Visualizing vital public spaces in Cairo using Twitter API

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Abstract:

The research examines the study and analysis of vital public spaces in Cairo, using social media networks as effective tools to uncover the dynamic social relationships of the community and identify their actual presence in urban areas without bias. It works to provide a lot of time and effort for researchers to observe and document patterns of human behaviour and complex social relationships. Based on several practices of different researchers using different research methods and tools, this research adopts the "Twitter Application Programming Interface (API)" tool to identify the most important and vital public spaces in the city. The aim of this study is to analyse the typologies of public spaces in Cairo and determine the most vital ones using real-time geotagged tweets from two heterotopias: Nasr City and New Cairo.

The research categorizes public spaces into two groups; nodes, and connectors, and calculates their vitality measures based on the density of tweets. The study suggests that nodes in Cairo play a vital role in enhancing the urban vitality of the city, with mixed-use buildings and street malls being key components of these nodes. The results of this research show that the use of Twitter API and social networks can be an effective tool for mapping vital public spaces and identifying the most important typology of public space within a city. This could greatly enhance the quality of life for both residents and visitors in Cairo.

The study also highlights the importance of public spaces in urban areas and how they can positively impact the social and economic development of a city. The research suggests that the identification and revitalization of public spaces can contribute to the overall well-being of a community.

In conclusion, this study demonstrates the potential of using social networks and Twitter API to map and analyse vital public spaces in urban areas. The results of this research provide valuable insights into the typologies of public spaces in Cairo and the significance of nodes in enhancing urban vitality. This study can serve as a useful reference for policymakers and urban planners in their efforts to create more liveable and vibrant cities.

الملخص:

يتناول البحث دراسة وتحليل الفراغات العامة الحيوية بمدينة القاهرة باستخدام شبكات التواصل الاجتماعي كأدوات فاعلة في كشف العلاقات الاجتماعية الدينامية للمجتمع وتحديد مناطق تواجدهم بصورة فعلية وحقيقية بالعمران دون تحيز، حيث تعمل على توفير الكثير من الوقت والمجهود للباحثين في الملاحظة والتوثيق لأنماط السلوك الإنساني والعلاقات الاجتماعية المركبة. وبناء على ممارسات عدة لباحثون مختلفون مستخدمون طرق وأدوات بحثية مختلفة، تبنى هذا البحث أداة "واجهة برمجة تطبيقات تويتر" Twitter API لتعيين الفراغات العامة الأكثر أهمية وحيوية بالمدينة. ويهدف هذا البحث إلى تحليل أنماط الفراغات العامة في القاهرة وتحديد الأكثر أهمية باستخدام تغريدات تويتر-محددة المواقع الجغرافية- تركيزا على دراسة

منطقتين: مدينة نصر والقاهرة الجديدة.

وتصنف الدراسة الفراغات العامة إلى مجموعتين، الموصلات والعقد، وتحسب قياسات حيويتها استنادًا إلى كثافة التغريدات بكلا منها. وأثبتت الدراسة إلى أن الفراغات العامة "العقد" في مدينة القاهرة تلعب دورًا حيويًا في تعزيز الحيوية الحضرية للمدينة، حيث تعد المباني المختلطة الاستخدام والمراكز التجارية المفتوحة في الشوارع من المكونات الرئيسية لتلك المحاور. من ثم تظهر نتائج هذا البحث أن استخدام واجهة برمجة تطبيقات تويتر وشبكات التواصل الاجتماعي يمكن أن تكون أدوات فاعلة لتصور وفهم الفراغات العامة الحيوية بالمدينة واستكشاف أنماطها. ويمكن أن يحسن ذلك بشكل كبير جودة الحياة للسكان والزوار في القاهرة. كما تسلط هذه الدراسة الضوء على أهمية الأماكن العامة في المناطق الحضرية وكيف يمكن أن تؤثر بشكل إيجابي على التنمية الاجتماعية والاقتصادية للمدينة.

وبالنهاية، تخلص الدراسة إلى إمكانية استخدام وسائل التواصل الاجتماعي وواجهة برمجيات تطبيق تويتر لرسم خرائط وتحليل الفراغات العامة الحيوية في المناطق الحضرية. وتقدم نتائج هذا البحث إلى رؤى قيمة حول تصنيفات الفراغات العامة في القاهرة وأهمية العقد في تعزيز الحيوية الحضرية. ويمكن لهذه الدراسة أن تكون مرجعاً مفيداً لصانعي القرار والمخططين الحضريين في جهودهم لإنشاء مدن أكثر حيوية ورفاهية.

الكلمات المفتاحية:

الفراغات العامة الحيوية، الشبكات الاجتماعية، القاهرة الجديدة، مدينة نصر

1. Introduction

Public spaces are vital locations where individuals come together to socialize and interact. In urban areas, an interconnected network of public spaces exists, reflecting the spectacle of social life (De Marinis et al., 2022), with actors and the audience continually exchanging roles (Mumford, 1937). However, capturing the dynamic nature of people's social relations within the context of contemporary cities poses a challenge (Li et al., 2022). This study seeks to explore the means to capture vital public spaces within the complex and dynamic urban environment and to determine the physical conditions related to these spaces based on a literature review.

Currently, social networks provide a new digital social life that offers an approximate understanding of the city's social life (Martí et al., 2019)if captured and analysed. Castells (2009) describes these new spatial arrangements under the digital paradigm as "space of flows," which creates networks through which information flows and time-sharing of practices are ensured. This study employs Twitter API as a tool to capture people's social network dynamics and track their coexistence in the built environment to map vital public spaces within the city.

The study commences by defining vital public spaces through a literature review and extracting the most significant factors that impact these spaces in urban areas. Finally, the study demonstrates the application of Twitter API as a tool to map vital public spaces in Cairo City and draws conclusions regarding the efficacy of using this modern tool in the field of urban design. This tool also provides an affordable means of assessing how residents feel about the city or public spaces in specific neighbourhoods, which could be useful for tracking the effects of public space (Sevin, 2016).

