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An Analysis of Impact of Recreational Facilities on Urban Park Visitation Using Flickr Posts: A Case Study of San Francisco

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1 Introduction

Urban green parks emerged with the development of modern cities, and have developed to become more and more abundant in terms of type, form, and function. As public open spaces may with recreational facilities in the city, urban green parks are the main places for leisure and sports for urban residents, providing several health-promoting functions. (Grilli et al., 2020). "A growing pool of evidence suggests that compared to other environments, nature-based ("green") spaces might promote greater health benefits gained from acute bouts of exercise and might better enable mechanisms that foster future adherence to exercise behaviors." (Rogerson et al., 2016, p. 1). A common but not unique definition of recreational facilities on the internet is that they are designed, unnaturally occurring facilities provided to individuals, groups, and families for relaxation or physical exercise. Cultural facilities such as historical sites and museums were not included in the recreational facilities in this study. Given the positive impact of green spaces on the health and well-being of urban residents, extensive studies emphasize the importance of promoting the use of recreational facilities in green spaces.

Park visitation has been an important topic for research (Grilli et al., 2020). Understanding the factors that contribute to park popularity can help urban planners and policymakers make informed decisions about where to invest resources. However, as far as we know, there has been less previous evidence for the impact of recreational facilities on various categories of urban park visitation by using geotagged social media data as a new approach for measuring visits to urban parks. It is of interest to investigate whether the number of recreational facilities has a positive or negative relationship with visitation to each urban park category.

In this study, we used geotagged Flickr posts to quantify visitation to diverse urban park categories in San Francisco. We used linear regression analysis and correlation analysis to answer the following questions: (1) Will recreational facilities attract more park visitation? (2) What is the impact of recreational facilities on visitation by the urban park category? (3) If recreational facilities have little or even a negative impact on park visitation by category, what are the reasons?

This study contributes to the existing literature by providing empirical evidence of the relationship between recreational facilities and park popularity, using a novel data source. The findings of this study will have implications for urban planning policies and strategies aimed at enhancing the attractiveness and usage of urban parks.

2 Literature Review

2.1 Urban Green Park and Recreational Facility

Within the realm of urban planning and environmental sustainability, there exists a broad consensus asserting the indispensable role of urban parks in fostering livable and sustainable urban environments. (Konijnendijk et al., 2013, p. 4). In Chiesura (2004), "The experience of nature in the city is the source of a large array of positive feelings to people. Freedom, Unity with nature, and Happiness are among the most frequently mentioned, along with beauty and silence."

Recreational facilities are places designed for leisure activities where people can participate in various forms of entertainment, social interaction, and exercise. They are designed to enhance the quality of life for individuals and communities by providing spaces for physical activity, relaxation, and socializing.

Several authors have considered the effects of recreational facilities on physical and non-physical health benefits. Previous research has established that among children, recreational facilities in parks have a positive impact on children's obesity. (Wolch et al., 2011). A study has shown that participating in leisure-time activities is better for adolescents' mental and physical health. (Badura et al., 2015, p. 7). In particular, the number of nearby recreational facilities and the number of nearby parks had a positive effect on girls' physical activity. (Norman et al., 2006). For middle-aged people, recreational activities appear to benefit mental health status, whereas specific social activities do not. (Takeda et al., 2015, p. 6). Compared to younger people, seniors may be less interested in vigorous physical activity due to physical function, and they prefer less vigorous exercises in some predictable environment. (Cohen et al., 2009, p. 250), such as indoor recreation center.

2.2 Urban Park Visitation and Social Media Data

Research into urban park visitation and usage has a long history. Given the intense competition for urban land use, the advocacy for park utilization has become a significant focus in the field of urban ecology. The elucidation of key factors influencing park visitation could substantially aid in the formulation of effective strategies and policies aimed at enhancing park patronage. (Liu et al., 2017).

Many factors can affect park visitation. A previous research has shown that in the context of "opportunity or orientation?", the motivation to visit parks and interact

with nature is driven more by nature orientation. (Lin et al., 2014). Ethnicity and age are also factors that influence park visitation. When looking at park visitation, senior adults and people of color are more likely to be non-visitors. (Payne et al., 2002). Climatic variables, such as temperature and rainfall, also affect park visitation. For instance, a research has provided evidence that temperatures above 33°C and below 11°C can decrease park visitation. (Hewer et al., 2016).

