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Relating Bike Racks and Bike Ridership

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Disclaimer: The following thesis was produced in the Environmental Studies Program as a student senior capstone project.

Relating Bike Racks and Bike Ridership

by

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Abstract

The purpose of this thesis was to investigate the relationship between bicycle ridership and bike racks in a given area. The goal was to discern whether or not the density of bike racks determines the number of riders in the area. I predicted that there would be higher ridership in the areas with a denser bike rack concentration. To investigate this point, I set up five different areas of varying sizes with a similar number of bike racks, and then observed them over a period of 5 business days. By using a simple tally of the bikes found on the racks and bikes locked to other objects, like railings, I collected data in the area during the day when there were likely to be many commuter bikes parked outside. The results show that there is a positive relationship between the density of bike racks in a given area and bike ridership. While there is a positive r-value, more data collection needs to be done to determine the relationship that may exist between bike ridership and bike racks.

Introduction

Bikes are one of the most practical and important inventions of mankind. Bike riding has been shown to increase physical health and is less polluting than automobiles or buses. There are many studies that highlight the health benefits of cycling (Humphrey 2005). In addition, the environmental benefits of people biking instead of driving are numerous. Unfortunately, with the enormous pressure being put on cities to develop roads, bicycles are getting lost in the mix.

Highlighting the role of bike racks in our transportation system is very important. Without an understanding of their importance, insufficient funds may be set aside for bike infrastructure. This may lead to fewer bike riders and hold back our transportation system. Increasing bike ridership is one of the cheapest ways to improve our transportation system without having to restructure the whole system (Anastasiadou 2009). Finding out more information about bikes, bike riders, and the facilities necessary for cyclists can help cities move towards a better system.

Once an understanding of the importance of bike racks is established, we can use the data to place more racks where they are needed, and avoid unnecessary waste. By incorporating more bike riders into our transportation system, we can improve the quality of life for riders and ease the impact on our transportation system with less automotive traffic (Feng 2009). Transportation diversity is important for improving the quality of life in cities, and is a necessity as we move into an uncertain energy future (Feng 2009).

The purpose of this thesis project is to study the relationship between bike ridership and bike racks in a given area. The purpose is to expose what relationship may exist between these two things so that city planners and people wishing to increase bicycle use can have evidence that establishes relationship. The relationship between bike racks and bike ridership is currently taken for granted, which means that the allocation of funds and racks may not be correctly distributed and utilized.

I believed that my thesis would find increased ridership in areas where bike racks were more densely distributed. I predicted that the number of commuters and people on daily errands are more affected by the bike rack density than the size of a given area. I was unsure how the different businesses would play into my predictions, but some kind of pattern should have emerged if a relationship exists.

For this study, I will define the term, "bike rack" as a stationary piece of equipment designed to hold bikes and placed specifically for bicyclists to use for parking their bikes. I did not differentiate between the types of racks to keep things simple.

The first step of my project was to establish my research areas. I defined five separate sections in which to conduct my counts and determined their location using the racks as markers. With the framework of this thesis project established, I will now move to discuss the literature related to bicycle infrastructure.

Literature Review

Anastasiadou, Magdalini et al. 2009. Determining the Parking Fee Using the Contingent Valuation Methodology. Journal of Urban Planning. and Development. Volume 135, Issue 3, pp 116-124.

This study has less to do with bicycles, and more to do with the costs people are willing to pay in order to park their cars in a downtown area. Cars need significantly much more space than a human being and more space than a single bicycle. As a result, the amount of money people are willing to pay for parking could be used as an estimate for the monetary value people would place on riding their bike or walking as an alternative means of transportation.

While bicycle parking is not free, the bulk of its expenses are in the installation of the racks themselves with little maintenance for the city to perform. Once in place, racks are free to users and can last a long time. Parking ramps and parking lots have comparatively high maintenance as they deal with trash, elevators, attendants, physical space, and other factors. As a result, car-parking facilities are far more expensive. I can use this study to demonstrate the costs associated with car travel compared with bicycle transit.

Cervero, Robert and Duncan, Michael. 2003. Walking, Bicycling, and Urban Landscapes: Evidence from the San Francisco Bay Area. American Journal of Public Health. Vol. 93, No. 9. pp 1478-1483.

This study examined which means of transportation a person was likely to use, specifically focusing on the topography, structure of the area, and the characteristics of the destination. The study found, unsurprisingly, that cars were the main choice of transportation. For the small percent of the time that walking and bicycling were chosen, there were some interesting factors that went into the decision; the slope of the area, whether the trip was made at night, and the purpose of the trip. The study shows that bicycling was more dependent on the characteristics of the destination than walking, though not by a large margin.

This study relates to my thesis because the bike racks and areas are essentially the destinations specified by this study. The racks are located near, or next to, the destination of people's trips, so if they are having an impact it is likely to be evident in ridership. It is possible to further the depth of Cervero's work by exploring what qualities the bicyclist's typical destinations possess, specifically the bike racks around the destination.

