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Testing the Use of Crowdsourced Information: Case Study of Bike-Share Infrastructure Planning in Cincinnati, Ohio

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Abstract
Considering the power of web-based tools for crowdsourcing, planning organizations are increasingly using these technologies to gather ideas and preferences from the public. These technologies often generate substantial, unstructured data about public needs. However, our understanding of the use of crowdsourced information in planning is still limited. Focusing on the City of Cincinnati Bike-share planning as a case study, this article explores the challenges and considerations of using crowdsourced information. Employing mixed analysis methods, the article analyzes participant suggestions and examines whether and how those suggestions were incorporated into the bike-share plan. Interpretive analysis of interviews provided insights about suggestions that were used in the final plan. The results highlight organizational opportunities and limitations. A variety of organizational factors affected the utility of crowdsourced information in Cincinnati bike-share plan. These include the capability of the planning organizations to analyze data and facilitate participation, and the perception of planners about the value of crowdsourced information and local knowledge.

Issue
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1. Introduction

How do planners and professionals use crowdsourced information in planning? What considerations should they take into account? Considering the importance of local knowledge in planning, and the ability of web-based technologies in crowdsourcing this knowledge, local governments and planning consultants are increasingly using new technologies to gather information from stakeholders (Evans-Cowley, 2010; Schweitzer, 2014). Crowdsourced information can be useful in infrastructure planning, but is not immune to the issues of data quality or organizational capability compared to other data collection methods (Goodchild, 2007). There is a growing discussion on the role of information technology in changing the pace and quality of information sharing and social interaction by citizens (Sanchez & Brenman, 2013). How-ever, our understanding of the usability of the information, crowdsourced through online participation of stakeholders, in planning and planners' perception of its value is still emerging.

Planning organizations have long faced the challenge of generating public participation and relevant input (Bryson, Quick, Slotterback, & Crosby, 2013). Without serious mandates for public engagement, planning organizations may not use participatory processes to collect public input (Hoch, 2007) over concerns that the costs of engaging the public may not pay off. Some planning organizations struggle with the costs of conducting public meetings, while others struggle to even attract citizen participation (Afzalan & Evans-Cowley, 2015; Rhoads, 2010). Some organizations are hesitant about the value of citizens' knowledge in responding to complex planning problems where expert-based knowledge is considered

more useful (Corburn, 2005). These challenges influence how planners see the value of crowdsourcing methods.

This article focuses on the City of Cincinnati Bike-share feasibility study as a case study of crowdsourcing. Bike-share planning is complex and involves such challenges as finding public space for bike-share stations (Krykewycz, Puchalsky, Rocks, Bonnette, & Jaskiewicz, 2010), analyzing station capacity and space use (Daddio, 2012), and equity considerations of implementing bike-share systems (Piatkowski, Marshall, & Afzalan, 2016).

In recent years, cities such as Cincinnati have used online crowdsourcing tools to ask potential users about their desired locations for bike-share stations. Drawing on the literature about using online participatory technologies and crowdsourced information in planning, this study employs spatial and content analysis methods to explore the uses of public input. Unstructured interviews with project managers explored how and why the suggestions were incorporated into the final feasibility plan and the limitations of doing so.

2. Online Participatory Technologies

Engaging communities through online technologies is becoming a common practice for planning organizations (Afzalan, Sanchez, & Evans-Cowley, 2017). These technologies include online tools that are specifically designed to augment public engagement (e.g. MySide-Walk), social media platforms (e.g. Facebook groups), or public participation GIS applications (e.g. SeeClick-Fix). These technologies are seen as advancing information sharing (Riggs, 2016; Williamson & Parolin, 2012), collaboration and interaction (Schweitzer & Stephenson, 2016), social learning (Goodspeed, 2013; Goodspeed et al., 2016); transparency (Schweitzer, 2014), and social mobilization (Frick, 2016). These technologies are used to facilitate engagement at different levels of the "ladder of participation" (Arnstein, 1969). Some are used to facilitate deep discourse and dialogue to discuss complex planning issues and some are used to simply collect data about public opinions (Afzalan & Muller, 2014; Brabham, 2009; Dashti et al., 2014). On the other hand, some scholars raise concerns about the social equity, privacy, and transparency concerns of using these technologies (Schweitzer & Afzalan, 2017). For example, issues of digital literacy have generated discussions around the consequences of using online tools for collaborative decision making processes where not all segments of the population can participate equally (Saad-Sulonen, 2012).

The use of computer-aided technologies in decision making and planning has been supported by the growth in popularity of GIS and its applications in augmenting location-based analysis and information sharing (see Mostafavi, Farzinmoghadam, & Hoque, 2014). Integrating GIS and web technologies has allowed planning organizations to implement public participatory processes using web-GIS applications (Karduni et al., 2017; Zhou, Wang, & Li, 2017).

