

EMERGING GIS TECHNOLOGIES IN REAL ESTATE MARKET ANALYSIS

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Abstract: *The aim of this study is the integration of new technologies in real estate market analysis that has significantly transformed the way professionals and investors evaluate properties, make predictions, and assess market trends. GIS technology helps in mapping and analyzing real estate data spatially. It provides valuable insights into location-based factors, such as proximity to amenities, transportation networks, and environmental factors, which influence property values and investment decisions. Modern GIS platforms offer interactive mapping tools that allow users to visualize property data on maps. Potential buyers and investors can explore properties visually, understanding their geographical context and nearby attractions, which aids in decision-making. By incorporating these new GIS technologies, real estate market analysis has become more data-driven, precise, and efficient.*

Keywords: *GIS, real estate, market analysis.*

1. Introduction

The aim of this paper is to promote appraisal transparency and efficiency for tax purposes and a focus on the utilization of Geographic Information System (GIS) technologies for analyzing the real estate market. The authors aimed to explore the integration of advanced GIS tools and methods in evaluating various aspects of the real estate sector.

The identification of a real estate property's location stands as the foundational GIS application within the realm of property evaluation. Additionally, GIS proves to be a potent tool for adeptly handling substantial datasets, integral not only for managing extensive information but also for facilitating statistical modeling in the evaluation process. The scrutiny of large datasets involves the application of well-established statistical methods, which serve as robust instruments in the evaluation process. Furthermore, the incorporation of statistical modeling tools into a GIS-based environment holds the potential to yield a pragmatic and valuable GIS platform catering to the needs of all valuers. [1]

Currently, in Romania, the Property Valuation Standards are issued by the National Association of Appraisers from Romania, ANEVAR, for short [2]. These standards define market value as the most probable price, on a specific date, expressed in cash or cash

equivalents or in another specified form, at which specified rights in real property could be sold after they have been adequately exposed in a competitive market. This occurs when all the conditions of a fair sale are met, and both the buyer and seller act prudently and with full knowledge of the relevant facts, assuming that neither is under undue pressure.

In order to establish the tax for a non-residential construction, it is necessary to draw up an evaluation report by a real estate appraiser. The owners are required to regularly undertake general reappraisals. This involves a tremendous amount of tax administration and appraisal work. The taxable value is a type of estimated value for the taxation purposes of non-residential buildings owned by individuals or legal entities and residential buildings owned by legal entities. [2]

Usually, the appraiser must inspect each building subject to assessment for taxation purposes. Inspection refers to the action of visually examining the exterior/interior of the building. The taxpayer will ensure the appraiser's access to the building subject to assessment. In cases where an interior inspection is not possible, the appraiser will ensure that they have accurately identified the building and its physical condition and will include photographs from the exterior in the appraisal report. [2]

The applicable valuation approaches are: the cost approach for assessable value, the income approach, and the market approach, as defined in the current valuation standards. When establishing the taxable value, only a single valuation approach can be utilized in cases where there is inadequate information for applying alternative methods. Nevertheless, it is a requirement for this approach to be the cost approach for determining the taxable value. The cost approach for the taxable value involves estimating the replacement cost new, from which physical depreciation and/or functional depreciation, as applicable, will be deducted. Economic/external depreciations will not be applied. [2]

The accuracy of analyses and predictions correlates directly with the quality of the data. Ensuring that any dataset integrated into a GIS application is accompanied by dependable quality information is crucial. [3] Climate change, socio-economic challenges, unregulated urbanization, and fluctuations in population growth or decline can significantly impact the sustainable development of cities and regions. Given the intricate nature of urban development concerns, information technologies and geographic information systems have emerged as indispensable tools. These tools play a pivotal role not only in the effective management of urban infrastructure but also in the formulation of strategic approaches for local development. [4] The swift urbanization and the evolution of the business landscape have given rise to significant challenges in land use planning, resulting in substantial environmental damage, climate change, and notable impacts on the health, both physically and psychologically, of urban dwellers. In this context, investigating open green spaces in urban areas has become more critical than ever. [5]

2. Additions

To initiate the case study, the first phase involved analyzing the location of the Municipality of Cluj-Napoca. The city is the capital of Cluj County, situated in the northwestern part of Romania, in the historical region of Transylvania, as shown in the Figure 1. Cluj-Napoca, located in the heart of Transylvania, is a vibrant cultural hub known for its rich history and diverse cultural scene. The city hosts numerous festivals, theaters, and cultural events, making it a lively destination for both locals and visitors.

