

G.I.S. TOOLS FOR TERRITORIAL DEVELOPMENT PROJECTS THE PRETABILITY OF URBAN SPACE FOR THE DEVELOPMENT OF MOBILITY CORRIDORS. CASE STUDY: SFÂNTU GHEORGHE MUNICIPALITY, COVASNA COUNTY

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ABSTRACT. – **G.I.S. Tools for Territorial Development Projects. The Pretability of Urban Space for the Development of Mobility Corridors. Case Study: Sfântu Gheorghe Municipality, Covasna County.** It is very important that the strategic approach takes into account as many elements as possible, and they need to be analysed in a transparent and prioritised integrated way. The purpose of the research is to present an integrated GIS analysis in order to obtain a result that can be properly interpreted and can provide a certain direction in the development of the mobility corridors within an urban system. At the same time, a personalised working methodology was created in order to obtain a true result based on an objective analysis (Grid index – equal areas distributed automatically on the studied territory), but also a subjective opinion, because the scoring methodology was created based on personal knowledge of the studied space, considering its study in various previous contexts.

Keywords: *mobility corridors, development, infrastructure, GIS, grid.*

1. INTRODUCTION

In the pursuit of sustainable urban development in Sfântu Gheorghe Municipality, the strategic planning of urban mobility corridors is vital. A pretability map, tailored to the city's unique characteristics, plays a key role in this process by highlighting optimal areas for this kind of developments. The map facilitates a comprehensive understanding of the spatial dynamics, enabling decision-

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makers to pinpoint optimal locations for mobility corridor implementation. By considering a lot of elements, the map becomes an indispensable tool in the strategic allocation of resources for mobility infrastructure.

The **pretability map of urban space for the development of mobility corridors** is a useful tool for decision-making in the planning and designing of urban space, taking into account certain elements underlying the development of a mobility corridor.

This map was created through the integrated approach of GIS, using several types of analysis: Grid Index Analysis, Reclassify Rasters, Raster Calculator. In general, the criteria underlying the development of efficient urban transport (Farkas, 2009) include several benchmarks, such as engineering, economic, institutional, social, and environmental factors.

These types of grids provide a great framework for categorizing and storing geographic data, enabling efficient data organization and analysis (Pfeifer et al., 2014). This can enable full evaluations of urban resources by enabling academics and professionals to manage complex datasets such as satellite imaging, topographical data, and a lot of elements with ease (Quan et al., 2001).

As defined by Elena Maria Minea, *"Urban mobility is a major concern, a space for debate, and extremely exciting analysis. It is an important driver of growth and employment, with a strong impact on sustainable development in the European Union"* (Minea, 2016).

"Mobility has been defined as the way in which the transport system meets accessibility to various socio-economic activities. In addition, the degree of mobility can indicate how attractive that area is in the territory" (Raicu & Popa, 2009).

Transport is one of the most important components of social and economic life, and the transport system constitutes the infrastructure of the economy, conditioning its efficiency and also the architecture of its entire system. These systems are influenced by several elements in synergy.

Efficient data processing is a strength of grid-based representation (Praveen et al., 2016). To efficiently extract information from complex data sets, the grid design simplifies processes such as interpolation, aggregation, and geographic searches (Loaiza et al., 2023).

2. METHODOLOGY

2.1. The GRID (SQUARE) method consists of creating a grid structure for the area investigated in the ArcGIS Pro software, resulting in a polygon layer, using the **Grid Index Features** function: - **Cartography Tools > Map Series > Grid Index Features**

- It is important that at parameters *Polygon Width* and *Polygon Height* pass the desired value, but also the outline after which to realise the **grid** (as the limit of the digitised Sfântu Gheorghe Municipality built-up area from the General Urban Plan is updated). We used 50 meters (in this way, obtaining a rectangular network of squares with an area of 2 500 m²). If we want a higher degree of detail, then we can use a lower value (e.g. 10/5 m), resulting in a denser rectangular grid.
- The result is a *Feature Class* of polygon type, in whose attribute table a column in the form of a unique identifier (FID) is automatically created. We used one grid for each analysis: classification in terms of mobility infrastructure types, accessibility to local points of interest, as well as urban functional zoning.
- Then in the attribute table we entered values ranging from 1 to 5 corresponding to the degree of pretability for the development of a mobility corridor, each square being used to *identify and locate specific elements* (see Table 1).