2. Vital public spaces

Urban design is an essential aspect of creating public spaces that serve various purposes depending on the location. According to Oldenburg (1999), public spaces serve as the third place designed for community social life within a city. However, the mere design of public spaces may not be enough to make them effective; the presence of people who articulate these

spaces is what creates effective environments (Carmona et al., 2010).

Public spaces serve as places where people from different backgrounds come together to interact and engage in various activities. They allow people to gather and socialize away from their homes and work activities (Oldenburg, 1999). The experience of face-to-face unpredictable meetings in public spaces determines the quality of cities (Gehl, 2011). Therefore, the vitality of public spaces determines the degree to which they are alive (Montgomery, 1998) and can attract diverse people for different types of activities at different times (Mouratidis et al., 2020). Vital public spaces can attract city capital and creativity while sustaining urban resilience and generating competitiveness within a city (Zhang et al., 2021). However, the factors determining the vitality of public spaces not only depend on the physical characteristics existing within these places but also come from the related built environment influencing their existence (Liu et al., 2022).

Different scholars have identified various factors that contribute to the vitality of public spaces, including the density of people, diversity of economic activities, accessibility, and environmental quality (Garau et al., 2022; Jacobs, 1992; Lynch, 1984; National Association of City Transportation Officials, 2019). Hillier (2007) and Jacobs (1992) argue that the presence of people enhances the feeling of safety in public space and provides the primary means by which space is naturally policed. In other words, the more the natural presence of people is eliminated, the greater the danger is felt. To them, general practices lead to the pedestrian populations accommodating public spaces are the main principle of urban vitality.

The issue of vibrant public spaces arises concern about the impact of social life in public spaces within the city, as a vibrant environment fosters society's social contract and elevates trust between individuals, solidarity, and cooperation (Pinna et al., 2021). Liu et al. (2022) try to connect the idea by considering the conceptual framework of the "vital triangle": Growth, diversity, and mobility. They mimic the vitality of public spaces with the metabolism of living organisms in nature. The growth represents population economy and buildings, while diversity represents a function, industry, people, and culture. Lastly, mobility represents the flow of people, material, and information. Accordingly, new dimensions of information flow emerge as external factors affecting the inner built environment to affect and interpret urban vitality.

Therefore, understanding the physical and nonphysical settings that affect people's existence in public spaces is critical to creating vibrant public spaces. Accessibility, diversity of activities, environmental quality, and urban morphology determine the physical characteristics (Figure 1), while information flow determines the nonphysical characteristics. These characteristics, in general, affect people's existence to determine vital public spaces. The vibrant public space is a place where diverse people are attracted and exist due to their physical and nonphysical settings. In line with the lived experience approach (Escudero, 2013), this paper captures urban vitality by capturing the dynamism of people's existence -as concluded from the literature review (Figure 2)-within public spaces using technological tools (information flow) that tell us how people's social relations exist within our built environment while giving us the opportunity to capture this dynamism and observe it over different times. With increasing interest in urban design, understanding the role of new location-based media and the impact of the increase in the availability of urban digital data is being understood. The paper investigates social networks (via space of flows) to capture people's social relations and connectivity to public spaces.
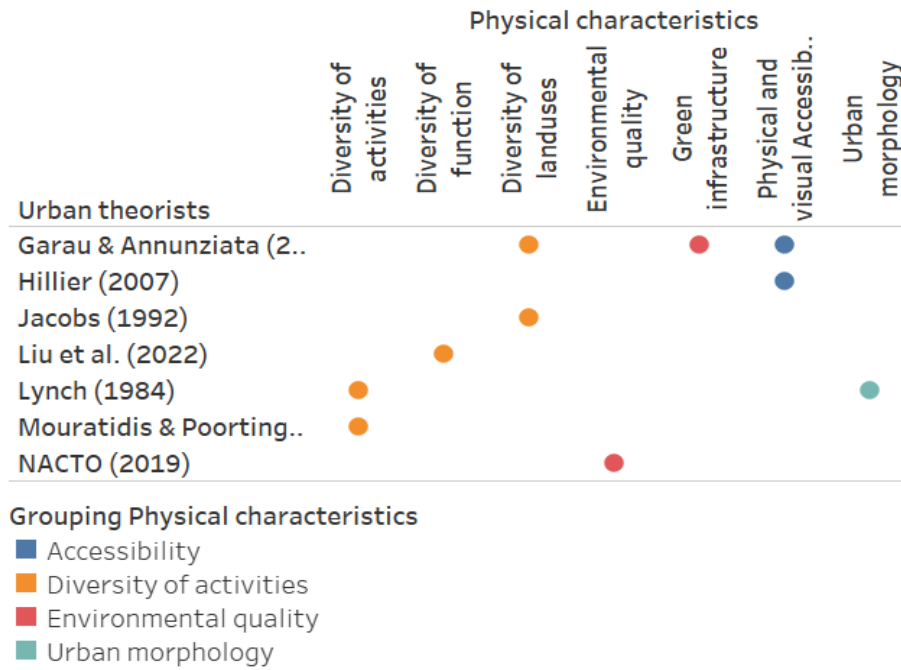
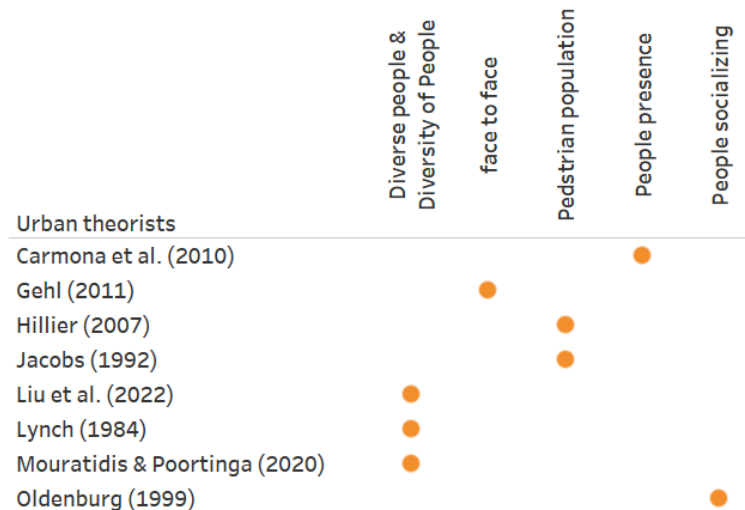**Figure 1: The physical characteristics affecting people's existence within public spaces (the Author)**

Figure 2: The phenomenon of diverse people existence as a key indicator of vital public spaces (the Author)

3. Space of flows in the urban areas

The information revolution has brought about significant changes in social interactions, mainly due to the widespread use of mobile technologies and social networking platforms. Online communities are now common, facilitated by web-based tools like Facebook, Twitter, Foursquare, Myspace, Google Plus, Flickr, and YouTube, among others, which allow individuals to connect with each other in real-time. These networks aim to link virtual and physical communities (Figure 3), as highlighted by Mohammad et al. (2014).