Regarding recreational facilities, in Neuvonen et al. (2010), authors used the regression analysis to reveal that opportunities for recreation activities increased the number of visits. For middle-school children, active recreational facilities are one of the most significant factors attracting them to parks. (Loukaitou-Sideris & Sideris, 2009).

As urban demographics change and social media emerge, park visitation patterns are likely to change as well. Traditional survey methods for monitoring park visitation are more costly in terms of time and money, compared to geotagged social media data which is less costly and more targeted. (Wood et al., 2013). Recent evidence suggests that local governments often lack resources for intensive survey implementation, social media may offer supplementary data or even alternative ways to measure visitation on a regular basis. (Hamstead et al., 2018).

2.3 Research Gap and The Current Study

Several previous studies have been carried out on the key role of urban parks in cities and the benefits of recreational facilities for health, also used geotagged social media data as a new approach to analyze park visitation. So far, however, there has been much less discussion about the use of geotagged social media data to analyze urban park visitation and park recreational facilities in terms of urban park categories.

The aim of this study is twofold. Without using costly traditional surveys, the first is to collect geotagged posts on Flickr as data to reveal 133 various urban parks' visitation in San Francisco. The second is to use linear regression analysis and correlation analysis as the methods to analyze the impact of recreational facilities on park visitation by 4 park categories.

3   Methodology

3.1   Data Collection

In this study, data was gathered from three distinct sources. Firstly, geotagged posts on Flickr from last two years were obtained utilizing the Flickr API, this database includes information of the location name, time, date, and geographical coordinates (latitude and longitude) of each post. Secondly, data pertaining to recreational facilities was collected from two sources: Google Satellite Map and DataSF[1]. Based on the recreational facilities information provided by DataSF and our manual observation on Google Satellite Map, the recreational facilities were classified as eight types in the following Table 1: it shows the total number of each recreational facility type from four park categories in this study.

Children Playing Area	Dog Playing Area	Picnic Area/Camp Ground	Sport Field/Court	Recreation Center	Trails	Skate Park	Sport Club/Gym
80	16	27	124	10	37	6	28

Table 1   Total number of various types of recreational facilities from all park categories

Lastly, data regarding urban parks was procured from DataSF. The database, titled "Recreation and Parks Properties," provided extensive information about the city's urban parks. To facilitate a more granular analysis, this database was further segmented into distinct categories, resulting in a separate database for each category.

Upon the completion of data collection and categorization, our analysis encompassed four categories of urban parks. These categories included Regional Parks, Neighborhood Parks and Playgrounds, Mini Parks, and Civic Plazas or Squares. In the category of Regional Park, we analyzed data from 14 parks, which collectively account for 16,376 Flickr posts and 129 recreational facilities. The Civic Plaza or Square category comprised 10 sites, which collectively generated 4,786 Flickr posts and contained 7 recreational facilities. The Mini Park category, while smaller in scope, included 8 parks, which accounted for 534 Flickr posts and 3 recreational facilities. Lastly, the Neighborhood Park or Playground category encompassed 81 parks and playgrounds, collectively generated 4,121 Flickr posts and contained 189 recreational facilities.

