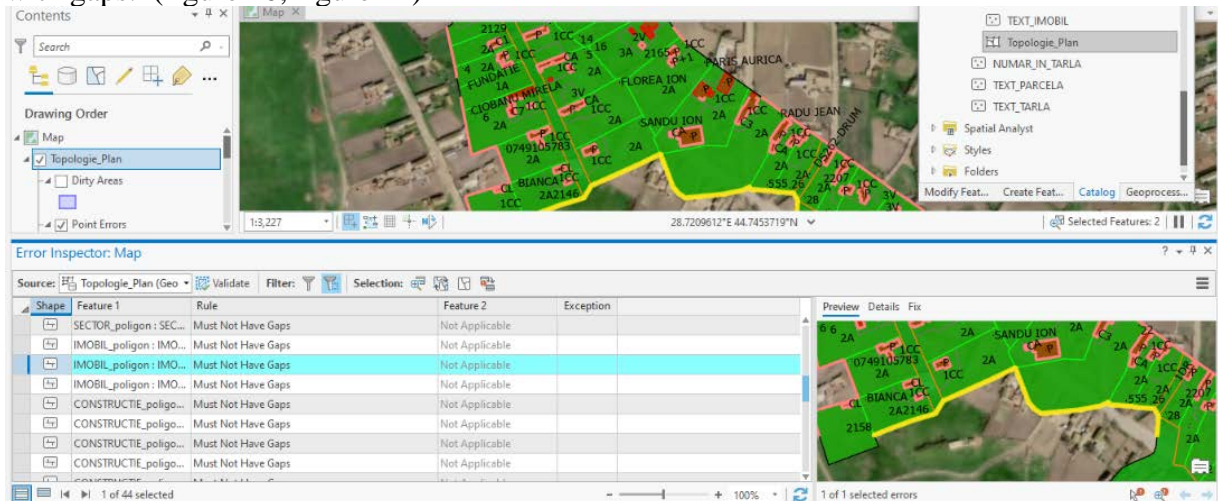


Figure 10 - Removing the Lines of the Empty Space Error in the Polygon

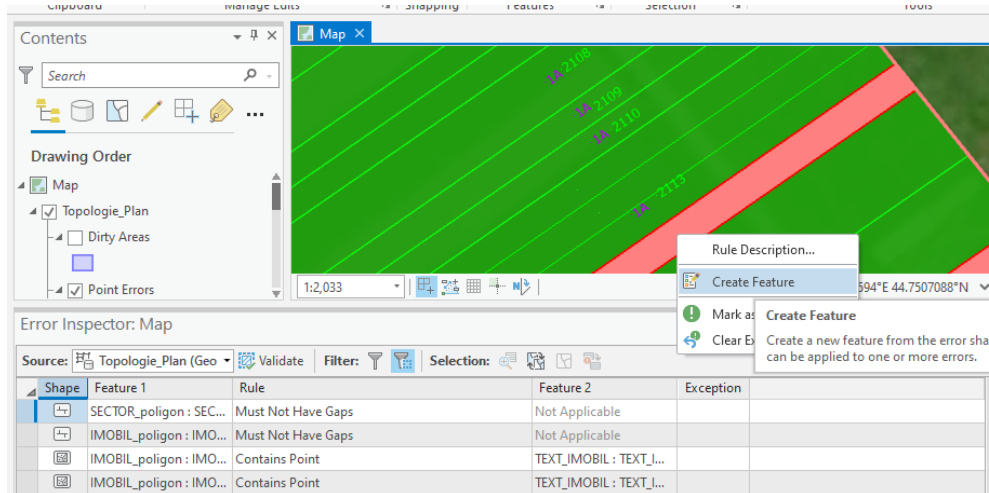


Figure 11 – Conversion of Unclosed Polylines into Closed Polylines

Another error identified in the plan includes buildings that do not have text with the name of the building.

This error was corrected by adding a point entity, supplemented by a text, to each of the buildings that were missing the text in the composition. These operations were performed until the error table no longer indicated any errors.

The verification of the correctness of geometries was performed using the "Check topology" function, provided by the "Topograph" application within the AutoCAD software product.

In this check, rules are automatically established among which are those previously added to ArcGIS Pro, namely the polylines do not overlap, have no gaps between them and be unique. After running the topology, in the map are highlighted the buildings that do not comply with the rules, and thus, as seen in the images below, two overlapping buildings were identified, the cause being the lack of vertices on one of the sides of the building. This error was corrected by simply adding the missing vertex on one of the sides of the building. (figure 12, figure 13)

Because, on the sides of this building, there were still open polylines, overlapped on the building in question, the rule of uniqueness of the 2D polylines was also violated, that is why these 2 buildings were also classified as erroneous. To eliminate the error, the sides that were extra were erased. Ultimately, following the correction of all errors, the topology run once again for a new check.

