CARTOGRAPHIC VISUALISATION OF THE SMART CITY VISIBILITY GAP IN THE SLOVAK REPUBLIC: A SPATIAL ANALYSIS OF CURRICULUM EXPOSURE AND THE SMART CITY INDEX AT THE DISTRICT LEVEL

KARTOGRAFICKÁ VIZUALIZÁCIA ROZDIELNEJ VIDITEĽNOSTI INTELIGENTNÝCH MIEST V SLOVENSKEJ REPUBLIKE: PRIESTOROVÁ ANALÝZA „OF CURRICULUM EXPOSURE“ A INDEXU INTELIGENTNÝCH MIEST NA ÚROVNI OKRESOV

Andrej KÓŇA[1]

Abstract

Smart city concepts have become key reference frameworks of urban policy in recent years, while their geographic distribution across Slovakia remains spatially highly differentiated. Although objective assessments of smart city development – such as the Slovak Smart City Index (People pillar) – capture real parameters of digital and social infrastructure at the district level, the question of how far this infrastructure is reflected in the education of young people has remained spatially unmapped. We refer to this phenomenon – the mismatch between the objective level of smart city development and its educational visibility as the smart city visibility gap.

The paper presents a cartographic analysis of this gap across 72 Slovak districts. It draws on data collected within the project KEGA 004UCM-4/2023 "Education for Smart Slovakia" (FSS UCM Trnava) – a survey of secondary-school students and the Slovak Smart City Index (SCI). The aims are to: (1) visualise the spatial distribution of curriculum exposure to the smart city concept, (2) identify the areas with the highest visibility gap, and (3) assess the spatial correlation between the smart city index and educational visibility.

The spatial analysis builds on two data sources. The first is a survey of secondary-school students conducted within project KEGA 004UCM-4/2023, in which N = 419 respondents rated (among other items) the degree to which the smart city concept is covered in their school curriculum (scale 0–3), the quality of internet connectivity at school (scale 1–5), and the perceived elements of smart infrastructure in their place of residence (scale 0–2). The data were aggregated to the level of 72 Slovak districts (mean values by the respondent’s district of residence). The second source is the Slovak SCI – People pillar, available at the district level as a z-score of a composite indicator (qualifications, lifelong learning, social plurality, cosmopolitanism, participation).

The spatial visualisations were produced with the geopandas and matplotlib libraries (Python 3.11); district boundaries were taken from the GADM 4.1 database (gadm.org). Bratislava I-V and Košice I-IV were dissolved into single polygons corresponding to the respective recording units in the survey data. The visibility gap was defined as the

[1] Mgr. Andrej KÓŇA, PhD., Institute of Political Sciences and Public Administration, Faculty of Social Sciences, University of Ss. Cyril and Methodius in Trnava, andrej.kona@ucm.sk

difference between the normalised SCI People pillar and normalised curriculum exposure: gap = norm (SCI) – norm (curriculum). A positive value indicates districts where the level of smart city infrastructure exceeds the degree of its educational reflection. Pearson and Spearman correlations were used to test the spatial association between the variables.

The choropleth maps of curriculum exposure) reveal pronounced spatial heterogeneity: most Slovak districts show zero or minimal curricular presence of the smart city concept (median = 0.71 on the 0-3 scale), with higher values located mainly in the central and northern parts of the country. School internet quality is spatially differentiated but does not display a pattern consistent with the SCI.

The key finding is a practically zero spatial correlation between the Slovak Smart City Index (People pillar) and curriculum exposure: $r = -0.044$ ($p = 0.715$), $r_s = -0.002$ ($p = 0.986$). In other words, the level of a district's smart city development does not explain the degree to which this development is reflected in the education of its youth. The visibility gap is positive in 61 of the 70 evaluated districts (mean gap = 0.29, SD = 0.30), meaning that the vast majority of Slovak regions have an objectively higher level of smart city infrastructure than its educational visibility.

The highest gap is found in the districts of Turčianske Teplice, Sobrance, Poltár, Krupina, and Bratislava – paradoxically including the capital, where the SCI is highest ($z = 0.068$) yet curriculum exposure remains moderate. The lowest gap – i.e., a relatively better educational reflection of the smart city reality – is achieved by the districts of Vranov nad Topľou, Veľký Krtíš, and Tvrdošín, where SCI values are low but curricular activity is above average.

The results document a spatial decoupling between smart city development and the educational visibility of that development. The cartographic visualisation of the visibility gap adds a spatial dimension to previous quantitative findings, enabling the identification of specific priority regions for education policy. The paper also demonstrates the potential of choropleth mapping for displaying socio-educational phenomena that traditional cartography has not treated as a "geographic" subject.

In the context of the GeoKARTO 2026 thematic sections, the contribution links to the discussion on web cartography and the geovisualisation of social data and offers a replicable open-source workflow (Python/geopandas/GADM) for producing thematic maps at the level of Slovak districts.

The contribution was carried out within project KEGA 004UCM-4/2023 "Education for Smart Slovakia" (Ministry of Education, Research, Development and Youth of the Slovak Republic). Data are available upon request (protection of minors' personal data).

Keywords: smart city, choropleth map, geovisualisation, curriculum exposure, spatial analysis, Slovak Republic

Kľúčové slová: smart city, kartogramová mapa, geovizualizácia, expozícia v učebných osnovách, priestorová analýza, Slovenská republika