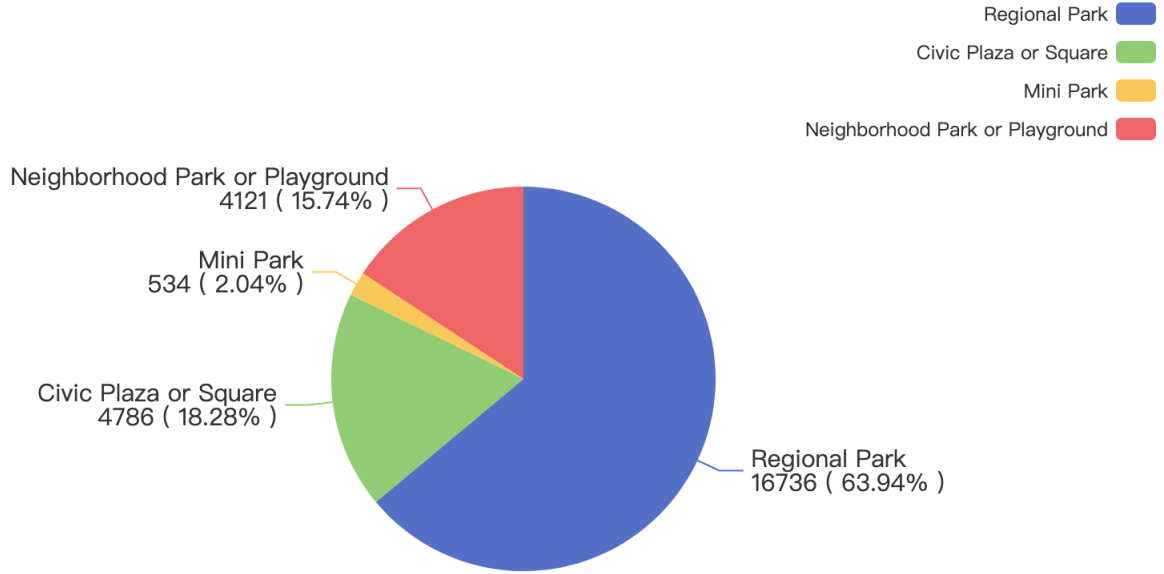[1]   https://datasf.org/

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Figure 1   Urban Park Categories and the Number of Flickr Posts of each category

The park categories, the number and percentage of Flickr posts collected for each category are shown in Figure 1. Figure 2 was generated with Kepler[2], which is an online geospatial analysis tool. This figure displays the distribution of Flickr posts on a map of San Francisco, with higher grid representing more Flickr posts.

3.2   Data Analysis

The data was cleaned and preprocessed to ensure its suitability for analysis. Considering that too few samples do not have much significance for data analysis, we cleared the data of the Parkway category and Zoological Garden category, which have only two parkways and one zoo respectively, and each category has at most no more than two recreational facilities.

The statistical techniques employed in this study are regression analysis using the Ordinary Least Squares (OLS) model and Correlation analysis. The OLS model was used to estimate the relationship between the number of recreational facilities in a park category and the number of geotagged Flickr posts associated with that park category. By analysing key components of OLS regression analysis, the relationship between park visitation and recreational facilities by park categories can lead to basic results. The general form of the model in a simple linear regression analysis is:
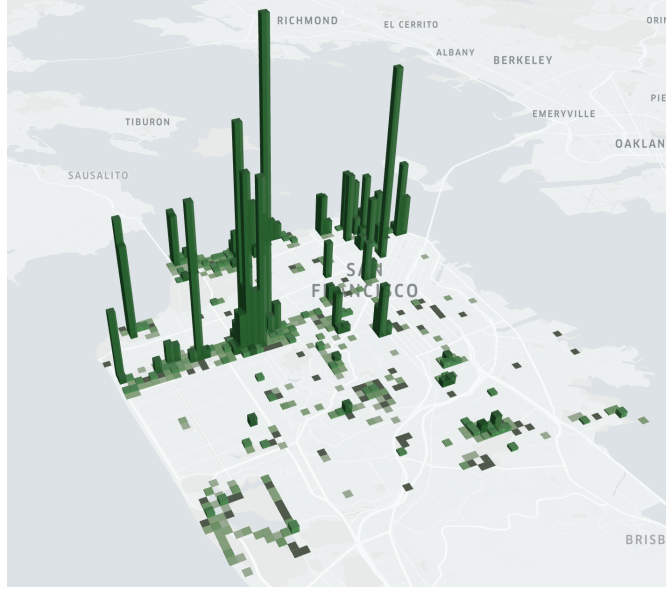
$$Y = b + aX + e$$

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[2]   https://kepler.gl/

Figure 2   Flickr Posts Distribution in San Francisco

In this study, Y is the number of Flickr posts, X the number of recreational facilities, a is the slope of the regression line, b is the intercept of the regression line, e is the difference between the observed and predicted values of Y (error term). R-squared is the coefficient of determination, which explains the proportion of the variance in the dependent variable that is predictable from the independent variable. (Miles, 2005). In this study, R-squared means how much proportion of the variance in 'posts count' can be explained by 'facilities count'. In p-value, a low p-value (typically below 0.05) would indicate strong evidence against the null hypothesis, suggesting that there is a significant correlation. A high p-value (typically above 0.05) would indicate weak evidence against the null hypothesis, suggesting that there is not a significant correlation.

