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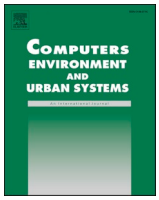

Informal participation in digital planning: How can third parties use social media to shift power relations in planning?

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ABSTRACT

In recent years, social media has become an influential tool for engaging various participants and facilitating inclusivity in digital planning. While many studies highlight local governments' use of social media for formal participation, limited research assesses its impact on power dynamics in informal participation. This study aims to fill the gap by identifying key features of social media that facilitate informal participation and applying Castells' four forms of network power to understand power dynamics among civil society, journalism, citizens, and governments in planning processes. It also develops a novel mixed-methods approach that combines social media scraping, social network analysis (SNA), semi-structured interviews, and field observation. This approach is applied to investigate the Enning Road regeneration project in Guangzhou as a case study. Analyzing data from China's Weibo, the study reveals network disputes across three dimensions: graph, community, and network statistics. Hyperlink-Induced Topic Search (HITS) and community detection results suggest that civil society and journalism have substantial networked power as they strategically utilize social media to promote collaboration, mobilize citizens, and foster communities. They also excise network-making power by switching online and offline networks, thereby transmitting online debate to a wide range of audiences and compelling local governments to shift planning priorities from demolitions to preservation.

1. Introduction

Digital transformation in urban planning is emerging in conjunction with technological developments, the emergence of digital datasets, multiscale digitalized planning projects, and the high needs of professionals (Batty and Yang, 2022). In such a context, various digital technologies are being applied to enhance inclusiveness, equality, and efficiency in planning processes at different scales and contexts. Although the use of technological tools such as planning support systems, participatory platforms, and apps may add value to planning processes, there is often an implementation gap due to the mismatch between supply and demand, usability issues, the threshold for participation, and the digital divide (Geertman and Stillwell, 2020; Lin and Benneker, 2022; Pelzer, Geertman, and van der Heijden, 2015). The growing popularity of social media shows a potential to bridge this gap due to its ease of use. Despite not being a specifically designed instrument for planning, social media has recently become a popular tool to capture a broad audience in digital planning because of its citizens-oriented features, such as connectivity, accessibility, and interactivity (Anttiroiko, 2021). However, some scholars argue that social media participation may lead to negative consequences such as shaping bias, disseminating fake information, and reinforcing authoritarian censorship (Lin, 2022; McKay and Tenove, 2021; Poell and Van Dijck, 2015; Ruths and Pfeffer, 2014). Despite these potential issues, social media have increasingly affected planning practices. On the one hand, different social media platforms have been used by local governments in many countries such as the Netherlands, Australia, the United States, and China as a participatory tool to disseminate planning information and collect feedback from citizens (Lin, 2022; Williamson and Ruming, 2019). Formal participation through social media is frequently initiated by governmental entities or professionals, regulated by policies, and embedded within institutional frameworks (Lin and Kant, 2021). Nevertheless, social media are usually used as an opinion-gathering tool or information dashboard. The power of citizens is low and related to the levels of consultation and placation according to Arnstein's ladder of citizen participation, since the final decision is still in the hands of the government and experts (Lin, 2022). On the other hand, social media has been used in bottom-up initiatives, especially in controversial

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planning contexts, to challenge the decisions of governments (Deng, Lin, Zhao, and Wang, 2015; Poell and Van Dijck, 2015). Informal participation through social media can be initiated by civil society, the media or citizens. It emphasizes informal discussions and debates online, often occurring outside formal participation procedures (Cao, 2022). Comparing it with formal participation controlled by governments, to some extent, informal participation can enhance social inclusion due to the engagement of marginalized social groups and civil societies who are otherwise unable to participate (Lin, 2022). Yet, some scholars argue that even though social networks can facilitate non-hierarchical, flat, and collaborative approaches, they often fail to change existing power inequalities between governments and societal actors (Goel and Vishnoi, 2022). A recent study also indicates that the effectiveness of social media in challenging power relations depends on the planning stage at which it is applied (He, Lin, Hooimeijer, and Monstadt, 2024). Although there has been a growing scholarly interest in the role of social media in participation, few studies have been conducted to measure the impact of social media on power relations in the informal participatory process.

Recent study implies that social media has changed the nature and intensity of public participation since it provides a new platform for citizens to engage in urban issues, express their voices, and interact with the government (Mukhtarov, Dieperink, and Driessen, 2018). This is because social media is featured as mobilized, networked and real-time (Kleinhans, Van Ham, and Evans-Cowley, 2015; Soon and Cho, 2011). Hence, it is able to facilitate easy channels of communication and lower the threshold for ordinary citizens to informally participate in public affairs (Potts, Riddle, Hollander, and Hartt, 2024). Some scholars argue that social media cultivates a networked public sphere that distinguishes it from the Habermasian public sphere (Friedland, Hove, and Rojas, 2006). In such a sphere, civil society and marginalized groups are connected and can participate actively in planning discussions, enhancing the opportunities for collective actions (Lin, 2022; Tayebi, 2013). Nevertheless, it remains questions whether social media can promote equal and inclusive participation since they facilitate the coexistence and intersection of the public sphere and micro-publics, emphasizing thematic debates among small/certain groups rather than the general public (Bruns and Highfield, 2015; Lin, 2022). Furthermore, some critics point out that surveillance and bias in social media can lead to a wide range of negative consequences (Poell and Van Dijck, 2015; Stockmann, Luo, and Shen, 2020). Moreover, few recent studies indicate that social media may generate new forms of power inequality influenced by the different positions of actors within a network (e.g., He et al., 2024; Zhao, Lin, and Derudder, 2018). Further research is needed to measure these emerging power dynamics and their relationship with the micro public.

This study explores whether and how social media enables a shift in power relations between government and societal actors in informal participation processes. The contribution of this study is twofold. Theoretically, we identify critical features of social media that facilitate informal participation and apply Castells' four forms of network power to understand power dynamics among third sectors, citizens, and governments. Methodologically, we develop an innovative mixed-methods approach that combines social media scraping, social network analysis (SNA), semi-structured interviews, and field observation. This approach is applied to investigate the renovation of Enning Road in Guangzhou, China. We collect data from the Chinese social media platform and then apply several SNA metrics to measure the new forms of power relations generated by social media. Especially, we measure the ego-network and community scales of third parties. In our research, third parties includes journalism and civil society organizations. We apply Hyperlink-Induced Topic Search (HITS) to compare the hub and authority of different actors in the network. Combining these findings with those from fieldwork, we can identify the substantial power of third sectors and the mechanisms by which they influence offline decision-making in planning processes.

The article is structured as follows. Section 2 is a literature review of social media for informal participation, network power, and SNA. Section 3 explains the methodological approach. Section 4 is the case study in Guangzhou and the results of analysis. Finally, Section 5 critically summarizes the complex influences of social media on planning and discusses the challenge of social media participation.

2. Literature review

2.1. Social media for informal participation in digital planning

Digital technologies have facilitated a transformative digitalization of planning, enhancing efficiency and enabling more inclusive processes that engage stakeholders and the wider public. Recent studies have shown the increasing influence of social media on participatory and collaborative planning practices (Lin, 2022; Mattila and Nummi, 2022; Williamson and Ruming, 2020). Batty and Yang (2022) argue that social media is the collective term for accessible interactive technologies that can be used on desktops and smart devices to connect different users, and its utilization is not exclusive to social networking purposes. Anttiroiko (2021) indicates that a social media approach to planning may enhance active participation since it puts citizens at the center of planning-related value creation and knowledge processes and facilitates communication, information sharing, social networking, and crowdsourcing. Nevertheless, the impacts of social media on planning practice varies from context to context, influenced by contextual factors such as the political institutions, the dominant actors, the participants, and the intervention time (Gil de Zúñiga, Koc Michalska, and Römmele, 2020; Gilardi, Gessler, Kubli, and Müller, 2022).