Clark, A. and Tracy L. 1995. Bicycle Safety-Related Research Synthesis. U.S. Department of Transportation. Federal Highway Administration Publication No. FHWA-RD-94-062. pp 11-19.

This is an excellent look into the decisions that go into bike ridership, including safety, regulation, and bicycle facilities like bike lanes and shoulders. The study covers many aspects of bicycle riding in great detail and lists out many different resources after every section. The study also has a section where people listed which mode of transport they would prefer for various common activities. There appears to be a fairly large untapped group of people who would choose to bike if the conditions were right.

This study is heavily related to my thesis in the way it seeks to understand how to involve the untapped bike riders who would bike if given the choice to do so. The study I have designed is working along the same idea that if there is an adequate infrastructure in place for cyclists, they will use that area more than if there are fewer facilities in place. The ideal conclusion to take from the book is that if we were to expand cycling facilities correctly, we could motivate those untapped bikers to bike regularly.

Feng, Cheng-Min, Hsieh, Cheng-Hsien. 2009. Implications of Transport Diversity for Quality of Life. Journal of Urban Planning and Development. Volume 135, Issue 1, pp. 13-18.

This article demonstrated the importance of diversity by comparing a modern day transportation system with the biological diversity found in nature. The need for diversity is tied into quality of life, environmental concerns, social equity, and economic efficiency. Because there are an enormous variety of needs being met by a city's transportation system, it makes sense to have a variety of transportation modes to meet those needs.

This study related very closely to my study in the way it discusses the need for diversity. By examining the habits of bikers and what promotes more bicycling, planners can more accurately incorporate bicycles into current transportation systems. Without acknowledging the need or importance of bikes in a modern day system, many transportation systems are now totally dependent on the automobile. As in nature, a monoculture in our means of transportation has led to some serious problems with pollution and congestion.

Humphrey, Nancy P. 2005. Does the Built Environment Influence Physical Activity? Transportation Research Board Institute of Medicine. Transportation Research Board Special Report 282. pp 2-2 – 2-6.

This report holds an enormous amount of information about physical activity, its effect on health in people, and many of the factors involved. The section I singled out focuses on the benefits of regular exercise by adults and the need for Americans to increase their level of regular physical activity. The costs associated with chronic illnesses and diseases are extremely high. Expenses resulting from obesity could be greatly reduced from regular activities that help people manage their weight.

I can utilize my study to demonstrate the need to investigate activities that increase the physical activity done by Americans. Biking instead of driving is a good way to increase the amount of regular physical activity by people who otherwise do very little in their profession. Daily or semi-daily commuting could both fulfill the physical activity requirements of adults while providing a practical service to the people who commute.

Jonson, G., Tengstrom, E. 2005. Urban Transport Development; A Complex Issue. Springer-Verlag Berlin Heidelberg. pp 1-5, 282-291.

This book includes a vast array of articles that detail many of the complexities imbedded in the world's transportation infrastructure. The article's focus was primarily on urban transport systems and the ways in which they are either insufficient or have been adversely affected by recent changes to the system. For example, in California many people now face a reverse commute to drive from inside the city out to the suburbs where jobs are located. This shift in the economic class of those living in the city and the types of jobs available in their area puts a strain on those who would typically rely on public transportation.

This book relates to my thesis in the way it exposes the need for a holistic approach to the problems with our transportation system. Cities need to be livable places that attract people and businesses that would otherwise move to the suburbs. By having a diverse infrastructure and working to increase bike ridership, it may be possible to both improve the quality of life and aid cities as they cope with the population shift.

Krizek, Kevin J. et al. 2009. Analyzing the Effect of Bicycle Facilities on Commute Mode Share over Time. Journal of Urban Planning and Development. . Volume 135, Issue 2. pp 66-73.

A recent study was done on the effect of bicycle facilities on commute share over a given period of time. The study examined how bicycle commuters were affected by the construction of new facilities built to enhance their commute. This consisted mostly of bike paths and bike lanes in different parts of the Minneapolis/St. Paul area. The study found that areas near newly constructed bicycle facilities had a sharp increase in ridership compared with areas farther away from the facilities.

This study related to my thesis in its examination of infrastructure on the habits of bicyclists. Because the construction of bicycle facilities in this study prompted higher bike usage, similar lines could theoretically be drawn between bike racks and bicycle ridership. While there are certainly differences in these studies, the spirit is the same in that they examine the tendencies of bikers to ride and use areas with more facilities than those without these facilities.

Pikora, Terri et al. 2003. Developing a framework for assessment of the environmental determinants of walking and cycling. Social Science and Medicine. Volume 56, Issue 8. pp 1693-1703.

This study examined the importance of a wide range of factors and how they influenced walking and ridership. The study found that the two factors bikers consider most when choosing whether or not to ride are if a continuous bike route exists, like a bike trail, and the speed and volume of car traffic associated with the route. The study also examined the importance of bike parking facilities, which, while not as important as the previous factors, were shown to have some significance to riders.