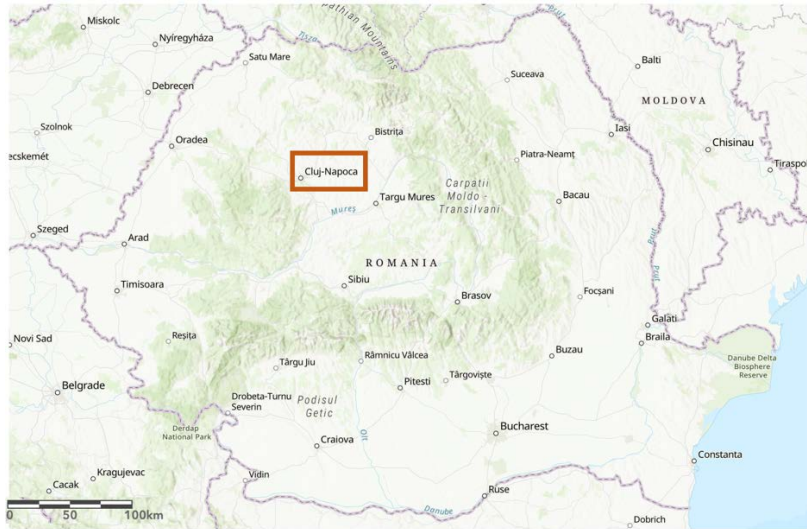


Fig. 1. Geographical position of Cluj-Napoca, Romania (created by the authors)

The city plays a crucial role in the economic development of the region, with a diverse economy that includes IT, industry, services, and trade. Cluj-Napoca's dynamic blend of history, culture, academia, and innovation makes it a captivating city with a lot to offer to both residents and visitors. The studied area is located in the Andrei Mureșanu neighborhood in the city of Cluj-Napoca, as shown in Fig. 2.