Table 1. Elements underpinning a mobility corridor

Degree of Preparability	Score	Type infrastructure	Accessibility to local points of interest	Urban functional zoning
Very Low	1	Footway	≤ 10 min. ⌚	• Special Destination Area • Railway communication paths and related facilities area • Area of technical-edillary constructions • Communal management area, cemeteries • Waters
Low	2	Service	≤ 8 min. ⌚	• Services area, trade, industry and warehousing • Agreement area, Loisir, sports-educational • Services area, trade and green spaces, leisure, sport
Medium	3	Residential	≤ 6 min. ⌚	• Industrial units and storage area
High	4	Secondary, Cycleway	≤ 4 min. ⌚	• Residential area and complementary functions • Green spaces, sports, leisure, protection
Very High	5	Primary	≤ 2 min. ⌚	• Public institutions, services, commerce, education area • Public Institutions, Services, Trade and residential area

Source: the author

As can be seen in table 1, we have created a working methodology for the ranking of urban areas (squares with equal surfaces inside the built-up area) according to the 3 criteria established subjectively, because this integrated analysis is a case study used as a model in future research. We mention that this analysis can be adapted in various fields of activity and the number/type of influence factors may differ depending on the type of outcome expected.

As a first step, we analysed vector data, for example the *urban mobility infrastructure types that intersect each square* in the previously created grid. So we scored every square of the grid with the representative note in Table 1.

- We used the **Select By Location > Grid Infrastructure Type (Relationship) function *intersects*** each type of infrastructure (*primary, secondary, footway, etc.*) > **The selected squares were scored for the methodology in Table 1, entering the scores from 1-5 in the attribute table.** The data used was downloaded free of charge from Open Street Map, and was classified by type of infrastructure (fig. 1).

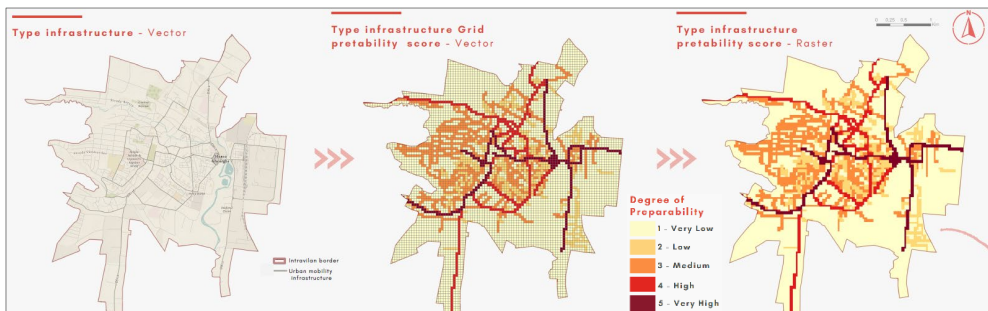


Fig. 1. Type infrastructure pretability score. *Source: the author*

- The same method was also used to score grids related to the other 2 analyses: *accessibility to local points of interest* (fig. 2), but also *urban functional zoning* (fig. 3). In the analysis of accessibility to the points of local interest we used shapefile isochronous (2, 4, 6, 8, and 10-minute walk) created by **Network Analysis > Service Area > Generate Walking-time polygons**. At the same time, the functional areas were digitised from the City's General Urban Plan (the updated version).