Based on this finding, bicycle-parking facilities do indeed play a role in the decision to ride to a destination, even if it is not the primary factor influencing the trip. It may be possible to increase the influence of bicycle parking facilities if more parking is available, or if there is a higher volume of people biking to a given destination. This study could be used as further evidence that bicycle parking facilities play a role in the decision making process of people using bikes for transportation.

Schneider, Robert. 2005. Integration of Bicycles and Transit: A synthesis of Transport Practice. Transportation Research Board. Washington D.C. pp 5- 18.

This literature details a variety of articles that examine what methods have been used to incorporate bicycles into our current transportation system. This book was compiled by interviewing a panel of experts about the integration of bicycles. Bike integration with buses, businesses, traffic, subways, and a number of other subjects is examined in this report.

There is a section that covers bike racks and other parking facilities. The section discusses how many different organizations consider it important to provide bicycle-parking facilities even if they aren't placed in extraordinarily convenient places. This section relates to the focus of my thesis looking at the importance that people attribute to bike racks and their role in our transportation system.

Sykes, Robert D., Driscoll, Trina Wicklatz. 1996. Creating Bicycle Transportation Networks: A Guidebook. University of Minnesota Department of Transportation. Report 96-14. pp 11-50, 95-97.

This guidebook provides a basic guideline for creating bicycle transportation networks. It covers a variety of aspects ranging from why bicycles make sense for communities to how systems can be made adequate for cyclists of all skill levels. This manual is very useful and is a good resource for city planners and those interested in integrating more bicycle use into current transportation systems.

This guidebook ties into my thesis very well because it outlines why bikes are important to communities, and the importance of building facilities for bikers. The ideal way to encourage bicycle use would be to make a destination easier to access by bike than by car. People interested in bicycle infrastructure should investigate this manual for the many useful.

Materials and Methods

Research Design and Approach

I narrowed my focus to bike racks because there are far too many factors to consider if one tries to include everything (Pikora 2003). The research I did in preparation demonstrated the importance of a bikers' ultimate destination, so it makes sense to assess racks near similar businesses to get an accurate idea of the association with bike racks (Cervero 2003) Another factor derived from my research is that biking downtown may have an efficiency factor associated with it compared to driving, so people who bike may be commuters trying to avoid automotive parking costs (Anastasiadou 2009).

This project was approached as a passive experiment and is observational in its nature. Because I did not have the resources or time to set up control experiments or place racks at precise locations, I used the racks already in place. I did not factor in the different types or brands of bicycle because I didn't feel it had a bearing on the action of biking itself.

I made some choices while creating my thesis. I chose to include all the bikes in the area even if they were locked to something other than bike racks. I feel that they are still apart of bike ridership in the area, and may be an indirect result of many bike racks.

Figure 1 – A bike locked to a U-rack in downtown Lincoln

I determined the number of bikes that each rack could hold based on the type of bike rack. I did my best to assess the practical capacity of each rack rather than its technical capacity since people rarely strive to maximize rack capacity. For example, I assigned the all U-Racks, like the two shown in Figure 1, a capacity of two bikes. While the rack could hold four bikes if used optimally, most riders use them in the fashion seen in Figure 1, which prevents optimal usage.

As a result of these and other factors, the study was designed to examine bike usage in given sections in the downtown area of Lincoln, Nebraska by counting the number of bikes present both at bike racks and otherwise present in the given area. The results will be assessed by the number of bikes present in each location in comparison to the linear distance the sections covered.

My theory was that smaller areas with a higher density of bike racks would have a higher number of bikes in the area than larger study regions with a smaller proportion of bike racks. I predicted that the highest densities would have the highest ridership overall.

Sampling Methodology

I chose to use five areas for my research. Each area had three primary points as seen in Figure 2. These three points formed a triangle, which represented the rough survey area in which my count was performed.

Figure 2 – The three pins represent the primary points I used to mentally outline the areas. The grey lines are a good representation of the area in which I conducted my counts.

All the racks inside of the area were counted in the study. The areas were all within the boundaries of the downtown area of Lincoln. The areas all fell into the same area where biking on the sidewalks is prohibited, so that should not have been a variable.

I chose these sections because the characteristics of these five sections and the bike racks contained within these sections would provide enough data for analysis. Also, the sections chosen are variable in size and distance between the bike rakes, so they should provide enough variety to yield interesting results.

The areas were purposefully different in size because bike racks are not distributed evenly around downtown Lincoln, so they should not be assessed with an even method. I divided my capacity and ridership values by the distance to remove its influence as a variable.

Figures 3 through 7 are aerial photos of the five different survey areas. To more easily identify these areas, they have each been assigned names: Area 1 is Nuvibe, Area 2 is Haymarket, Area 3 is Scooters, Area 4 is Library, and Area 5 is Starbucks.