The mobile interface has further enhanced the interactive potential of social networking, as these tools can now be accessed on the go and spontaneously. Castells (2009) introduced the

concept of the "space of flows" to capture the new spatial arrangements that emerged in the information age. This space is defined by the places where activities take place, the material communication networks linking those activities, and the flows of information that give those activities meaning and function. Within this space, each place is defined by its nodal role in its respective networks (Castells, 2009).

Social media platforms are not only a source of information for administrative decision-making but also a means of rapidly gauging public opinion. In the past, this was often done through interviews and hearings, but social media now allows for a stream of comments related to city planning whenever news is published, as noted by Wakamiya et al. (2011). This is an efficient means of monitoring public opinion and perceptions.

Furthermore, social media can provide cities with access to information that is not geographically limited. According to Cerrone et al. (2015), this new data source offers a cost-effective way to research urban phenomena and monitor activities in urban areas. Therefore, social media can be an invaluable tool for decision-making, enabling cities to react and adapt quickly to changes in urban space use.

The growth in mobile phone usage has revolutionized the way people communicate, access information, and interact with their environment. It has created new opportunities for utilizing mobile networking to engage in social interactions and facilitate physical gatherings in public areas, as highlighted by Humphreys (2010) and Mohammad et al. (2014).Also, Wang et al. (2021) and Wu et al. (2018) demonstrated that the use of smartphones and sensors has resulted in the availability of a greater variety of big data, improving the assessment of urban liveliness and enabling the measurement of urban vitality using quantitative data sources.

Geodesign, is an iterative design method that uses stakeholders' input, geospatial modelling, impact simulations, and real-time feedback to facilitate holistic and smart decisions, is a vision for using geographic knowledge to actively and thoughtfully design (Foster, 2016). These developments have opened up new possibilities for creating liveable and sustainable urban environments. The rise of location-based social networks (LBSNs) (Martí et al., 2017) and volunteered geographic information (VGI), such as Google Maps or Open Street Map, has made it possible for almost any citizen with an internet connection to generate and publicize their own maps and geographic information, providing valuable data for urban planning decision-making, as highlighted by Adams (2013), Goodchild (2007), and McElvaney (2015).

Therefore, Social networks have the potential to provide us with significant amounts of data regarding the frequency of people's presence and their social relationships in public spaces. By capturing and analysing this data, the research paper's methodology can be enriched.
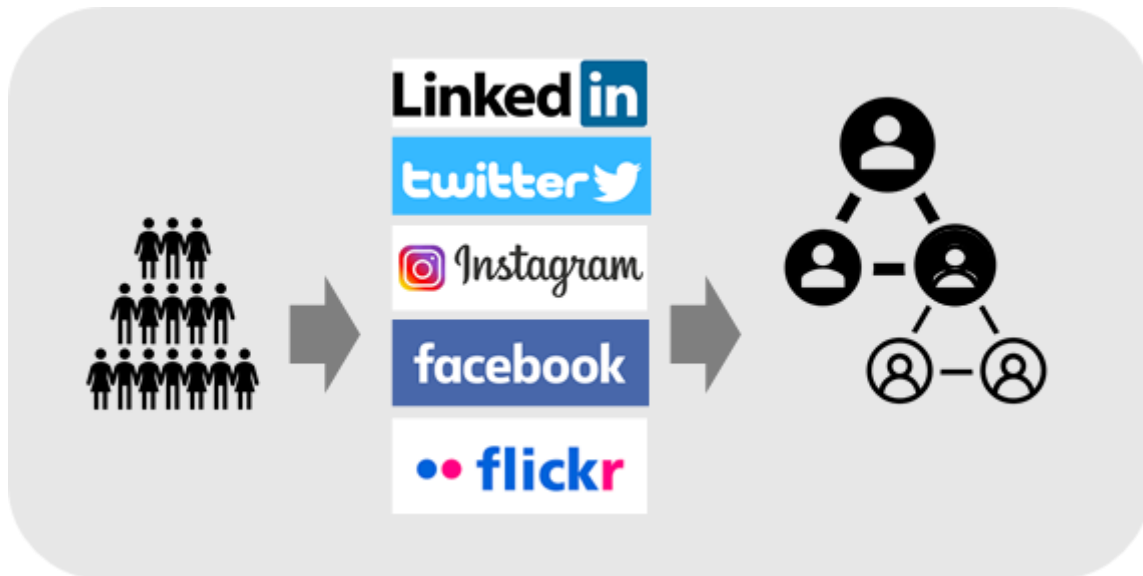
Figure 3: Social networks connecting physical communities over the space of flows (the Author)

4. Mapping vital public Spaces

4.1.Methodology

The advent of mobile phones has revolutionized communication, information access, and interaction with the environment. Location-Based Social Networks (LBSNs) and Volunteered Geographic Information (VGI) have generated a vast amount of data that can inform urban planning decision-making. According to Statista, the number of mobile phone users globally is projected to reach 7.49 billion by 2025 (Taylor, 2023). Twitter, with over 500 million tweets generated daily (Shepherd, 2023), has emerged as a popular platform for news consumption, socializing, and sharing experiences in cities. Twitter allows users to post up to 280-character long tweets to followers, as users make use of Twitter to get news articles, read friends' updates, and chat with each other. It offers individuals the opportunity to share their experiences in cities using pictures, videos, posts, and check-ins (Vukmirovic et al., 2022). Twitter geodata is a form of LBSNs that this study uses as a method to map geographical visualization and network analysis for Twitter data. With only 1-3% of total tweets containing geospatial data (Shihao Ran, 2023), Twitter data presents a valuable source for mapping and network analysis. Twitter gained much success in 2012 and gained more than 100 million active users (Prodhan et al., 2012) while nowadays it reaches about 396.5 million users globally (Shepherd, 2023).