3. Crowdsourcing Information for Planning: Opportunities and Challenges

3.1. Opportunities

This study considers public input as the core component of participatory goals to democratize decision-making (Raymond et al., 2010). With the growth of social media and information technology, planning organizations have more convenient options for crowdsourcing citizens' ideas and learning about their interest (Seltzer & Mahmoudi, 2012; Yli-Pelkonen & Kohl, 2005). Crowdsourcing is a method for outsourcing problem solving and assists with exploiting ideas of a group to help organizations work more efficiently (Brabham, 2009). It can be used to engage the public to share their ideas about a planning problem. While the new advancements in communication technologies have made the implementation of crowdsourcing methods easier for organizations, using crowdsourced information in planning is still challenging (Seltzer & Mahmoudi, 2012).

The popularity and increasing accessibility of the Internet has facilitated crowdsourcing activities. Web 2.0 has the capacity to produce user generated content and harness the collective intelligence of communities (O'Reilly, 2007). Online crowdsourcing methods provide opportunities for exploiting a crowds' wisdom (Brabham, 2009) and overcoming some of the issues of the traditional methods of participation, including lack of participants' diversity and limitations of time and space for engagement (Evans-Cowley & Hollander, 2010). In addition, the integration of Web 2.0 and GIS is important for the geographic context of public input such as through Volunteered Geographic Information (VGI) (Goodchild, 2007). VGI can enhance institutions' decision making by providing qualitative and quantitative locational information (Barton, Plume, & Parolin, 2005). It also contains types of data that have not been discovered in traditional mapping before. Local organizations or governments can use VGI in their planning processes for sharing spatial information, gathering ideas that consider existing or proposed situations, and learning about potential sources of tension (Goodchild, 2007).

3.2. Challenges

Planners differentiate public participation from scientific or expert knowledge as inputs to plan making. Combining these types of data has been traditionally challenging for planning organizations due to different levels of precision and reliability (Corburn, 2005). However, with the new advancements in online crowdsourcing methods, opportunities exist for verifying publicly generated information with expert analysis (Goodchild & Li, 2012).

Planning organizations face several constraints with using local knowledge in general and specifically crowdsourced information, in planning and decision making (Flyvbjerg, 2013). Local knowledge is not always applica-

ble to socio-economic issues at all scales. In addition, citizen generated input is produced through bottom-up approaches without top-down monitoring processes that control the information quality. This type of input is not filtered; therefore, it may not be well organized, accurate, or up to date. (Flanagin & Metzger, 2008). These issues—beside the large quantity of crowdsourced knowledge, issues of information quality, issues of information credibility and vagueness (Roberts, 2017)—make it challenging for organizations to analyze and interpret crowdsourced information. Using this information may also raise concerns regarding issues of privacy or security as well as Internet accessibility and digital literacy for governmental or non-governmental planning organizations (Schweitzer & Afzalan, 2017).

Table 1 summarizes previous research on the opportunities and challenges of crowdsourcing for urban planning applications.

4. The Case Study

This study focuses on the use of crowdsourced information from a web-GIS tool to engage citizens in the City of Cincinnati's bike-share feasibility study. The City's Department of Transportation & Engineering, in collaboration with a private consulting company, collaborated on creating the feasibility study for a bike-share program. The bike-share program is part of The City of Cincinnati's goal in providing a new option for local mobility around town that is affordable, accessible and visible for citizens and tourists (Alta Planning + Design, 2012).

The organizations involved used a web-GIS crowdsourcing tool (Shareabouts[1]) for collecting ideas about desired locations for bike-share stations, mainly in the downtown, Over-the-Rhine, and uptown area. The tool was promoted using posters, flyers, and online advertisements. This open source tool, developed by OpenPlans, was used by various organizations for diverse types of participatory projects. It allowed users to locate points on a map of Cincinnati to suggest new locations or to support existing locations by clicking a support button (see Figure 1). In addition, participants were allowed to describe why they proposed a location or participate in a discussion by supporting or opposing other suggestions (Alta Planning + Design, 2012). The participants were not required to register or provide personal information such as e-mail address. Of those who did provide personal information, 54% were male, 30% were female, and 16% did not specify. An online platform called Gender Checker[2] was used to identify whether a name was female or male. Over the 36 days that the crowdsourcing tool was running, there were 206 engagements, 330 suggested locations and 503 comments. In addition, 1773 times various locations received supports (likes) from the participants.

Table 1. Opportunities and challenges of crowdsourcing information in planning.