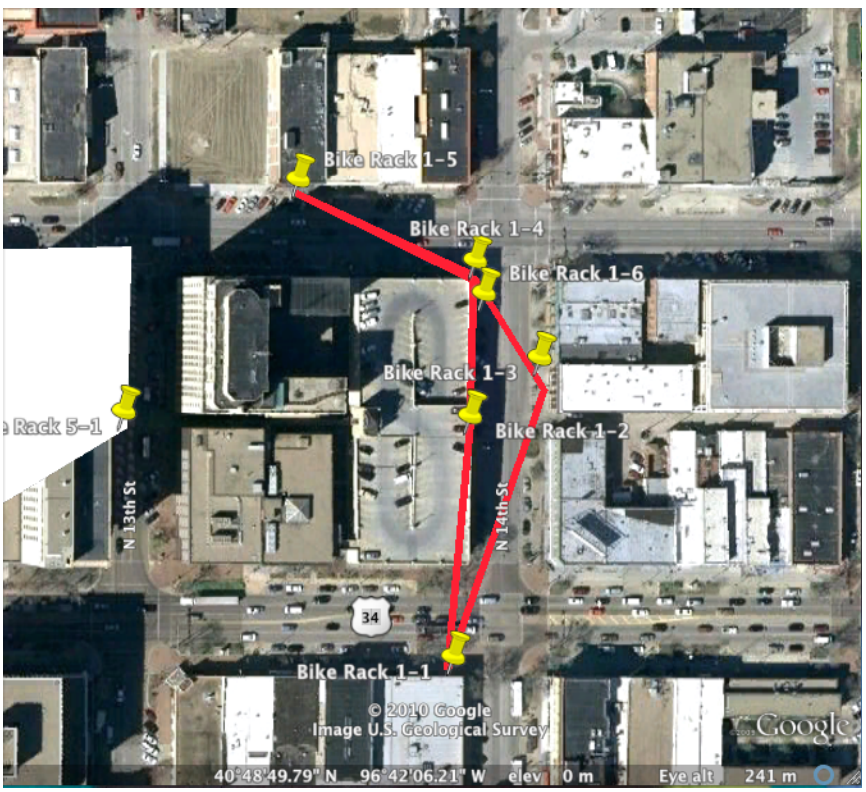


Figure 3 – Area 1, Nuvibe. This area was located primarily on 14th Street and P Street. It has 6 different bike racks as represented by the pins.

Figure 4 – Area 2, the Haymarket. This area contained 6 racks as shown by the pins above.

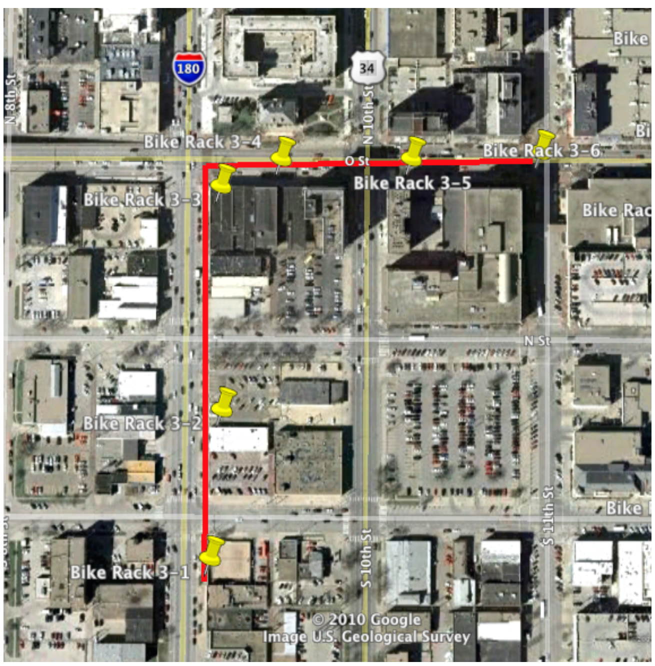


Figure 5 – Area 3, Scooters. This area had six racks as seen by the pins. This area ran only along 9th Street and O Street, so it was slightly different from the other triangle based areas.

