Analysis of Warsaw's Gastronomic Services Using Big Data in the Context of the 15-Minute City Concept

MSc Arch
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This paper analyzes the gastronomic service infrastructure of Warsaw using a proprietary algorithm based on big data, incorporating qualitative data such as user reviews and current price levels. It visualizes the quality of the service network, gaps, and dysfunctions in the form of pixel maps at city scale, providing new insights for urban planning.

Stalder, in his analysis of Manuel Castells' works, notes that "the changing logic of capitalist development has created new expectations for the city as a spatial system." He further observes that the difference in global informational capitalism lies in its fundamentally nonlinearity and systemic instability [1]. ICT platforms (Information and Communications Technology), which aggregate large datasets and AI algorithms, appear to be a fundamental tool for the contemporary economy [2]. Network and access theories [3] manifest in the rise of peer-to-peer digital platforms [4]. Platforms like Foursquare, Google Maps, or Polands' Pyszne.pl significantly influence how a city functions, often holding monopolistic or oligopolistic market positions. Most of these platforms fall into the category of location-based services (LBS), as their presence in the city impacts the so-called 'cyberscape' [5].

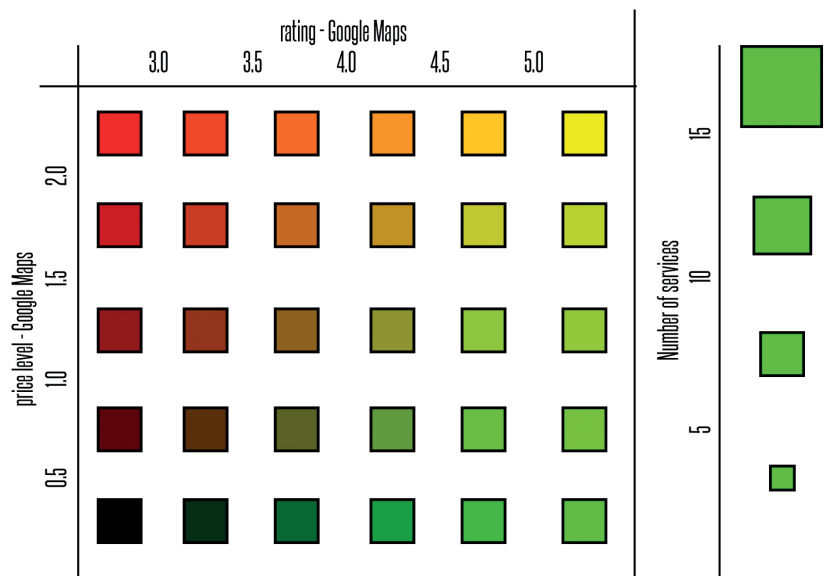

Fig. 1. Legend for pixel maps of proprietary algorithm, Authors' own work

Thanks to LBS, businesses can reach larger masses of customers, often in conjunction with digital mobility platforms [6]. The so-called network capitalism [7] or platform capitalism [8] has grown from a technological and social phenomenon to a perfect model of the informational economy [7]. Researchers from the McKinsey Global Institute showed in 2016 that over 162 million Americans use independent work through digital platforms [9]. The companies holding power over digital infrastructure, have control over those dependent on it [2]. Rahman classifies this control into power of transmission (over goods and data), access (filtering), and ranking (positioning and exclusion). As these platforms represent so-called 'lean platforms' [8], a mix of strong power, monopolization of trust, and low social responsibility of employers increases the number of dependent individuals daily. With the development of new technological power, one must develop innovative mechanisms of analysis and oversight [2]. Modern ICT technologies and digital platforms, considered in the context of urban service infrastructure, demand a serious urbanistic approach and the creation of appropriate frameworks to reclaim the data they collect and reuse it for city analysis [10]. The use of platform data for automated analysis is an emerging field of researching the urban fabric [11][12][13]. In the context of the 15-minute city concept, city data seems to be critically intertwined with urban services [14] and digital platforms may hold the key to gaining valuable new insights. Focusing on Warsaw, Poland's capital, selected due to the high density of services and a deep presence of urban platforms, the author aims to analyze the walkability and quality of the gastronomic network in search for new insights, valuable for city officials and urban planners.

