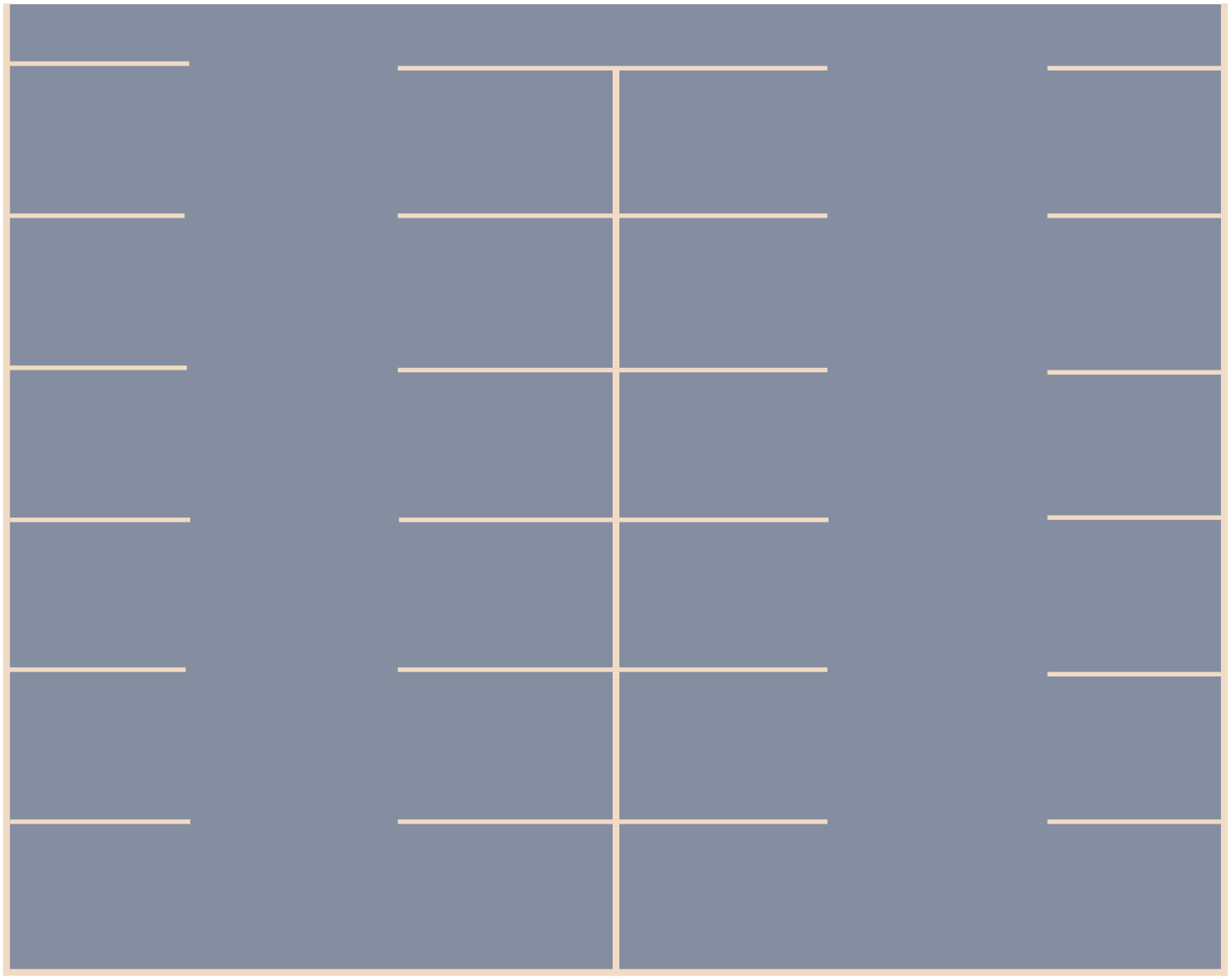

Insights into Multifamily Residential Parking Demand for Madison, WI

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Acknowledgements

I am truely honored to have worked alongside so many incredible people, having constant support throughout my time as a graduate student at UW – Madison. To my fellow classmates and the faculty and staff at URPL, thank you for being a welcoming home-away-from-home since day one. Many thanks to Christopher Spahr for introducing me to the SSTI team, which led to my involvement in this project. A huge thank you to Christopher McCahill and the rest of the SSTI team for placing their confidence in me, being patient with me, and teaching me a thing or two along the way. Lastly, thank you to Professors James LaGro and Teresa Adams for their support, guidance, and flexibility over the last year.