Social media is often used by government as a tool in formal participation. According to Arnstein (2020, p 711), public participation is "the redistribution of power that enables the have-not citizens, presently excluded from the political and economic processes, to be deliberately included in the future." It can be divided into different levels on a participation ladder. Pflughoeft and Schneider (2020) argue that social media have the potential to fulfill many different participation needs, including informing, consulting, involving, collaborating, and empowering citizens to influence decision-making. Formal participation is an officially authorized and implemented public participation initiative, typically performed in parallel with information disclosure and acting as a public information-gathering approach (Bertot, Jaeger, and Hansen, 2012). Social media's functions enable users to orchestrate the themes and contents, raise questions and forward posts, and establish virtual communities (Mattila and Nummi, 2022). Recent practice has documented that many governments and planners in Australia, China, and the Netherlands have used social media to support formal public engagement (Lin and Kant, 2021; Williamson and Ruming, 2019). However, social media is usually applied as an opinion-gathering tool or information dashboard rather than a digital tool with a vital interaction function in formal participatory processes (Fredericks and Foth, 2013; Lee and Vandyke, 2015; Williamson and Ruming, 2020). Non-state actors are often situated in a low position of power, corresponding to nominal consultation on Arnstein's participation ladder (Lin and Kant, 2021). This is because authorities tend to deliver information and collect feedback rather than engage in dialogue with citizens. Besides, the government can decide the extent to which to take participation input (Lin, 2022; Lin and Kant, 2021). From this perspective, social media appears to be a new tool to enhance governance efficiency through formal participation, often lacking substantial citizen empowerment.

However, social media also holds the potential to empower societal actors to step up the participation ladder through informal participation because it can efficiently reach the general public and achieve influence outside the traditional planning process (Deng et al., 2015; Poell and Van Dijck, 2015; Tayebi, 2013). At the same time, informal participation implies a way for actors to question planning decisions spontaneously and outside formal planning agendas (Deng et al., 2015). Referring to Damurski's (2015) and Hillier's (2000) study on informal strategy and communication, the informal strategy involves independent actions initiated outside the official planning institutions. We define informal

participation as actively participating outside the formal avenue and challenging original planning decisions with actors' self-organization. Recent studies have shown a growing trend of third-sector actors using social media to influence planning decision-making or spark public controversies (Deng et al., 2015; Lin, 2022; Tayebi, 2013). Civil society organizations, journalists, and professionals use social media to share information, influence public opinions, and challenge government decisions (Yang, 2018; Zhao et al., 2018). As an informal public participation tool, social media has been used in bottom-up initiatives, especially in controversial planning contexts, to challenge top-down planning decisions (Deng et al., 2015; Poell and Van Dijck, 2015). Three critical features of social media have made it a tool to support informal participation. First, social media is designed for instant communication rather than a formal engagement process (Poell and Van Dijck, 2015). The real-time flow of information in social media allows for effective information dissemination and transparency in decision-making processes (Polívka and Reicher, 2019). Unlike the traditional top-down model, which relies on a single source and direction, social media enables real-time information exchange in horizontal networks, allowing more bottom-up information and voices to be heard in urban planning (Deng et al., 2015). Second, social media is designed for the general public rather than specific authorities or professionals, characterized by ease of use, low cost, and high accessibility (Lin and Kant, 2021; Willems, 2021). Compared to formal participation methods like on-site workshops, social media participation is more feasible for individuals, as users can actively produce, share, and discuss content related to planning events anytime and anywhere. Unlike many planning support tools that require training or specific skills, social media is user-friendly, enabling it to capture a wider audience of participants (including marginalized groups) and augment public participation (Fredericks and Foth, 2013; Lin, 2022). Third, the open nature of social media has enabled individuals and organizations to establish new networks or expand their existing networks, enabling crossing geographical boundaries for collective actions (Lin, 2022; Zhao et al., 2018). It is easy for non-governmental actors such as citizens, civil society, and journalists to develop communicative and interactive networks and influence online discourse in planning processes (He et al., 2024).

Nevertheless, as a double-edged sword, social media also entails specific challenges. There may be bias and disinformation in social media, leading to false content being incorrectly perceived by the public as mainstream views (McKay and Tenove, 2021). Vulnerable groups, such as the elders and even stakeholders who are not proficient in using social media, may lose their voices in social media participation (Deng et al., 2015; Robinson et al., 2015). Furthermore, in authoritarian contexts, widespread censorship in social media may significantly limit the space for discussion of public affairs (Lin, 2022). Moreover, social media has created micro-publics on specific topics or themes rather than the general public (Bruns and Highfield, 2015). Therefore, the extent to which social media can enhance an inclusive and equal participation remains questionable. Although there is growing scholarly interest in the impact of social media on citizen participation, it remains unclear whether and to what extent social media can challenge power relations in planning practice. Additionally, existing planning research has noted the significance of network power in planning practice but mainly focuses on offline, formal public participation. (Fang, Wen, Zhang, Erlebacher, and Staley, 2023; Kim, Chung, and Lee, 2019; Lienert, Schnetzer, and Ingold, 2013). There is a lack of assessment of power relations in social media-enabled informal participation through the perspective of network power.

2.2. Social media and network power

According to Castells (2011), power is exercised through networks in the networked society. Social media facilitates the creation of horizontal networks of interactive communication, fostering the effective flow of information and encouraging citizen actions (Castells, 2010). It is difficult for the state to control such networks, which provide a platform for constructing the autonomy of individuals or social organizations (Castells, 2015). With these remarkable features, social media has become the vehicle of the networked society and has given rise to a virtual public sphere (Castells, 2015). Invoking cases from Iceland, Spain, Greece, and the United States, Castells, Fernandez-Ardevol, Qiu, and Sey (2009) outlined the hidden power behind online social networks and their power to bring people together to generate change. Recently, cases from China have shown that online social networks can also demonstrate influence on public affairs in authoritarian contexts (Zhao et al., 2018). Emotional expression and counter-narrative communication in new media destabilizes the traditionally understood planning process and emerge in planning matters in a way that challenges pre-existing power relations (Trapenberg Frick, 2016).

In this study, we apply the network power theory (Castells, 2011a) to understand various forms of power generated by social media platforms in participatory planning. Castells (2011b) has classified network power into four categories: networked power, network-making power, network power, and networking power. Table 1 shows the definitions of the four types of power.

Therefore, power can be differentiated by including or excluding from the network, actor's positions in the network, rules in the network, and actor's capacities for programing and switching networks. First, networked power describes the power within a network and assumes that different individuals in a network share different levels of power. Elites, third parties and professionals, who have more connections in social media, can become power centers of the network, as indicated by their centrality metrics (Zhao et al., 2018). Second, network-making power distinguishes the power to program and switch different networks according to the interests of dominant actors in various networks. This power is associated with the capability of actors to switch their roles across various networks, both online or offline. Critical actors, like journalists, can transit through different networks, such as online and offline networks connecting different participants. Third, network power is exercised not by exclusion from the networks but by imposing rules. For instance, authoritarian governments have higher network power to regulate and censor social media platforms (Zhuravskaya, Petrova, and Enikolopov, 2020). Fourth, networking power emphasizes not being included in a network, such as the lost participatory potential of stakeholders who cannot use social media (Deng et al., 2015).