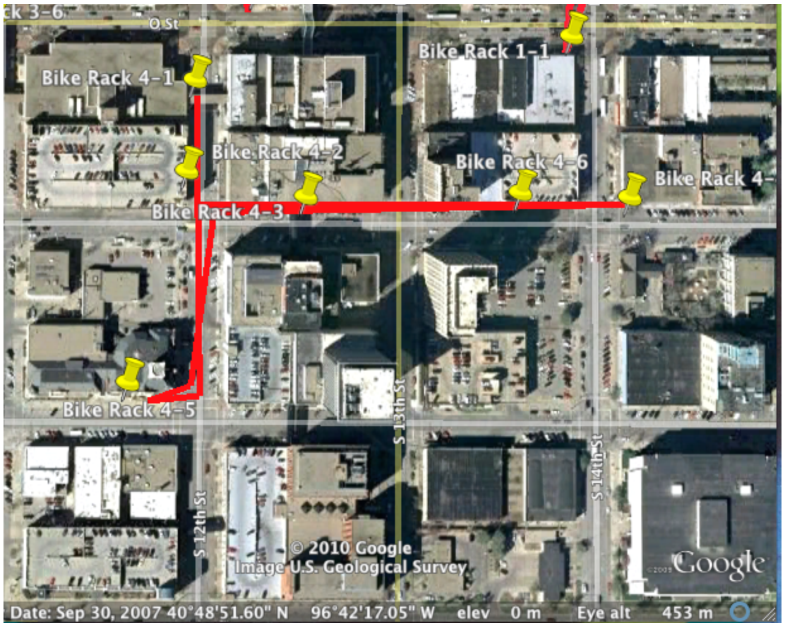


Figure 6 – Area 4, Library. This section had six racks as seen by the pins.

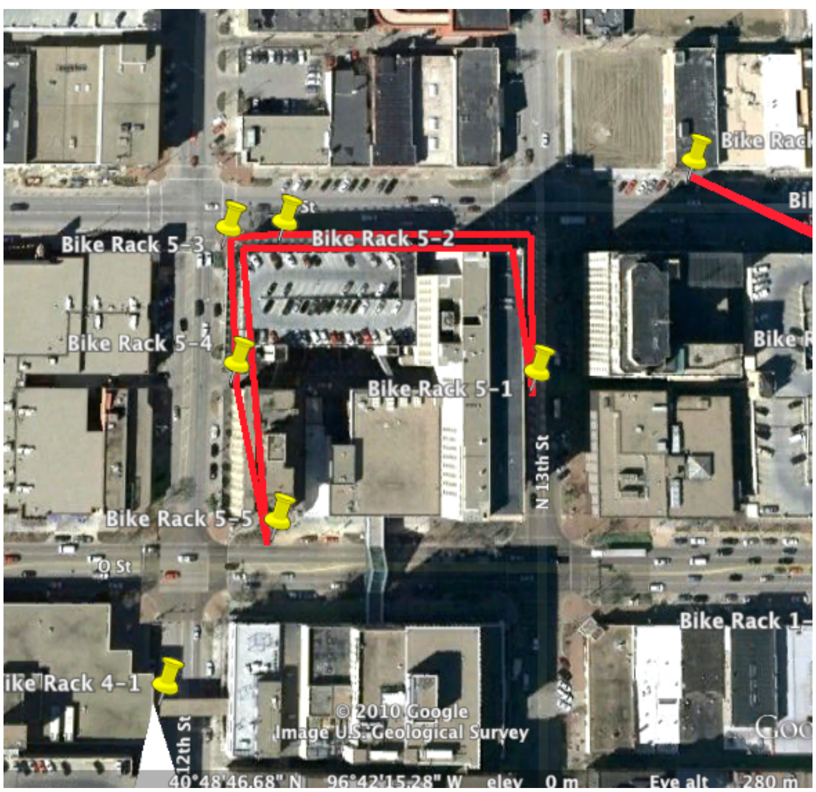


Figure 7 – Area 5, Starbucks. This was the final area and had five racks. This site was a bit irregular because it primarily ran around the block rather than forming a strict triangle.