Opportunities

New and unexpected information:
• Gathering novel and unexpected information (Brabham, 2009; Roberts, 2017)
• Gathering information from a diverse and large community (Afzalan, Evans-Cowley, & Mirzazad, 2015; Seltzer & Mahmoudi, 2012)

Information gathering and use:
• Engaging people without considerations of time or place for information gathering or engagement (Evans-Cowley & Hollander, 2010; Riggs & Gordon, 2015)
• If public participatory GIS applications are used, the collected spatial data is easily measurable, interoperable, and quantifiable (Zhang & Feick, 2016)
• More cost and time effective information gathering, comparing to traditional participatory methods (Brabham, 2009, Schweitzer, 2014)

Challenges

• *Information evaluation:* The concerns about quality (Scheuer, Haase, & Meyer, 2013), credibility, and vagueness of the collected information (Longueville, Ostlander, & Keskitalo, 2009) can make interpretation of the information challenging. Collected information may not represent the public interest (Seltzer & Mahmoudi, 2012). Information representativeness should be evaluated for equitable planning.
• *Analysis methods and facilitation:* Institutions may not have staff or resource capacity to fully benefit from the collected information (Klosterman, 2013; Townsend, 2013), to facilitate online participation, or analyze data (Saad-Sulonen, 2012).
• *Education and attitude:* The knowledge, attitude, and perception of professionals and planners may influence the usefulness of the collected information in planning and decision making (Minner, 2015; Slotterback, 2011)
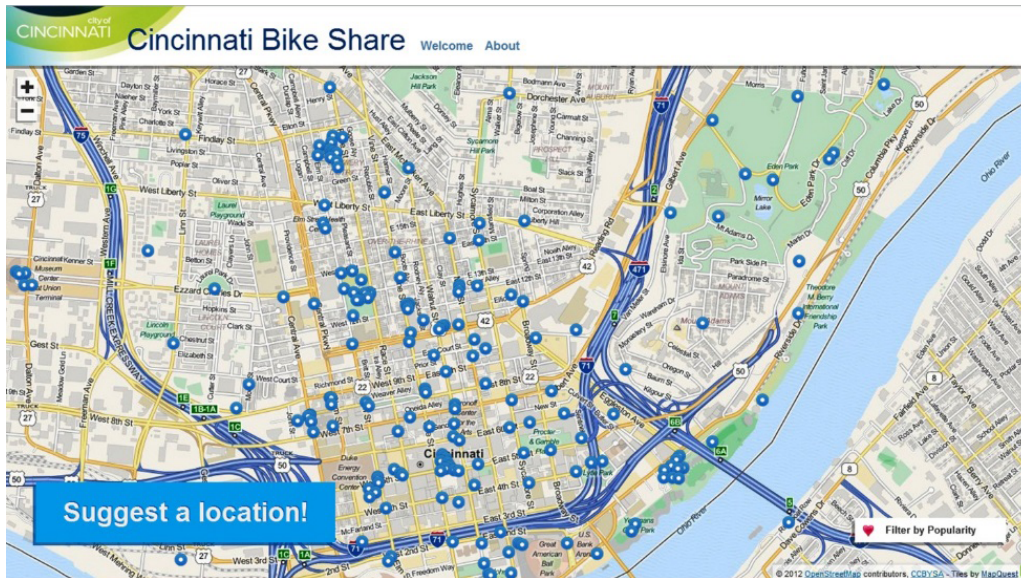
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[1] http://blog.openplans.org/category/shareabouts
[2] http://genderchecker.com

Figure 1. The City of Cincinnati's interactive GIS website interface.

The data collected through the crowdsourcing website was used primarily to identify desired locations for bike-share stations. Among the five main objectives of this plan, the crowdsourcing website informs two of them: (a) Evaluate the preparedness of Cincinnati and identify the most suitable areas for bike sharing and any obstacles that could impact success and (b) Identify an initial service area and size for a potential bike-share system from which to forecast expected demand, costs and revenues (Alta Planning + Design, 2012, p. 1). The project did not include other public participatory processes, relying completely on the online crowdsourcing tool. The crowdsourcing website was their main medium for collecting ideas and interests regarding the location of bike-share stations (Interview with professional 1, July 2014). Eight expert-based meetings with business owners and similar stakeholders were arranged. These meetings focused on exploring desired locations for bike-share stations, based on space need and availability, travel flow, businesses' needs, and community demands (Interview with professional 1, July 2014). These meetings did not involve the public, but instead focused on "expert" opinions about bike-share planning (Interview with professional 2, July 2014). Since the mayor funded the project, the City Council was not responsible to approve the project.

The feasibility plan was created in 2012 and the first phase of the stations were installed in 2014. Among 35 total stations suggested by the feasibility plan, 30 of them are now operational. Nineteen of these stations were located in the downtown area, 11 of them were located in the uptown area, with 60 percent of the suggested locations for bike-share stations in the first phase being implemented. A local non-profit organization was responsible for implementing the plan. One professional argued that various factors influenced the final installation locations of the bike-share stations, clarifying that "there are many demands on sidewalk right-of-way space: contiguous space for pedestrians, ADA requirements, benches, lights, man holes, hydrants, newspaper racks, parking meters, etc.…the final locations were the closest they could get based on these restraints" (Interview with professional 2, June 2015). Figure 2 shows the suitability analysis done as part of the feasibility study.

