Exploring User Experiences and Challenges in the POGOH Bike Sharing System

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This study investigates user experiences and challenges within the POGOH bike-sharing system in Pittsburgh. Through in-person interviews and observational research, participants' interactions with the system were explored, revealing insights into usage patterns, attitudes, and barriers to adoption. The quantitative analysis of trip data highlighted the predominance of short trips, contrasting with POGOH's service model geared towards longer commutes. Qualitative interviews with regular, occasional, and potential users uncovered themes of usability, safety concerns, and infrastructure limitations. Recommendations for improving system functionality and user experience were proposed, emphasizing the importance of addressing usability challenges and aligning service offerings with user needs.

CCS Concepts: • **Human-centered computing** → **Ubiquitous and mobile computing**.

Additional Key Words and Phrases: urban fabrics, urban mobility, public bike-sharing, infrastructure

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1 INTRODUCTION

Urban mobility is undergoing a significant transformation in the era of Smart Cities, with public bike sharing emerging as a pivotal component of this paradigm shift.[16] Bike sharing systems facilitate urban transportation across short distances and address the first/last mile problem, thereby complementing traditional modes of public transportation such as buses and trains. In cities across the world, Station/Dock-based Public Bicycle sharing (SD-PBS) systems have increased in the last decade, allowing access to public bicycles for convenient and efficient travel within urban landscapes.

Bike-sharing services represent a dynamic and flexible alternative to conventional public transportation models e.g. buses, with the goal of providing users with an environmentally friendly, efficient form of short-distance travel from strategically located bike stations that is always available. Often, these same cities are simultaneously trying to increase active transportation, in which the goal is to integrate pedestrians, cyclists, scooters, and transit users, without increasing auto traffic. Bike sharing systems are seen as new infrastructures that can be built upon existing transit and auto dependent networks, sharing the road with automobiles and public buses.

SD-PBS systems leverage technology within smartphone applications to identify users, track the paths they cover, and provide real-time information on the current bike availability across a geographic region. Embedded sensors in both bikes and docking stations enable the collection of valuable data, facilitating dynamic adjustments to the service based on user demand in the short term. Moreover, this data can inform long-term planning efforts, guiding the expansion of

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bike-sharing systems by identifying areas requiring additional bikes or stations, and informing the development of new bike lanes along frequently traveled routes.[2]

However, traditional Station/Dock-Public Bike Sharing (SD-PBS) systems face inherent limitations, which can affect experiences and deter new users. In the SD-PBS system, fixed stations with bicycle docks are positioned between sidewalks and roads equipped with a number of bicycles, restricting station mobility and scalability of the number of bikes.[8] This fixed infrastructure can negatively affect user access and convenience, as user may encounter challenges in renting and returning bicycles when stations are not conveniently located or available. It has been established that maintaining service availability during rush hour is one of the most important issues to consider when examining effective SD-PBS systems. As bike traffic is not homogeneous across stations and dynamically changes over time, there may be empty and full stations, a condition that we referred to as "outage" in this article to indicate that the service becomes temporarily unavailable from those dock stations for customers that want to take or deposit bikes, respectively.

In the realm of urban mobility and bike sharing systems, researchers have extensively studied the growth and impact of Station/Dock-based Public Bicycle Sharing (SD-PBS) systems.[5] These systems have been recognized as valuable solutions to address the first/last mile problem and promote sustainable transportation options within cities. However, existing literature highlights several limitations inherent in traditional SD-PBS systems, particularly regarding user adoption and engagement. Despite efforts to promote bike sharing as a viable mode of transportation, many individuals remain hesitant to embrace cycling as a primary means of travel within urban environments. [12]

In this paper, our interest lies in examining how the POGOH bike sharing system integrates into the urban landscape of Pittsburgh, Pennsylvania, and how the travel habits and pain points of its current users align with the intended goals of the infrastructure designers. This focus stems from the recognition that while bike sharing systems like POGOH aim to offer a sustainable and convenient mode of transportation, their success hinges on factors such as user adoption, engagement, and satisfaction.

By focusing on the barriers to bike adoption and user engagement, this paper seeks to shed light on the nuanced complexities that shape individuals' perceptions and decision-making processes related to cycling. Through a comprehensive analysis of the POGOH bike sharing system in Pittsburgh, Pennsylvania, we aim to uncover the underlying motivations, concerns, and barriers that influence people's reluctance to embrace cycling as a mode of urban transportation. Hence, in this paper, we conduct an examination of behavior and challenges experienced by users within the POGOH bike sharing system, employing an approach that focuses on qualitative analyses through interviews and observational research. Specifically, we had the following research questions (RQ):

- RQ1: How does the POGOH bike sharing system in the city of Pittsburgh align with or challenge existing models of urban transportation?
- RQ2: Who is more likely to use bike sharing? When, where, why, how long, how regular do users usually use car sharing?
- RQ3: What is limiting the POGOH bike from widespread adoption, despite initiatives to make the system more accessible (i.e. free for students)?

To answer these questions, we conducted on-site observations and interviews at docking stations in Pittsburgh and analyzed large publicly available datasets concerning trip information. [14]

To this end, our data analysis follows a highly exploratory approach, wherein we analyze the collected interview data and bike sharing operation data through lenses of user behavior that are highly relevant to the community within the city of Pittsburgh. The major contributions of this work are the following:

- To our knowledge, this research is among the first to comprehensively examine the user experience and challenges within the POGOH bike sharing system in Pittsburgh, Pennsylvania. By employing a mixed-methods approach, we combine qualitative analyses through interviews with observational research to gain insights into the nuanced complexities that shape individuals' perceptions and decision-making processes related to cycling.
- Through semi-structured in-person interviews, we qualitatively explored participants' subjective perceptions of the POGOH bike sharing system, shedding light on their motivations, concerns, and barriers to adoption. Additionally, by conducting on-site observations and interviews at docking stations, we captured real-time user experiences and interactions with the system. This approach provided valuable insights into system reliability, usability issues, and potential areas for improvement, critically examining a public infrastructure from a bottom-up perspective building on qualitative data.
- Our findings contribute to a deeper understanding of urban mobility and bike sharing systems, particularly in the context of addressing the first/last mile problem and promoting sustainable transportation options within cities. By identifying key challenges and barriers to adoption, we offer actionable recommendations for policymakers, urban planners, and bike sharing operators to enhance the accessibility, usability, and overall user experience of bike sharing systems.