Academic researchers can retrieve up to 10 million tweets per month using Twitter's API (Application Programming Interface) (*About Twitter's APIs*, n.d.), which is the way computer programs are talking to each other in a way enabling them to request and deliver information. Twitter API platform provides broad access to public Twitter data that users have shared with the globe (Miller, 2011). Through urban design, Twitter data can help researchers understand the role of new location-based data and increase the availability of urban digital data. Twitter's API allows developers to access tweets through keyword searches or requesting samples from specific accounts, albeit with a limit of 300 requests per 15 minutes (*About Twitter's APIs*, n.d.). Previous studies have employed various techniques to characterize urban areas and detect geo-social events. For instance, Fujisaka et al. (2010) proposed a method for detecting geo-social events based on crowd movement patterns, while Lee & Sumiya (2010) used crowd activity

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regularity to detect geo-social events. Similarly, Vieira et al. (2010) introduced the Dense Area Discovery (DAD-MST) algorithm to automatically detect dense areas using cell phone network infrastructure, and Kurashima et al. (2005) created a Blog Map of Experiences to characterize sightseeing locations using association rules from blog entries. However, these studies primarily focus on detecting events rather than characterizing urban areas using geo-social tweet databases.

Several researchers have investigated the impact of Twitter on lifestyles, topical trends, and identifying useful topics from microblogs. For instance, Krishnamurthy et al. (2008), Java et al. (2007), and Zhao & Rosson (2009) have analysed Twitter's impact on lifestyles and topical trends. In contrast, Yusuke (2009) proposed a method to identify useful topics from microblogs. These studies have primarily focused on analysing textual message content and the link structure of users' followers.

Wakamiya et al. (2011) proposed a new method for characterizing urban areas based on crowd behaviour on Twitter. They classified urban areas into different categories such as bedroom towns, office towns, nightlife towns, and multifunctional towns based on crowd behaviour on Twitter. Their approach accurately characterizes living spaces in urban areas, allowing analysts to adjust time periods and region sizes for diverse granularities.

Consequently, the research adopts the Twitter API tool to assist in mapping diverse people's presence within the most vital public spaces in a city, as it captures people's dynamics irrespective of their socioeconomic status, gender, age, and ethnicity. The research methodology involves selecting a case study, collecting data, processing data, visualizing data, and analysing data as shown in Figure 4. Data collection involves retrieving data from Twitter using the Twitter API, followed by data processing and cleaning. The cleaned data is then visualized using various statistical and visualization methods. The research concludes with data analysis, reflected in the research results and conclusions.
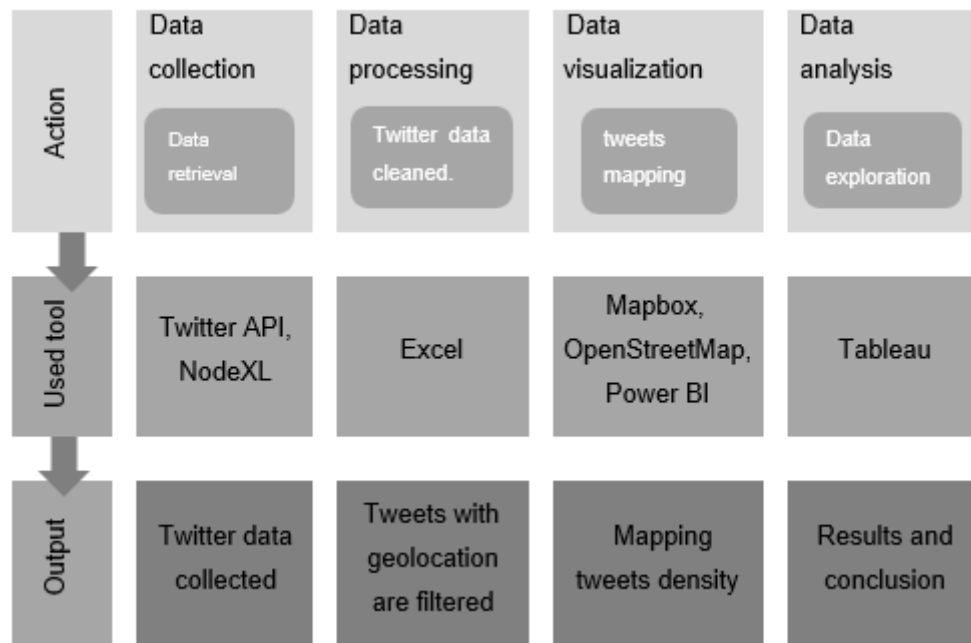

Figure 4: The Flowchart of research methods, tools, and results (the Author)

4.2. Data collection

This stage involves retrieving data from Twitter database by determining the location of the desired data and utilizing appropriate tools or methods to extract it. The research utilizes cosmopolitan Cairo, with its unique public space patterns and morphology, as a case study to obtain valuable material for this process. Although the search for important spaces in Cairo is linked to the city's neoliberal era, the study focuses on Nasr City and New Cairo heterotopias to represent public spaces during that period. The research utilized the Twitter API in conjunction with NodeXL to access real-time geotagged tweets within Cairo's public spaces, specifically within the predefined area. By gathering tweets over a two-year period (from January 2021 to February 2023), the researcher identified the most crucial public spaces based on tweet density. Within the designated time frame, 19841 tweets were obtained from the selected boundary area for Nasr City and New Cairo City (bounding box: [31.322, 29.9692, 31.5747, 30.0988]).

4.3. Data processing

After retrieving the necessary data in the previous stage, this stage involves filtering the extracted 19841 tweets. Using Excel processing, the tweets are filtered based on tweets with specific geolocation while removing duplicate tweets from the same user. As a result, about 10332 tweets remained from the obtained data, which represents approximately 52% of the original tweets.