Methodology

Following the above assumptions, the author wrote and tested a new analytical tool in Python via PyCharm, allowing for the visualization of the current state of urban service infrastructure, using large datasets obtained from the digital platform Google Maps. The resulting visualizations were then overlaid on maps using Adobe Photoshop.

Below is a brief overview of the modules and functions, that have been coded by the author and together form the core of the proprietary algorithm:

- User inputs the center of the studied area as GPS coordinates.
- User inputs the side length of a square in kilometers, used as the search area.
- A function divides the city into a matrix of nodes using a pixelation method based on a 1,2x1,2km grid, with X and Y coordinates, resembling a 15-minute walk range.
- A function performs automated keyword queries to the Google Places API [15] for each node in the matrix. Data returned includes a detailed list of services corresponding to the keywords and is saved as a .json file for later interpretation.
- A function reads stored data for each node and performs sub-functions including:
- Averaging the data and objectifying it via sorting by distance and limiting results to 1.2 km from the center, largely neutralizing the positioning algorithm.
- Removing items with too few user reviews.
- Assigning color and scale to nodes, thus creating a pixel that synthesizes node analysis results according to the legend shown in Figure 1.
- The above function runs for each node in matrix and later saves the generated city-wide pixel map to a vector format (.eps)

Following the above pixel map generation, a manual step takes place by overlaying the generated pixels on the city map in Photoshop. This step can also be automated in future revisions of the algorithm.

Thus a distilled visualization of the gastronomic service structure is created, which can be manually inspected for patterns, gaps, and dysfunctions.

The legend in Figure 1 explains the pixel scale and color. As the pixel size increases, the variation of venues (quantity) increases, and the color indicates the quality of venues at the time of the query, on a scale from red to green, in a matrix dependent on rating and price.

Results

The study was conducted using the algorithm on January 14, 2024, with the keyword 'restaurant', and a 15-minute node range,