2 LITERATURE REVIEW

2.1 Contextual Details

The advent of bike-sharing systems has created considerable research interest, facilitated by the availability of real-world data from publicly accessible bike-sharing services in numerous cities. [7] While these systems represent a novel approach to urban transportation, they operate within existing infrastructural frameworks that shape the dynamics of urban mobility.

The concept of urban fabrics[10] provides a valuable framework for comprehending the intricacies of urban transportation. These fabrics, namely the auto fabric, transit fabric, and walking fabric, delineate the predominant modes of mobility within cities. The auto fabric encompasses personal vehicular transport, which dominates commuting patterns in many American cities like Pittsburgh. Conversely, the transit fabric pertains to public transportation systems, such as Pittsburgh's Port Authority transit system, which plays a pivotal role in urban mobility. Lastly, the walking fabric represents pedestrian-friendly zones and neighborhoods, where foot traffic is a prominent mode of transportation. Analyzing bike-sharing systems within the context of these urban fabrics is essential for understanding their impact on transportation dynamics and addressing discrepancies in transportation options.

Furthermore, the notion of "Marchetti's constant," [15] which posits a universal travel-time budget of approximately one hour per day for individuals, underscores the fundamental role of transportation in shaping cities and their physical infrastructures. By considering the overlap and interaction between walking, transit, and auto-centric urban fabrics, researchers can gain insights into the underlying mechanisms driving urban mobility patterns. Previous studies have utilized urban fabric frameworks to analyze transportation systems in various cities, highlighting the importance of considering the diverse infrastructural contexts in which bike-sharing systems operate.

2.2 Existing Literature on Bike-Sharing Systems

Existing literature on bike sharing systems in urban environments offers valuable insights into various aspects of these systems, particularly in cities similar to Pittsburgh. [3] Analyzing historical data has enabled researchers to design

models and frameworks that provide insights into how and when bike-sharing services are used, facilitating system improvements. Some studies propose analytical schemes based on Markov chains or queuing theory,/citeliu2021excess while others employ machine learning tools to directly learn bike traffic patterns from observed data.[1] While the former approaches offer parameterized models adaptable to different bike-sharing systems, the latter allows for the inclusion of factors like accessibility that may affect service usage.[4]

Moreover, much of the research on urban bike sharing systems has focused on station placement and rebalancing techniques for station-based systems from efficiency and economic perspectives. [13] While many studies analyze trip data to understand large-scale usage patterns of bike docks across entire systems, there is a paucity of qualitative data examining the reasons why some individuals use the system while others do not. [1, 3, 4, 13] While quantitative prediction models based on trip data provide valuable insights, they often overlook factors contributing to the minority of service users compared to the overall population with access to the service.

Notable pilot projects and subsequent research on them have evaluated the effectiveness of bike sharing as a sustainable transportation solution.[6] While the success of other bike sharing systems is well-established, it is important to note that they are concentrated in very few cities across the United States.[9] The country's largest systems generate the vast majority of all bike share rides, with the five biggest systems (Citi Bike in New York, Capital Bikeshare in Greater Washington DC, Citi Bike in Miami, Divvy in Chicago, and Hubway in Greater Boston) generating 85 percent of all bike share trips. [9] In 2016 alone, riders took over 28 million trips, on par with the annual ridership of the entire Amtrak system[9], showing that bike share systems can largely compete with traditionally accepted forms of public transportation. Successful integration of bike share systems in cities like New York relied on creating routes that maximized efficiency of travel in coordination with the subway, highlighting a necessity for ease of mode-switching.[3] By examining the successes of these case studies, researchers gain valuable insights into factors that make the system work in its respective city. The concentration of successful bike sharing systems in a select few cities underscores the nuanced challenges associated with their replication in diverse urban contexts. The unique combination of urban fabrics and demographic compositions that make up neighborhoods necessitate careful consideration when assessing the attitudes towards bike sharing systems. Thus, while insights from successful case studies are valuable, they highlight the need for a more comprehensive understanding of the contextual factors that influence the adoption and effectiveness of bike sharing systems across different urban environments. For example, New York City is less of an auto-dependent city while it is more common to have a car in Pittsburgh, so the system from New York could not be applied here with the expectation of the exact same response. Since infrastructure is not a "one size fits all" solution from one city to another, there can be a mismatch between what urban planners and makers of infrastructure expect a system to be used as rather than how it actually is.

2.3 Mobile App Integration in Public Transportation and MaaS

A growing trend in public transportation systems worldwide is the integration of mobile apps, which serve as a central interface for various mobility services. [6] This trend aligns with the concept of Mobility as a Service (MaaS), which involves the bundling of mobility modes such as trip planning, reservations, and payments through a single platform. One notable example is the Transit app, which is integrated with the POGOH app in the city of Pittsburgh. Case studies from cities or regions where mobile apps have been successfully implemented reveal their effectiveness in enhancing the user experience of public transit users, particularly in European cities where biking or public transportation is already prevalent.[6]

The concept of Mobility as a Service (MaaS) encompasses several core characteristics, including the integration of transport modes, flexible tariff options, a unified platform for multiple actors, the use of advanced technologies, demand orientation, registration requirements, and personalization.[6] MaaS platforms vary in complexity, ranging from Level 0 platforms that offer booking and payment for a single trip, Level 1 platforms that offer a range of travel modes without payment options, Level 2 platforms that provide integrated routing, booking, and payment options for various modes, to Level 3 platforms that offer subscriptions to a bundle of transport modes, and Level 4 platforms that offer all of the above in addition to being integrated with the government.

Mobile apps offer a range of features and functionalities aimed at facilitating trip planning, fare payment, real-time tracking, and user feedback. The integration of these features into public transportation networks has been shown to positively impact ridership, customer satisfaction, and overall efficiency. Drawing parallels between mobile app integration in public transit and its potential role in promoting user engagement in bike-sharing systems like POGOH can provide valuable insights into the future of urban mobility and the integration of diverse transportation modes. By understanding features about MaaS that appeal to users, like real-time tracking and trip planing, these methods that emphasize convenience and time management can be implemented into bike systems as well. This review sets the stage for examining the role of mobile app integration in enhancing the user experience of bike-sharing systems and its implications for urban transportation planning.