4.4. Data visualization

Following the filtering of the required data, this stage focuses on mapping the resulting 10332 tweets. Utilizing Power BI processing, alongside Mapbox and OpenStreetMap tools, the tweets are mapped based on their geolocation. Visual filters are applied to generate a heat map, whereby tweets that are closer together appear denser than those that are more spread out and less dense (Figure 5).
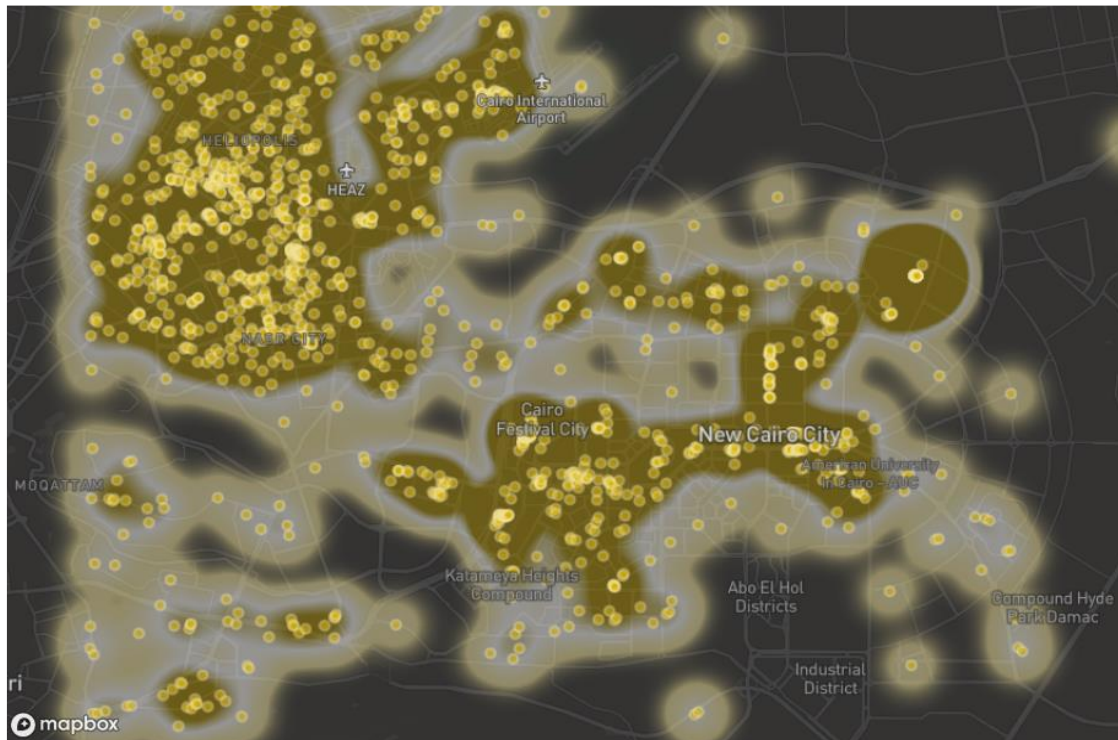

Figure 5: The heat map of filtered tweets; Nasr City to the upper left and New Cairo to the Right (the Author).

5. Results

In this study, the produced heat map of Nasr City and New Cairo heterotopias determines visually dense areas based on the density of tweets for each public space. The number of tweets was divided by the space area in acres to relate the number of tweets to the parcel size of each public space. The vital public spaces were then divided into two categories: Nodes, such as squares, plazas, and parks, and connectors, such as streets and roads (Ahmed Abdel-Rasoul et al., 2017). The study finds that Twitter activity was highly concentrated in certain parts of the city, especially public spaces as nodes and connectors, with a few central locations accounting for most geo-tagged tweets (Figure 7, Table 1). This suggests that Twitter data is closely tied to physical spaces and the urban environment.

The analysis revealed that New Cairo heterotopia consisted of more social gathering nodes compared to Nasr City Heterotopia, about 11 nodes: 6 nodes respectively. New Cairo attracted more people for hanging out activities annually, as shown by the increase in total tweets extracted from New Cairo Heterotopia in 2022 compared to 2021, while they decreased by more than half in Nasr City Heterotopia (Figure 7). This suggests that New Cairo has planned to alleviate congestion in the Cairo urban core, including Nasr City Heterotopia (Abdel-Kader, 2002; Ahmed Abdel-Rasoul, 2018; Farid et al., 2002).

In the modern city, Nodes were found to be more critical to urban vitality in Cairo City than connectors. The number of nodes was overwhelming in New Cairo Heterotopia, while connectors had low vitality measures, except for two corridors -Mohamed Naguib Axis and El-Benouk Road- assigned to a street mall and mixed-use buildings (Figure 8, Figure 9). In Nasr City heterotopia, tweets were dispersed along the heterotopia connectors, as these connectors were accompanied by mixed-use buildings that acted as street malls (Figure 10). In Cairo, the study finds that squares and plazas are most likely to be vital nodes rather than gardens, parks, and clubhouses, as these nodes are characterised by commercial and food-beverage zones.