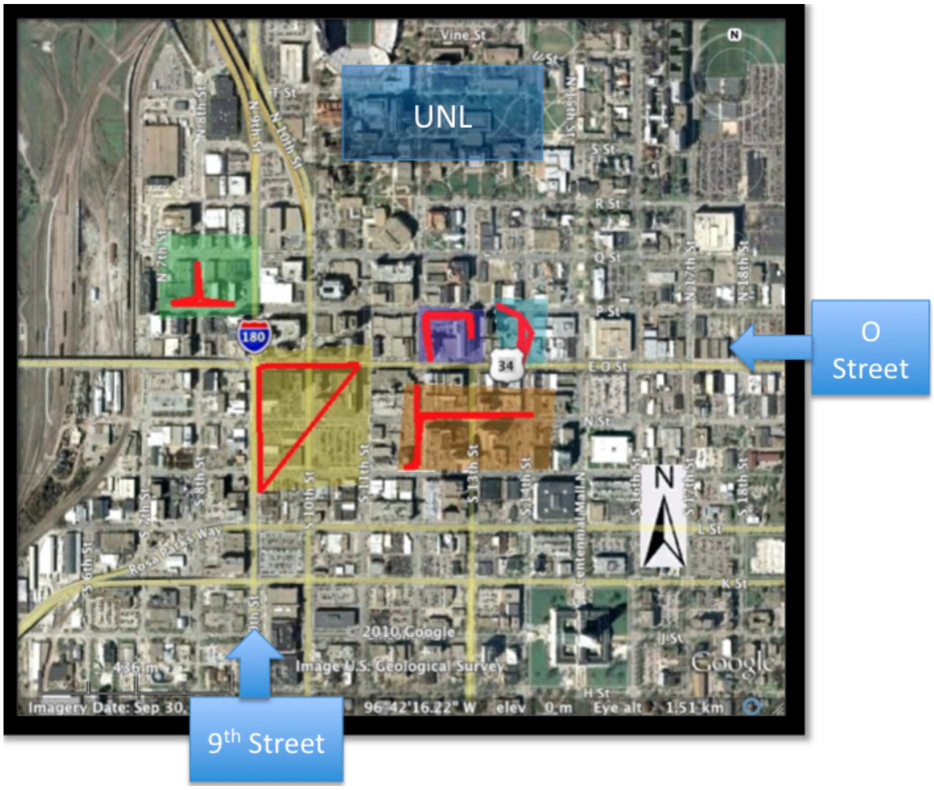


Figure 8 – This is an image of the entire research area with the general regions shaded.

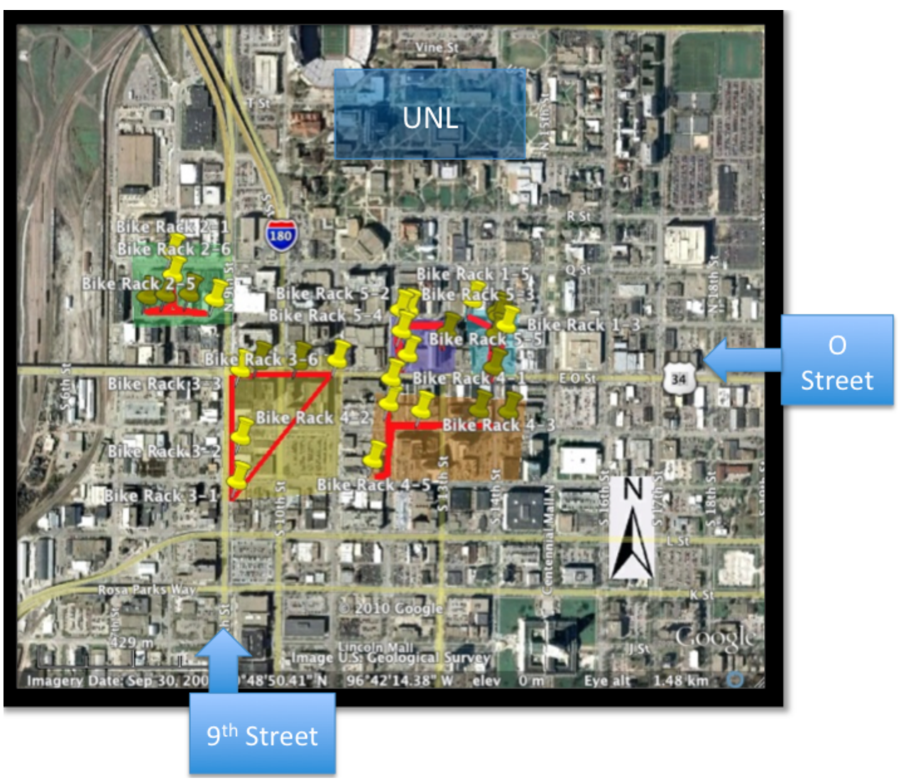


Figure 9 – This is an overview with the regions shaded and all of the bike racks included as pins.

To assure quality information was gathered, I took several steps to increase the quality of my data. Once I began my count, I was finished within 30 minutes to procure the best snapshot possible. Because of time constraints I did all of my data collection between March 22nd and March 29th.

I then did a count of the number of bicycles present in the given areas using a notebook, pencil, and my bicycle. I counted all the bikes present in the area whether on the rack or chained to another structure. I did not count bikers unless they were clearly leaving or arriving when I started my count.

The counts took place between the hours of 12:30 p.m. and 2:00 p.m. on weekdays so that commuters could be taken into account effectively. In the end, I collected five days worth of data, as well as counts that determined the number of bikes slots available at the given locations.

To start the analysis I put the data into a spreadsheet in Microsoft Excel. I created a ratio between the available number of bike slots and ridership observed by dividing them both by their area's linear distance. By eliminating distance as a variable I was able to meaningfully examine my results.

For my graph, the dependent variable on the X axis was the rack capacity and the independent variable on the Y axis was the total number of bikes observed throughout the data collection. I put these into a graph, onto which I added a linear regression. The regression drew a line based upon the average resulting from the bike presence data.

Results

Below is the raw data for the number of bicycles observed for each date, along with each bike rack where the bicycles were tallied. Bikes tallied under, "other" were observed within the research area, but were not locked to a rack.