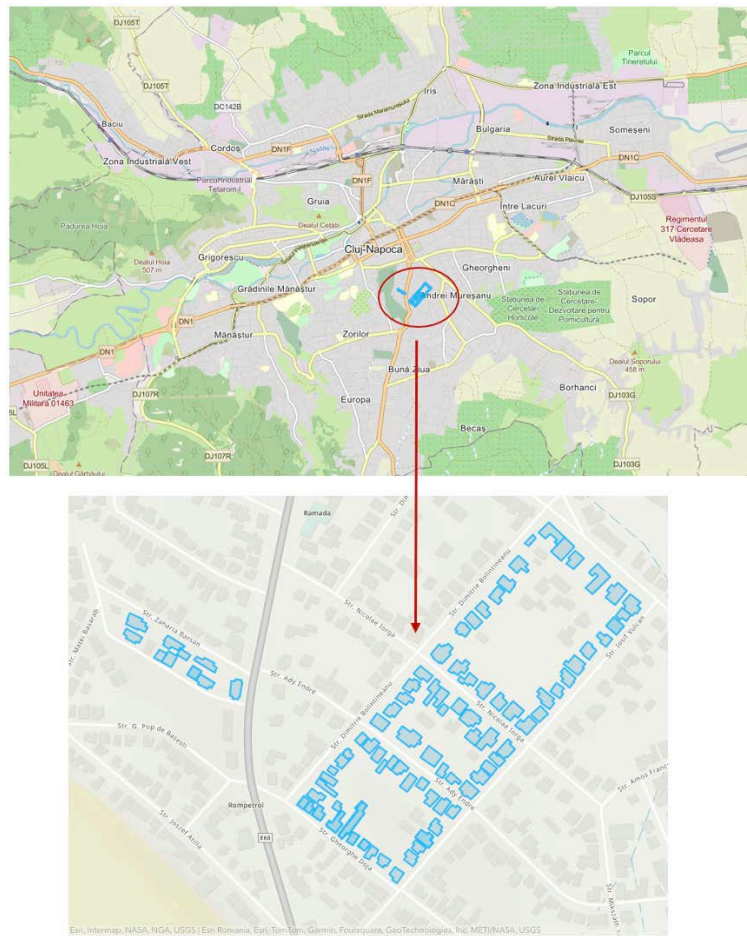


Fig. 2. The study area from Cluj-Napoca city (created by the authors)

Using ArcGIS Online we were able to create a web map in which the location of the constructions from our analysis can be observed as shown in Fig. 2.

The Andrei Mureșanu district in Cluj-Napoca is a residential area situated in the central-western part of the city. It is characterized by a mix of residential and commercial spaces. The district features green spaces and parks, providing residents with areas for relaxation and outdoor activities. There are educational institutions in and around the Andrei Mureșanu district. Additionally, being centrally located, it provides convenient access to various facilities, including schools, medical centers, and cultural venues. The district includes a mix of housing options, from apartments to houses. The real estate landscape may feature a combination of historic buildings and modern developments, catering to different preferences. As with any neighborhood, the Andrei Mureșanu district has its unique character and amenities, making it an integral part of Cluj-Napoca's urban fabric. It provides a blend of residential comfort, cultural richness, and convenient access to various services and facilities.

To collect the necessary information from the field, a survey was drawn up with the help of ArcGIS Survey 123 (<https://survey123.arcgis.com>). This process greatly contributes to the automation of the evaluation process and can replace the traditional inspection sheet. As can be seen in the figure below, Fig. 3, the survey can be accessed from any available electronic device (laptop, tablet, or phone).

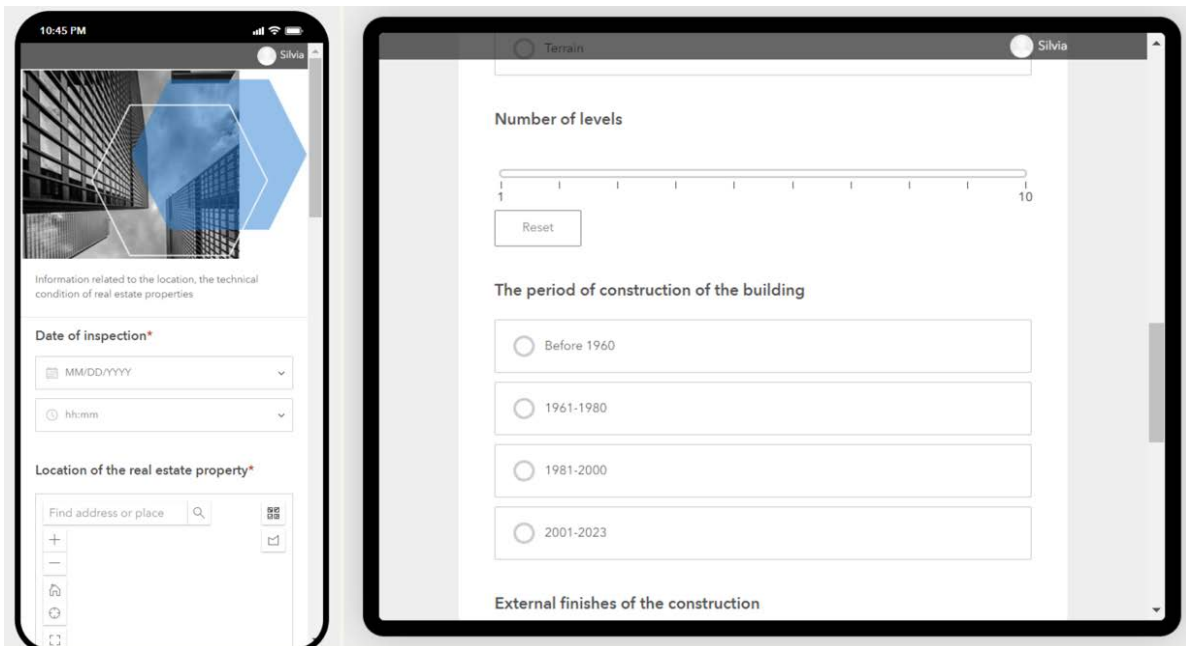


Fig. 3. Survey interface created by the authors in ArcGIS Survey

With the help of ArcGIS Survey, the collected data were analyzed, drawing up the following graphs, as shown below.