The four forms of network power provide a helpful framework for understanding power relations generated by social media in urban planning. Few recent studies show that networked power, in which experts and civil society played an more influential role, could be formed in Chinese social media (He et al., 2024; Zhao et al., 2018). However, there is a lack of research on the other three forms of network power. A broader perspective is also needed to examine how power generated by social networking sites challenges existing power structures and reshape the power relationships between third parties (e.g., media, and civil society), citizens and government in decision-making processes. Actors with who have multiple identities and participate in various networks

Table 1
Four types of network power (Castells, 2011a).

Type of power	Definition
Networked power	The form of power exercised by certain nodes over other nodes within the network
Network-making power	The power to program specific networks according to the interests and values of the programmers, and the power to switch different networks following the strategic alliances between the dominant actors of various networks.
Network power	The power resulting from the standards required to coordinate social interactions in the networks.
Networking power	The power of the actors and organizations included in the networks that constitute the core of the global network society over human collectives and individuals who are not included in these global networks.

may use social media to expand their influence, thereby gaining network-making power. States and social media companies can also acquire network power by setting norms and rules that constrain online communication on social media platforms. Moreover, power studies are rarely associated with the concept of networks, and there is limited research that quantitatively measures power relations in networks (Fang et al., 2023; Kim et al., 2019; Lienert et al., 2013). Social network analysis offers promising theoretical and methodological potential because of its focus on social interactions.

2.3. Social network analysis

Network science provides a new approach to measuring power relations quantitatively. Social media enables online protests and actions and facilitates the establishment of informal communication networks (Freelon, McIlwain, and Clark, 2018). According to Fuchs (2009), power relations are established through communication and creating a shared understanding of what constitutes power. This indicates that evaluating and measuring network power in communicative networks is possible. Some planning research suggests that by treating actors as nodes and interactions as edges, networked power can be measured with SNA on specific networks (He et al., 2024). As Scott (2011) states, SNA is both a theoretical perspective on how the interactions of actors shape social structures and a set of techniques for measuring interactions between actors in a network. It allows for identifying, measuring, and analyzing structural influences in planning practice (Dempwolf and Lyles, 2012). Some studies have leveraged SNA to evaluate power relationships in stakeholder networks related to governance activities, communication networks in economic development, and community networks in urban regeneration (Fang et al., 2023; Kim et al., 2019; Lienert et al., 2013). However, these studies primarily rely on traditional datasets such as interviews and survey. Planning controversies in social media platforms, including users' interactions (e.g., retweets and comments), provides new data sources for SNA. A recent study by He et al. (2024) demonstrates that SNA can be utilized to measure the inequality of networked power generated by social media in planning controversies. Nevertheless, it remains unclear how this inequality relates to the microstructure of a network, such as communities and primary-giant networks within the overall network. Moreover, the existing studies that use SNA for power analysis often emphasize the degree of centrality and betweenness centrality (Smith et al., 2014). Scholars argue that this classic SNA approach to power analysis tends to be simplified and may lead to a neglect of the complexity of power (Kent, Sommerfeldt, and Saffer, 2016). There is also a lack of study on measuring micro-publics in social media, and there is limited understanding of whether they exercise different forms of power. Therefore, examining power relations on a more detailed cluster scale, including community detection and egocentric network (ego-network) analysis, is necessary.

In SNA, communities are defined as clusters formed by aggregating nodes with the help of community detection algorithms, a collection of a class of actors with strong ties and similar behaviors in a given network. Community detection methods include traditional algorithms, modularity-based algorithms, dynamic algorithms, spectral algorithms, and so on (Fortunato, 2010). Due to the small size of the planning controversy network and its bottom-up progressive emergence, the classical Girvan-Newman (GN) Algorithms are used in this study to delineate the communities, which is a modularity-based algorithm. Compared to other algorithms, this algorithm applies to the network with no more than thousands of nodes by bottom-up detection of small communities and upward aggregation, eventually leading to a stable community delineation (Javed, Younis, Latif, Qadir, and Baig, 2018). It has been noted that the pattern of information dissemination in online social networks is closely related to the structure of the user's ego network (Arnaboldi, Conti, Passarella, and Dunbar, 2017). Attention to the ego network in social network analysis helps identify the actors' initial communicative capacity in the network development process. In addition, recent research demonstrates that given the large number of actors in an online dispute network, actors may play different roles in the information flow (He et al., 2024). Therefore, the Hyperlink-Induced Topic Search (HITS) method is introduced in this study to identify the authority and hub nodes. This metric is used to identify and rank the most influential nodes. It has the advantage of taking into account both the direction of information flow and differentiate valuable nodes into two types: catalogue-type nodes with useful information and sourcing-type nodes with original information (Saxena & Jadeja, 2021). For example, the classical centrality (e.g. degree centrality) of node B is usually higher when B's forwarding of node A's content results in a large number of forwards. However, this does not imply that node A's content lacks importance. The algorithm calculates two values for a node: its authority, which estimates the value of the node's content, and its hub value, which estimates the value of its links to other nodes (Kleinberg, 1999). Each node will be assigned the parameters of authority and hub based on the connectivity pattern with other nodes. A high authority value means a node is targeted by many nodes with a high hub value. A high hub value means a node is targeted to many nodes with a high authority value. Since these two types of nodes promote each other, it can also be further verified if there is a pattern of cooperation between the two nodes.

3. Methodology

This study employs a mixed-method approach that combines the quantitative measurement of social media data with qualitative research through interviews. The strength of mixed methods lies in their ability to retrieve authentic information by combining both types of information sources and thereby enhancing the robustness of the findings and allowing for a comprehensive restoration of story development. A mixed-method approach is particularly suitable for empirical studies with smaller spatial scales and longer time spans of the case, as it allows the collection of multiple pieces of evidence (thick data) to thoroughly review the dynamics of event development (Bornakke and Due, 2018). Despite the strengths of our mixed-method approach, we acknowledge limitations in our approach. The data captured from Weibo and interviews only partially reflected the entire controversial story regarding the regeneration of Enning Road.

As shown in Fig. 1, this study developed an innovative mixed approach consisting of six steps: information targeting, post-chain collection, data preparation, network visualization, parameter calculation, and interviews and examination. Through keyword searches on Baidu (the Chinese search engine) and Weibo (the Chinese blog social media platform), we first identified the key message and the main social media accounts on Weibo related to this planning controversy. We then scraped all the retweets and attached short comments related to the key message from a key public account. For privacy and data protection purposes, the data were subsequently anonymized to remove any personal information. After cleaning and organizing the collected data, we graphed the network and calculated centrality metrics, modularity metrics, and HITS metrics to measure the strength of power relations, community differentiation, and information flow patterns. By combining the results of these calculations with those from fieldwork, we were able to examine different forms of power among third parties, citizens, and governments, as well as the mechanisms by which third parties influence offline decision-making. Quantitative analysis of social media data can be validated through semi-structured interviews and field observations.