Table 1 – Raw collection data

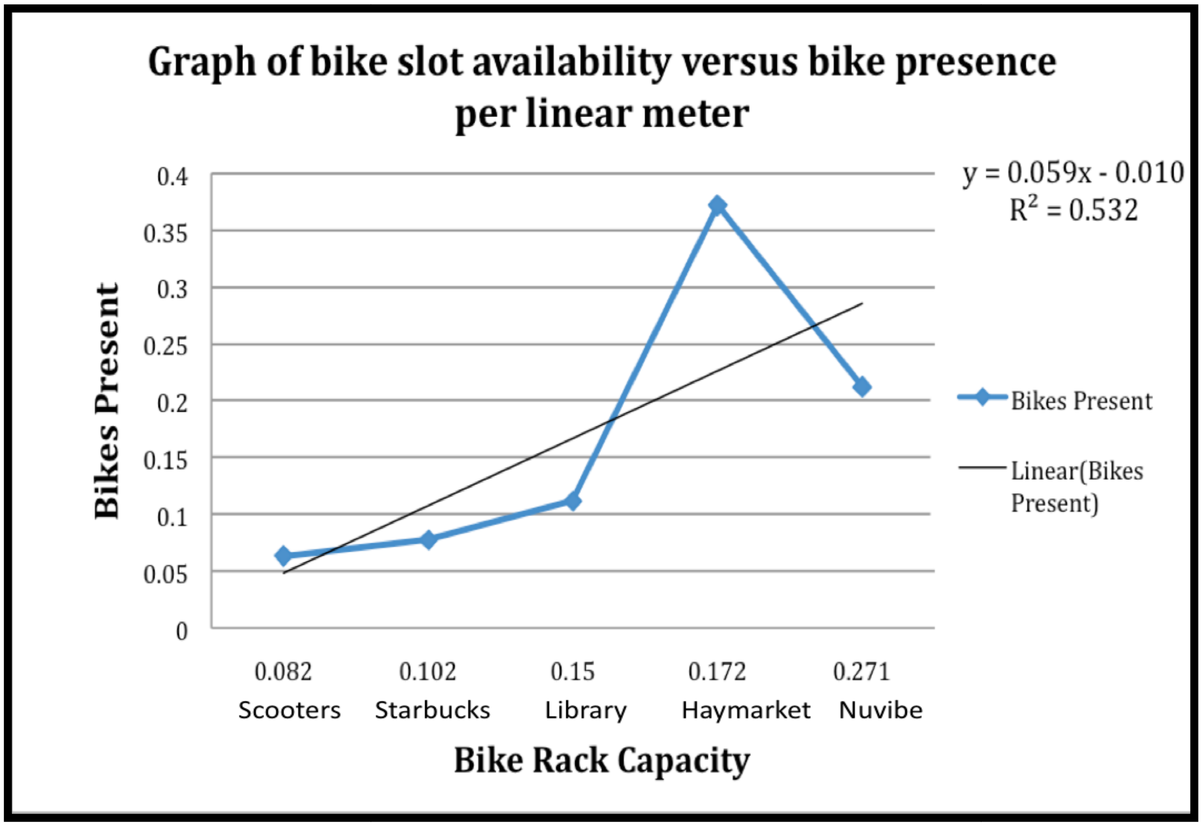
	Rack Space Available	22-Mar	23-Mar	25-Mar	26-Mar	29-Mar
Nuvibe-1	14	0	0	1	0	1
Nuvibe-2	6	2	2	1	1	1
Nuvibe-3	10	1	2	0	1	1
Nuvibe-4	6	0	0	0	0	2
Nuvibe-5	20	5	3	4	6	8
Nuvibe-6	4	0	1	1	1	1
Nuvibe - Other	0	0	1	0	0	0
Total	60	8	9	7	9	14
Haymarket-1	8	5	2	4	4	5
Haymarket-2	6	2	4	3	4	3
Haymarket-3	4	0	0	0	0	0
Haymarket-4	8	2	3	2	2	7
Haymarket-5	6	1	2	2	1	0
Haymarket-6	12	1	3	3	4	4
Haymarket–Other	0	3	1	4	4	10
Total	44	14	15	18	19	29

Scooters-1	10	0	0	0	0	0
Scooters -2	6	0	0	0	0	0
Scooters-3	4	3	3	1	1	4
Scooters-4	4	0	1	1	1	1
Scooters-5	4	0	0	0	0	0
Scooters-6	14	3	2	2	2	2
Scooters–Other	0	4	0	0	0	1
Total	42	10	6	4	4	8
Library -1	12	3	5	2	4	5
Library-2	6	0	0	0	0	0
Library-3	20	2	2	1	1	1
Library-4	20	5	3	5	3	5
Library-5	10	0	0	0	0	0
Library-6	4	0	2	1	1	1
Library–Other	0	1	0	0	0	0
Total	72	11	12	9	9	12
Starbucks-1	10	0	0	1	1	0
Starbucks-2	2	1	0	0	0	1
Starbucks-3	8	0	1	1	0	1
Starbucks-4	2	1	1	1	1	1
Starbucks-5	6	0	0	1	1	1
Starbucks–Other	0	3	1	1	1	0
Total	28	5	3	5	4	4

Below is the data for the distances of each section. The X ratio column represents the bike rack slot availability ratio over the linear distance of each area. The Y ratio column represents the total number of bikes observed over the linear distance of each area.