Therefore, the findings of this study highlight the importance of public spaces in urban vitality and demonstrate how social media can be used to analyse and understand the usage and popularity of such spaces. The study concludes that social media data can be a useful tool for planners and policymakers in understanding public space use and user preferences.
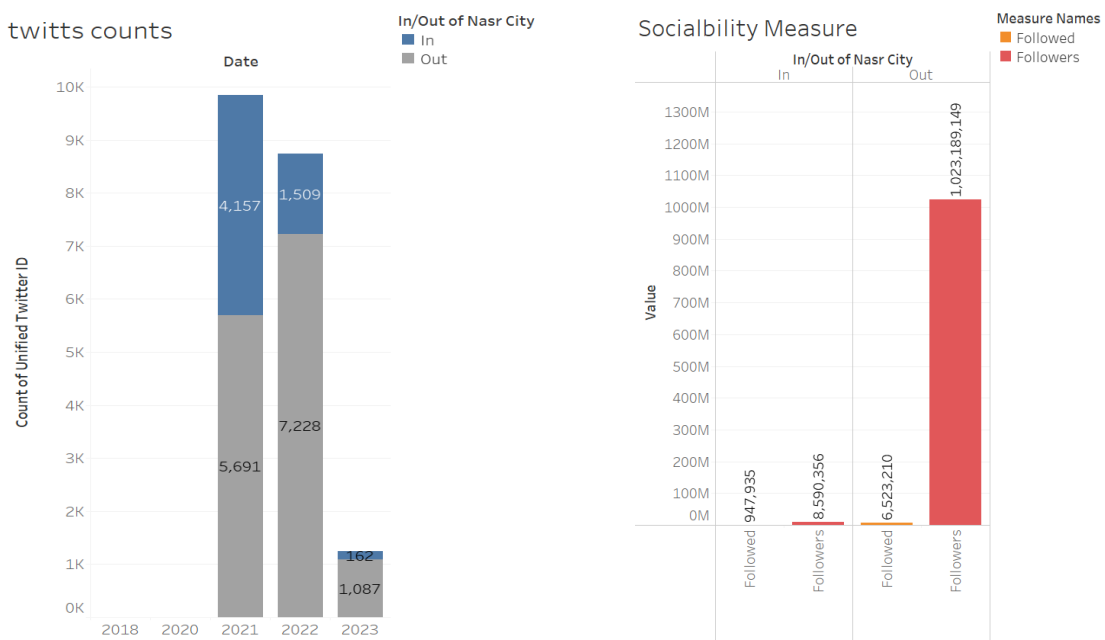
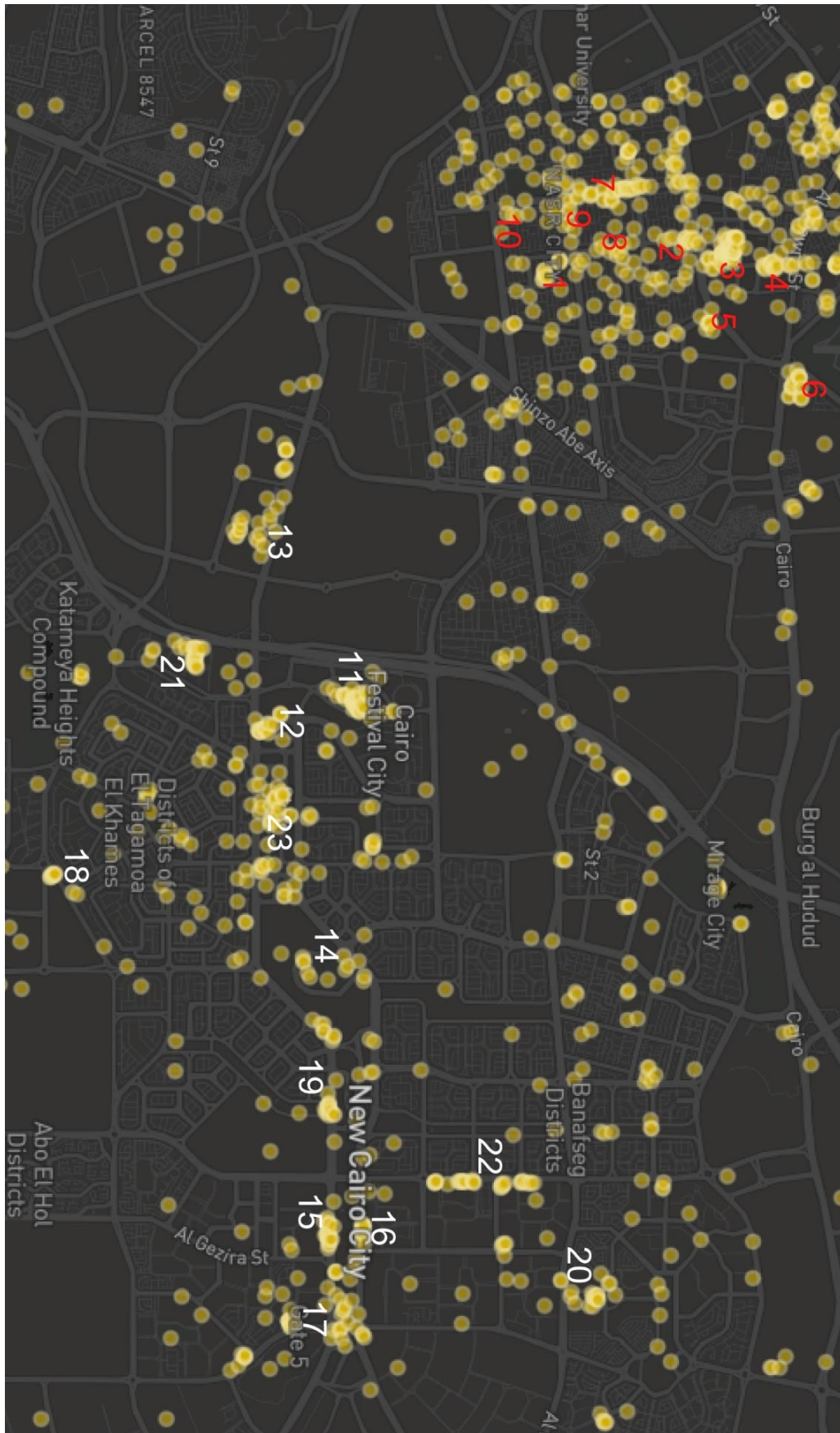**Figure 6: The retrieved tweets and sociability measures (the Author).**

Figure 7: Tweets density map: Nasr City vs. New Cairo (the Author).