3.1. Information targeting, post-chain collection and data preparation

This study collects digital data from the social media platform - Chinese Weibo. We used web crawlers (Locoy) to extract data from related public accounts on Weibo. The collected data includes text content and forward relationships regarding the planning controversy

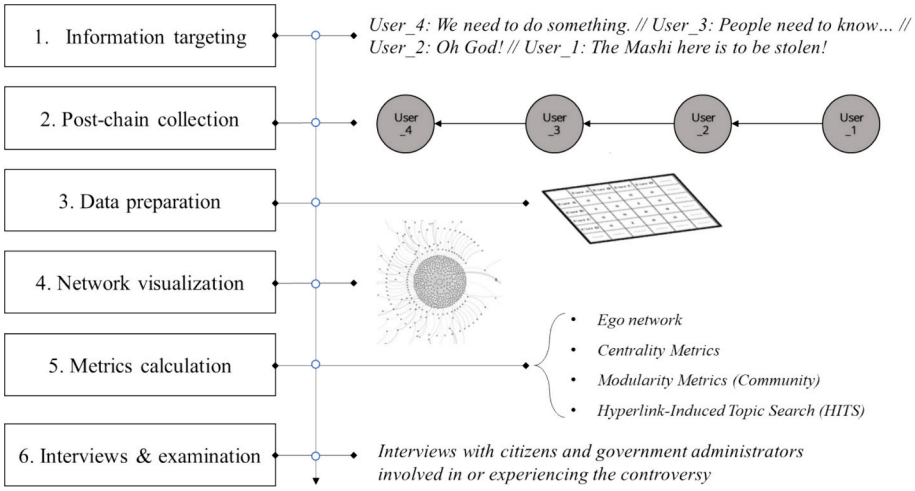

Fig. 1. Research methods.

about the protection of Mashi Street. When user A forwards user B's content, this is counted as one forwarding interaction, a so-called edge. Therefore, this research uses a directed and weighted graph. User C can forward B's content again. Hence, a large number of forwards generates a network. A typical posting forwarding chain which is stored as follows:

User_4: We need to do something. // User_3: People need to know… // User_2: Oh God! // User_1: The Mashi here is to be stolen!

Starting from a post related to Mashi Street posted by the public account "Watching Enning" (a public account on Weibo which was established by a civil society organization), we collected 1038 retweets, corresponding to 1038 edges. Similar to Tweets, retweets on Weibo contain information about the retweeter. According to manual verification, the main controversy surrounding Mashi street centers on the posts from this specific social media account. There is no general hashtags in the targeting posts, and fuzzy-search cannot accurately scrape the posts. Therefore, we used this public social media account, rather than hashtag, to acquire data. After segmenting the text by recognizing specific separators, we identified 1147 non-duplicate users regarded as actors. Therefore, this network contains an abundance of nodes. The forwarding relationship data is stored in a matrix. We further anonymized all the users and assigned random unique codes. A node and edge files were finally prepared as a basis for network visualization and calculation.

3.2. Social network visualization and calculation

This study applied social network analysis (SNA) to measure interaction between network actors (nodes). We used Gephi as the software platform for SNA mapping and analysis. After importing the edge and node files into Gephi, we first generated a colored timeline network with a statistic on the number of New Edges Per 10 Minutes. Such a network allowed us to trace back the full development of the controversy and identify dramatic changes of the forwarding network in a short period. Subsequently, we extracted Ego Sub-networks for further analysis. An ego network is a microstructure of a social network that is typically stratified according to social intensity (Arnaboldi, Conti, La Gala, Passarella, and Pezzoni, 2016). In this study, the ego network covers nodes directly connected with a target node (depth is one). The ego network corresponds to a sub-graph for a given node where only its adjacent neighbors and their mutual links are included. It expresses more precisely the local environment of a node than the sole order (degree).

First, we calculated different types of nodes' Degree Centrality and Betweenness Centrality to represent the power relation according to information flow within the network (See Table 2). Centrality metrics focus on both the number of forwarding messages and the position of node. The Degree centrality is the number of a node's connections to other nodes. Betweenness centrality is a way of detecting the amount of influence a node has over the flow of information in a graph. It is often used to find nodes that bridge one part of a graph to another.

Table 2
Indicators of centralities and HITS.

Indicators	Description
Degree centrality (DC)	The sum of the number of connections a node has to other nodes
Betweenness centrality (BC)	The capacity of an actor to control the flow of information of an online controversy network
Hyperlink-induced topic search (HITS)	The capacity of an actor to be targeted by more nodes and to target to more nodes

Second, we use the Hyperlink-Induced Topic Search (HITS) algorithm to further identify Authority and Hub nodes and investigate the information distribution or information gathering characteristics of those essential nodes (See Table 2). This measure enables us to understand some crucial actors' power and relations with potential collaborators. The centrality indicators and HITS are used to measure the importance of nodes at different weight logics, i.e., networked power.

Third, we conducted community detection based on the Girvan-Newman (GN) Community Detection Algorithm in Gephi, a greedy optimization method to extract communities from large networks. The results of the detection were that primary communities formed around different citizens, organizations, or journalists. This helps to identify the size of micro-publics in online controversy and the comparison between them. The number of actors in each community is counted and used to verify the existence of Power-law Distribution across the network. Power-law Distribution suggests that the largest entity is typically more significant, valuable, or powerful than all others combined. This enables researchers to understand the unbalanced nature of power relations in a network.

3.3. Interview, investigation and validation

In addition, field observation and several in-depth interviews were conducted to understand the case study and the influence of third parties. These provided additional information to validate the social network analysis results, which enhanced the reliability of the data analysis results. We conducted in-depth interviews with six stakeholders from June to July in 2022. Each interview lasted approximately one hour. The core questions included the process by which online

participation influences offline engagement, the role of third-party actors (including media and CSOs), and the long-term and short-term impacts of these events. The interviews were designed to validate online information and understand the impact of online participation on offline decision-making and the consequent changes in participatory mechanisms The interviewers included planners, residents, members of the civil society organizations involved in the case, and officials in the local neighborhood committee. We also visited the site, observing the current conservation status of local paving stones, the built environment features, and cultural heritage reservations.

4. Case study

4.1. The Mashi street protection movement

Enning Road is an urban area with many historical buildings in the Liwan District of Guangzhou. In 2006, the local government planned to demolish many historic buildings within the area to renew the urban landscape. It caused resistance from residents and concerns from cultural preservationists and architectural conservators. The redevelopment of Enning Road in Guangzhou is a long-term planning process involving offline protests and online communication. Citizens, civil society organizations, and the media played a significant role in this case (Huang, 2017; Tan and Altrock, 2016; Zhang and Li, 2016). The use of social media in the Enning Road case significantly amplified the impact of citizen opinion, expanding local conflicts over regeneration into broader public discussions on themes including heritage protection and cultural conservation. In 2007, the local government in Guangzhou introduced a top-down redevelopment project (without any substantive public participation) to demolish "dangerous buildings" in the Enning Road area. Residents subsequently initiated resistance against the project. Experts, civil society, and journalists used social media to create a series of public debates. The debates contributed to the change of the original urban regeneration project. Social media and media activists profoundly influenced the struggle to regenerate the Enning Road. One of the influential online debates was called the Mashi Street Protection Movement. The movement was triggered by the movement of Mashi, a kind of stone typically used for street pavement in Guangzhou. The stone symbolizes the local heritage and practical functions, such as preventing pedestrians from falling on rainy days. It evolved into a widespread protest organized by third parties with social media support. Consequently, the local government changed the original plan and compromised to preserve the street as a heritage asset. This study mainly focuses on the role of third parties in the movement.