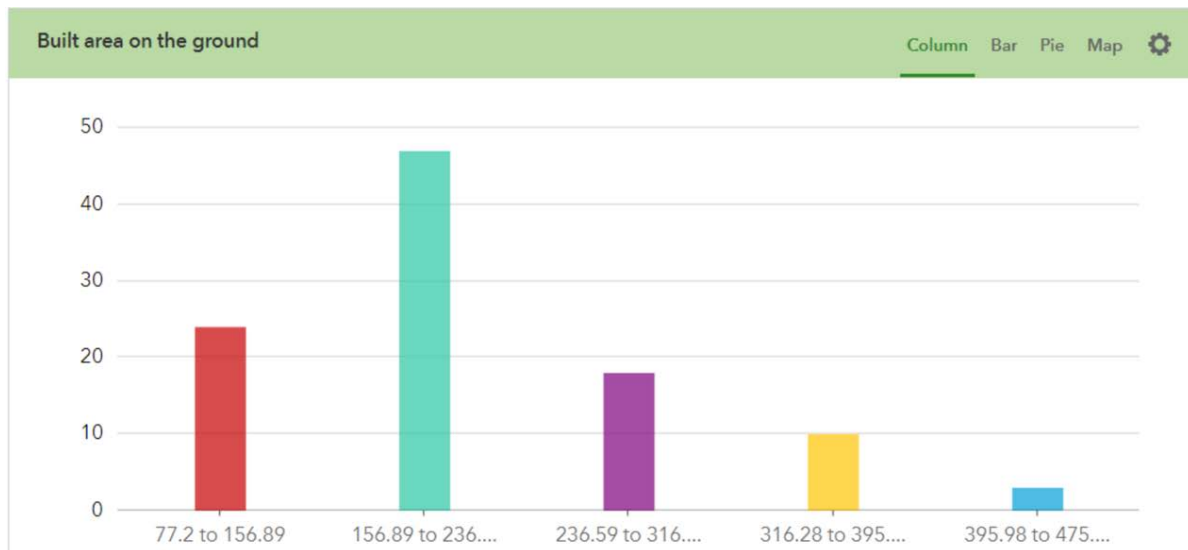


Fig. 4. The representation based on the ground floor area of the analyzed constructions, created by the authors, in ArcGIS Survey 123

Initially, a graphical representation illustrating the ground floor area of the examined properties was generated. As depicted in Figure 4, the graph reveals that the minimum built-up area was 77.2 sqm, while the maximum ground floor area reached 475.67 sqm. As a result, the average built-up area was calculated to be 213.3 sqm.

The compiled database consists of houses, specifically 96 single-family real estate properties, and also includes apartment buildings (3 such cases were subject to analysis). The number of levels was also analyzed as shown in the Fig. 5, revealing real estate properties with one level (minimum) and five levels (maximum). The calculated average was 1.8, indicating that the majority of the analyzed real estate properties have 2 levels.