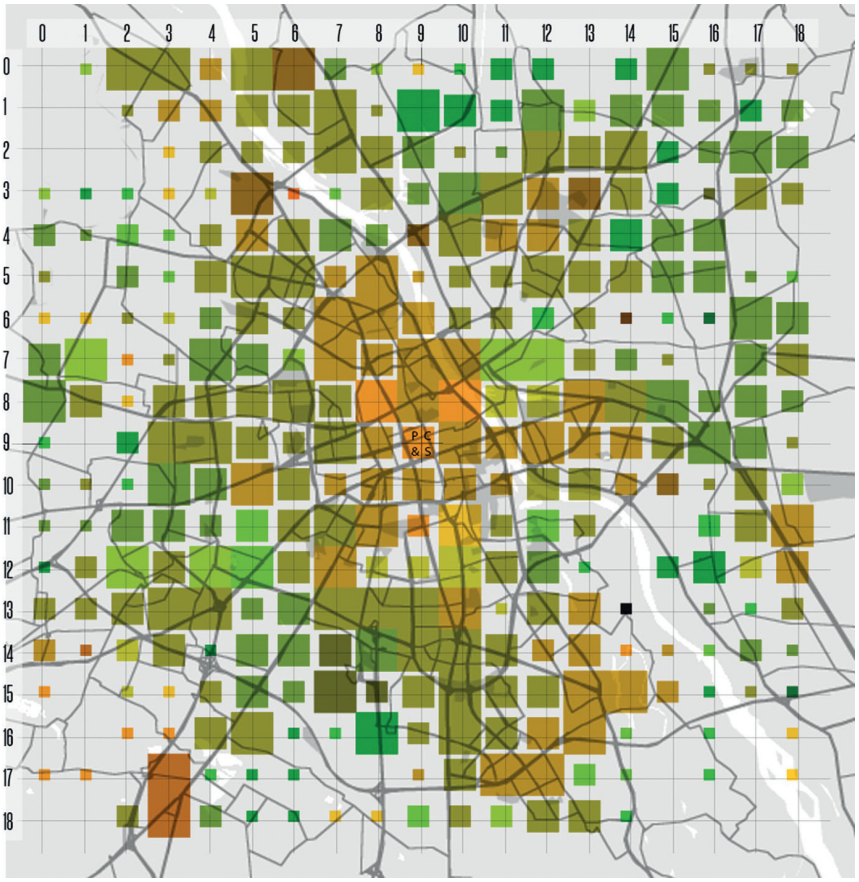

Fig. 2. Restaurant services in Warsaw, Generated by proprietary algorithm

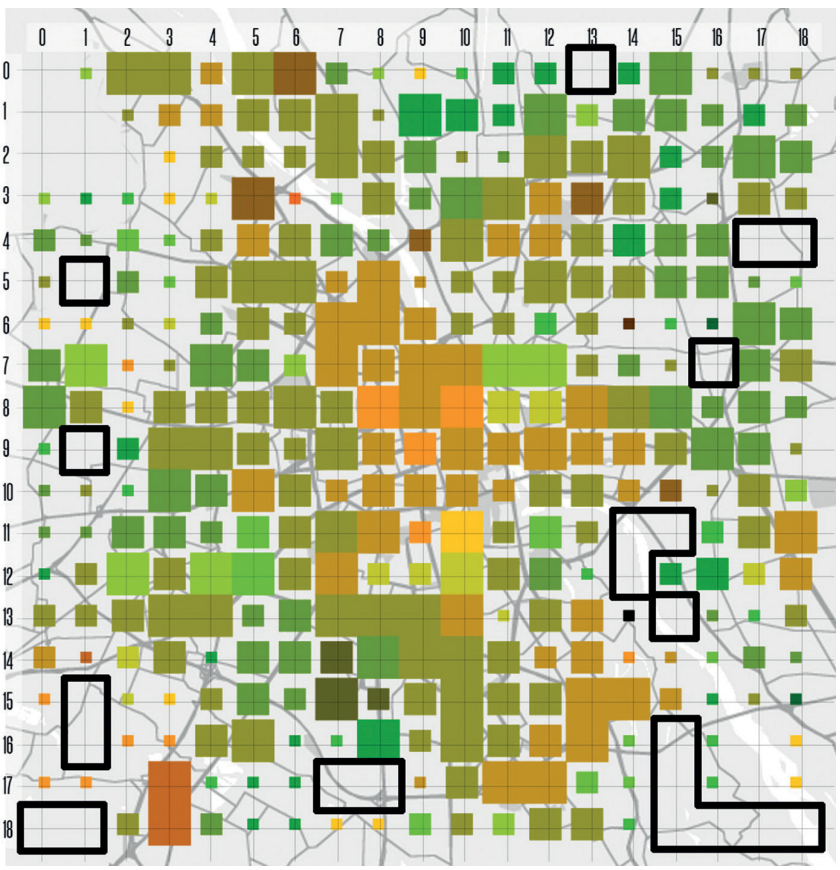

Fig. 3. Gaps in gastronomic services, Generated by proprietary algorithm

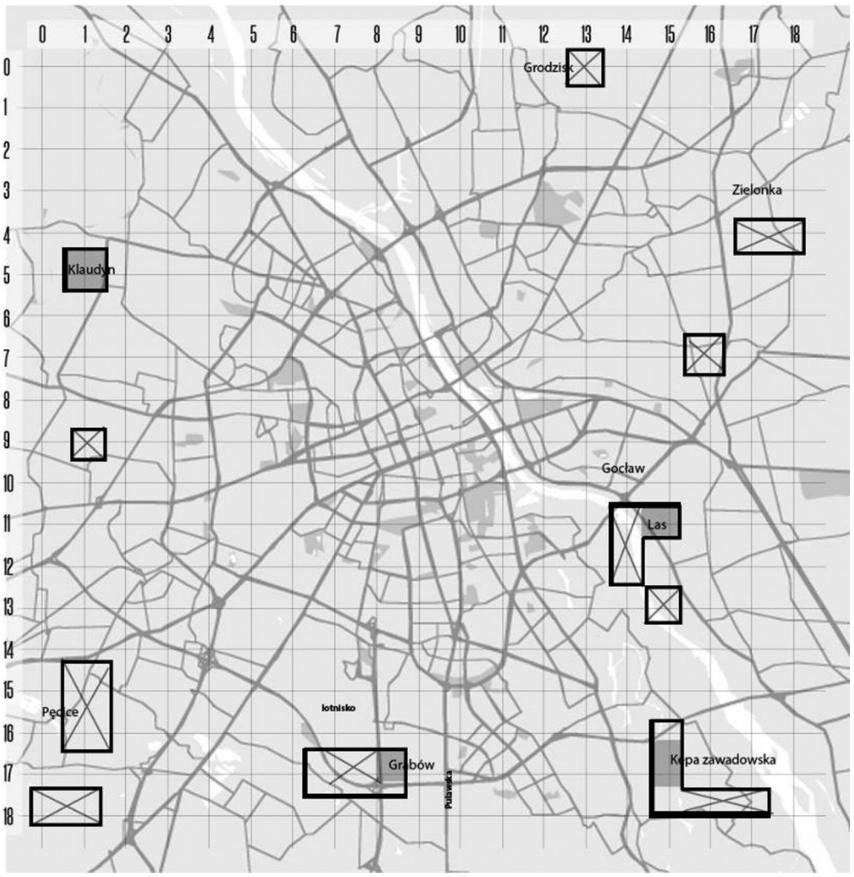