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Public space Typology	Name	Tweets density (tweets/acres)
Nasr City Nodes	1. Al-Serag Mall	4.58
	2. City Centre Mall	5.88
	3. City Stars Mall	6.87
	4. Tivoli Plaza	3.70
	5. Al-Ahly Sporting Club	0.60
	6. Al-Maza Mall	1.36
Nasr City Connectors	7. Abbas Al-Aqad Street	3.78
	8. Makram Abid Street	2.15
	9. Mustafa Al-Nahas Street	1.18
	10. Ahmed Al-Zomor Street	0.81
New Cairo Nodes	11. CFC Mall	5.04
	12. Katameyia Downtown	3.00
	13. International Exhibition Land	0.38
	14. Petrosport Club	0.35
	15. Concord Plaza	7.56
	16. White Mall (Waterway)	10.15
	17. Point 90 Mall	5.10
	18. Arabella Plaza	1.68
	19. Teleperformance Plaza	5.25
	20. Rehab Shopping Market	1.13
	21. The Drive-by & 5A Mall (Water Way)	3.27
New Cairo Connectors	22. Mohamed Naguib Axis (From Salem Hegazi to Ahmed Rizk)	3.99
	23. El-Benouk Road	5.13

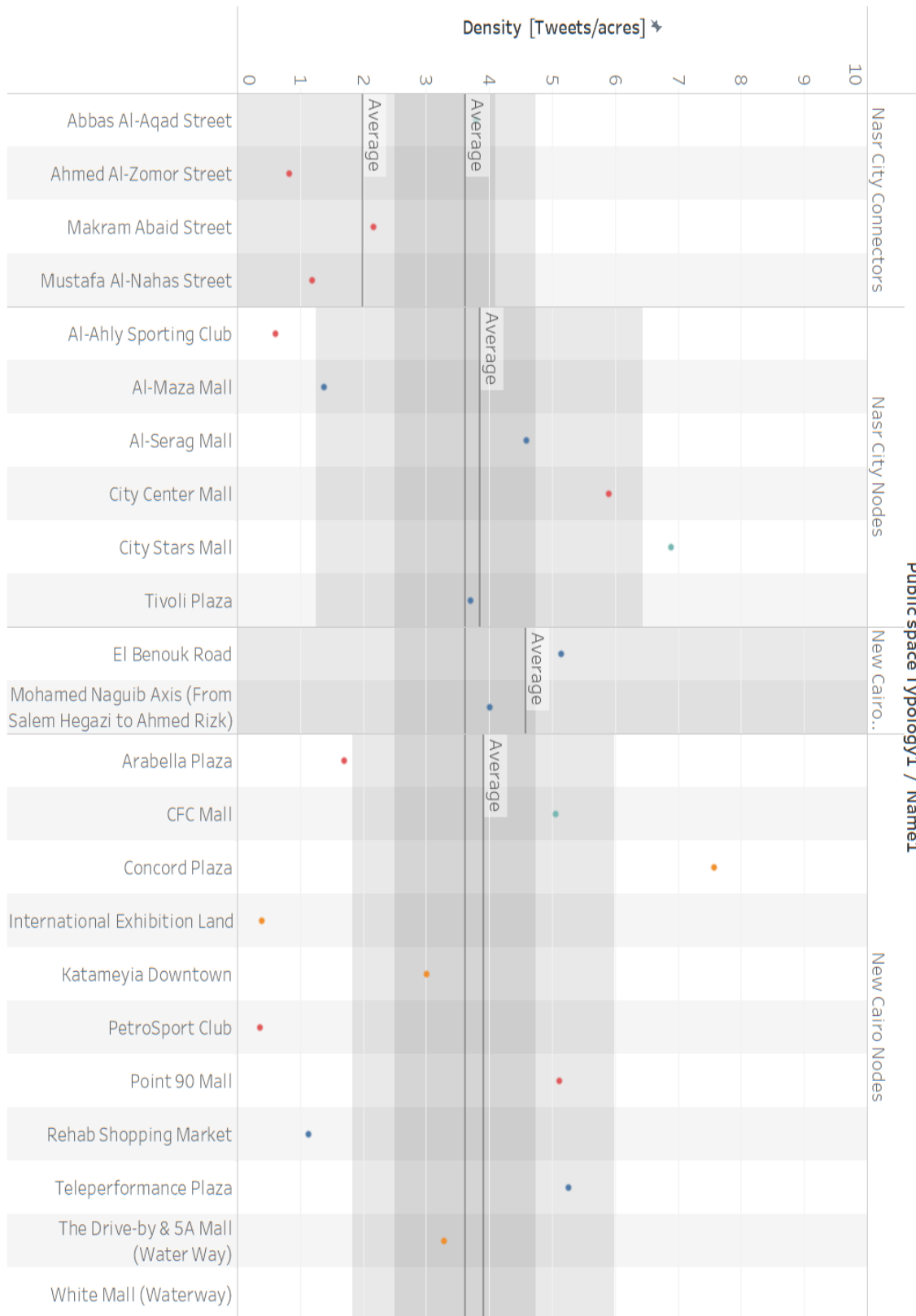**Table 1: Public spaces vitality rank in Cairo based on tweets density (the Author).**