Executive Summary

For the past half century parking infrastructure has been a main component of any development proposal; citizens, developers, and local policymakers worry about not having enough available to meet peak demands. In fact, a significant and growing body of literature argues that most cities are actually overprescribed in their amount of parking. There have been several initiatives in other U.S. cities in response to this, seeking to better understand local parking demand trends and to estimate appropriate supply numbers.

This project analyzes parking supply and demand for multifamily residential properties throughout Madison, Wisconsin. After collecting data on over 50 sites, the results indicate that on average 30 percent of the parking spaces are vacant during peak demand hours. Furthermore, the analysis shows that variables like population density, access to transit and bicycle infrastructure, and monthly parking price have inverse relationships with parking demand.

Table of Contents

Figures

Tables

Introduction

Parking … everyone's favorite thing to complain about. It has been a major aspect of new development since the 1960s and 70s, when federal housing and transportation policies, combined with changing consumer preferences, led automobile use to drastically rise to levels we see today. Around that time, nearly all U.S. cities with populations over 25,000 enacted some form of zoning regulation regarding how much parking to supply, depending on the land use.[1] Most commonly these took the form of minimum parking requirements, meaning new development was built in such a way as to meet the peak parking demand upon it.[2] Madison's own zoning code, although recently updated to encourage alternative transportation modes, still contains the minimum parking requirement concept.[3]

Since the nationwide enacting of those polices, a variety of scholarly initiatives have focused on the implications of these regulations, and parking in general, on development patterns and urban life. Donald Shoup, with his book The High Cost of Free Parking, is usually the first name that comes to a planner's mind. In their recent Transportation Research Board submission, McCahill et al.[4] pulled together a collection of parking research done by others. Thus there exists now a significant and growing body of literature arguing that most urban areas are actually over-prescribed in their supply of parking, creating a variety of negative externalities for individuals and cities.

Parking lots and garages are expensive to build and maintain. They can range from $20,000 - $40,000 per space depending on the cost of land and these development expenses are typically passed on to tenants, driving up housing costs and decreasing affordability.[5] Thus parking can chew up very valuable land, causing the city to lose out on potential tax revenue that could result from other uses of that land as well as negatively impacting the vibrancy and vitality of urban areas.[6] Lastly, an abundance of parking encourages more driving and the need for more parking, creating and sustaining a cycle of inefficiency.[7] In spite of all this, high rates of automobile use continue to dominate the personal transportation system. Residents, developers, and policymakers still worry about inadequate parking supply when considering new development. To determine if these are legitimate concerns, more research is needed on current parking supply and demand.

Objectives

With those externalities in mind, this project set out to observe how much parking is actually being used on a typical day for multifamily residential properties in Madison, WI. Can that demand data be explained by other property and neighborhood variables? This inquiry was inspired in part by the 2013 "Right Size Parking" initiative in King County, Washington and

[1] Ferguson, 2004. Page 178.
[2] Shoup, 1999.
[3] City of Madison Zoning Code Ordinance, Chapter 28.141.
[4] McCahill et al., 2015.
[5] Shoup, 1999; Shoup, 2005.
[6] Davis et al., 2010; Manville & Shoup, 2005; Shoup, 2005.
[7] McCahill et al., 2015.

the "Park Right DC" initiative in Washington, D.C.[8,9] The result of both projects was an online interactive map based on a multiple regression model. Within the map an individual can input a number of attributes regarding a potential multifamily residential development, in response the map will indicate an estimate for the appropriate parking supply.

If this approach could be replicated for Madison, it could help the City be more successful with transportation demand management efforts and help developers to better estimate the amount of parking that new developments would utilize. My findings will contribute to the development of a similar tool for Madison, however the full tool was beyond the scope of this project. Rather, this report will outline the data collection methodology and discuss the findings and their implications.

Data Collection Methodology

To begin to understand how parking is supplied and used, multifamily residential properties were identified and analyzed. Size and price of the units, total income-restricted units, parking supply and price, property location, neighborhood characteristics, and accessibility were the primary variables collected. Total occupied parking was the measure used for parking demand at each property.