Fig. 4. Gaps in gastronomic services highlighted on map, Google Maps

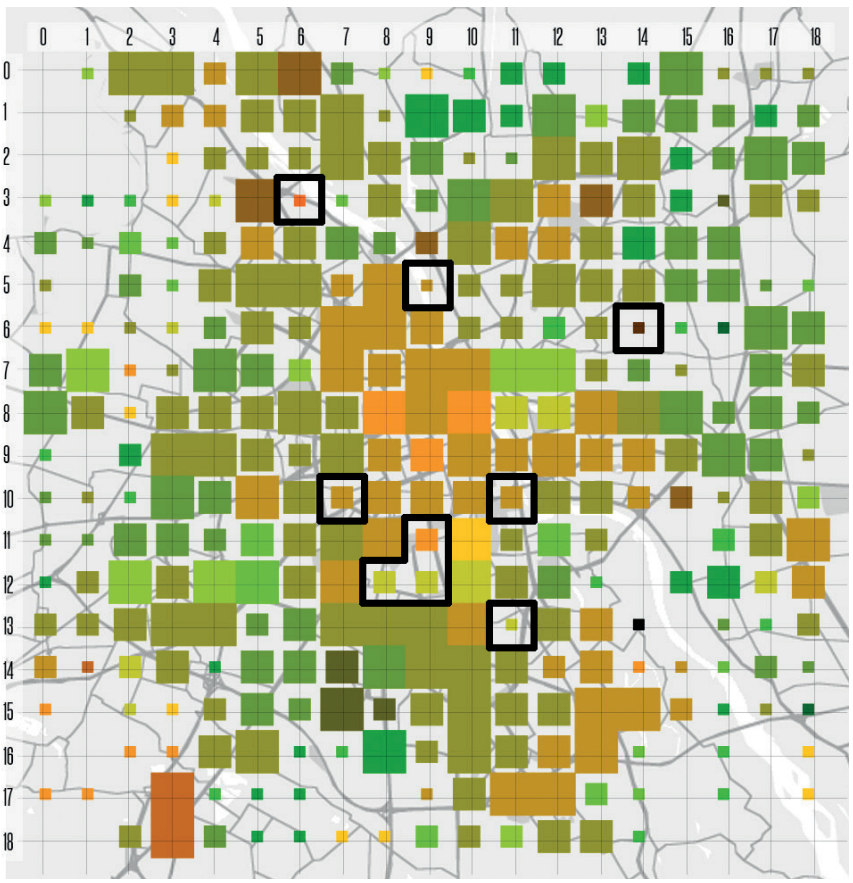

Fig. 5. Dysfunctions in gastronomic services, Generated by proprietary algorithm

for Warsaw - an area of 22x22km, with the center defined as the Palace of Culture and Science, as shown in Figure 2.