The Protection Movement was a crucial milestone for the ongoing Enning Road regeneration project (which started in 2007). It took place in the early stage of the project's implementation. It was highly controversial because the residents opposed the rough and unacknowledged demolition process. Residents complained about the abrupt demolition and the inadequate compensation. Some professionals and third parties later joined the debate of this urban regeneration project. The movement effectively stopped the government's attempts to change the traditional road into a new plaza. Local authorities were forced to work with the local university to preserve the stones and other heritage elements. In the process, Weibo, a leading Chinese social media platform, was widely used by third parties to disseminate information about Mashi Street. It created a network that reached many actors, affecting local government's decisions on the plan. The residential area on the north side of Enning Road included many long stone-paved streets (Fig.2), thirteen of which were officially defined as valuable for conservation after the movement.

4.2. Informal participation in social media

In August 2012, residents in the Enning Road area noticed that the demolition team was removing the original paving stones around their homes. They were informed that these stones were removed to create a commercial plaza. This activity of destruction led to protests from both residents and civil society. Civil society organizations (CSOs), journalists, and citizens used social media to initiate debates in the network and express their dissatisfaction with demolition activities without a public participation component. The following Fig. 3 presents the development of the online controversy in a network graph with gradient coloring from green to red.

In Fig. 3, the largest node of the network represents a journalist, while the second largest node is a CSO -Watching Enning. The information dissemination began with a post from the CSO account: "*Emergency call! Save Mashi Street first! Please add the word 'STOP' and all*

Fig. 2. The stone-paved street (Photographed by the first Author in 2022).

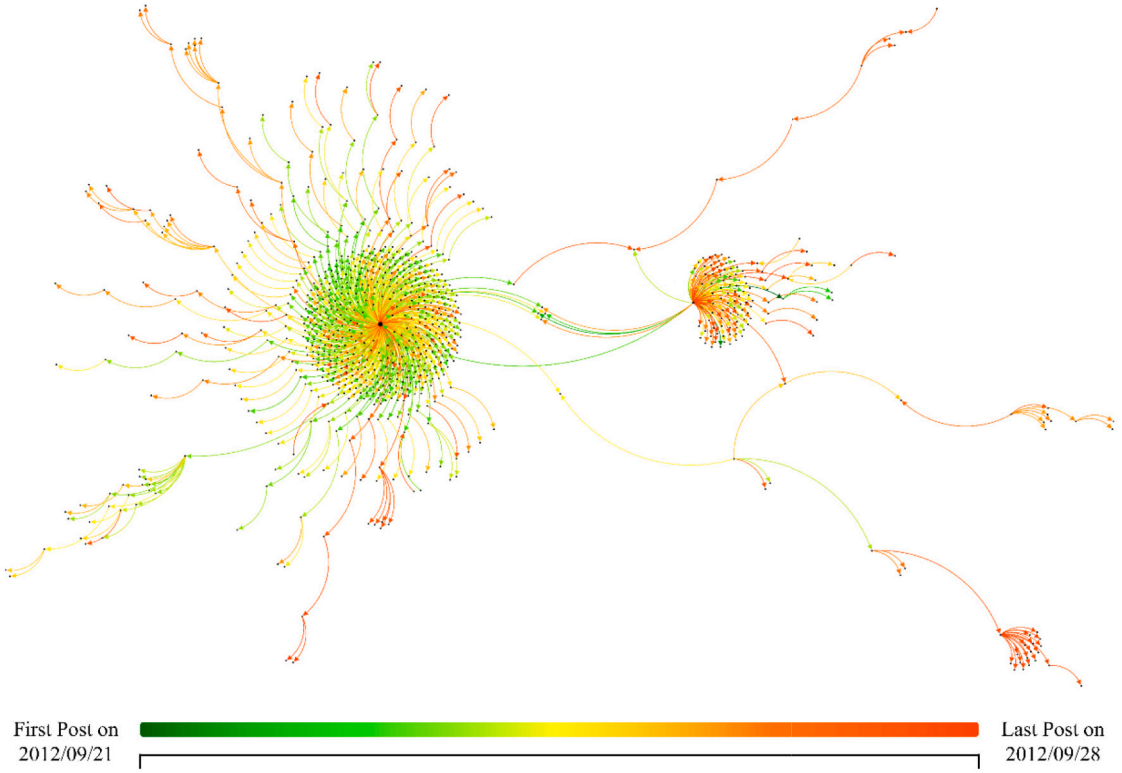

Fig. 3. Network development of the online controversy. (The colors is based on the timeline between September 21 to September 28, 2012 by Bézier curves)

neighbors forward it please! …… Enning Road is Guangzhou's! Stop!". This post was subsequently shared by a journalist account around 17:00 on September 21, 2012, triggering rapid growth in the forwarding network within a short period (as shown in Fig. 4). This online controversy involved many citizen actors inclined to respond to the views of the original posters using the interactive features of forwarding and commenting. Forwarding the post led to information proliferation and further information flow growth.

The 10-minuties statistics of new edges over an 8-day period (Fig. 4) illustrate the trend of new forwards for the post. The statistics show that

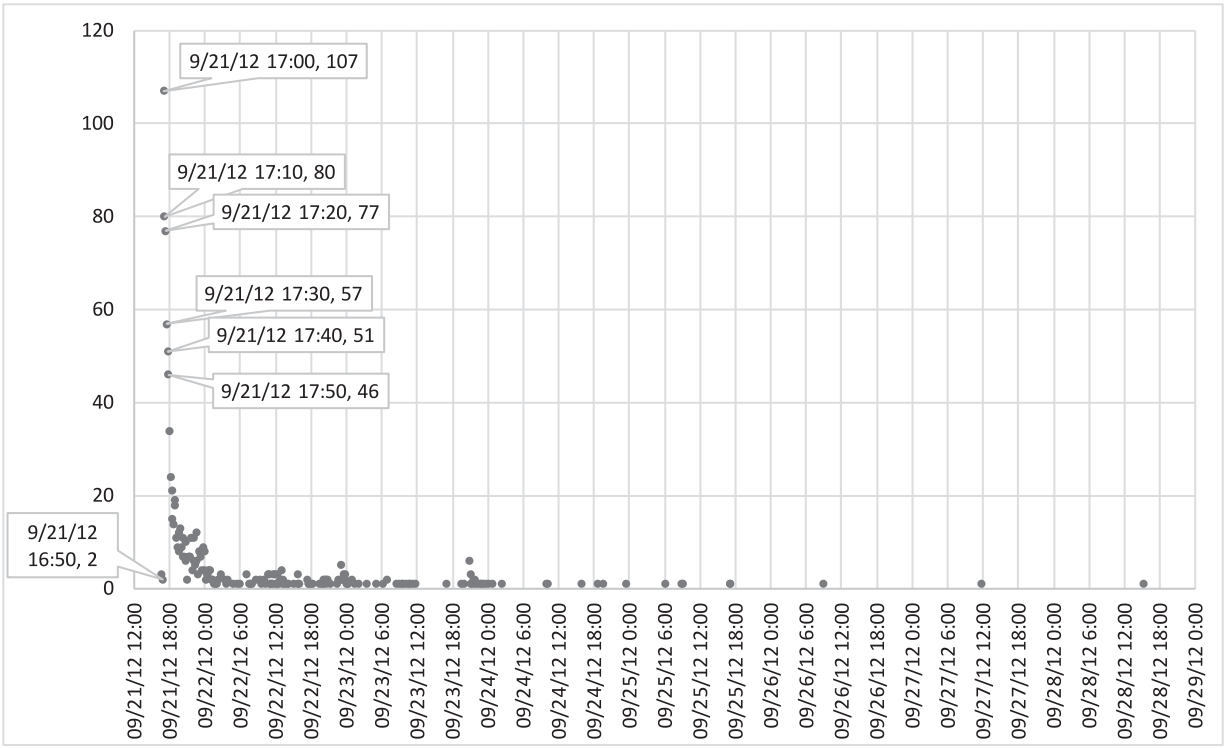

Fig. 4. Number of new edges per 10 minutes (September 21, 2012 to September 28, 2012).