Correlation analysis was used to measure the strength and direction of the linear relationship between the number of recreational facilities and park visitation. The formula of Pearson Correlation Coefficient is:

$$r = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2 \sum_{i=1}^{n}(Y_i - \bar{Y})^2}}$$

Where X is the number of recreational facilities in an urban park. Y is the number of geotagged posts on Flickr. $\bar{X}$ and $\bar{Y}$ are the means of X and Y respectively. The value of r ranges from -1 to 1. A negative value represents a negative correlation and a positive value represents a positive correlation. The value of 1 implies a perfect positive correlation, and the value of -1 implies a perfect negative correlation. A value of 0 implies no correlation. (Emerson, 2015).

4 Results

This study analyzed 4 urban park categories and 113 urban parks after collecting geotagged post data on Flickr. Table 2 and Figure 3 show the basic total number of parks, posts, recreational facilities in 4 categories, and Flickr posts distribution in San Francisco. As the heat map in Figure 3 shows, most of the Flickr posts tagged in the park are scattered, as the park is widely distributed in the city and some users may not tag park-related posts in the park area. Only the eastern part of Golden Gate Park has a large concentration of posts, and this area has a relatively large number of stadiums, tennis courts, skate parks, and other recreational facilities.

Park Category	Parks Count	Posts Count	Facilities Count
Regional Park	14	16736	129
Civic Plaza or Square	10	4786	7
Mini Park	8	534	3
Neighborhood Park or Playground	81	4121	189

Table 2   Park categories, number of parks, number of posts, and number of facilities

4.1 Linear Regression Analysis

Based on OLS model of linear regression analysis, the model appears to be most effective for Regional Parks, where it explains a substantial portion of the variation in the post count and is statistically significant. For the other categories of parks, the model explains a much smaller portion of the variation and is not statistically significant. The coefficients suggest that the number of facilities is positively associated with the post count for Regional Parks, Civic Plaza or Square, and Neighborhood Park or Playground, but negatively associated for Mini Park. However, the relatively large standard errors, particularly for the constant term, suggest that there is substantial uncertainty around these estimates. The t-statistics and p-values suggest that the number of facilities is a statistically significant predictor of the post count for Regional Parks, but not for the other park categories.
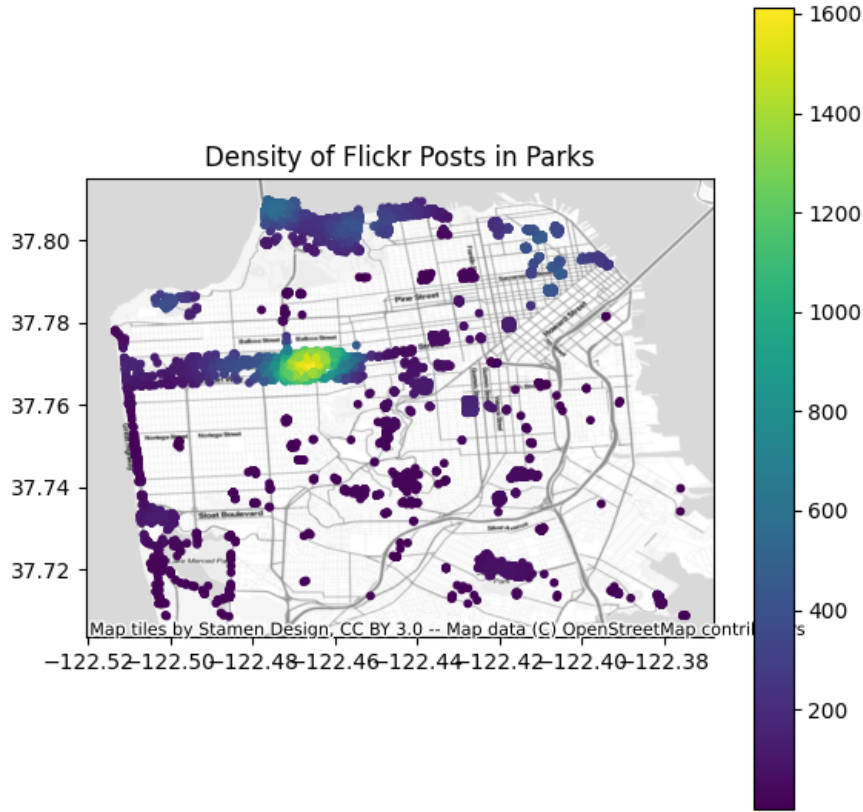
Figure 3   Heat Map of Flickr posts distribution in San Francisco