5. Methodology

This study employed mixed methods for data collection and analysis. Data collection methods included archival research and semi-structured interviews. Archival research was used for two purposes: collecting and digitizing suggested locations and comments, and collecting information regarding the Cincinnati bike-share feasibility plan. The locations suggested online, along with comments, were collected from the crowdsourcing tool manually, since the researchers did not have access to the data collected by the City[3]. The study conducted in-depth semi-structured phone interviews with the two project managers who were involved in using the tool and creating the plan: including a professional from a consulting firm, and another from the City of Cincinnati. Each interview took approximately an hour and explored several open-ended questions, including how and why the crowdsourced information was used in the feasibility study, how the value of the information was perceived, and whether and how the crowdsourced web-GIS tool was helpful. To respect the anonymity of the interviewees, no more information about their backgrounds can be revealed. The interviewees were selected because they were the two main professionals involved in using and implementing the crowdsourcing tool and incorporating the collected information in the feasibility plan.

[3] The City did not respond to the researchers' request to access their gathered data.
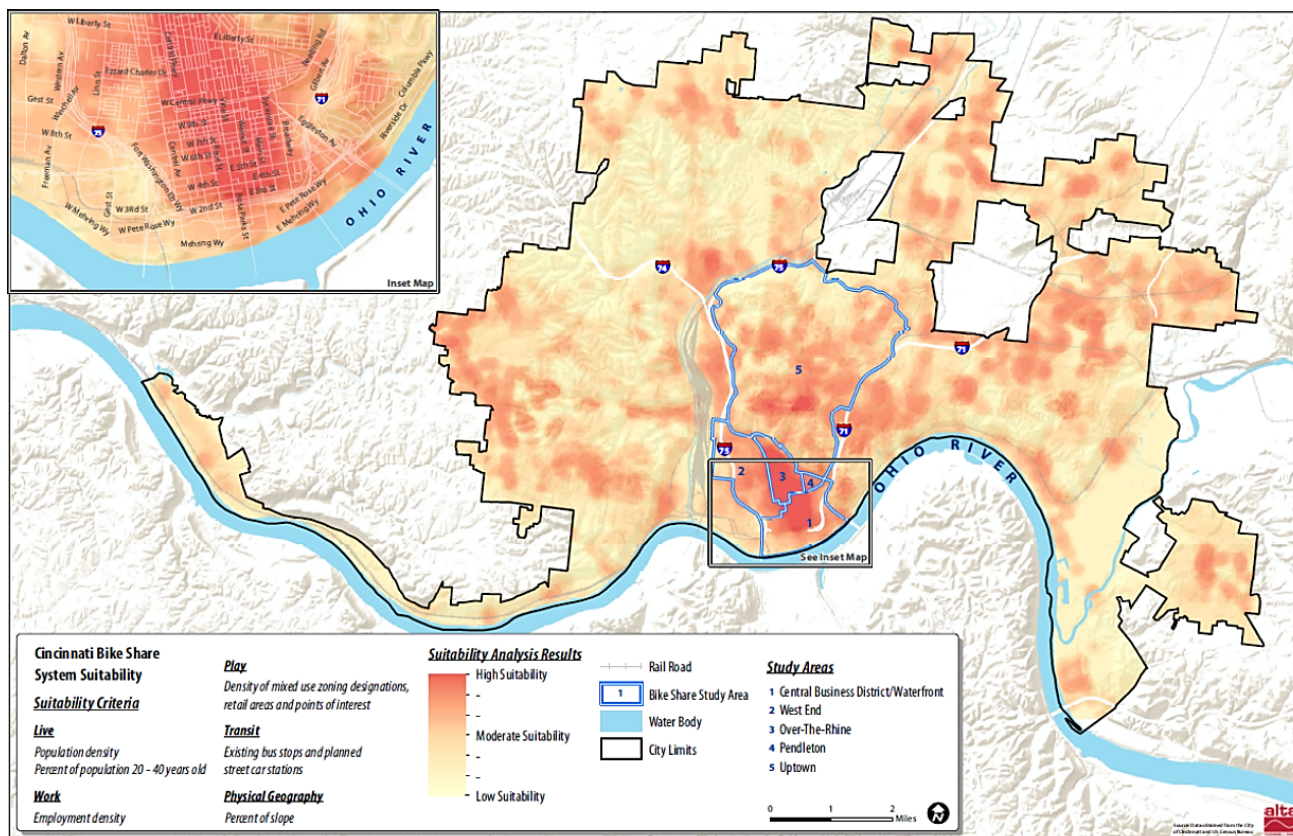
Figure 2. Suitability analysis for Cincinnati Bike-Share Feasibility Study (Alta Planning + Design, 2012, p. 29).

The other professionals involved in this project were not as familiar with the details of using the tool and crowd-sourced data.