However, much of the existing research on MaaS has been speculative, as many pilot programs featured as case studies were short-lived or terminated before becoming public.[6] The majority of the focus on MaaS interfaces and services centers on Level 3 platforms that offer subscriptions to a wide range of transportation services, leaving a gap for focused research on platforms that offer a subscription to just one mode of transportation, such as bike sharing in the case of the POGOH system. Unlike MaaS systems that include subscriptions or ticketing services for buses, trains, subways, ferries, Ubers, taxis, scooters, and bikes, the POGOH app provides different tiers of subscriptions or a pay-as-you-go model for their bikes.

3 METHODOLOGY

3.1 Participants

The study engaged participants from the user base of the POGOH bike sharing system in Pittsburgh, Pennsylvania. Participants were selected based on their active utilization of the system and their willingness to participate in interviews. Convenience sampling was employed, initially targeting individuals within the researcher's social network, followed by on-site recruitment at a popular docking station. Given that the interviews were conducted in the neighborhoods surrounding the University of Pittsburgh campus, a majority of interviewees were students at the University, aged 18 - 23. This also meant that all of the participants had free access to the POGOH bike system through their university, eliminating cost as a deterrent to bike sharing system use.

That being said, it's important to note that while the bikes were free for University of Pittsburgh students to use once a discount code was obtained, access was not as straightforward. Prospective users needed to retrieve the code via email and input it into the app, along with providing credit card information. This process meant that access to the service was contingent upon knowledge of its availability by searching for more information, making it less accessible compared to other transportation options such as the bus system, which is fully integrated into students' ID cards. Thus, while the bikes were technically free to use, their accessibility was limited by the requirement for prior knowledge of the process.

Table 1. Interview Participant Information

Subject ID	Age	Recruitment Source	Usage Frequency	Total Rides
S1	22	From social network	Regular	354
S2	21	From social network	Potential	0
S3	21	From social network	Occasional	80
S4	20	From social network	Occasional	32
S5	23	From social network	Potential	0
S6	20	From social network	Regular	119
S7	19	From social network	Potential	0
S8	21	From social network	Occasional	28
S9	20	From dock station	Regular	304
S10	21	From dock station	Regular	202
S11	20	From dock station	Regular	196
S12	21	From dock station	Occasional	48
S13	20	From dock station	Regular	156
S14	21	From dock station	Regular	260

Participants in the study were categorized into distinct groups based on their usage patterns and familiarity with the POGOH Bike Sharing System:

- **Regular Commuters**: Individuals who self-identified as frequent users of the POGOH bikes, utilizing them on a regular basis for their daily transportation needs. These users also had over 100 trips recorded in their trip log through the POGOH mobile app.
- **Occasional Users**: Participants who reported using the POGOH bikes sporadically, infrequently, or in the past, often for specific purposes or as a secondary mode of transportation. These users had less total trips in their trip logs, between 20 and 80 recorded.
- **Potential Users**: Individuals who had never utilized the POGOH bike sharing system but expressed interest or curiosity about its functionality and potential benefits. As a result, these users had recorded zero logs.

This stratification allowed for a comprehensive examination of user experiences across different levels of engagement with the bike sharing system, ranging from established users to those without interest in the system.

During the study, a total of 14 individuals were interviewed. Among them, 8 participants were recruited from the researcher's social network, while the remaining 6 were recruited from two different docking stations with high traffic. Half of the participants from these docking stations were from a station centrally located on the University of Pittsburgh Oakland campus (Forbes Ave and Schenley Dr), while the other half were chosen from a station situated in a high-traffic area between the University of Pittsburgh and Carnegie Mellon University in the North Oakland neighborhood (N Dithridge St and Centre Ave).

3.2 Data Collection

Data collection for this study involved conducting semi-structured interviews with participants to gain insights into their commuting habits, preferences, and experiences with the POGOH Bike Sharing System. The interviews were guided by a predetermined set of questions designed to explore various aspects of participants' interactions with the bike sharing system and their overall commuting behavior.

Participants, regardless of use of POGOH, were asked about their typical commuting practices, including the modes of transportation they used for different distances and the factors influencing their transportation choices. Specific inquiries were made regarding participants' frequency of using the POGOH bike sharing system, their likes and dislikes about the system, challenges encountered during usage, and their experiences with the accompanying mobile application platform.

For participants without experience with the POGOH bike-sharing system themselves, questions were asked about their interactions with public transportation in their existing routine as well as attitudes towards biking, road safety, and accessibility related to bike sharing.

Interviews were conducted in-person, with each session lasting approximately 15-30 minutes, allowing for detailed exploration of individual experiences and perspectives. Once the primary set of questions were answered, fluid conversation allowed for clarifying follow ups as well as time for interviewees to give talk freely about their experiences using the POGOH bike and app infrastructure. The responses from each interview were meticulously recorded in real-time using a combination of handwritten notes and digital audio recording, with explicit permission obtained from each participant prior to recording. This dual method of real-time note taking and post-interview transcription ensured accuracy and completeness in capturing the nuances of the interviews, spoken and unspoken.

In addition to the responses from the interviews, qualitative data was collected through observational research conducted at the two selected docking stations where the six onsite interviews were held. By conducting interviews and observational research during the school week between class times, this observational period while waiting to interview POGOH users coincided with the busiest times for student commuters, allowing for a targeted examination of user interactions with the bike sharing system. That being said, I decided not to interview some POGOH bike users who stated that they were busy or did not have time for an interview.

3.3 Data Analysis

The qualitative data analysis employed a thematic reading approach to explore the interview transcripts and observational notes. Initially, an open coding process was conducted, involving the systematic examination and labeling of significant concepts and patterns related to attitudes, emotions, pain points, and experiences within the data. This process facilitated the identification of recurring themes and incidences relevant to the participants' experiences with the POGOH bike sharing system.

After the initial round of open coding, axial coding was employed to further refine and organize the generated codes into overarching themes and sub-themes. This involved examining the relationships between different codes and grouping them based on commonalities and connections. Through iterative rounds of coding and thematic refinement, a comprehensive understanding of the data was achieved, highlighting key insights and perspectives.

For example, codes such as "system reliability," "user interface," "bike returns," and "availability information" emerged during the open coding phase, reflecting the diverse challenges and concerns expressed by participants. Subsequently, these codes were organized into broader themes, such as "usability issues" and "system functionality," during the axial coding process. Through subsequent rounds of coding and thematic refinement, these themes were further elucidated and contextualized, providing valuable insights into the user experience with the POGOH bike sharing system.