Park Category	R-squared	Adjusted R-squared	F-statistic	Prob(F-statistic)
Regional Park	0.407	0.357	8.232	0.0141
Civic Plaza or Square	0.324	0.239	3.832	0.0860
Mini Park	0.085	-0.067	0.5579	0.483
Neighborhood Park or Playground	0.007	-0.006	0.5320	0.468

Table 3   R-squared, Adjusted R-squared, F-statistic and Prob(F-statistic) results of four urban park categories in San Francisco

The results of Linear Regression Analysis using OLS model are shown in the following Table 3, Table 4 and Table 5. In this analysis, the dependent variable is Flickr posts count.

For the category of Regional Park, the R-squared value indicates that approximately 40.7% of the variation in the post count can be explained by the model. The positive

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Park Category	Coefficients		Standard Error	
	const	facilities	const	facilities
Regional Park	-394.5551	172.5564	851.319	60.144
Civic Plaza or Square	331.8911	209.5842	131.119	107.058
Mini Park	103.0000	-96.6667	79.250	129.414
Neighborhood Park or Playground	37.9618	5.4873	22.569	7.523

Table 4   The results of Coefficients, Standard Error

| Park Category	t-statistic		P> $|t|$	
	const	facilities	const	facilities
Regional Park	-0.463	2.869	0.651	0.014
Civic Plaza or Square	2.531	1.958	0.035	0.086
Mini Park	1.300	-0.747	0.241	0.483
Neighborhood Park or Playground	1.682	0.729	0.097	0.468

Table 5   The results t-statistic and P>|t|

coefficient for the facilities count suggests that an increase in the number of facilities is associated with an increase in the post count, holding all else constant. The p-value for the facilities count is 0.014, less than 0.05, indicating that the number of facilities is a statistically significant predictor of the post count at the 5% significance level. (see Figure 4a) In the case of Civic Plaza or Square, the variation in the post count is about 32.4%. The positive coefficient for the facilities count indicates that more facilities are associated with a higher post count. The p-value for the constant term is less than 0.05 (0.035), indicating that the constant term is statistically significant at the 5% significance level. However, the p-value for the facilities count is greater than 0.05 (0.086), suggesting that the number of facilities is not a statistically significant predictor of the post count at the 5% significance level. (see Figure 4b)

For Mini Park, the R-squared value is low (0.085). The coefficient for the constant term is 103, while the coefficient for the facilities count is -96.6667, suggesting that an increase in the number of facilities is associated with a decrease in the post count. (see Figure 4c) Lastly, for Neighborhood Park or Playground, the R-squared value is quite low (0.007). For these two categories, both p-values are greater than 0.05, suggesting that neither the constant term nor the number of facilities are statistically significant predictors of the post count at the 5% significance level. (see Figure 4d)
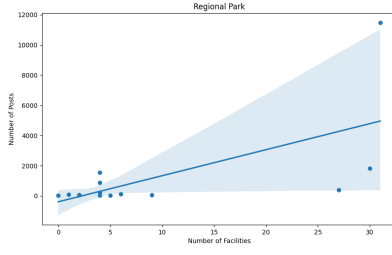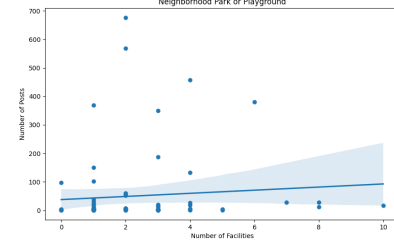
(a) Regional Park
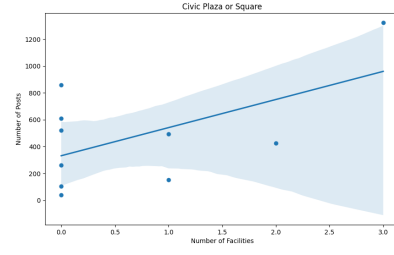
(b) Civic Plaza or Square
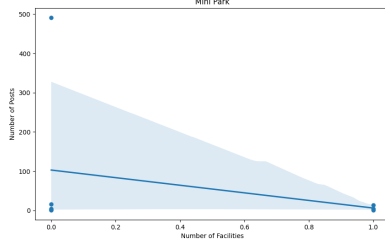
(c) Mini Park

(d) Neighborhood Park or Playground

Figure 4   Correlation between Number of Facilities and Number of Posts

4.2   Correlation Analysis

The results in Table 6 suggest that the presence of facilities may have a more significant impact on social media activity in certain types of parks: Regional parks and Civic plazas or squares compared to other two. However, further research may be needed to fully understand these relationships and the factors influencing them.