Defining Sites

Multiple criteria and definitions were established prior to initiating the site selection process. First, all sites were required to be within the City of Madison municipal boundary. To ensure sites would have a significant amount of space dedicated to parking infrastructure, "multifamily residential" was defined as residential property with at least ten housing units. Condominiums and apartments were treated equally in the selection process. Since time and resources were limited, a goal of 50 sites was established.

Site Selection

For the sample to be representative, the chosen sites had to contain a variety of locations, sizes, prices, and total units; thus, sites were not chosen randomly. Instead they were stratified spatially using Google Maps' Earth View, checking buildings street by street, neighborhood by neighorhood until a satisfactory variation in site characteristics was achieved. Site names and addresses were recorded into a database as they were selected.

Gathering Data

Initially a survey (Appendix A) was created and emailed to property managers. After experiencing a low response rate and slow response times, data sources were broadened to include publicly available information from property websites and City Assessor data. Property websites often advertise information about the number of units, number of bedrooms per unit, unit price, parking price, and vacancies. Assessor records provided a secondary source for the total number of units, number of bedrooms, and total residential area. Any remaining gaps were filled in by calling or emailing property owners with specific questions.

[8] Rogers et al., 2016.
[9] King County Metro Transit, 2013.

There were many instances where the Assessor data didn't match up with what was found through property websites or conversations with property managers. In those cases deference was given to the information gathered via phone/email or property website. There were also cases where no information could be found for a site from any source (e.g. no website, no Assessor record, no answer to phone calls, etc.). Those sites were skipped and replaced since they could not be completed. The final database contained 54 completed sites and 13 skipped sites. A map of the selected properties can be seen in Figure 1.

Site Visits

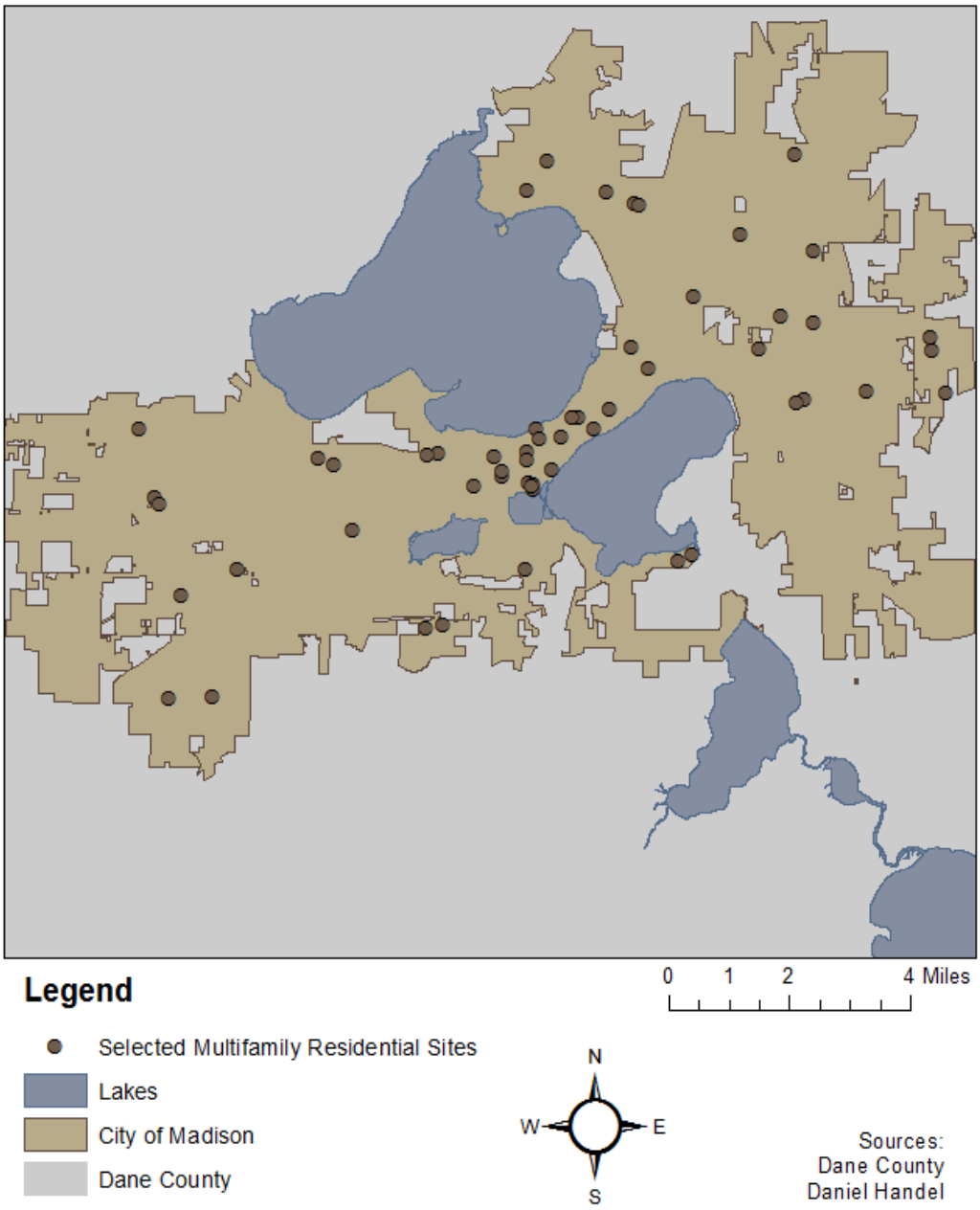
Parking occupancy was observed at each location during the peak period for residential developments, defined as 7pm-10pm Monday through Thursday according to *Shared Parking*.[10] Two observations were made at each site on different dates to account for anomalies, with both recorded alongside their time and date. Sites were accessible to the public, or access was provided by property managers and tenants.