In addition to qualitative analysis, quantitative analysis was conducted on POGOH trip data, specifically focusing on 27,417 trips from March 2024. This time period was chosen as it correlated with the in-person interviews were being conducted, so that the quantitative data would be aligned with the qualitative data. This dataset, obtained from the Western Pennsylvania Regional Data Center, included trip duration, start and end station details, and rider type.

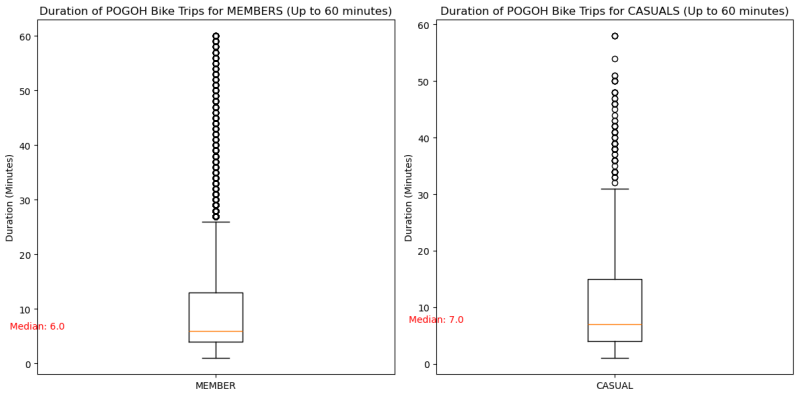

Fig. 1. Box and whisker plots depicting trip lengths up to 60 minutes for annual membership holders (left) and "pay as you go" riders (right).

Out of the total entries, 25,964 data points were considered by filtering for 'Normal' rides, excluding those less than a minute ('grace period') and over 24 hours ('terminated'). Additionally, the trip data differentiated between users that were "Members" and users that were "Casual". In other words, "Members" indicated riders with a membership, whether it was an standard annual membership, annual student membership or annual corporate membership. These riders payed a subscription fee for unlimited 30 minute or 60 minute rides and additional costs over the time limit. "Casual" indicated users using the "Pay as you Go" method, where the costs were associated with each minute the bicycle was used. Detailed findings from the quantitative analysis will be presented in the subsequent results section.

4 FINDINGS

4.1 Quantitative Analysis of Trip Data

4.1.1 Trip Duration Statistics. Quantitative analysis of trip data revealed:

- **Mean of all trip durations**: 13.64 minutes
- **Median of all trip durations**: 6 minutes
- **Mode of all trip durations**: 4 minutes
- **Range of all trip durations**: 1311 minutes

Of the 27,417 trips recorded in March 2024, these statistics show that most of the trips have short durations. Despite the maximum in this sample being 1312 minutes, or 21 hours and 52 minutes long, the mean of the trip durations amounts to less than 14 minutes. Further examination revealed a high incidence of outliers with trip durations extending over several hours. These prolonged durations may be attributed to user errors, such as failing to properly return the bike to the docking station, thereby extending the trip duration erroneously. However, these outliers did not exceed 24 hours, indicating that they were not terminated by POGOH or reported as technical issues. Considering the outliars, it felt appropriate to analyze the data up to certain time increments, such as 30 and 60 minutes, as those are the lengths laid out in the annual membership passes.

Analysis of the difference in trip data between annual membership holders, which includes the free student memberships offered by the University of Pittsburgh, and pay as you go riders show that the median remains roughly the same, with only a difference of one minute. Considering that annual membership holders are the overwhelming majority, at

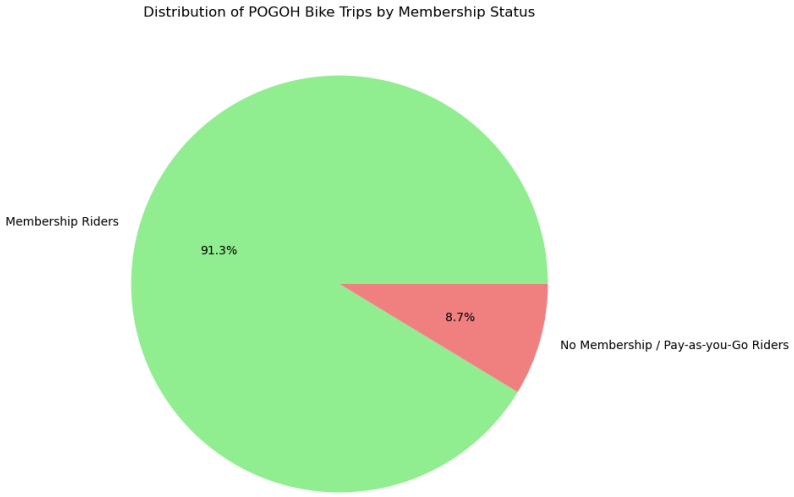

Fig. 2. Pie chart of the ratio of annual membership holders and "pay as you go" riders.

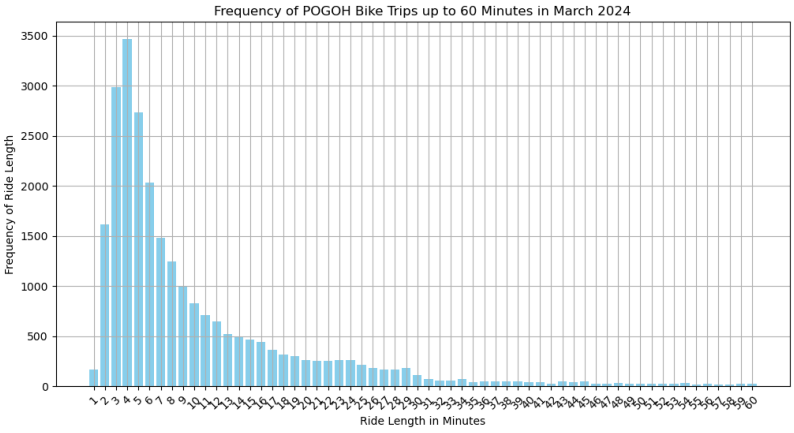

Fig. 3. Bar graph of trip lengths taken up to 60 minutes.

91.3 percent of all riders in March of 2024, it is interesting to consider how POGOH bikes are largely used for "unlimited" 30 minute or 60 minute travel. Therefore, the findings that those who have access to longer durations of travel included as part of their plan do not actually take longer trips. In fact, the median of those with annual memberships is a minute less than those who pay per minute and have incentives to take shorter trips.

This bar graph depicting trip frequency for durations up to 60 minutes showcased the predominance of short-distance trips, with the majority falling between 3 and 8 minutes. Analysis by dock locations indicated that these short trips primarily occur within the university campus, facilitating travel between student housing and academic buildings.