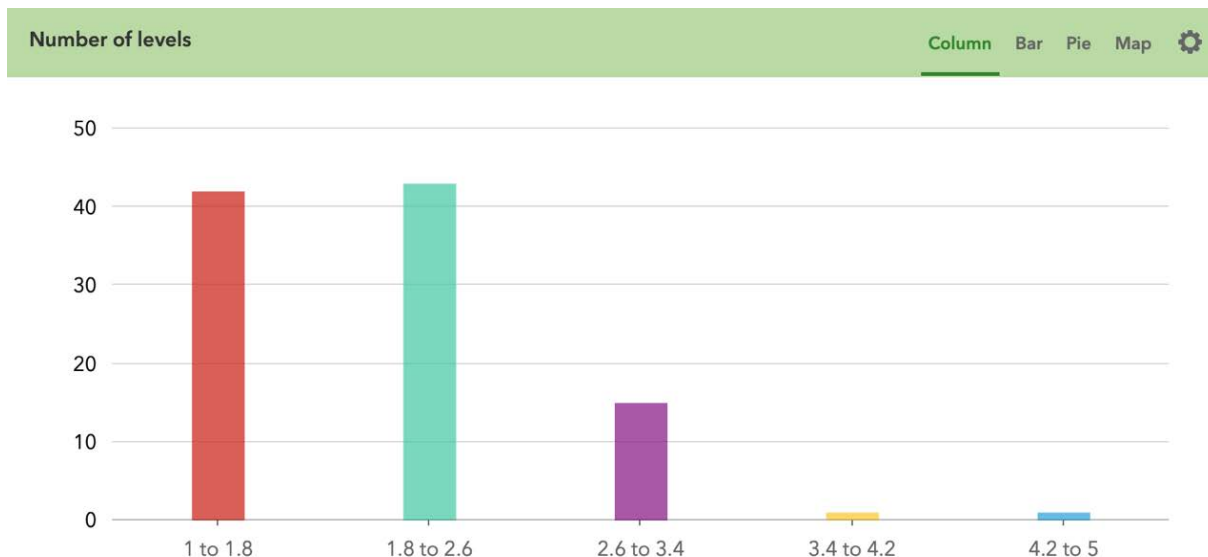


Fig. 5. The representation based on the numbers of levels of the analyzed constructions, created by the authors, in ArcGIS Survey 123

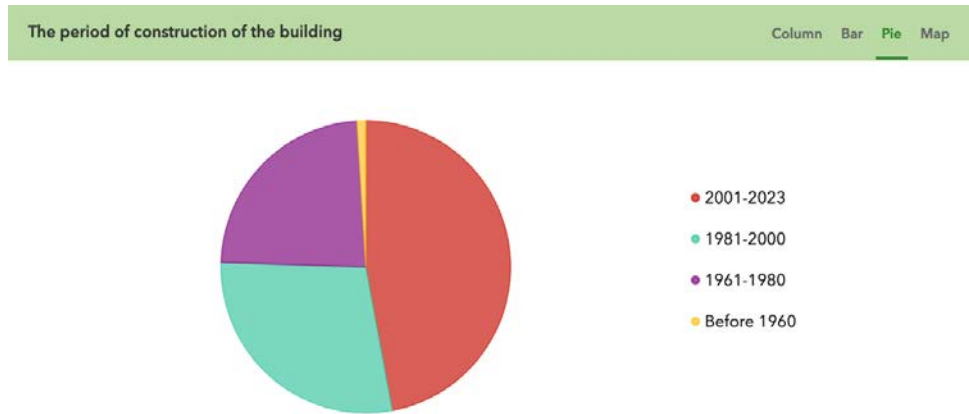


Fig. 6. The representation based on the period of construction of the analyzed constructions, created by the authors, in ArcGIS Survey 123

For the purpose of this study, the construction period was estimated since access to technical documents was not available. Consequently, several intervals were established as follows: before 1960, 1961-1980, 1981-2000, 2001-2023. Hence, 47.06% of the analyzed real estate properties were built in the period 2001-2023, 28.43% were constructed between 1981-2000, 23.53% between 1961-1980, and 0.98% before 1960.

The exterior finishes of the real estate properties were also analyzed, as shown in the figure 7, yielding the following results: 55.88% of the properties have intermediate finishes, 27.45% have superior finishes, and 16.67% have inferior finishes. The description of exterior finishes in real estate properties typically refers to the materials and treatments applied to the outer surfaces of buildings. Intermediate finishes may include standard materials and treatments that provide a balanced and functional appearance to the exterior. This could involve common siding materials like vinyl, basic paint applications, and standard roofing materials. Superior finishes usually involve higher-quality materials and more intricate treatments, contributing to an enhanced and upscale appearance. This might encompass premium siding options such as stone or brick, high-quality paint or stucco, and more sophisticated roofing materials. Inferior finishes suggest the use of basic or lower-quality materials in the exterior treatment, often resulting in a more economical or modest appearance. This could include basic siding materials, simpler paint applications, and standard roofing options.