The analysis contained on the map, in addition to visualizing the quality and density of the gastronomic network, also allows for identifying gaps in Warsaw's restaurant infrastructure, assuming a 15-minute walk accessibility. The graphically processed map result is shown in Figure 3.

Most gaps have peripheral characteristics, naturally correlating with decreasing variation proportionally to the distance from the center. Some are green or undeveloped areas, but a few gaps require detailed analysis. A noticeable lack of gastronomic venues is found near the airport around Grabów (node 8-17), on the left bank near Kępa Zawadowska (node 15-17), on the right bank near Gocław, and near Klaudyn in the east (node 1-5), as seen in Figure 4. These are residential areas with single-family housing, presenting a niche in gastronomic services. In the context of the 15-minute city, considering the very low variation on the peripheries of identified gaps, they appear as interesting candidates for investment, possibly in gastronomic-entertainment hubs.

Another group of conclusions from the obtained and visualized big data is the identification of spaces with low variation and sub-standard quality despite seemingly attractive locations, in other words, service dysfunctions. The search aims to identify nodes requiring revitalization. Potential dysfunctions are marked in Figure 5.

After eliminating undeveloped areas and those without services, the following dysfunctions in Warsaw's gastronomic network were found:

- the beach near the Museum of Sport and Tourism by the Vistula (node 9-5)
- the area around the municipal stadium of Legia (node 11-10)
- Old Mokotów (node 9-11)

The first two are characterized by a small number of gastronomic venues and low quality, despite good locations and short distances from 'green' nodes and neighboring high-value functions - the beach and the stadium. Investing in gastronomic points or revitalizing these locations would seem to have the power to unlock their latent potential and strengthen the city's service network. An interesting case is Old Mokotów, where the number of gastronomic points is below the local average. The quality is above average, however the small number of venues may suggest that this area requires thorough analysis and investment.

In summary, the study of Warsaw's gastronomic network using a proprietary algorithm allowed for the visualization of the city's restaurant network quality and drawing conclusions about its gaps and dysfunctions.

The study was also repeated for other cities and keywords to demonstrate the algorithm's versatility (Figures 7, 8).

The author has also used the tool for further studies as part of his PhD dissertation, analyzing Warsaw and Poznan's service infrastructure, including gastronomy, entertainment and retail, using various keywords.

Conclusion and discussion

The proprietary tool for studying urban service networks using large datasets from the Google Maps platform, via the Google Places API, allows for insights and drawing conclusions about network quality, 15 minute walkability, structural gaps, and gastronomic dysfunctions. This can lead to a faster, more automated way of identifying areas suitable for short and long term spatial interventions, for example, by facilitating bottom up initiatives, investing in gastronomic hubs or improving local spatial plans. The use of user ratings can quicken the selection process, approximating the current user satisfaction levels without the need for costly surveys. The keyword feature allows for both broad and niche queries to be made quickly and efficiently, better suiting the individual spatial goals of each city. As shown in figures 7 and 8, the tool is scalable, transferable, and could thus aid urban planners and city officials in quickly identifying areas in need of spatial intervention, with the long term potential to strengthen the service network resilience and improve walkability.

The inherent limitations of this tool stem from the nature of the source of big data used - Google Maps. Even though steps have been taken to objectify the data, Google's closed-source algorithms that provide the data remain a black box. Similarly user ratings always carry a risk of subjectivity, even when sourced from big data and analyzed at scale. Further expansion of the algorithm is suggested, where two or more sources of data could be combined, preferably from open-source platforms. Additional databases like Bdot10k or local population density maps could also be integrated into the algorithm to aid automated gap and pattern recognition. Finally, the tool could be field-tested in cooperation with local officials to identify suitable plots for short term spatial interventions, followed by post project data collection and analysis.