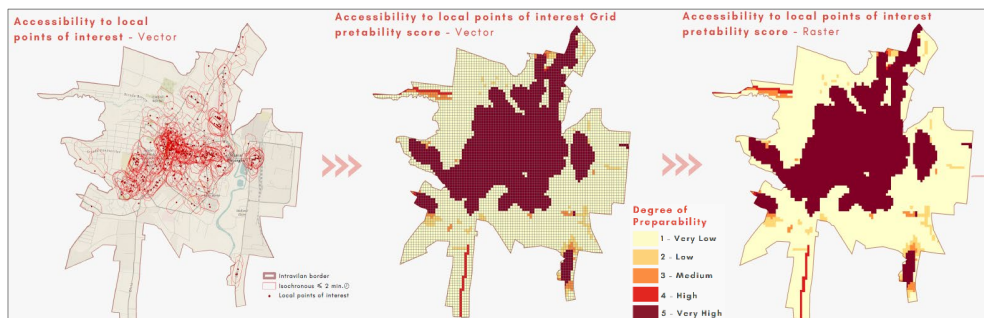


Fig. 2. Accessibility to local points of interest pretability score. *Source: the author*

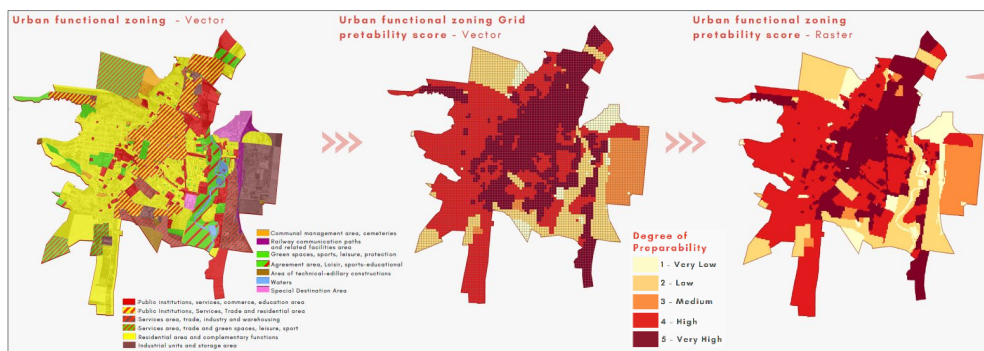


Fig. 3. Urban functional zoning pretability score. *Source: the author*

- **Symbolisation of the grid** by qualifying the score awarded (5 colour classes, *light beige* for a very low degree of value, to *dark red* for a very high degree).
- **Conversion Tools > Feature to Raster >** results in a **Raster Grid** with pixels of different colour depending on the 5 grades.
- **Symbolisation of the raster** according to the colours shown in **Table 1** (5 colour classes, *light beige* for a very low degree of value, to *dark red* for a very high degree). **Layer Properties – Symbology – Categories – Unique value**
- We finally got a raster for each type of analysis: Raster – Type infrastructure, Raster – Accessibility to local points of interest, Raster – Urban Functional Zoning.

2.2. Multicriteria Analysis consists of combining rasters obtained for the investigated area, resulting in a final raster layer. It can be achieved by several methods:

- a) **Image Analyst Tools > RASTER CALCULATOR** (= *Builds and execute a single Map Algebra expression using Python syntax, ArcGIS Pro definition*) > **Multiplicating the 3 rasters** > resulting in a **final Raster** > Next, we processed the obtained layer: **Layer Properties – Symbolology – Categories – Unique values**, using the specific colors in table 1 (fig. 4).
- b) **Spatial Analyst Tools > WEIGHT OVERLAY** (= *Overlays several rasters using a common measurement scale that weights each according to its importance, ArcGIS Pro definition*) > **Introduction of the 3 rasters** (providing a weight in the equation for each layer). Here we used **50 %** – infrastructure type raster, **30 %** – urban functional zoning raster, and **20 %** – raster accessibility points of local interest, respectively > **final Raster** > Next, we processed the obtained layer: **Layer Properties – Symbolology – Categories – Unique values**, using the specific colours in table 1 (fig. 5).