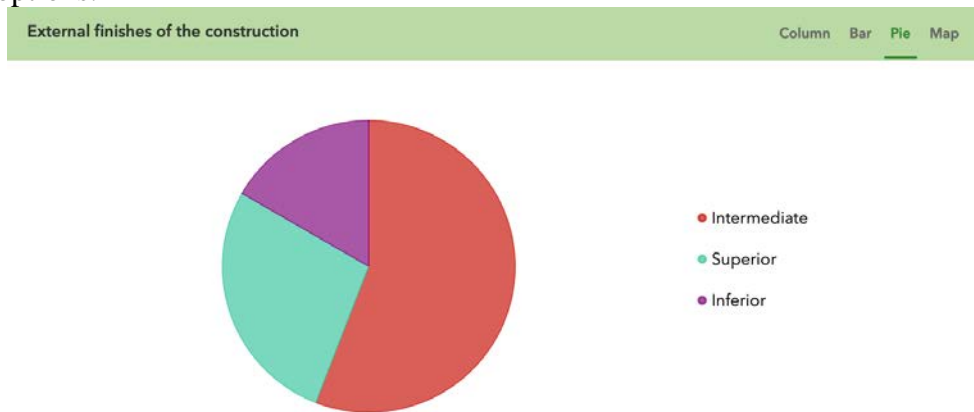


Fig. 7. The representation based on the external finishes of the analyzed constructions, created by the authors, in ArcGIS Survey 123



Fig. 8. The representation based on the physical condition of the analyzed constructions, created by the authors, in ArcGIS Survey 123

To describe the physical condition of a construction (figure 8), one would typically assess various aspects. In the context of this study, the assessment of the physical condition of the structures involved an examination of the following aspects: structural integrity, exterior, foundation, finishes, maintenance, and upgrades or renovations. The authors evaluate the structural elements to ensure they are sound and free from significant damage or deterioration, examine the exterior surfaces for signs of wear, damage, or needed repairs, inspect the foundation for any cracks, examine finishes, including paint, flooring, consider the level of maintenance evident in the construction, including any deferred maintenance issues, identify any recent upgrades or renovations that may have been performed and assess their quality and impact on the overall condition. Therefore, within the properties examined, the authors classified 13.73% as being in excellent condition, 26.47% in good condition, 43.14% in satisfactory condition, and 16.67% in unsatisfactory condition. Notably, no real estate properties were identified in a severely deteriorated state necessitating demolition.

This process greatly contributes to the automation of the evaluation process and can replace the traditional inspection sheet. The photos (186) were used to validate data entry and identify errors.



Fig. 9. Photographs taken by the authors according to the on-site situation

With the help of ArcGIS Online, we created several thematic maps according to the most important criteria.



Fig. 10. Visualization of real estate properties according to the physical condition of the building



Fig. 11. Visualization of real estate properties according to the construction period



Fig. 12. Visualization of real estate properties according to the built area

3. Conclusions

In conclusion, the notions presented in this paper can be applied in a building taxation system, in order to automate the evaluation process. The ArcGIS Survey 123 form has reduced redundant appeal submissions and saves time during the appraisal process.

Thematic maps are a specialized type of map designed to visualize and communicate specific information about a particular theme, topic, or subject matter. Unlike general reference maps, which provide a broad overview of geographical features, thematic maps focus on representing spatial patterns and relationships related to a specific attribute or phenomenon. Thematic maps rely on accurate and reliable data sources. Geographic Information Systems (GIS) play a crucial role in the creation and analysis of thematic maps by integrating spatial data with attribute data.

The use of GIS technologies can provide valuable insights and enhance the efficiency of real estate market analysis by incorporating spatial data and geographical considerations.

4. References

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