In conclusion, quantitative big data combined with ratings and price levels enable finding patterns, gaps and dysfunctions, which are hard to trace in conventional map analysis. An effective, transferrable, and scalable tool for analyzing large digital datasets obtained from city-operating digital platforms can therefore provide valuable insights for city officials in the context of platform urbanism and the 15-minute city concept.

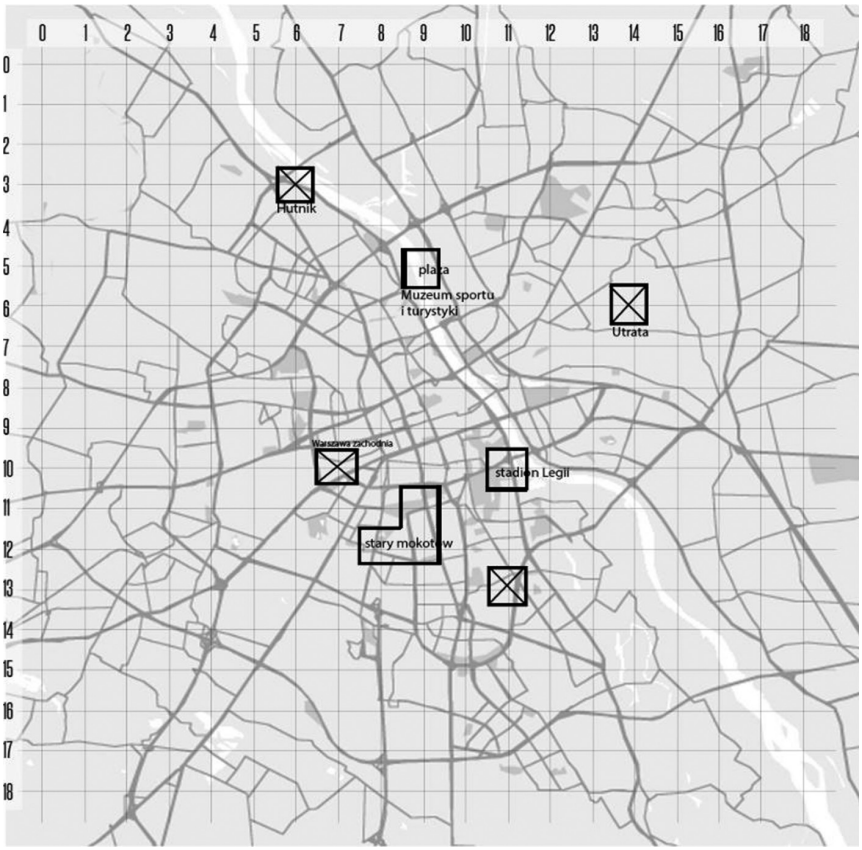

Fig. 6. Dysfunctions in gastronomic services highlighted on map, Google Maps

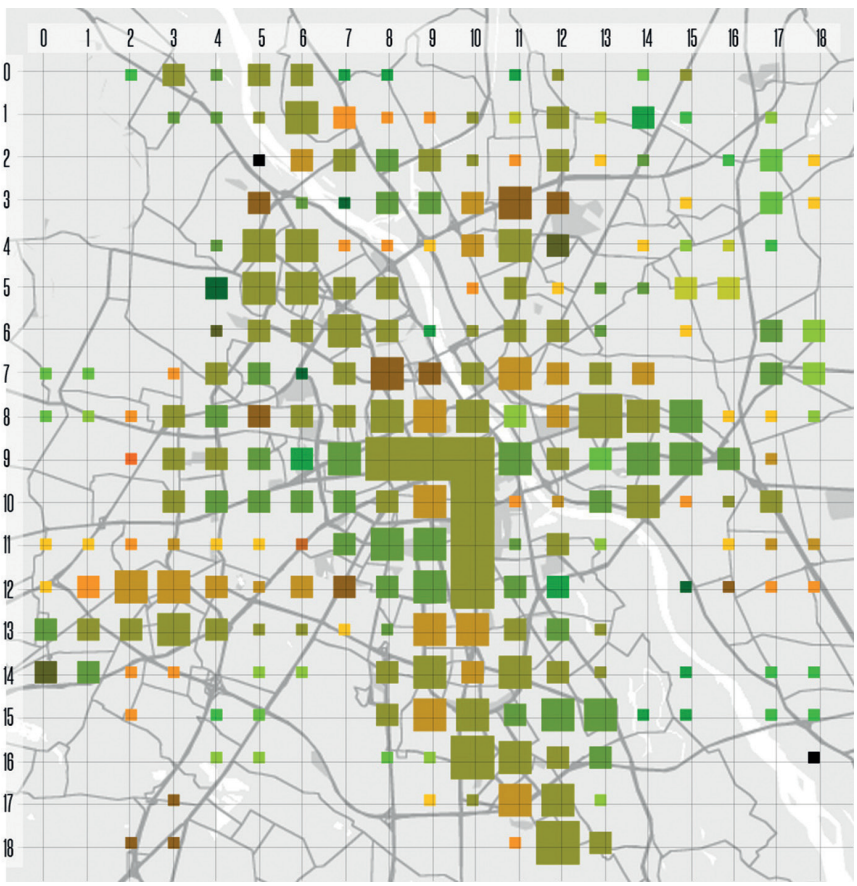
Fig. 7. Bakeries in Warsaw, Generated by proprietary algorithm

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ABSTRACT:

This paper analyzes the gastronomic service infrastructure of Warsaw using a proprietary algorithm based on big data, incorporating qualitative data such as user reviews and current price levels. It visualizes the quality of the service network, gaps, and dysfunctions in the form of pixel maps at city scale, providing new insights for urban planning. Assuming a networked society as the baseline social structure and the shared economy and platform capitalism as new economic models, the author proposes an analytical framework that divides the city into pixels with a length of 1200 meters, representing a 15-minute walking distance. The proposed analytical structure, in the form of a pixel/node matrix, responds to the emergence of platform urbanism. Under these assumptions, the gastronomic services of Warsaw were analyzed using a proprietary algorithm written in Python, utilizing big data from the Google Maps API. The research parameters for the nodes include variation, quality extrapolated from user ratings, and the price level (accessibility), referring to Rahman's analyses of digital power. The study was conducted for the keyword 'restaurant' in January 2024. The tool allows for the acquisition and visualization of data on the current state of the city service infrastructure and draws conclusions by overlaying the results on a conventional map. Further studies have also been conducted as part of the authors PhD. The tool is transferable and scalable, allowing research on any city based on given keywords, drawing both quantitative and qualitative data, which is a distinctive feature of the study.