Table 2 – Table of distance and the ratios produced using the totals

	Distance	X Ratio	Y Ratio
Nuvibe 1	221.62	0.271	0.212
Haymarket 2	255.34	0.172	0.372
Scooters 3	511.15	0.082	0.063
Library 4	478.56	0.15	0.111
Starbucks5	273.93	0.102	0.077



Graph 1 – This graph represents the results of the data after analyzation

The angle of the line is positive, with a slope of .059. The R^2 ratio that resulted from the trend line analysis is 0.532.

To perform all these calculations I used the analysis programs in Microsoft Excel. I also received statistics analysis help from Dr. Eskridge in the statistics department.

Discussion

The principle objective of this study was to determine if a relationship exists between the density of bike racks in a given area and bike ridership in those areas. This was to be assessed by collecting data on the number of bikes present in different areas. The data collected suggests that there may indeed be a positive relationship between bike racks in an area and ridership.

The linear regression performed showed a slope of .0593, which essentially means that for every increase of 1 bike rack spot per meter, the number of bikes in the area would go up by .0593 bikes per meter. There is an r^2 value of .532, which implies that about 53.2% of the pattern seen is a result of the data collected. The results suggest that bike racks may have a larger influence than is being taken into account at the present time.

I did not perform an analysis to assess the statistical significance of my data because I have too few data points to do a meaningful analysis. This is not to say that my data would not benefit from further analysis or significance testing, but there are limits to what can be proven with analyzing data. This study could be more meaningfully assessed if it is either performed over a longer time span, or is performed in more geographic locations.

The results of this study need to be examined with some alternative explanations in mind. The region that showed the highest bike ridership was consistently the Haymarket. It may be the case that the city placed more racks in the Haymarket in anticipation of greater ridership in the area. I observed a fairly consistent number of bikes chained up outside of Indigo Bridge Books at 8th Street and P Street even though the rack across the street had room for several more bikes. I witnessed only a handful of bikes locked to non-rack objects outside of the Haymarket area.

Another interesting trend that emerged during the data collection was that certain bike racks were not being used on any given day of data collection. It seems especially strange that the bike racks in front of Brothers located at O Street and 14^{th} street had either one or no bikes. There were always bikes at the other racks just down the street. In fact, the rack across the street in front of Jimmy John's Gourmet Sandwiches, also on 14^{th} Street and O Street, had bikes on its rack consistently.

Two of the three bike racks on 9th street in Scooters saw no usage at all during the time I surveyed them. While low usage seems understandable, no usage suggests that commuters in the area are not using the bike racks near their work. A study looking into usage at different times of day would be helpful to expose what the actual ridership is at different racks in a given day.

The weather may or may not have played a role in the number of people commuting. The weather on most of the days I collected was in the mid 50s, and was either cloudy or partly cloudy. On the last day I collected data it was warm and sunny, but the only noticeable difference in ridership was in the Haymarket. There was a jump in ridership of nearly 50% in the Haymarket, but there was no noticeable increase at the other sites. It is hard to say why the weather did not influence the other sites to the same degree.

The time frame over which the data was gathered over may have played a role as well. The spike in ridership in the Haymarket may have just been an anomaly, which would be compensated for with more data. Also, taking data during in the middle of a season rather than the transition between winter and spring might yield more consistent data.

My study agrees with the work I researched in that there appears to be many different factors involved with bike ridership. If there was a completely dependent relationship between the racks density and the number of bikes, there should have been a straight line of data points.

Bicyclists and drivers may prefer different destinations, so some of the racks may have been underutilized in areas with fewer biker friendly businesses. Based on what I observed in my data collection, I would say that coffee shops and popular lunch restaurants attract more daytime biker. The bars and banks did not appear to attract many bicyclists, though this may be due to the time of day. Investigation into which businesses attract bicyclists would be beneficial for understanding bike racks to a higher degree.

There may be some other qualities that make the use of a particular rack more desirable than other racks. I did not factor the type of bike rack into my study, so that may have influenced ridership. Different types of bikes may work more smoothly with different kinds of racks.

A comprehensive approach is necessary if we are to get a better grasp of the nature of bike riders.

Summary & Conclusion

This study was performed in order to investigate what relationship, if any, exists between the density of bike racks and bike ridership in different areas. My theory was that the areas with higher density would have a higher number of bikes than areas with a lower density of bike racks.

The results of my study show a positive relationship between the bike rack density and the number of bikes in a given area. The r-value I found was positive, which shows that there are some outside factors influencing the variables I assessed. Whether or not these trends are consistent in Nebraska, or nationwide, will require further investigation, but it is a start towards understanding the role of bike racks more thoroughly.

My primary recommendation for further study would be to investigate the preference given to different bike racks. Understanding what factors make a bike rack desirable or undesirable is the next step in understanding how to optimize bicycle facilities. Once we have more knowledge about what drives ridership, we can use effective strategies to increase ridership everywhere, for the benefit of all.

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