3. RESULTS

These analyses resulted in 2 maps of the urban space for the development of urban mobility corridors in Sfântu Gheorghe municipality. The first map, obtained using the Raster Calculator method, is much more restrictive than the second, where the Weight Overlay function was used. From the point of view of quality, it can be seen that the medium-classified areas have a different extension in the two maps, and the main areas with a high degree of value are represented by the main transport arteries within the urban space but also the areas near the bridges of interest where different institutions and other flow generating points are located.

Despite the fact that grid-based systems are more prevalent in natural resource management, it is important to recognize their limitations as they may have an impact on their effectiveness in certain circumstances (Worighi et al., 2019). One limitation is the scale and resolution of the grid. Grid cells, which have fixed sizes and shapes, may not accurately depict the variability and fine-scale changes from the analyzed space (Cao et al., 2022).

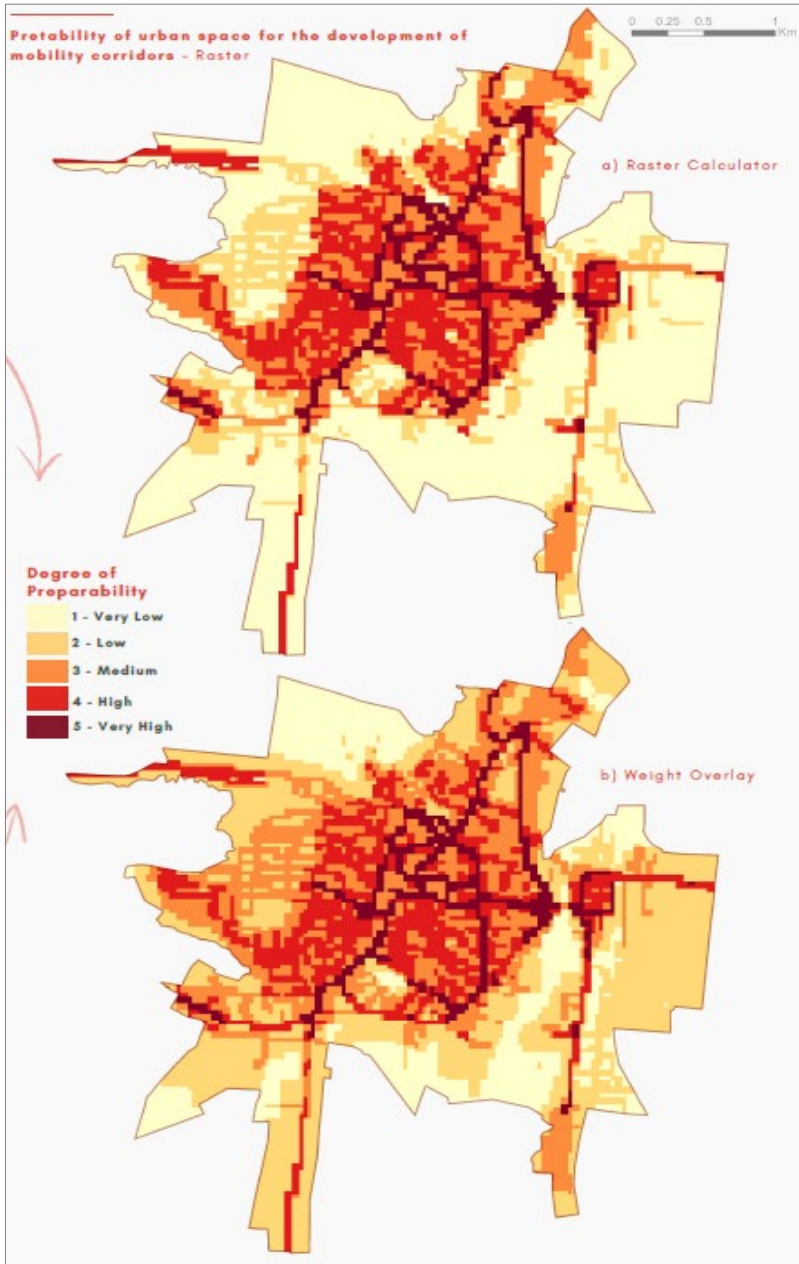


Fig. 4. Pretability of urban spaces for the development of mobility corridors.
Source: the author

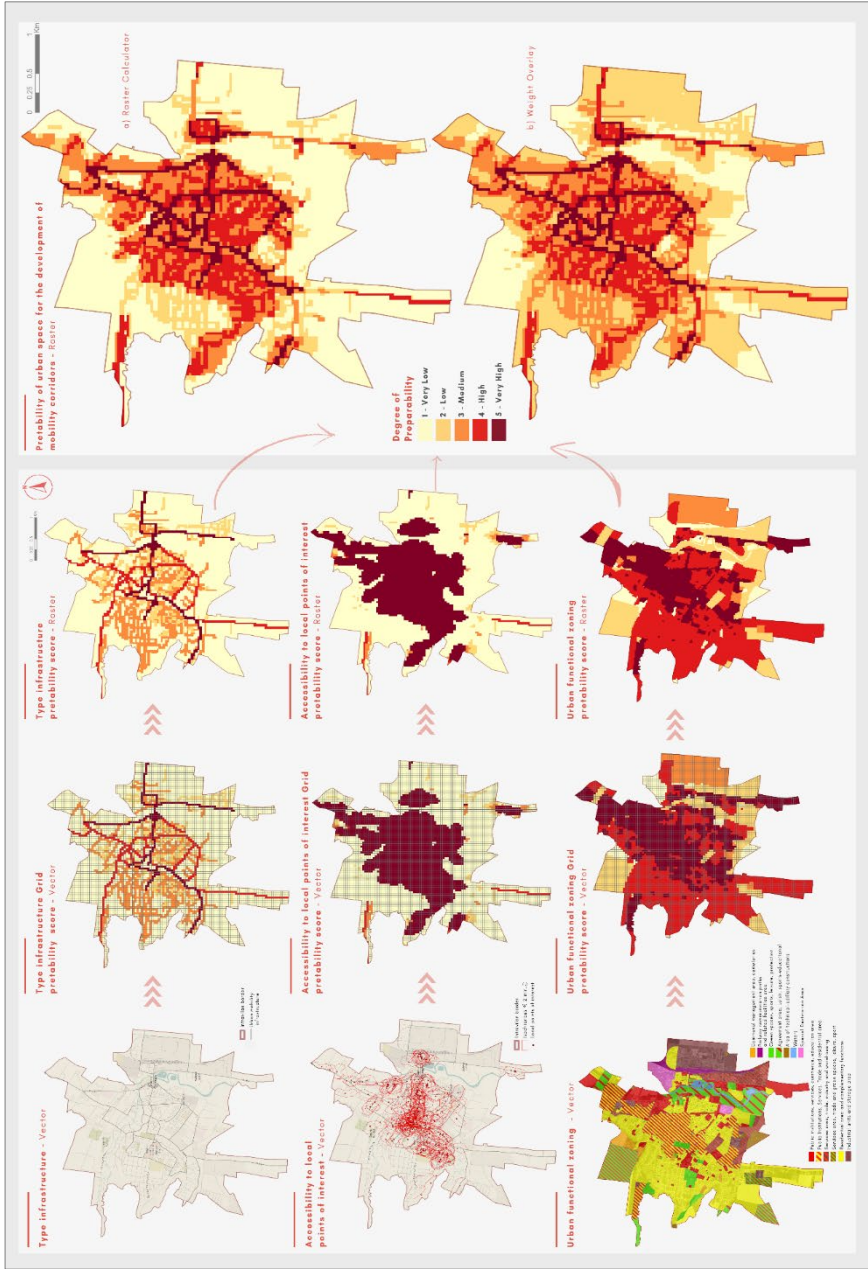


Fig. 5. Process of Pretability Map for the development of mobility corridors.
Source: the author