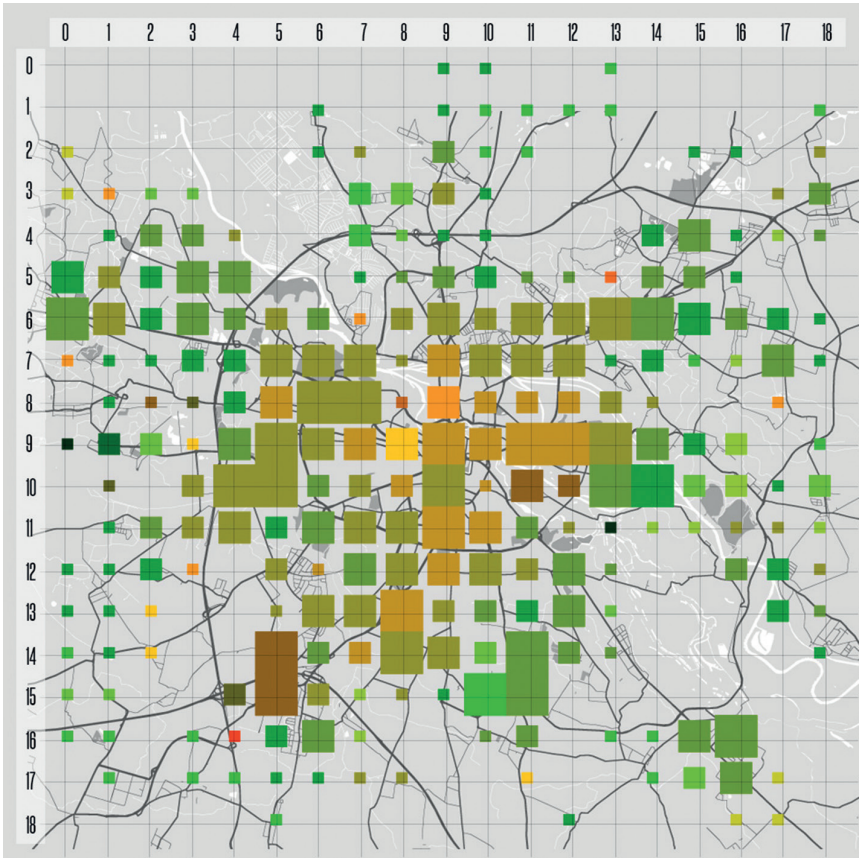

Fig. 8. Restaurants in Wrocław, Generated by proprietary algorithm

KEYWORDS:

urban services, 15-minute city, big data

STRESZCZENIE:

ANALIZA USŁUG GASTRONOMICZNYCH WARSZAWY PRZY UŻYCIU DUŻYCH ZESTAWÓW DANYCH W KONTEKŚCIE KONCEPCJI MIAST 15-MINUTOWYCH. Celem artykułu była analiza infrastruktury gastronomicznej Warszawy przy użyciu autorskiego algorytmu, opartego na dużych zbiorach danych, uwzględniającego dane jakościowe – opinie oraz aktualne poziomy cenowe. Algorytm pozwala na wizualizację obecnego stanu jakości usług, luk w tkance oraz dysfunkcji w formie pikselowych map o dowolnym zasięgu, generując nowy wkład w wiedzę o usługach w kontekście planowania urbanistycznego miast. Zakładając społeczeństwo sieciowe jako wyjściową strukturę społeczną oraz ekonomię współdzieloną i kapitalizm platformowy jako nowe modele ekonomiczne, autor proponuje metodę analityczną dzielącą miasto na piksele o boku 1200 metrów, odzwierciedlające w uproszczeniu 15-minutowy spacer. Zaproponowana struktura analityczna, w postaci macierzy pikseli/węzłów odpowiada na emergentne zjawisko urbanistyki platformowej. W myśl tych założeń dokonano analizy tkanki usług gastronomicznych Warszawy za pomocą autorskiego algorytmu napisanego w języku programistycznym Python, korzystając z dużych zbiorów danych platformy Google Maps, poprzez API. Parametry badawcze węzłów to zróżnicowanie (wariacja), jakość ekstrapolowana z ocen użytkowników (rating) oraz grupa cenowa (dostępność), nawiązując do analiz władzy cyfrowej Rahmana. Badania przeprowadzono dla słowa kluczowego 'restaurant' w styczniu 2024 roku. Narzędzie umożliwia pozyskanie i zobrazowanie danych o obecnym stanie infrastruktury usługowej miasta oraz wyciąganie wniosków poprzez nałożenie wyniku na podkład mapowy. Autor wykonał również szersze badania z wykorzystaniem algorytmu w ramach swojej pracy doktorskiej. Narzędzie jest transferowalne i skalowalne, pozwala na badania dowolnych miast na podstawie zadanych słów kluczowych, czerpiąc zarówno dane ilościowe jak i jakościowe, co stanowi wyróżnik badań.

SŁOWA KLUCZOWE:

usługi miejskie, miasto 15-minutowe, big data