Park Category	Pearson Correlation Coefficient
Regional Park	0.6379
Civic Plaza or Square	0.5691
Mini Park	-0.2917
Neighborhood Park or Playground	0.0818

Table 6   Pearson Correlation Coefficient Results

For Regional Park, the Pearson correlation coefficient is 0.6379, indicating a moderate positive linear relationship between the number of facilities and the number of posts. In the Civic Plaza or Square category, the Pearson correlation coefficient is 0.5691, also suggesting a moderate positive linear relationship. This indicates that an increase in the number of facilities is associated with an increase in the number of posts. (see figure 4a, 4b)

For the Mini Park category, the Pearson correlation coefficient is -0.2917, indicating a weak negative linear relationship. For the Neighborhood Park or Playground cat-

egory, the Pearson correlation coefficient is 0.0818, indicating a very weak positive linear relationship. (see figure 4c, 4d)

Based on the linear regression analysis and Pearson correlation coefficient, for Regional Parks and Civic plazas or Squares, the number of recreational facilities may have a more significant positive impact on the number of social media geotagged posts compared to Mini Parks and Neighborhood Park or Playground. Regional Parks are much larger in size than other categories of parks, with large areas of land available for recreational facilities, and it is in this category that the correlation between park visitation and the number of facilities is greatest. The Civic Plaza or Square category has fewer parks (10 parks) but the second highest total number of posts (4786 posts), with Union Square, which is a major tourist destination and a well-known gathering place in downtown San Francisco [3], having the highest number of posts and recreational facilities. However, the relationships are not strong in all park categories, indicating that other factors may also play a significant role in influencing social media activity in these parks, such as cultural infrastructures, park size, accessibility, etc.

Some parks have no or few recreational facilities, but a relatively high number of posts. By looking at the photos on Flickr, we can see that some factors significantly affect the number of park posts. For example, Mission Dolores Park has only two recreation facilities but 676 posts. This park has a large green space to relax and overlooks the city, making it a great place for scenery. (see Appendix Figure 6) Ina Coolbrith Park has no recreational facility but 491 posts, because this park is on a hill with a panoramic nice view of San Francisco (especially at night), so people would like to take panoramic pictures of the city here and upload them to Flickr. (see Figure 5)

Figure 5   A picture took in Ina Coolbrith Park by Flickr user Stephen Kacirek

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[3]   https://en.wikipedia.org/wiki/Union_Square,_San_Francisco

5 Discussion

This study can contribute to urban park planning and development in San Francisco and other cities. With the effective use of recreational facilities in urban parks, there is considerable potential to promote moderate to high levels of physical activities among urban residents. These findings underscore the importance of using urban parks to promote the health of urban residents.

The three questions in the Introduction Chapter can be answered after processing and analyzing data. The results of the linear regression analysis showed that there is a significant relationship between the number of facilities and the number of posts for Regional Parks and Civic Plaza or Square categories. However, for Mini Parks and Neighborhood Parks or Playgrounds, the relationship was not significant.

The Pearson correlation analysis further confirmed these findings, showing a positive correlation for the Regional Park and the Civic Plaza or Square, and a negative or weak correlation for the Mini Park and the Neighborhood Park or Playground. The positive correlation and significant relationship for Regional Park and Civic Plaza or Square suggest that the number of recreational facilities in these parks is a significant factor influencing the number of posts on Flickr. This could be because these parks offer more amenities and attractions, leading to more social media activities. Our data shows that people prefer to visit Regional Parks with large green areas than small ones. Large green areas have a relaxing function where people can exercise, picnic, hike, etc. Previous studies have shown that young people are the majority of the group using park recreation facilities (Payne et al., 2002), and the user group for social media is also more likely to be young people (Zickuhr, 2013), which is one of the reasons why regional parks have the highest number of posts.