4. DISCUSSIONS

Mobility corridors are major communication pathways which at the level of some localities cause traffic flows so that the movement between two destinations is done in real time with as few interruptions of flow as possible, predictably, safely and in the most environmentally friendly way possible (Andriesei, 2022).

According to RP 2021-2027 North-West RDA is recommended **to use public transport and other forms of green urban mobility**, following interventions including:

- **Infrastructure for non-motorised journeys:** development, expansion of cycling infrastructure; arrangement of pedestrian areas, semi-pedestrian areas; introduction of bike-sharing systems with GIS monitoring applications, etc.;
- **Public transport systems**, including through the purchase of zero-emission means of transport and the development of the necessary infrastructure (including depots, bus stops, intermodal public transport stations), park & ride parking;
- **Sustainable urban mobility corridors**, through interventions such as (but not limited to):
 - The creation of prioritised routes for public passenger transport;
 - Managing movement flows by establishing innovative methods;
 - Refurbishment of spaces by including infrastructure for non-motorised journeys – cycling lanes, pedestrian areas that provide access to the main mobility corridors.

The Sustainable Urban Mobility Corridor is an element or a set of elements (newly built or in the process of reconfiguration) of the street network, aimed at traffic with major impact within localities. It may consist of the following components:

- public transport with priority way;
 - cycling or pedestrian trails (including alignment vegetation and urban/terrace furniture, public lighting);
 - road infrastructure used as a priority for clean urban public passenger transport;
 - road infrastructure (separate lanes) used exclusively for public passenger transport;
 - road infrastructure on urban streets served by public passenger transport to prioritise public passenger, cycling and pedestrian transport.
- **Development of alternative fuels infrastructure;**

- **Development of urban mobility management systems**, such as traffic management systems, mobility as a service applications, and other GIS WebApp applications (e.g. car park management application in Brăila Municipality).

Mobility corridors may consist of:

- a) Road part (for motor vehicles)
- b) Dedicated/prioritised lanes (for public transport)
- c) “Slow-motion” transport facilities (bicycle tracks, scooters, etc.)
- d) Pedestrian area

5. CONCLUSION

Multi-criteria analysis based on the three specific criteria, chosen subjectively (the type of infrastructure for urban mobility, accessibility to local points of interest and urban functional zoning) is a useful work tool for spatial management from the point of view of territorial development projects. This comprehensive approach allows for a detailed assessment of the potential of a given territory to host transport infrastructure and improve urban mobility.

By analysing the type of urban mobility infrastructure, it assesses the existence and quality of existing transport networks, main roads, public transport, etc. This assessment makes it possible to identify shortcomings and needs for the development of transport infrastructure to support increasing mobility flows in the urban environment. By assessing accessibility, the distance and connections between different points of interest in the urban environment, such as shopping centres, residential areas, business centres and public institutions, shall be analysed in detail. Understanding the level of accessibility helps to identify areas with high potential for the development of mobility corridors so that they meet the mobility needs of the population. Functional zoning analysis makes it possible to assess the coherence between existing mobility infrastructure and current and planned land uses. It helps to identify synergies and possibilities for integration between mobility corridors and types of areas, ensuring sustainable urban development.

This analysis was based on several working stages, placing and classifying grid with squares of equal surfaces, then transforming them into raster data in order to be used in mathematical calculation functions, resulting in a raster (image) that can express certain directions in the future planning of urban space. This method is a work model that can be adapted in various fields of activity.

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