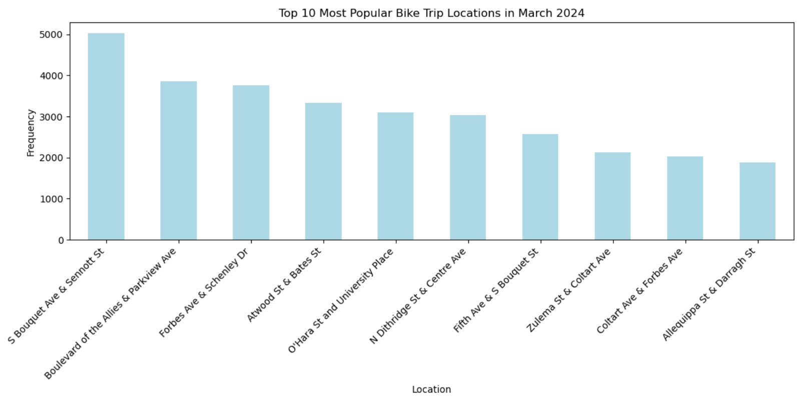

Fig. 4. Bar graph of trip lengths taken up to 60 minutes.

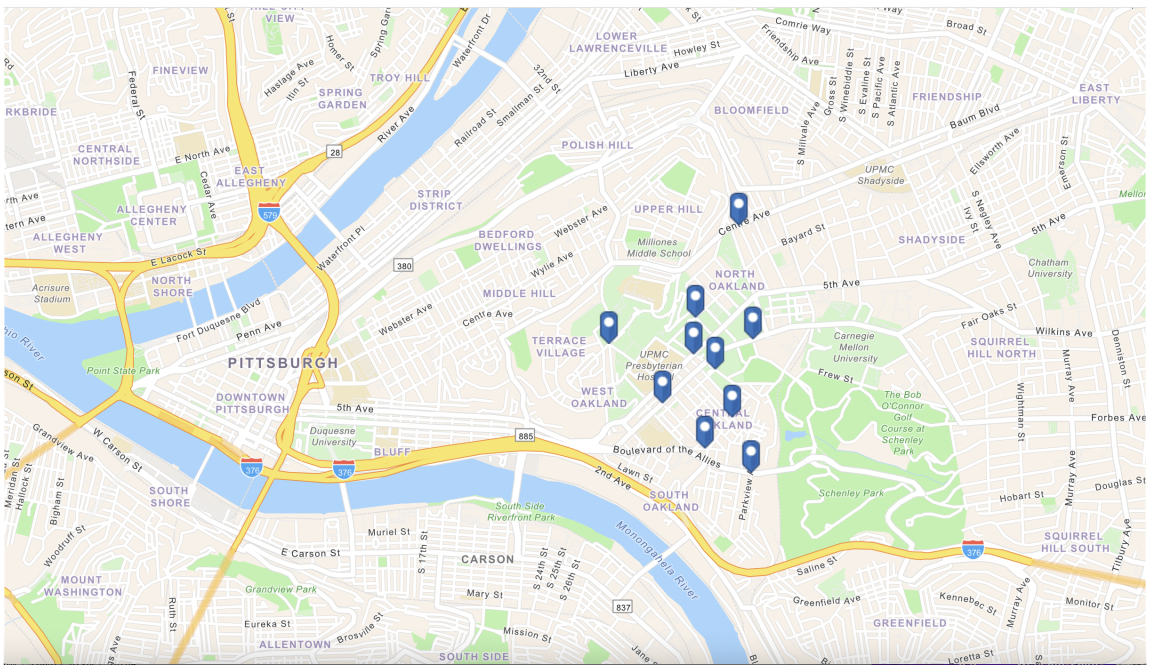

Fig. 5. Map of top 10 most frequented POGOH bike docking locations

In fact, by analyzing the frequency of dock locations in terms of the starting dock in which users unlock their bikes and the ending lock in which users return their bikes shows that all ten of the top ten most used locations are contained within the University of Pittsburgh's Oakland campus and student residential areas.

By analyzing trips with durations between 3 to 6 minutes, it was observed that many of these trips originated from student residential areas and terminated outside academic buildings. For instance, Trip ID 913, with a duration of 4 minutes and 14 seconds, started from a predominantly student residential area (Atwood St and Bates St) and ended

Table 2. Top 10 Most Popular Bike Trip Locations in March 2024

Location	Number of Uses
S Bouquet Ave & Sennott St	5036
Boulevard of the Allies & Parkview Ave	3856
Forbes Ave & Schenley Dr	3765
Atwood St & Bates St	3326
O'Hara St and University Place	3109
N Dithridge St & Centre Ave	3032
Fifth Ave & S Bouquet St	2567
Zulema St & Coltart Ave	2130
Coltart Ave & Forbes Ave	2034
Allequippa St & Darragh St	1875

outside a science building (O'Hara St and University Place). Similarly, Trip ID 939 commenced from outside a large student apartment building (N Dithridge St and Centre Ave) and concluded at an intersection of three major academic buildings (S Bouquet Ave and Sennott St). Trip ID 1807 was between another student residential area (Boulevard of the Allies and Parkview Ave) and outside the library (Forbes Ave and Schenley Dr). These findings suggest that the program offering free rides to University of Pittsburgh students has been effective, as a majority of POGOH traffic originates from students who require forms of micro-travel outside of regular rush hours, which may not align with bus routes.

4.1.2 Interpretation and Implications. The discrepancy between the intended usage model and actual user behavior raises questions about the alignment of POGOH's service offerings with user needs. POGOH's plan models anticipate longer bike rides, as evidenced by their annual membership boasting "unlimited 30-minute rentals" and their mobility justice membership offering "unlimited 60-minute rentals." Additionally, the benchmark time for their pay-as-you-go option is 4 dollars for 30 minutes.

However, the median and mode trip durations reveal that most trips hover around five minutes long. Even with the outliers, the average trip is less than half of the allotted 30 minutes. This discrepancy suggests that rather than serving as a healthy and sustainable alternative to bus and car infrastructure for travel from neighborhood to neighborhood in Pittsburgh, POGOH bikes are primarily used for micro-travel from building to building, particularly relevant to college campuses.