Data analysis methods included interpretive discourse analysis, spatial analysis, and content analysis. Spatial and content analysis were used to identify citizens' and the plan's suggestions for bike-share stations. They helped with exploring the first question of how the organizations use crowdsourced information, by providing a basis for comparing the crowdsourced information with the plan's suggestions. Qualitative interpretive analysis of the interviews helped with exploring the second question and to determine how the information was incorporated into the plan and how it could be used. The interview results were also used to provide background information about the project.

To explore why participants like or dislike having bike-share stations in the suggested locations, the study analyzed participant comments through a content analysis method. Considering comments as the unit of analysis, the study implemented content analysis to "interpret meaning[s] from the content of text data" (Hsieh & Shannon, 2005, p. 1277) by examining all the 503 comments qualitatively. This study used a content analysis software, NVivo, to find and categorize the repeated themes in the comments. The software computed the number of times each word or term was used and identified emerging themes. This provided a basis for the researchers to identify repeated words, such as "downtown", or "access", or themes such as "downtown access" and qualitatively define themes and sub-themes that explain the participants' reasons for suggesting the stations. The software was then used to review each of the comments and manually code them into an already identified theme (e.g. downtown access) or in new emerging themes or sub-themes that were identified based on the researchers' interpretation of the comments. Since the users' informal communication often used slang and contextual information, qualitative categorization was crucial to ensure the accuracy and comprehensibility of the analysis. The results on the content analysis were not software dependent, as all the comments were reviewed by the researchers.

To identify participants' most desired locations and areas for the placement of bike-share stations, spatial analysis methods were used: to identify clusters of suggested locations we used the Kernel Density tool in ArcGIS software[4]. Kernel Density is a spatial analysis method that creates heat maps by computing the density of each feature in a neighborhood around them. The resulting clusters and heat maps helped researchers visually and qualitatively examine whether the plan's suggested locations for bike-share stations were located within those clusters and overlapped with the online sug-

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[4] We used "densities" as the output value in the Kernel Density tool. We accepted the other default factors suggested by Kernel Density tool, as the created heatmap was supposed to be used for a qualitative exploration.

gestions. These clusters can vary in size due to parameters that can be defined by the software, but in this study, the clusters were created only for visualization of the online suggestions and to qualitatively compare those clusters with the actual location of the implemented bike-share stations. All the spatial analysis, including overlaying the clusters of peoples' suggestions and the plan's suggested locations were produced in ArcGIS desktop.

The following criteria informed the case study selection for this research: (a) tool capability: the project uses a web-GIS crowdsourcing tool that allows a large crowd to express their ideas by locating points on a map, creating comments, explaining their intentions, and reasons for their suggestions; (b) plan completion: at the time of the study this was the only plan of its type that was developed and implemented, using a crowdsourcing tool accessible to public, which helped the researchers explore how the information gathered was used in plan creation; and (c) data: the data was geo-tagged, including point and text-based data. This helped the researchers examine how the organization used structured and unstructured crowdsourced data.

6. Analysis Results

This section discusses the results of the content and spatial analysis to explore why and where people like to have bike-share stations.

6.1. Content Analysis

Tables 2 and 3 show the content analysis results and report why people like to have bike-share stations in locations that they have suggested. The tables categorize peoples' reasons for having bike-share stations as themes, sub-themes, and groups. The numbers show percentage of the number of times that a theme, a sub-theme, or a group of comments is repeated. For example, only 1% of the online comments were related to "avoid parking fee", when people were talking about reasons for choosing locations for bike-share stations (See Table 2).

The majority of the participants (83.5 percent) report "accessibility" to particular locations as the main reason for suggesting a location for a bike-share station. This seems like an obvious response since users will want to be close to station locations for convenience as well as those with good access to desired destinations. Each of the themes above were also coded into sub-themes and groups, which are shown in Table 3.

The majority of comments that mentioned "accessibility" as one of the main reasons for suggesting a location for a bike-share station (34%) referred to having access to commercial locations such as restaurants or hotels. In the accessibility theme, downtown accessibility was the second most important reason for suggesting bike-share stations.

6.2. Spatial Analysis

This section builds on the results of spatial analysis to compare online and plan's suggested locations for bike-share stations. The heat map on Figure 3 shows the clusters and density of the suggested locations by people and the plan. Of course, these clusters could have been a bit smaller or larger, depending on the parameters we chose in computing the Kernel Density. However, the final result would not be different, as we were using these clusters for a qualitative comparison. As shown in Figure 3, the number of participant suggestions for bike-share stations are not only high in the downtown or business district area, but also in other neighborhoods up to four miles away from the downtown or business district. The suggested locations in the feasibility study highly overlap with participant suggested locations.