the network of online controversy erupts and rapidly declines at a centralized point, different from more sustained offline actions. This rapid surge and subsequent decline align with typical patterns of information dissemination on social media. However, the online controversy also sparked offline actions, as residents adopted a more activist stance, actively rejecting the construction team's removal of paving stones from their neighborhood. Social media played an instrumental role in such a process. The ease of use and the high accessibility of social media ensured that different actors could easily and quickly retweet the post with their opinions and messages. This has led to the engagement of many participants and the creation of an extensive network for information flow. As the controversy festered, the government was forced to change the planning decision, stopping the move of Mashi stones.

In such an online network, we note that an unregistered civil society organization (CSO), the Enning Road Academic Focus Group (Node 888 in Fig. 5), emerged as a significant source of first-hand information. They launched a signature campaign to protect the historic paving stones. They made several posts on their public social media account on Weibo. One of the posts, "The most immediate demands of the neighborhood are two: First, to preserve Mashi Street; Second, to call a halt to the project and save the Enning Street," was forwarded extensively to a wide range of citizens and other actors (over 1000 times). They followed the dynamics of the Enning Road regeneration project long-term and reported to the public. Another critical factor was a local media professional (Node 596 in Fig. 5), who forwarded the mentioned post and highlighted that "urgently call a stop! Protect Mashi Street. Enning Road belongs to Guangzhou! Stop!". The community detection result shows several communities, illustrated by different colors in Fig.5. For instance, the media professional (node 596) is at the center of the largest community, while the CSO (node 888) is at the center of the second-largest community. We further analyzed the forwards of the posts on the social media accounts of the CSO and the media, and extracted two ego networks (Fig. 6) from the total network. The ego networks are formed with a central node; the other nodes directly connected can indicate the magnitude of a node's direct influence.

The comparison of the two ego networks (Fig. 6) reveals that despite the CSO first forwarding the post and initiating information dissemination, the media played a more influential role by forwarding the information to more audiences. The CSO paid more attention to the actions of residents and issues related to heritage conservation. However, the media had a more significant effect on citizen groups at a larger spatial scale. This was confirmed by interviews with the CSO's members, shown on the network. With many followers and connectors, the media professional developed a more extensive ego network to disseminate his preservation vision. This actor expanded a neighborhood-scale issue into a city-wide discussion. The size of each node in the ego network is positively correlated with the degree of centrality. The large-scale ego network in Fig. 6 reflects that the media is the power center and

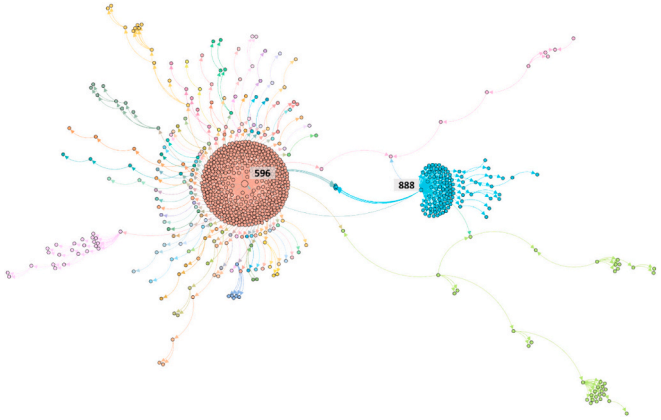

Fig. 5. Online network graph of Mashi street protection movement.

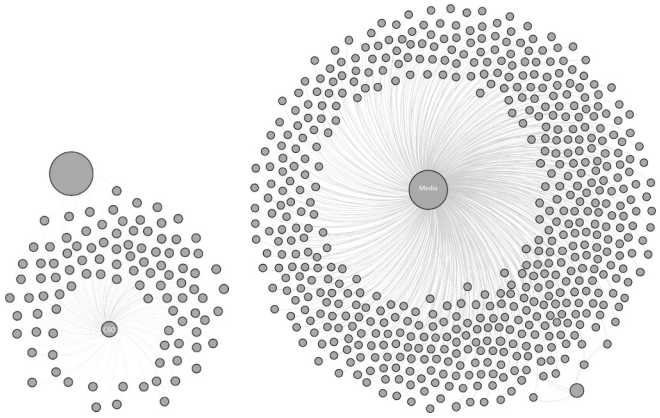

Fig. 6. Ego networks (depth = 1) of the CSO (left) and the media (right).

influences citizens as the network nodes. In short, the CSO and the media professional strategically used social media in this context to expand their networks. The interviews also indicated that this active social media strategy influenced offline decision-making.

4.3. Sub-communities, power distribution and micro public

To analyze the results of entire information dissemination throughout the event, we further divided and classified sub-communities of the network by the count of nodes based on the community detection method. The result (Fig. 5) indicates the co-existence of dominant large and many small communities in the online controversy. To further investigate the differential impact of actors in organizing the sub-community, the number of nodes in each community is used to measure the distribution pattern. After ranking from highest to lowest, the equation to fit the power-law distribution is established as Fig. 7. The result of R2 is 0.8254. The distribution of the node numbers in the community is aligned with power law distribution. This means that the network is a scale-free network. Such a network implies that most nodes have few connections while a few critical nodes have many connections. It reveals two crucial facts of the online controversy. First, there are significant power differences among actors in the network in terms of building sub-communities, which implies that inequality exists within the informal collaborative networks. Second, micro-communities exist in online public debate (Fig. 5). This supports the idea that social media creates micro-publics. However, the combination of findings from the interviews suggests that the controversy is limited to preserving cultural heritage values instead of losing focus.

The power differences suggest the unequal power of different actors in influencing public opinions throughout the network. Key actors spread ideas and influence others through social media. The more individuals retweet an actor, the larger the actor's community can create. The sub-community analysis shows that some nodes control the primary resources. The statistical results show that the media leads communities 1 and 3, and the CSO leads community 2. Only the critical node of Community 4 is led by a citizen. Most of the citizens mainly organize small subcommunities. In short, the organizers of large communities are media activists with an extensive network. They are more capable of generating group debate than citizens. The original posts forwarded in the communities reflect the opinions and claims of the community organizers, which are quickly distributed to their extensive networks. In other words, the power of third parties in the online public sphere is more significant than most ordinary citizens. Besides, numerous micro-communities demonstrate the characteristics of a long-tailed distribution. This corroborates the existence of micro-publics in social media. Despite significant nodes, many fragmented discussions and opinions are distributed throughout the network, especially among small citizen groups on the network's periphery.