Additionally, POGOH's messaging raises questions about the alignment between this mission and the actual usage patterns of their bike-share system. As part of POGOH's "Mission and Values", the organization states: "Bike Share Pittsburgh is dedicated to creating and expanding connections throughout Pittsburgh using an intuitive bikeshare system." While the word "connections" could have multiple meanings, in terms of urban planning it implies facilitating travel between different neighborhoods or areas within the city. However, since our analysis reveals that the most common trips taken with POGOH bikes are between stations within the same neighborhood, this suggests that users would be more likely to benefit from a greater density of bike dock locations rather than distant connections.

4.2 Qualitative Analysis of Interviews

The qualitative research consisted of interviews with eight participants from the researcher's social network and interviews and observations with six participants from two docking stations in the areas surrounding the University of Pittsburgh.

4.2.1 Bike-sharing in daily life. The significance of bike-sharing in daily routines varied greatly depending on its integration into participants' commutes and activities. While those who had never utilized the POGOH system did not perceive the bikes as influential on their daily routines, regular users with over 100 trips logged expressed heavy reliance on the service for their transportation needs. Central to this reliance was the alignment of bike dock locations with commuting routes, particularly for travel between residences and educational or work institutions. Electric bikes, in particular, were favored for their ability to provide swift transportation over short distances. One participant shared their positive experience, stating, "I love using the bikes, especially the electric ones. If I'm late to class I can get on one and park right in front of the building, and because it's electric it's so easy." (S1) Given that the interviewees, like 60 percent of total POGOH bike users in 2023, [11] were all undergraduate students, they predominantly enjoyed the convenience of the bikes for commuting to educational institutions and workplaces. The regular riders commented on a sufficient number of docking locations on campus, expressing satisfaction with the system's convenience for their commute. In contrast, potential users showed less interest in incorporating bikes into their daily commutes.

4.2.2 Value: Reliability. For regular users, reliability emerged as a critical factor in their perception of the POGOH system. The availability of bikes and open spaces at docking stations was very important for seamless usage. Although the POGOH app provides real-time information on bike availability, regular users often did not check the app frequently, as they typically commuted between specific starting and ending points. Additionally, the riders did not have a lot of flexibility in their starting and end points, and so reliability of specific locations was a major value point. Instances where docking stations were full posed challenges, as users were forced to travel additional distances to return bikes. This dock-specific inconvenience overshadowed broader infrastructural concerns like bike lanes and road safety. One participant recounted a scenario where they had to travel out of their way to find an available docking station: "I've never had it happen to me, but I'm sometimes nervous that there won't be a spot to return it because the docks can get very busy. The other day there was only one spot left, and I wouldn't know what to do if it wasn't." (S6) This uncertainty highlights the importance of rebalancing bikes to ensure a reliable experience. Even for regular riders, the possibility of not having enough spots are an issue that negatively affects the trip.

4.2.3 Value: Safety. Safety emerged as a significant concern across all levels of engagement with the POGOH bicycles. While regular and occasional users found safety to be important, even in the absence of dedicated bike lanes, potential users expressed heightened fears related to traffic safety. For individuals who had never used POGOH bikes, safety concerns were primarily rooted in perceived risks rather than firsthand experiences. Through axial coding, a common theme of *safety on the road* emerged, especially concerning busy streets or areas lacking designated bike lanes. The absence of bike lanes on high-traffic roads was a significant deterrent for some potential users, who preferred walking on sidewalks or using public transportation as alternatives to biking alongside cars: "If there isn't a bike lane, I'm not going to take a POGOH because I don't feel comfortable biking in front of cars. I'm going 15 miles an hour and cars are trying to go what, 30 miles an hour? I feel like I'm holding people up...and also I don't want to get hit." (S3) Moreover, concerns about street safety, especially on high-traffic streets without bike lanes or in hilly areas, further discouraged potential users from embracing the system: "I've never used POGOH because I'm not comfortable biking in the city. I worry about safety, especially on busy streets without bike lanes." (S7) Therefore, bike lanes are put forward by the participants as an infrastructural mediation that is needed in order to improve the experience of bike-sharing systems.

A significant source of apprehension regarding riding alongside cars stems from the lack of dedicated bicycle lanes in areas with high amounts of traffic. In Pittsburgh, most streets lack designated bike lanes, and existing lanes often terminate abruptly or merge with automobile traffic. While some riders explained that they preferred to use sidewalks

instead on such busy streets, this is unsafe for pedestrians and many sidewalks are neglected and unsafe for high speeds. Only a few main roads in Pittsburgh have dedicated lanes for bike riders on either side, but they are not well incorporated into regions where the POGOH bikes are being used. Notably, of the top ten most frequently used dock locations in March 2024, all situated within the University of Pittsburgh campus and its surrounding residential area, only two directly connect to a bike route.

Table 3. Top 10 Most Popular Bike Trip Locations in March 2024

Location	Number of Uses	Connected to Bike Path?
S Bouquet Ave & Sennott St	5036	No
Boulevard of the Allies & Parkview Ave	3856	No
Forbes Ave & Schenley Dr	3765	Yes
Atwood St & Bates St	3326	No
O'Hara St and University Place	3109	Yes
N Dithridge St & Centre Ave	3032	No
Fifth Ave & S Bouquet St	2567	No
Zulema St & Coltart Ave	2130	No
Coltart Ave & Forbes Ave	2034	No
Allequippa St & Darragh St	1875	No

This underscores the inadequate infrastructure supporting the POGOH system. Safety on the road is a paramount concern for all riders, and the lack of proper infrastructure poses a significant barrier to the system's expansion. Enhanced bike lane infrastructure could encourage current users to explore routes beyond their daily commutes, while also incentivizing potential users to adopt the system.

4.2.4 Barrier to Adoption: Accessibility. In terms of accessibility, POGOH offers three different types of membership plans tailored to different user needs. These include an annual membership, a flex pass, and a pay-as-you-go option. The annual membership, which provides unlimited 30-minute trips, caters to regular users. Additionally, POGOH offers a mobility justice membership for individuals receiving government assistance, which includes free access to the bike-share system. University of Pittsburgh students are also eligible for a promotional code where they receive the annual membership for free through an email invitation at the beginning of the school year. However, despite these offerings, there are significant barriers to access for some potential users. Obtaining a membership card, which is necessary for those without smartphones or who prefer not to use apps, is not straightforward. There is no online application process, and obtaining a card requires calling customer support, which is counterintuitive as a solution for people without access to a smartphone. Furthermore, the lack of prominent advertising or clear onboarding processes for certain groups, such as University of Pittsburgh students, means that potential users may not even be aware of their eligibility for free or discounted membership. Two people interviewed who were potential riders admitted to not knowing about their free access to POGOH bikes and could not locate their promotional codes.