7. Using Crowdsourced Information in the Plan

Based on the Cincinnati Bike-share Feasibility Study and interviews with the project managers, the crowdsourced information was primarily used for identifying suitable locations for bike-share stations but not to explore why and how people are interested in particular locations. The plan's suggested locations for bike-share stations strongly overlap with the suggested locations by citizens. All of the plan's proposed locations are in the areas that were suggested by citizens or very close to their exact location. In addition, the areas suggested by the participants overlap with the heat map that was created as part of the suitability analysis for the Cincinnati Bike-share Feasibility Study (see Figure 2).

The feasibility plan does not directly refer to participant priorities or desired types of activities (e.g. access to parks, businesses, university, etc.). However, it provides a list of high-demand destinations in the study area based the feasibility analysis that includes reviewing participant comments. These included "Washington Park, Fountain Square, Findlay Market, the Purple People Bridge, Ludlow Avenue, Eden Park, Union Terminal, and Gov-

Table 2. Results of the content analysis categorized by themes.

Theme	Accessibility	Replace trips that would otherwise be made on foot	Avoid riding up the hill	To be Green	Negative effects on businesses	Avoid being stuck in traffic	Avoid parking fee
Percentage	83.50%	6.60%	4.10%	2.10%	1.30%	1.30%	1%

Table 3. Results of the content analysis categorized in themes, sub-themes, and groups.

Theme	Sub-Theme	Percentage of each sub-theme	Percentage of each group	Group
Accessibility	Access to Commercial Units	34.10%	8.9%	Access and proximity to businesses (general)
			4.5%	Access to a parking area
			5.2%	Access to a restaurant, cafe or a bar
			3.6%	Access to hospitals
			2%	Access to hotels and meeting centers
			3%	Access to or for a growing business district or new development
			1.3%	Findlay Market
	Downtown Accessibility	16.20%	6.5%	Access to Downtown/Business district
			5.8%	Access within the Downtown/Business district
			1.3%	Access from Downtown/Business district
	Access to College or University	8%	8%	Access to College or University
	Access to Public Services	9.30%	3.7%	Access to a bus stop or a metro station
			2%	Access to bike trails and paths
			2%	Access to Municipality City Hall Court
			2%	Access to cemetery
	Access to Park and Recreation	17.80%	3%	Access to cultural activities and sports
			2.4%	Access to fountain square
			9.5%	Access to parks
	Access to Offices	3%	3%	Access to offices
	Access to Neighborhoods	9.30%	6.3%	Neighborhood and community access (general)
			1.5%	Access to New Port
Replace trips that would otherwise be made on foot			2.6%	Helps people bike instead of walk
			1.5%	To park and walk from here
Riding up the hill			1.3%	Riding up the hill
To be Green			1.3%	Reduce car use
			0.8%	Being Green
Negative effects on businesses			6.7%	Negative effects on businesses
Avoid being stuck in traffic			0.8%	Avoid being stuck in traffic
Avoid parking fee			1.3%	Avoid parking fee

ernment Square, etc. and sites on the University of Cincinnati campus, along McMillan/Calhoun, the Banks, Coffee Emporium, the Cincinnati Zoo, Duke Energy Convention Center, Lytle Park, the Great American Ballpark, and at major employers such as Procter & Gamble and Hewlett Packard" (Cincinnati Bike-share Feasibility Study, Alta Planning and Design, p. 31). This list introduces various types of destinations identified in our study, such as access to the university, downtown, public services, or parks, which also correlate with the participants' suggestions.

On the other hand, some of the suggestions for new stations were dismissed in the feasibility study. A number of these suggested stations were ignored due to lack of adequate open or public space for station implementation. However, the majority of these stations were located in residential neighborhoods outside of this phase

of the feasibility study, which is the main reason these suggested locations were not selected (Interview with professional 1, July 2014).

The participant's text-based comments were reviewed without using any particular analytical methods to assess the reasons why participants suggested the locations. However, there was no direct reference to these comments in the plan.