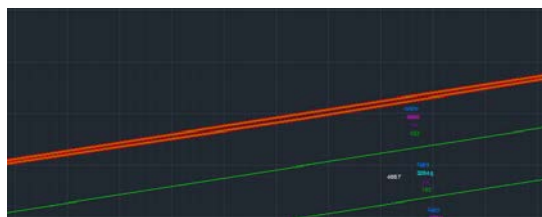


Figure 12 - Identification of the Building that Violates the Overlapping Rule

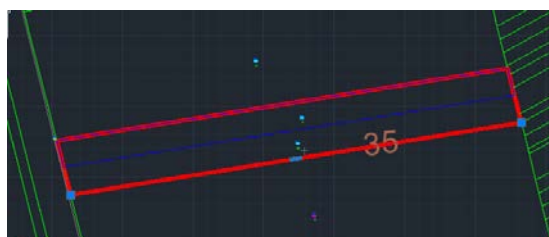


Figure 13 - Identification of the Building that Violates the Uniqueness Rule

Creating the 3D Model of a Building in Revit for Autodesk Cloud

The importance of data management in CAD/BIM can be highlighted by creating a 3D model of a building, which is why it was chosen the Revit software product from Autodesk.

The building survey was first integrated into Revit, which was later processed in 3D.

After the integration of the survey in the plan, the 2 floors were added, because the ground floor is predetermined from the project. The heights for each floor were chosen by 3 meters.

The next step in creating the 3D model, was to choose the type of wall from which the walls are made up. Another feature set for the walls is the level to which they continue, choosing in this case to be up to the 2nd floor. Their axes were then drawn, using the survey integrated in the previous stage. After drawing the walls, the drawing of the windows, stairs and sliding doors was carried out. In the case of glass walls, the wall model "Storefront" was chosen, and for viewing the result of the drawing of the walls, it is necessary to select the 3D View mode. (figura 14, figure 15, figure 16)