On the other hand, the lack of a significant relationship for Mini Park and Neighborhood Parks or Playground could be due to the smaller size and fewer facilities, which may be a problem from a public health equity perspective. In the Mini Park category, children playing areas make up 100% of the recreational facilities. Playing areas visitors are children who may not have mobile phones or be restricted from using social media, so social media posts would be underestimated compared to traditional field survey counts. (Hamstead et al., 2018).

These findings have important implications for urban planning and park management. They suggest that increasing the number of park facilities may increase social media activities, which in turn may increase park visitation and usage. This can help urban park planning agencies understand the relationship between different park categories'

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visitation and recreational facilities, and in future park planning, the issue of facility equity in small-scale parks can be addressed by incorporating surveys of surrounding land use and the demographic composition of surrounding neighborhoods.

The method of using social media posts count as a proxy for park visitation saves time and effort, but it has its limitations. One key consideration is that some posts from private accounts are not available to us. And, some users who post about that park will not be geotagged to the park, they may be located in the neighborhood or further away. This can cause us to lose some posts about the park. This study is also limited in that we only considered the number of facilities in parks, not their quality or condition, some recreational facilities may be obsolete, which can also affect visitation. We collected Flickr posts from the past two years, although they are new in terms of time, park visitation may have decreased compared to the pre-covid19-epidemic period because some recreational facilities may be closed due to the epidemic. And we only used data from Flickr, which may not represent all social media activity. As of now, Instagram is the more favored social media platform for sharing photos compared to Flickr, but after 2018, the use of the Instagram API has been greatly restricted, and collecting Instagram data has become difficult.[4]

Future research should consider other factors that could influence social media posts number in parks, such as the quality of recreational facilities, park size, location, etc. It would also be beneficial to use data from other social media platforms to get a more comprehensive picture of social media activity in parks. For instance, we can analyze by collecting data from Flickr and Twitter together, by comparing Flickr data with Twitter data to analyze the park usage patterns of these two social media platforms. In addition, we can collect social media data before the covid19-epidemic to compare it with the data after that to analyze the impact of the covid19-epidemic on park visitation and recreational facilities usage. In the case of the mini parks where the recreational facilities are all children's playgrounds, we can use the original survey to collect park visitation since children do not often use mobile phones, which may give us more accurate analysis results.

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[4]   https://eclincher.com/instagrams-api-limitations-2022/

6 Conclusion

In the contemporary digital era, social media has experienced exponential growth, becoming an integral part of people's lives as they increasingly share their experiences on social media platforms. This trend presents an opportunity for local governments, which traditionally rely on surveys to gather data on park visitation, to supplement their methods with data derived from social media. (Hamstead et al., 2018). In this study, we leveraged geotagged data from Flickr as a proxy for park visitation across four distinct categories of parks in San Francisco.

Our findings elucidate the relationship between the number of recreational facilities and park visitation, as indicated by the volume of Flickr posts. The results underscore the feasibility of utilizing Flickr data for such studies, offering a cost-effective and time-efficient alternative to traditional data collection methods, with the added advantage of remote data collection. Future research could further enrich these findings by incorporating data from multiple social media platforms.

As urban populations continue to grow and the emphasis on physical health intensifies, the importance of high-quality urban parks has been more important. Our study revealed that larger regional parks, which boast the highest number of recreational facilities, attract the most visitors. This category includes renowned attractions such as Golden Gate Park and Presidio of San Francisco. Consequently, future research could explore patterns of park visitation, distinguishing between local residents and tourists.

Interestingly, our study found that in the categories of Mini Park and Neighborhood Park or Playground, the influence of recreational facilities on visitation was minimal or even negative. This counterintuitive finding suggests that factors such as park size and user age may play a role, warranting further investigation.

The insights gleaned from this study, when combined with additional information on park visitation, surrounding land use, accessibility, and the age-ethnic distribution of residents, can guide park planning and management strategies. This would enable them to enhance park facilities and promote equitable distribution of parks and facilities, thereby contributing to the overall quality of urban life.

A   Appendix: Very important stuff

OLS: Ordinary Least Squares

Figure 6   A photo took in Mission Dolores Park by Flickr user Rachid H

Bibliography

Badura, P., Geckova, A. M., Sigmundova, D., van Dijk, J. P., & Reijneveld, S. A. (2015). When children play, they feel better: Organized activity participation and health in adolescents. *BMC public health*, *15*, 1–8.

Chiesura, A. (2004). The role of urban parks for the sustainable city. *Landscape and urban planning*, *68*(1), 129–138.