Additionally, the process of signing up for a membership, whether through the app or by phone, involves inputting credit card information at the very beginning of the sign up process. Without a free trial, riders have to spend time before their trip weighing the odds of a year long annual commitment. This may deter individuals who are wary of sharing financial details or who may not have access to traditional banking systems. This complexity, coupled with the challenge of locating discount codes or navigating emails for eligible discounts, further hinders accessibility. One user

commented: "If I'm trying to rent a bike, that means I'm trying to go somewhere. I didn't realize that I would have to pull out my credit card information in the middle of the sidewalk, I thought we would just have to enter the code for the free access!"(S4) This shows the the inconvenience of payment hinders mobility, which can become a barrier to adoption. Whether people want to use the pay as you go pass for sightseeing or the annual pass for their commute to work, the on-boarding process may take longer than the actual planned trip, considering the average length of POGOH bike trips.

Ultimately, if potential users are unaware of the resources available to them or find the sign-up process overly complicated, these resources do not effectively serve their intended purpose. Accessibility goes beyond simply offering discounted or free memberships; it also encompasses ensuring that the process of accessing these benefits is straightforward and navigable.

4.2.5 Barrier to Adoption: Availability. Participants highlighted the significant impact of system availability on their engagement with the POGOH bike sharing system. Challenges concerning bike availability, station proximity, and the simplicity of rental and return procedures emerged as crucial factors influencing user satisfaction. However, persistent issues related to ensuring proper bike returns and occasional inconsistencies in the app's real-time bike availability data compromised the system's transparency, thereby impeding user experience and discouraging continued use.

Real-time updates for selected docking destinations may be an opportunity for design changes that reflect the need for accuracy. As the findings from earlier present individual trips to be much shorter than anticipated, it can be said that the availability of docking stations can rapidly change as well. Addressing these challenges is paramount to ensuring a seamless and user-friendly experience for both existing and potential users.

4.2.6 Barrier to Adoption: Usability Challenges. Overall, interview responses regarding the usability of the technology yielded positive results. Regular and Occasional users expressed that the app was "simple" and "intuitive," with only 4 screens to navigate. While the user experience of the app was easy, several users stated that the onboarding of the subscription plan was difficult.

When asked about challenges, three of the seven regular users cited little to no challenges or negative experiences with the system. However, amidst the positive sentiments, a recurring issue emerged concerning proper bike returns amongst the other interviewees. As a POGOH bike "trip" begins and ends with the bike being securely locked into one of the scattered dock locations throughout the city, instances where bikes were not securely docked could lead to problems for the user. Even if a bike was returned to a docking location, some regular users had experiences where the green light signaling a proper return was not signaled or was falsely signaled, leading to prolonged periods of being considered "in use" and resulting in exorbitant charges for users. One interviewee aptly described these charges as "insane," highlighting the frustration and financial burden caused by such occurrences.

4.2.7 Barrier to Adoption: Discomfort. Beyond discomfort with biking due to safety concerns due to the lack of biking infrastructure in Pittsburgh, some of the potential and occasional users pointed out their hesitancy towards biking from the start. Socio-cultural factors, such as a lack of exposure to biking during childhood, was a factor that curbed curiosity towards participating in a bike-sharing system, especially among individuals from urban neighborhoods where biking was not part of the urban fabric of their youth.

For those who were not already using bikes as their daily mode of transport, some thought of biking as "uncool": "I use it in the early morning when it's too cold to walk but I want to go to the gym. I don't use it otherwise because I

don't really like the idea of people perceiving me on a bike; it feels a little dorky." (S8) Compared to riding a personal bike or walking, using a ride-share bike was perceived to attract negative social judgement from others.

4.3 Recommendations for Improvement

Participants offered a range of recommendations aimed at enhancing the POGOH bike sharing system's functionality and user experience. Key suggestions included improving bike availability and distribution, proving helmets to alleviate safety concerns, enhancing signage and wayfinding mechanisms, and implementing educational initiatives to promote cycling safety and awareness.

The findings suggest opportunities for improvement in real-time information accuracy and seamless integration of the payment/subscription process. Addressing these usability concerns could enhance the overall user experience and reduce potential frustrations with potential users who are turned off by the paywall upfront.

Real-time updates for selected docking destinations may be an opportunity for design changes that reflect the need for accuracy. As the findings from earlier present individual trips to be much shorter than anticipated, it can be said that the availability of docking stations can rapidly change as well. Addressing these challenges is paramount to ensuring a seamless and user-friendly experience for both existing and potential users.

Additionally, advocating for better urban infrastructure, including the development of dedicated bike lanes and traffic-calming measures, emerged as a crucial recommendation to address systemic barriers and facilitate the widespread adoption of bike sharing systems.

5 DISCUSSION

This mixed-methods study of quantitative data analysis and qualitative research yielded valuable insights into the usage patterns, user experiences, and challenges associated with the POGOH bike-sharing system in Pittsburgh. The quantitative analysis revealed a predominance of short trips, with a median duration of 6 minutes, contrasting with POGOH's service model geared towards longer commutes of up to 30 or 60 minutes. The qualitative interviews highlighted that POGOH's primary users are university students utilizing the bikes for micro-mobility within the campus and surrounding areas, and that their transportation priorities, challenges with the existing system, and general attitudes towards biking vary depending on their level of comfort (or lack thereof) with the POGOH bikes.

The key findings underscore the disconnect between POGOH's intended usage model and the observed user behaviors, raising questions about the alignment of their service offerings with actual user needs. While the system was designed for longer commutes for the greater Pittsburgh community, its primary utility lies in facilitating short-distance trips within a localized area. This discrepancy presents an opportunity for POGOH to reevaluate its pricing structure, membership plans, and marketing strategies to better cater to the needs of its core user base, namely university students and local residents engaged in micro-mobility

5.1 Aligning with Existing Literature

The findings of this study both corroborate and extend existing literature on bike-sharing systems. Consistent with previous research, the observed prevalence of short trips aligns with the notion that bike-sharing systems primarily serve the "last mile problem" transportation needs rather than long-distance commutes. However, the qualitative insights from user interviews provide a more nuanced understanding of the factors influencing user behavior and adoption, complementing the quantitative models and frameworks prevalent in the literature.