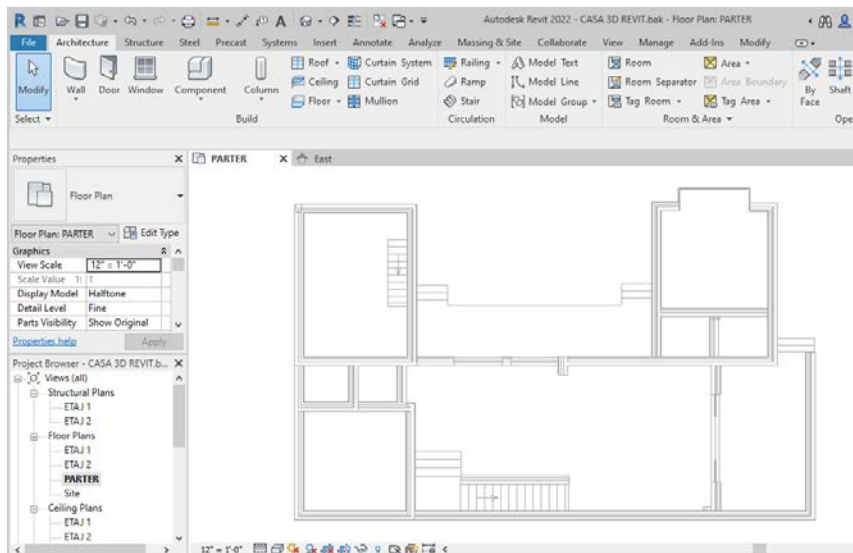


Figure 14 – Drawing the Axis of the Building

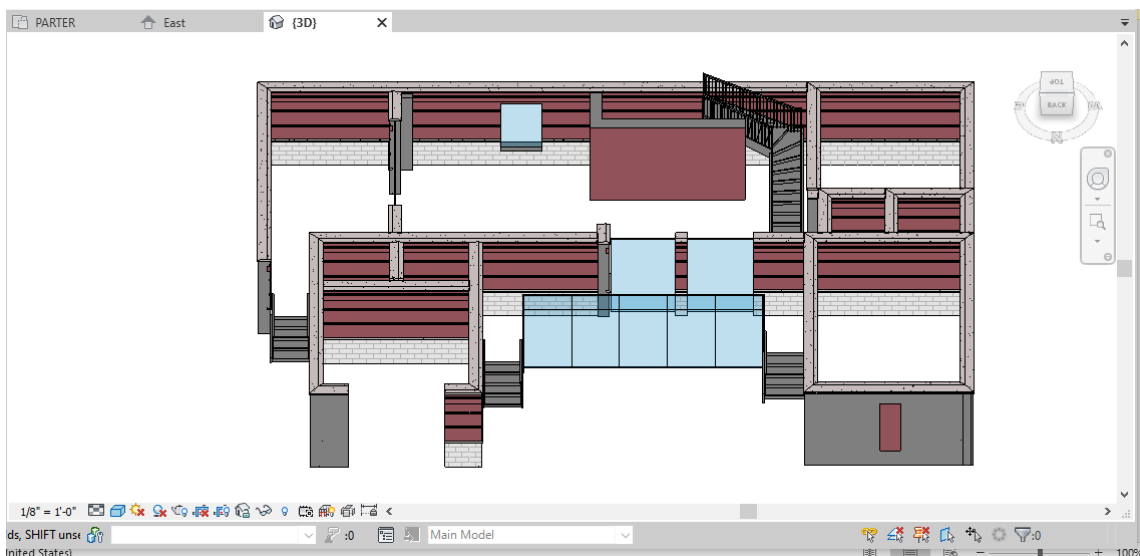


Figure 15 – 3D view of the elements added

The floor and ceiling of the ground floor were created using the functions "Floor" and "Roof".

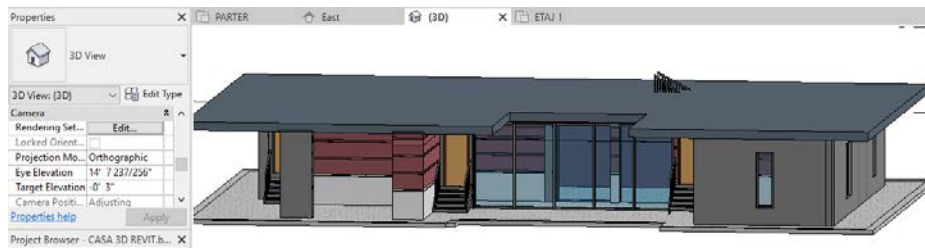


Figure 16 – Appearance of the house after completion of the ground floor

For the 1st floor and the 2nd floor, the exposed steps were repeated. In figure 17 below it can be viewed the 3D model of the house, made in the Revit software product.



Figure 17 – 3D view of the whole house

The project was saved as a Cloud model, thus being automatically saved in the Autodesk Cloud account as well. (figure 18)

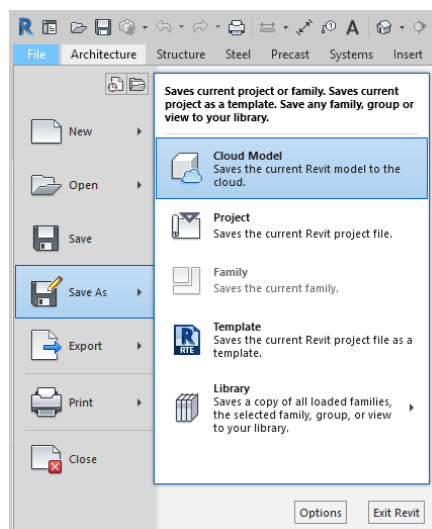


Figure 18 – Saving the project to the Cloud account

3. Conclusion

Both real estate and construction works are becoming more and more active, and the geospatial data related to them need to be updated more and more often.

In this regard, there is a continuous need to implement modern methods and technologies for information management, for processing data from a graphic and textual point of view, and for updating the information in the databases, as a result of the changes occurred in the field.

As a result of the use of a cadastral dataset, based on which various essential functions and applications were used, it was possible to highlight how to manage geospatial data in CAD and GIS environments.

At all stages, from planning to maintenance, we need both detailed digital representations of individual BIM-based objects and more inclusive representations of entire cities and landscapes based on 3D geographic information systems, i.e. GIS data.

The method of carrying out construction projects using modern technology, such as building information modelling, is evolving upwards and rapidly, to the detriment of manual methods of carrying out projects, which is a very important step in this industry.

Therefore, the possibility of data management with the help of GIS-CAD software is a big opportunity for evolution, representing the opportunity of a modern and constantly developing workflow.

4. References

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