Figure 8: Vitality mean across Nasr City and New Cairo Heterotopias (the Author).
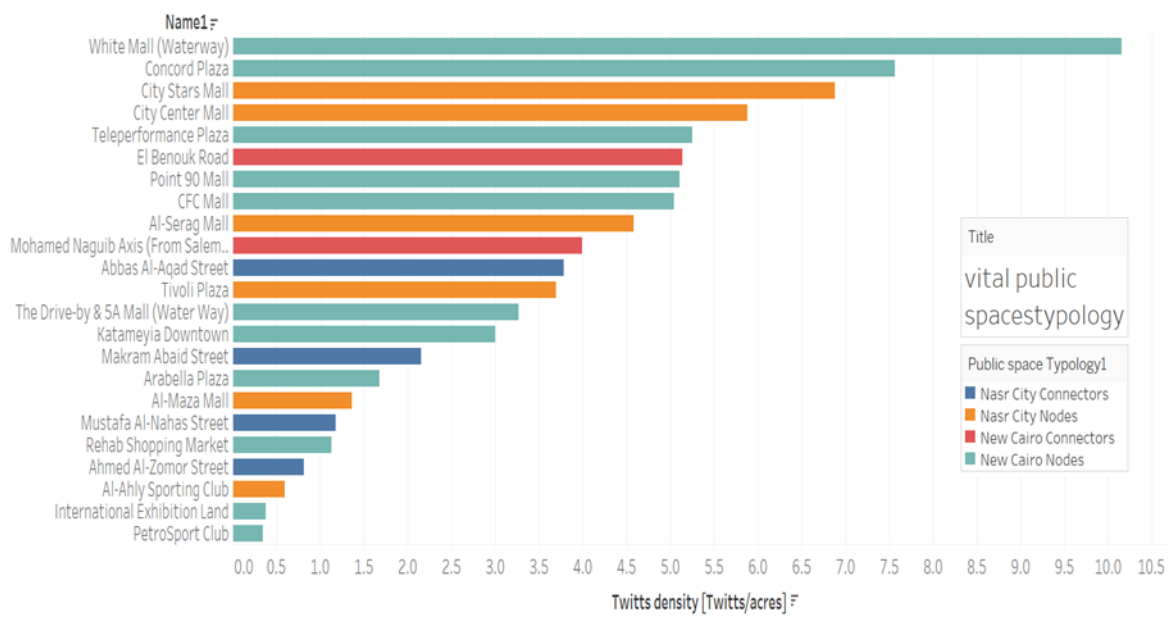
Figure 9: Ranking vital public spaces categories across the two heterotopias (the Author).
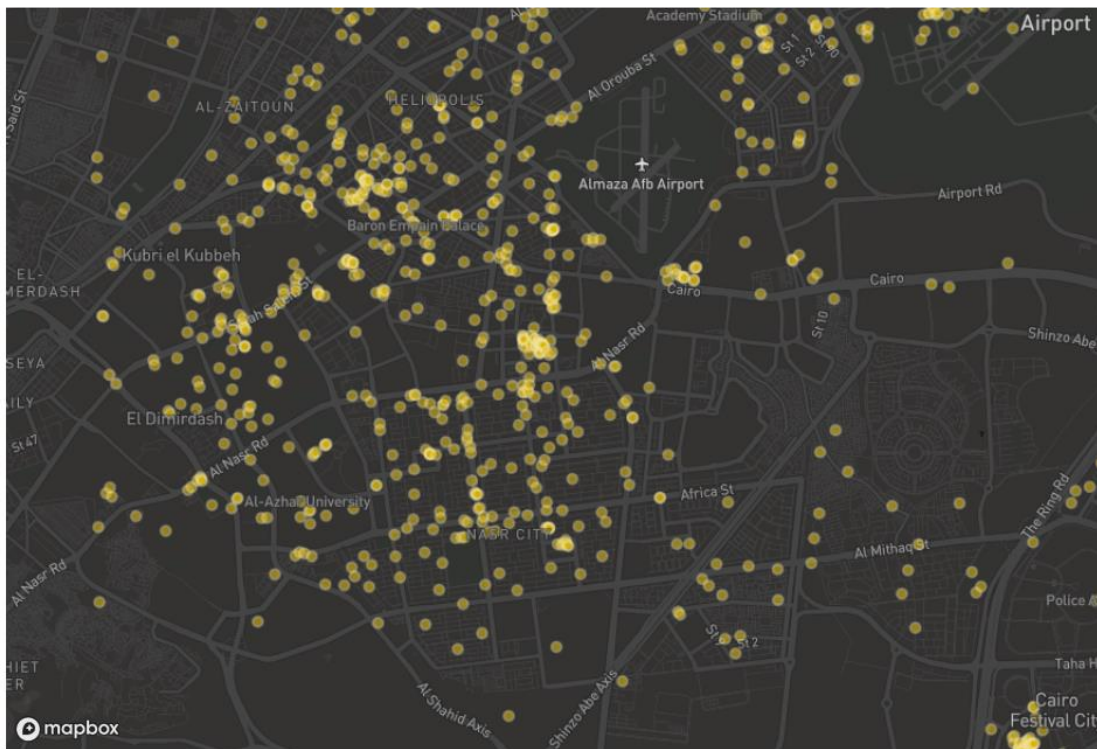

Figure 10: Dispersed tweets along connectors of Nasr City (the Author).

6. Discussion

The study's findings are consistent with previous research that has shown the importance of public spaces in urban vitality. The study by Abdel-Kader (2002), Abdel-Rasoul (2018), and Farid & El Shafie (2002) have demonstrated the significance of public spaces in enhancing social interaction and community engagement in the urban environment. The current study extends these findings by using social media data to better understand the usage and popularity of public spaces.

Furthermore, the study's findings are consistent with the argument put forth by Abdel-Rasoul et al. (2017) that New Cairo heterotopia consists of nodes of public spaces playing a vital role in social activities of the community. The current study's analysis shows that New Cairo has a higher number of social gathering nodes than Nasr City, indicating that it attracts more people for hanging out activities annually. This result is in line with Erturan & Aksel (2022) argument that connectors were accompanied by mixed-use buildings that acted as street malls which emphasized that urban vitality is a product of the diversity of urban function and commercial activities that are crucial for social activities.

Finally, the study's findings align with the argument made by Iranmanesh & Atun (2018) that social media activity is closely tied to physical spaces and the urban environment. The current study uses Twitter data to demonstrate that Twitter activity is highly concentrated in certain parts of the city, particularly in public spaces as nodes and connectors, indicating the close relationship between social media activity and physical spaces in the urban environment. The study also supports the conclusion by Kim et al. (2018) that there is a potential for using social media in the design and evaluation of public spaces.

7. Conclusion

The present study provides evidence that Twitter API is an effective means for mapping vital public spaces in urban areas. By providing real-time geotagged data that reflects people's choices and presence in different public spaces, the tool enables researchers to identify the most frequented locations in the city. Additionally, this study sheds light on the significance of different nodes and connectors in enhancing urban vitality. Specifically, it highlights the importance of vital nodes, such as squares and parks, in comparison to connectors, such as streets and roads, in shaping the modern city.

Furthermore, the study offers an insight into the main vital nodes across Cairo city, revealing that plazas and squares existing within shopping malls and street malls are the most frequented public spaces. This finding has practical implications for urban planners and policymakers, who could use this information to develop more attractive public spaces that enhance the quality of life for residents and visitors alike.

However, it should be noted that Twitter API may not be useful for studying informal urban areas, as it is not a common platform for socializing among their inhabitants. Therefore, the research recommends exploring other digital social networks, such as Snapchat, Facebook, and Flickr APIs, to further investigate the vitality of public spaces in such contexts.

8. References

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