Unlike successful bike-sharing systems concentrated in major cities like New York City and Chicago, the POGOH system faces unique challenges in a city like Pittsburgh, where biking infrastructure and cultural norms may vary. Analyzing the most popular dock locations from the dataset of all trips taken in March of 2024, it is undeniable that a large number of the trips occur within the radius of the University of Pittsburgh. In that sense, the POGOH bike system is wildly successful amongst these university students (considering they receive discounted/free rates). However, it is uncertain whether this correlates with widespread adoption by non-students throughout the city. As Pittsburgh's roads–and lack of bike lanes–demonstrate, this city was built for automobiles. For decades Pittsburgh had a "tough working class city" stereotype, and this may have had an influence on the lack of infrastructure built for pedestrians and bicylists. This study highlights the importance of considering contextual factors specific to each urban environment, as opposed to relying solely on insights from highly successful case studies.

The findings of this study underscore the importance of considering bike-sharing systems within the broader context of urban fabrics and transportation infrastructures. As stated earlier, Pittsburgh is primarily an auto urban fabric. While POGOH was envisioned as a complementary mode to Pittsburgh's existing transit and auto fabrics, the observed user behaviors suggest a more localized role in facilitating micro-mobility within specific neighborhoods and the university campus area. This aligns with the concept of walking fabrics, where pedestrian-friendly zones create a conducive environment for short-distance trips facilitated by bike-sharing systems.

Furthermore, the discrepancy between POGOH's intended usage model (longer commutes) and the actual user patterns (micro-mobility) highlights the need for a more nuanced understanding of Marchetti's constant and its implications for urban transportation planning. While the one-hour travel-time budget may apply to commuters traveling across the city, the predominance of short trips observed in this study suggests that individuals may allocate shorter time budgets for micro-mobility within their immediate surroundings.

5.2 Considering User Needs

The disconnect between POGOH's intended usage model and the observed user behaviors raises questions about the alignment of their service offerings with actual user needs. While the system was initially designed to facilitate longer commutes within the city, the findings suggest that its primary utility lies in supporting short-distance trips. This insight presents an opportunity for POGOH to reevaluate its pricing structure, membership plans, and overall value proposition to better cater to the needs of its core user base.

For instance, putting their more flexible pricing options at the forefront or implementing distance-based pricing could incentivize and encourage the observed micro-mobility use cases. Additionally, exploring partnerships or targeted marketing strategies with local universities and residential communities could further enhance POGOH's visibility and relevance among its primary user demographic.

5.3 POGOH Bike-Share as MaaS

The findings related to user experiences with the POGOH app and the identified usability challenges align with the growing trend of mobile app integration in public transportation and the concept of Mobility as a Service (MaaS). While existing literature has primarily focused on MaaS platforms offering bundled subscriptions to multiple transportation modes, this study provides insights into a platform centered around a single mode (bike-sharing).

Addressing the usability concerns and enhancing real-time information accuracy within the POGOH app could potentially improve user engagement and encourage wider adoption of the bike-sharing system. This aligns with

the core principles of MaaS, where seamless integration and personalization are key to enhancing the overall user experience.

While MaaS platforms aim to integrate diverse transportation modes, bike-sharing systems may require tailored approaches and design considerations to cater to their unique user base and usage patterns, as evident from the observed micro-mobility trends in this study.

5.4 Implications for Urban Mobility Planning

The findings also carry significant implications for urban mobility planning and infrastructure development. The identified barriers to adoption, such as a lack of docking stations safety concerns, dedicated bike lanes, and education on safe bike riding, highlight the need for a comprehensive approach that integrates transportation planning with other systems and infrastructures.

Collaborating with local authorities, advocacy groups, and community stakeholders to promote cyclist education, awareness campaigns, rewards, and the development of dedicated bike lanes is crucial. These efforts not only address the perceived barriers but also foster a more inclusive and accessible urban environment that encourages active transportation modes like cycling.

Furthermore, the study's insights underscore the importance of user-centric design in transportation systems. Incorporating user feedback and addressing usability challenges, such as real-time information accuracy and seamless integration of payment processes, can significantly enhance the overall user experience and encourage wider adoption of bike-sharing services.

5.5 Limitations and Future Research

While this study provides valuable insights, it is important to acknowledge its limitations. The qualitative data was collected from a relatively small sample size, primarily comprising university students. Future research could expand the scope by including a broader demographic representation and exploring user perspectives from different urban contexts.

Additionally, the study focused on a specific geographic location (Pittsburgh) and a single bike-sharing system (POGOH). Conducting comparative studies across multiple cities and bike-sharing providers could yield further insights into the influence of local factors, such as urban design, infrastructure, and cultural norms, on user behaviors and system adoption.

Furthermore, as bike-sharing systems continue to evolve and incorporate emerging technologies (e.g., electric-assist bikes, dockless systems), future research could investigate the impact of these advancements on user experiences, mobility patterns, and overall system sustainability.

Despite these limitations, this study contributes to the growing body of knowledge on bike-sharing systems and their role in shaping urban mobility landscapes. By addressing the identified discrepancies and challenges, stakeholders can work towards fostering more sustainable, equitable, and user-centric transportation solutions in cities like Pittsburgh and beyond.

6 CONCLUSION

In conclusion, the exploration of user experiences and challenges within the POGOH bike-sharing system offers valuable insights into the alignment between service offerings and actual user needs. The quantitative analysis reveals a discrepancy between the intended usage model, which emphasizes longer commutes, and the observed user behaviors,

which predominantly consist of short-distance trips. This misalignment prompts critical questions about the effectiveness of current pricing structures, membership plans, and marketing strategies. Moreover, the qualitative findings shed light on various barriers to adoption, including issues of accessibility, availability, usability challenges, and discomfort, all of which underscore the importance of user-centric design in urban transportation planning.

As we contemplate the future of bike-sharing systems like POGOH, a thoughtful question arises: How can stakeholders, including policymakers, urban planners, and bike-sharing operators, collaborate to bridge the gap between service offerings and user needs, thereby fostering more sustainable, inclusive, and user-friendly transportation solutions? Addressing this question requires multifaceted approaches, including the refinement of pricing models to incentivize desired usage patterns, the enhancement of infrastructure to ensure safety and accessibility, and the integration of user feedback to improve system usability and overall user experience. By embracing these challenges and working collaboratively, we can pave the way for a more equitable and efficient urban mobility landscape, where bike-sharing systems play a pivotal role in enhancing connectivity and promoting active transportation modes.

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