8. Discussion: Using Crowdsourced Information

In this section, we draw upon the literature, the results of the interviews, spatial analysis, and content analysis to discuss how the crowdsourced information was used, and suggest factors that can be considered for its effective use.
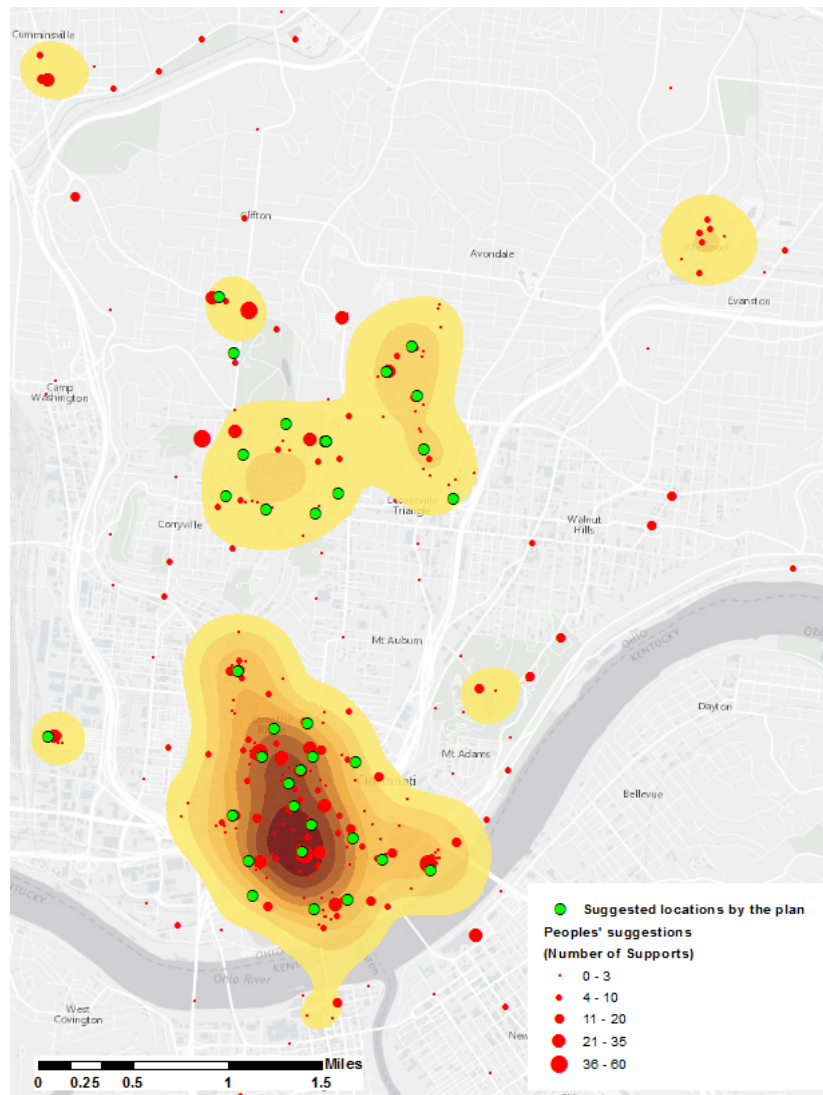
Figure 3. The relationship between suggested locations by participants and the plan.

8.1. New and Unexpected Information

The planners believed that participant-suggested locations in the study area were not different from the locations planners would choose without citizen online participation. Therefore, they did not find the crowdsourced information revealing.

However, the bike-share planning team received some unexpected input that they considered to be valuable. These inputs included considerable interest in having bike-share stations in residential neighborhoods outside of the primary area that was originally defined by the project. Learning about the interest pushed the planning team to more seriously consider this idea in the next phase of the bike-share system expansion (Interview with Professional 1, July 2014).

The planners could have learned more about unexpected information by using the content analysis methods from our analysis. For example, the content analysis could have helped them understand priorities in gaining access to destinations or services. Based on our inter-

views, the planners did not know whether people were more interested in using bike-share stations to access the University of Cincinnati or parks and recreation areas.

8.2. Information Gathering and Use

The professionals were satisfied with the capability of the crowdsourcing tool in gathering geotagged information from a relatively large crowd, especially since they could easily integrate it with their datasets.

The professionals had different ideas about the value of using the online information. While one professional used the information to learn about participant interests, the other professional used the information mainly to validate the feasibility study process. The second professional argued that the main value of the online comments was to validate the planning process by showing that they have conducted a participatory process:

The most useful thing was having a map and say here we did public participation…The actual data was not

used much. The outreach was the most important…It was a great way to reach a large number of people. But, still good that those people feel they are part of the process…nobody wants to be responsible for a fail process. It was helpful for validating [our planning process]. (Interview with Professional 2, July 2014)

In addition, the crowdsourced information was helpful for the planning team to make sure that their ideas were consistent with participant comments and suggestions, especially with a large crowd. As the first professional argued, while the gathered information was not much different from what they already knew, it was still valuable to the planning team to make sure that their plan corresponds with user needs or desires.

The professionals could have enriched the information gathering process by combining the crowdsourcing approach with more traditional participatory methods (e.g. public meetings) to engage the public. In addition, our study shows a need for educating professionals about the value of public engagement and the ethical concerns of dismissing it.

8.3. Information Evaluation

We found that the planners did not evaluate the quality and credibility of the information. For example, several suggested locations belonged to one online participant who expressed her objection regarding the location of more than twenty of the stations suggested by other participants. Our interview with the two project managers indicated that they were not aware of such action since they did not analyze the text-based comments.

Anonymity of the online participants introduced other concerns in the use of the crowdsourced information, especially since the online crowdsourcing tool was used as the main medium for soliciting public input. Although the interviewees preferred to have access to the participants' demographic information, they were satisfied that they had not asked for such information since it may have reduced the number of participants. Although both planners considered the quantity of crowdsourced information to be valuable, there is still a question of representativeness: to what extent this information represents the overall community and the public interest?