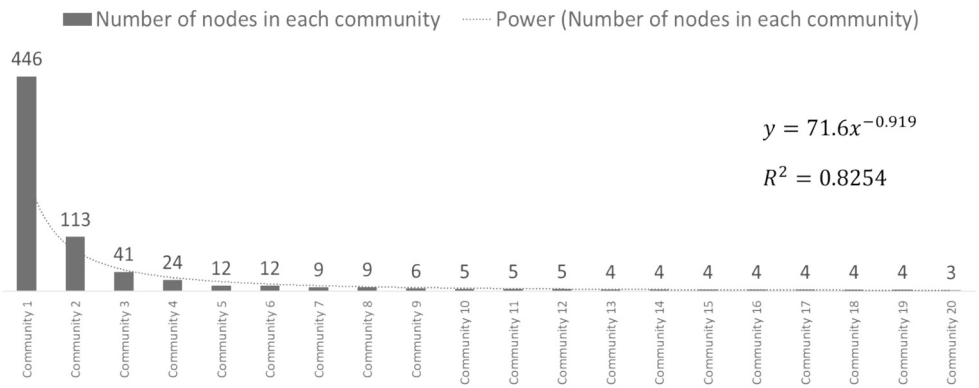

Fig. 7. The number of nodes in each community (only displaying the top 20 communities).

4.4. The dominant and cooperative civil society and journalism

4.4.1. Networked power

While the unequal power characteristics are evident, the extent to which and in what ways different actors control information remains ambiguous. Previous research suggests that planning experts use social media to reinforce their discourse (Deng et al., 2015; He et al., 2024). Recent media studies also indicate that journalism's influence on social media is becoming increasingly significant (Usher, 2021). Therefore, it is necessary to investigate further how the different actors position themselves in the entire network and consolidate their networked power. By mapping networked power to the strength of node interactions in a network, network centrality indicators can quantify the differences in nodes' influence across dimensions (Limtanakool, Dijst, and Schwanen, 2007). The centrality indices and HITS indices are calculated further to identify the networked power of different nodes and their information distribution pattern (Castells, 2011b; Scott, 2011).

Table 3 shows that the CSO-1 and the Media-1 possess a significantly higher degree of centrality than other actors, which implies more substantial networked power. These two key nodes are the media professionals and CSOs mentioned in the previous section. Furthermore, Media-1 exhibits the highest betweenness centrality in the overall network. The result shows that the journalism actor plays a crucial role as information bridges, channeling public opinions by selectively delivering information in the online controversy. Hub scores reflect the value of the information carried by the node, calculated as the sum of the authority scores of all the users it points to. A node receives a high hub score when the users it points to are typically the authoritative nodes of a network. Media-1 also has the highest hub value in the network, suggesting that critical information is more likely to be disseminated through this node. In short, the media is a crucial node in the information flow in the network generated by the social media platform, thereby excising substantial networked power and influencing other actors in the network.

Table 3
Key nodes' identities and their network indices.

Id	Identity	Degree centrality	Betweenness centrality	Authority value	Hub value
596	Media-1	526	0.000945	0.000414	0.999948
888	CSO-1	103	0	0	0.009482
610	Citizen-1	19	0.00008	0	0
850	Media-2	14	0.000064	0.043639	0
608	CSO-2	8	0.000038	0.000414	0.001949
998	Citizen-2	8	0.000031	0.043639	0
1049	Citizen-3	8	0	0	0
392	Citizen-4	6	0.000021	0	0
584	Citizen-5	5	0.000014	0.043639	0
686	Citizen-6	4	0.000031	0.043639	0
1091	Citizen-7	4	0.000006	0.000415	0
609	Citizen-8	4	0.000004	0.000414	0
959	Citizen-9	4	0.000061	0.000085	0
770	Citizen-10	4	0.000033	0	0
661	Citizen-11	4	0	0	0

There is also cooperation between the media and the CSO. According to the authority value results, Media-1 is the most significant information hub, while the original author of the most influential post is CSO-1. Its forwarding chain suggests that the actor from journalism delivered crucial information from CSO-1 to the online public. This suggests that social media connectivity provides media actors with an informal but effective information source. With the use of social media, third parties like media professionals and civil society organizations achieved an informal but tacit cooperation. This cooperation ensures policymakers address demands for preserving historic stones outside the formal agenda. Such controversial debates can further broaden the public debate and thus expand the network of actors' participation. Our field investigation revealed that the valuable paving stones involved in the controversy have been successfully preserved to the present day.

4.4.2. Networking power and network-making power

While SNA can measure networked power and the power differences between online participants, it remains to be seen how online participation influences offline debate and decision-making. The interviews revealed that other forms of network power generated by social media also play a vital role in informal participation by connecting different networks and enabling online debates to affect offline decision-making. The third parties (including journalists and CSOs) have a solid capacity to be involved in different online and offline networks. This demonstrates the presence of networking power, i.e., this power enables actors to be included in a network and participate in a debate arena. Moreover, they can switch between these different networks, excising network-making power. For instance, Media-1 (see Table 3), a journalist, not only has an extensive network in social media but also holds a crucial position in traditional mass media such as newspapers, radio, and television. Therefore, the journalist has a wide range of connections with audiences from online social media, newspapers, and the general public. This allows the journalist to easily switch between new and traditional media, which often have different user bases, enabling the rapid dissemination of information regarding the planning controversy to different networks of audiences.

Similar network-making power is found in the CSO members who

have close personal relationships with offline networks of residents in local communities. Interviews also revealed that residents trusted the CSO members and were willing to share up-to-date information and concerns. Many residents were not involved in the discussion of online controversy. Although CSO-1 had a smaller network that the media, it leveraged its close relationships with residents to capture a superior position of power. Although online participation was short, as illustrated by the timeline network graph (Fig. 3) and the new edges statistics (Fig. 4), the CSO and the journalist continued to organize and encourage residents to take offline actions, including a signature petition and a banner campaign. As part of the banner campaign, a banner reading "Each stone is special, each building is authentic" was displayed on a neighborhood wall (according to an anonymized Weibo post). Over the next two months, the controversy spread both online and offline to residents through media broadcasting and citizen action, eventually compelling local authorities to respond. In short, media professionals and the CSO could switch between online and offline networks, the so-called network-making power (Castells, 2011a). These powers allow them to challenge the decision-making process informally. Local authorities were compelled to respond effectively to the debate and the criticism in the media. They were forced to change the plan for the Mashi in the Enning Road area, recognizing street paving and other elements of historical value as essential resources to be preserved. The online activism, as a part of a long-term controversy, pressured both high-level government and local authorities to develop more inclusive policies to address citizens' participation needs in urban planning issues. Our interviews also show that, due to this informal participation and the residents' resistance, the local government was pushed to establish a Co-Creation Committee to support formal participation in the implementation stage. This committee has engaged residents, media professionals, experts, and other actors in discussing the project's implementation issues. Although the level of public participation is still debatable, social media certainly facilitates informal participation to challenge top-down planning decisions. It informally enables public opinions, which would otherwise be disregarded, to be incorporated into planning decisions and facilitate the emergence of new participatory mechanisms.