Neighborhood Characteristics

Walkscore, an online tool for considering non-automobile modes of tranportation by address, was used to collect pedestrian, bicycle, and transit scores for each site. Several Census Tract level variables were also collected for each site. The American Community Survey's 2014 5-year estimates[11] were used to determine population density (persons/square mile), median household income (2014 dollars), and median age. Longitudinal Employer-Household Dynamics data[12] from the Census Bureau's Center for Economic Studies provided employment density (total jobs per tract).

[10] Smith, 2005.
[11] U.S. Census Bureau.
[12] Center for Economic Studies.

Figure 1 - Site Map



Analysis

For the purposes of analysis the data collected were split into two categories: site-specific and location-specific. Site-specific variables pertain to each individual property whereas location-specific variables consider the Census Tract that each property falls within. Graphic comparisons have been compiled for each, complete with an r-squared value indicating the strength of the relationship between the independent and dependent variables. The stronger the relationship, the closer the value will be to 1.

Site-Specific Data

Nearly all variables in this category came directly from property websites, speaking to property managers over the phone, or City of Madison Assessor records. As can be seen in Table 1, a wide range of properties were selected as sites. Several sites were large apartment complexes of multiple buildings with hundreds of units and parking spaces, but the majority were single apartment buildings of various sizes. Of the 54 total sites, ten had some amount of income-restricted units and three were condominiums. Additionally, 28 of the sites had above- or below-ground garages and street parking was available for 35 of the sites.

Table 1 - Site-Specific Data Summary

Variable	Lower Bound	Upper Bound	Median	Mean
Property size (sq. ft.)	5,000	521,433	70,767	100,888
Total residential units	10	404	64.5	104.6
Total bedrooms	10	720	121	173.75
Occupied bedrooms	10	714	115	171.94
Total parking spaces	0	688	76	136.4
Monthly rent*	200	2,536	962.37	1,101.89
Monthly parking price	0	185	0	37.87
Total parking spaces per unit	0	1.9	1.25	1.18
Total parking spaces per bedroom	0	1.35	0.9	0.8

**Three sites were omitted here due to rent being dependent on monthly income.*

Site visits and parking counts happened between July 2015 and March 2016, with the results summarized in Table 2. These numbers represent the maximum of the two observations for each site rather than the average in order to better represent peak parking demand. On average, nearly one-third of all spaces in parking lots and garages were vacant.