Cohen, D. A., Sehgal, A., Williamson, S., Marsh, T., Golinelli, D., & McKenzie, T. L. (2009). New recreational facilities for the young and the old in los angeles: Policy and programming implications. *Journal of Public Health Policy*, *30*, S248–S263.

Emerson, R. W. (2015). Causation and pearson's correlation coefficient. *Journal of visual impairment & blindness*, *109*(3), 242–244.

Grilli, G., Mohan, G., & Curtis, J. (2020). Public park attributes, park visits, and associated health status. *Landscape and Urban Planning*, *199*, 103814. https://doi.org/https://doi.org/10.1016/j.landurbplan.2020.103814

Hamstead, Z. A., Fisher, D., Ilieva, R. T., Wood, S. A., McPhearson, T., & Kremer, P. (2018). Geolocated social media as a rapid indicator of park visitation and equitable park access. *Computers, Environment and Urban Systems*, *72*, 38–50.

Hewer, M., Scott, D., & Fenech, A. (2016). Seasonal weather sensitivity, temperature thresholds, and climate change impacts for park visitation. *Tourism Geographies*, *18*(3), 297–321.

Konijnendijk, C. C., Annerstedt, M., Nielsen, A. B., & Maruthaveeran, S. (2013). Benefits of urban parks. *A systematic review. A Report for IFPRA, Copenhagen & Alnarp.*

Lin, B. B., Fuller, R. A., Bush, R., Gaston, K. J., & Shanahan, D. F. (2014). Opportunity or orientation? who uses urban parks and why. *PLoS one*, *9*(1), e87422.

Liu, H., Li, F., Xu, L., & Han, B. (2017). The impact of socio-demographic, environmental, and individual factors on urban park visitation in beijing, china. *Journal of Cleaner Production*, *163*, S181–S188.

Loukaitou-Sideris, A., & Sideris, A. (2009). What brings children to the park? analysis and measurement of the variables affecting children's use of parks. *Journal of the American Planning Association*, *76*(1), 89–107.

Miles, J. (2005). R-squared, adjusted r-squared. *Encyclopedia of statistics in behavioral science.*

Neuvonen, M., Pouta, E., Puustinen, J., & Sievänen, T. (2010). Visits to national parks: Effects of park characteristics and spatial demand. *Journal for Nature Conservation*, *18*(3), 224–229.

Norman, G. J., Nutter, S. K., Ryan, S., Sallis, J. F., Calfas, K. J., & Patrick, K. (2006). Community design and access to recreational facilities as correlates of adolescent physical activity and body-mass index. *Journal of physical activity and health*, *3*(s1), S118–S128.

Payne, L. L., Mowen, A. J., & Orsega-Smith, E. (2002). An examination of park preferences and behaviors among urban residents: The role of residential location, race, and age. *Leisure sciences*, *24*(2), 181–198.

Rogerson, M., Gladwell, V. F., Gallagher, D. J., & Barton, J. L. (2016). Influences of green outdoors versus indoors environmental settings on psychological and social outcomes of controlled exercise. *International journal of environmental research and public health*, *13*(4), 363.

Takeda, F., Noguchi, H., Monma, T., & Tamiya, N. (2015). How possibly do leisure and social activities impact mental health of middle-aged adults in japan?: An evidence from a national longitudinal survey. *PloS one*, *10*(10), e0139777.

Wolch, J., Jerrett, M., Reynolds, K., McConnell, R., Chang, R., Dahmann, N., Brady, K., Gilliland, F., Su, J. G., & Berhane, K. (2011). Childhood obesity and proximity to urban parks and recreational resources: A longitudinal cohort study. *Health & place*, *17*(1), 207–214.

Wood, S. A., Guerry, A. D., Silver, J. M., & Lacayo, M. (2013). Using social media to quantify nature-based tourism and recreation. *Scientific reports*, *3*(1), 2976.

Zickuhr, K. (2013). Who's not online and why.

Declaration of Authorship

I hereby declare that, to the best of my knowledge and belief, this thesis titled *An Analysis of Impact of Recreational Facilities on Urban Park Visitation Using Flickr Posts: A Case Study of San Francisco* is my own, independent work. I confirm that each significant contribution to and quotation in this thesis that originates from the work or works of others is indicated by proper use of citation and references; this also holds for tables and graphical works.

Münster, 21.06.2023

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