5. Discussion and conclusion

This study identifies the necessity to focus on informal participation in digital planning practices. While Batty and Yang (2022) emphasize the strengths of social media as an information-collecting tool from a top-down perspective, they overlook its potential roles in initiating movements, challenging authorities, and shifting power relations in informal ways. Our research reveals that social media can effectively strengthen the influence of informal participation on planning decisions. Although the third parties (e.g., journalists and CSOs) involved in the Enning Road case study were not able to secure a seat at the offline negotiating table, they effectively used social media to establish a networked online public sphere. This platform enabled information communication and interaction between third parties, citizens, and governments. Consequently, this mode of informal participation induced apprehension with local governments regarding public opinion, compelling them to become more responsive and accountable. According to Bherer, Dufour, and Montambeault (2023), informal participation is a new form of political participation, which presents a politics of small actions in daily life. Social media can enable these small actions to accumulate and realize the broader implications. Since authoritative planning departments tend to dominate planning decisions by setting exclusive agendas, inconvenient venues for participation, and exclusive selection of participants (Blue, Rosol, and Fast, 2019; Slaev et al., 2019), it is difficult to challenge and question planning decisions within the traditional planning approach. As a low-cost, user-friendly, and highly accessible tool, social media offers an alternative channel for public participation. It is important to note, however, that this accessibility may not involve marginalized people, such as disabilities, seniors, and children, who are unable to use social media actively. In contrast to formal public participation, citizens in informal settings are not limited to discussing issues set by authorities; instead, they can contribute new perspectives and knowledge to planning practices. By creating large-scale networks and mobilizing public debate, informal participation can significantly challenge existing power relations in planning practices.

We apply network power theory and network science to reveal significant inequalities in, between, and beyond online networks to understand emerging power relations further. HITS and community detection results suggest that third parties (including journalists and CSOs) play an influential role in the network generated by social networking sites, and thereby having more networked power than the general public. This finding aligns with the previous research on unequal power relations in social media platforms (Zhao et al., 2018). To further interpret networked power generated by social media platforms, this study measures the ego network and the power law distribution of power inequality. The findings show that third-party actors (including journalists and CSOs) significantly influence other citizens by strategically extending their ego networks. Some media researchers noted that ego networks and the hierarchical structures they presented are consistent across social contexts and are not affected by using a particular communication media (Arnaboldi et al., 2017). Our study suggests that the pattern of online controversy and the development of its networks aligns with this argument. Moreover, the results of community detection show the co-existence of large and small communities in the online controversy. We also find that power law and long-tailed distribution simultaneously exist at the community size statistics. Previous research has identified power law distributions of power inequality in networks as being present in social relations (e.g., number of followers) and node centrality statistics (He et al., 2024; Zhao et al., 2018). Our study further proves that power law distributions of power inequality can also occur in community sizes constructed in the network. We also discovered that the distribution pattern of communities appears to be a long-tail characteristic: many small communities become essential parts of the network, even though they lack nodes with high centrality (Ma and Zhang, 2022). This implies the existence of many micro-publics, which are small and fragmented communities generated by individual relationships. Besides the leading ego network, micro-publics should also be considered when measuring power inequality in the networks generated by social media. This finding quantitively supports Bruns and Highfield's (2015) arguments on micro-publics' existence in social media. Even if social media content is not fully public, its dissemination in many connected micro-publics could still profoundly impact public discourses.

However, we argue that networked power is not the only means of influencing offline decision-making. Our analysis shows that third parties also have strong networking power (the power to participate in a network) and network-making power (the power to switch between online and offline networks). They not only utilized offline networks to gather resident opinions and information, but also transmitted online debates to a wide audience by switching between new and old media, thereby affecting offline decision-making. The power inequalities in networks are reinforced by the actions of these key actors, who strategically establish, develop, and switch between different networks to meet their interests. Whereas our research suggests that the third-party actors can access network-making power by switching and bridging to other networks, some researchers point out that the commercial purposes of social media and government regulations may hinder the capacities of these actors to excise power in networks (Zhuravskaya et al., 2020). This is related to what Castells refers to as "*network power*," i.e., the exercise of power not by excluding people from the network but by enforcing rules of inclusion and exclusion. For example, governments and corporations can impose rules, censorship, and standards for participation and interaction in social media to alter the inclusion or

exclusion of potential actors. Despite the censorship of social media platforms in China, the central government allows public discourse on specific urban issues (e.g., cultural heritage protection) that are not considered sensitive and do not challenge the regime's stability. Since the case study in this research involves a planning controversy regarding cultural heritage protection, online discussion is tolerated by governments, and there is little evidence to show that the government exercises network power. It is also important to notice that the Chinese government is increasingly utilizing various social media platforms and actively participating in different networks. This involvement may enhance the government's network-making power and its ability to shape public opinion (Medaglia and Zhu, 2017), potentially influencing future online debates on planning issues.

The lesson learned from the case study is that the public may informally participate in the planning process if there needs to be more inclusive participation. Along with the digital transition in society and planning, more digital devices have been developed, providing more channels for the public to express their voices, values, and interests and organize collective actions (Allam and Allam, 2020). Ignoring public opinions, especially in complex planning contexts, could put planning proposals to a halt since the third sector and citizens can easily use social media and other digital platforms to establish networks, mobilize public debates, and oppose government decisions. Such digital planning confronts us with new challenges that ask for innovative solutions. Therefore, promoting more proactive participation by using social media and other digital tools in planning practice is essential. Despite potential challenges such as bias and information credibility, social media participation has several strengths. First, traditional formal participatory methods often have encountered problems such as limited participants and inflexibility caused by fixed space and time. The low-cost, real-time, highly accessible, and easy-to-use features of social media make it a tool that captures a broader audience of participants (Lin, 2022). It can empower citizens and third parties, promoting a more inclusive planning process. Second, social media can cultivate a new networked public sphere for shaping discourse, perceptions, and power (Kaiser, Fähnrich, Rhomberg, and Filzmaier, 2017). Although new forms of power inequality can be created, planning practitioners' active entry into this new networked public sphere is conducive to rebalancing power relations in planning processes. Third, the stages of social media application in the planning process should also be considered. Early engagement of citizens by using social media and other digital tools in the planning process can help identify problems and solutions and increase social acceptance of plans and policies. Recent cases across different contexts illustrate how social media amplify controversies and link them to broader social issues such as environmental protection, sustainable governance, and heritage conservation (Deng et al., 2015; Fredericks and Foth, 2013; Ma and Zhang, 2022). Nevertheless, attention should also be given to organizing social media participation in various institutional and cultural settings. It is notable that citizen participation can be influenced by local policies, media freedom, and cultural factors (Zhang, Lin, Hooimeijer, and Geertman, 2020). In our study, the open culture, high degree of media freedom, and strong civil society in Guangzhou provide a robust foundation for facilitating informal participation through social media. Additionally, the effectiveness of social media in supporting digital planning primarily manifests through diffusion and communication, while significant shifts in power relations often remain rooted offline. Further research is needed to comprehensively understand how social media can enhance citizen participation in digital planning, especially within institutional settings characterized by hierarchical administration and centralized power. Key areas for exploration include the interaction between formal participation channels and informal social media engagement, the development of effective discursive strategies by citizens within authoritarian deliberation, and the mechanisms through which social media platforms reshape citizens' power dynamics (Jungherr, Posegga, and An, 2019; Stockmann et al., 2020; Weng, Schwarz, Schwarz, and Hardy, 2021).

CRediT authorship contribution statement

Junyao He: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yanliu Lin:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Pieter Hooimeijer:** Writing – review & editing, Supervision. **Jochen Monstadt:** Writing – review & editing, Supervision.

Data availability

The data that has been used is confidential.

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