8.4. Analysis and Facilitation

In our assessment, the professionals could have used the text-based data more effectively. Their analysis did not consider participant's suggested priorities in detail. For example, the content analysis results showed that having access to the downtown area from other parts of the town is only one of the five most desired suggestions made by the online participants. However, the plan was still focused on the downtown area and uptown accessibility without discussing the accessibility to other parts of the city mentioned by the online participants. Based

on the interview results, the planners did not use content analysis methods or tools (e.g. NVivo) for various reasons, such as lack of resources—especially time and staff—lack of experience with analyzing text-based content, and lack of belief in the value of structured analysis of online comments.

This study does not argue that the online comments should be fully incorporated in the plan; instead it reveals that conducting structured methods or tools for analyzing the textual data could show patterns that planners may find useful. For example, using content analysis methods could help the planners identify objections about implementing bike-share stations in particular locations. Based on our case study, conducting the analysis by using only the geo-tagged points may lead to false analysis since some of the geo-tagged points are about rejecting a location for a new station and not supporting it. Furthermore, content analysis could help the planners learn about why people were interested in bike sharing. As our analysis results showed some of the comments revealed interest in the use of bike-share because of their interest in being "green" or walking more.

While both of the project managers had access to the online tool, none of them were involved in facilitating online participation by providing information or responding to questions. Both planners believed that facilitating the online participation was not their priority due to their limited resources.

8.5. Education and Attitude

A planner's knowledge and attitude can influence how crowdsourced information is used. While technical expertise matters in ways in which the information can be analyzed, perception and attitudes towards the use of the information was important too. For example, one of the interviewees believed that citizens' online comments were generally not as useful as the suggestions made by experts due to the citizens' lack of knowledge about the topic. Here is how Professional 2 perceived the value of the online comments:

Stakeholder [expert-based] meetings were more useful, since people were on the ground…Online feedback had a lot of personal bias…[expert-based] meetings were better…Anytime when you have meeting with people, you get some useless information. But, in your stakeholders meetings they are experts. Stakeholders have more realistic information about where people are travelling…a lot of people [who participated online] were living [somewhere] in the city that was 20 minutes far from downtown. So, you get comments from people that do not know about traffic patterns in downtown.

Appropriate use of crowdsourced information does not only require providing technical education for planners and professionals. We suggest that professionals should

also learn more about the value of using local knowledge in planning and what it adds to expert-based knowledge.

9. Conclusions

Using crowdsourced information in planning processes was related not only to the quality and relevancy of the information, but to other factors such as the organizations' capability of analyzing the information, planner's perceptions of the value of the information, and the planner's attitude towards allocating resources for using the tools and information. This study contributes to the literature on the use of crowdsourcing methods in planning and policy, by discussing various factors that could be considered in using crowdsourced information.

Using qualitative content analysis methods can be resource intensive for planning organizations. It requires time, skilled staff, and financial resources. Planners may consider the type of data they collect by using these technologies before they start using them. Some of the more recent tools provide summary statistics results of the participation or create categories of comments for decision makers. These tools can help planners analyze the comments more quickly and easily.

Considering the role of planners in making plans, it is important to explore how planners and policy makers should be prepared to effectively incorporate new technologies into their projects or plan making processes. It involves educating planners and professionals. Learning about effective uses of crowdsourced information, requires planners' attention to institutional or contextual issues, such as online facilitation, information quality, and technical skills of planners and communities.

Particularly, issues of representativeness and digital literacy should be considered. Although allowing people to participate without registration may help with attracting more participants, it raises concerns. For example, using crowdsourced information that lacks data on the socio-economic background of the participants raises questions about the validity and representativeness of this information.

Professionals' use of crowdsourced information can create ethical concerns about ways in which public participation and knowledge is being used or misused in planning processes. For example, as we saw in this case study, one of the planners used the crowdsourced information mainly to advocate for their interests. While using new participatory technologies can facilitate planning and decision-making by providing valuable information for planners and easier participation for citizens; it can lead to disengagement if they are used instrumentally to legitimize pre-determined elements of a plan.

Due to the focus of this study on a single case, and interview of a small number of professionals, the generalizability of the results should be interpreted cautiously. Different professionals have different skills, perceptions, and attitudes towards using new technologies, data sources, or information in their projects.

The current literature on using crowdsourcing technologies for online engagement has a strong focus on issues of data quality and analysis. It lacks a clear understanding of the effects of organizational behavior on technology and information use in planning processes. With the rapid advancements in the development and adoption of these technologies, planning organizations will have more access to data about citizens' needs and interests. Future studies are needed to explore the use of crowdsourced data in different types of plans and by various types of organizations, focusing on perceptions and attitudes of planners towards using these data.

Conflict of Interests

The authors declare no conflict of interests.

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