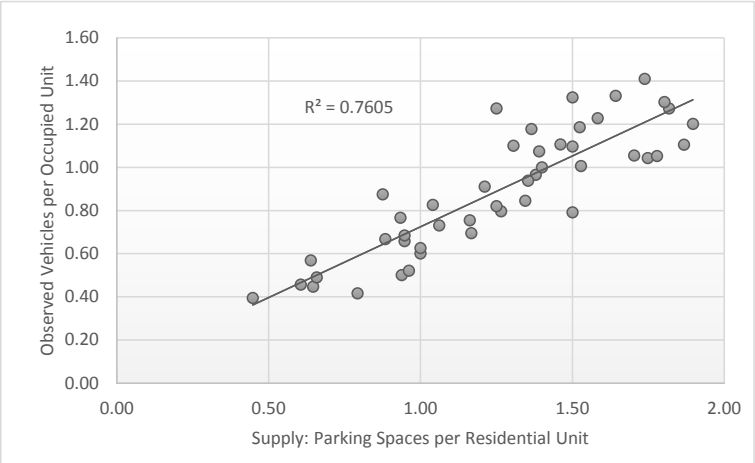
Table 2 - Site Visits Summary

Variable	Lower Bound	Upper Bound	Median	Mean
Occupied parking as percent of total*	40.28%	100.00%	70.00%	70.45%
Observed vehicles per occupied unit	0.00	1.38	0.81	0.79
Observed vehicles per occupied bedroom	0.00	1.02	0.55	0.53

**Two sites were omitted here because they do not offer any parking spaces for their tenants.*

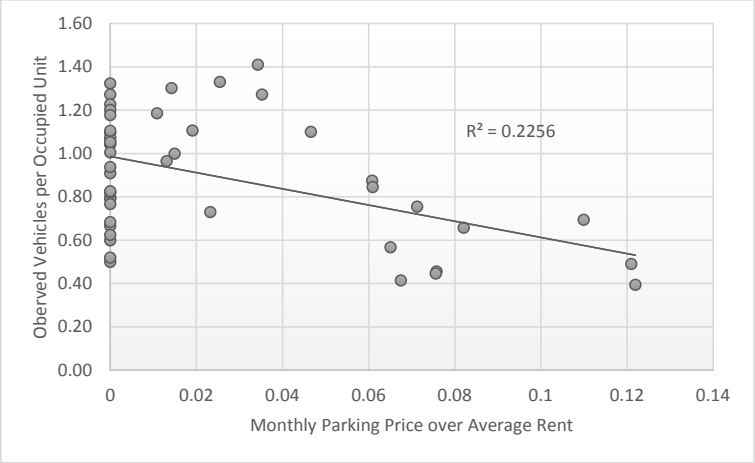
Using 'Observed Vehicles per Occupied Unit' as the dependent variable and a series of site-specific observations as independent variables, the following graphs explore how parking demand is influenced by these site-specific factors. After accounting for outliers, the total number of sites included in the graphs decreased from 54 to 46.

Figure 2 - Total Parking Supply



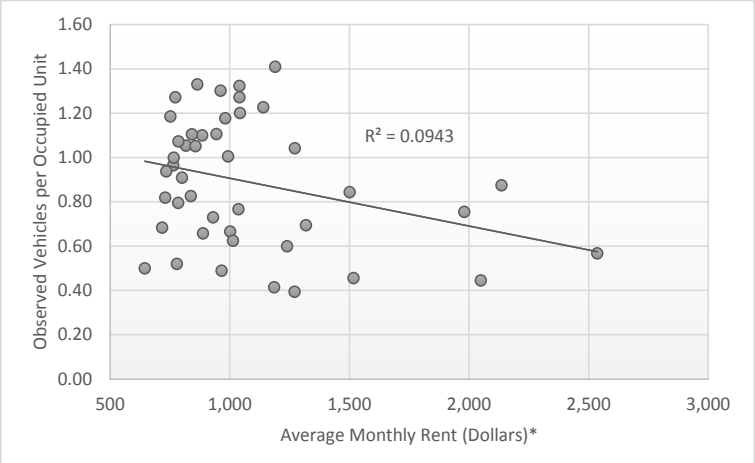
How much parking is being supplied per unit at each site? How much of it is being used? This basic analysis, visualized in Figure 2, shows that parking supply and demand are strongly related but that demand isn't the same everywhere.

Figure 3 - Monthly Parking Price



The next variable considered was the monthly price of parking, represented in Figure 3 as a fraction of each site's average monthly rent. High variability can be seen when parking is included in rent, however when parking is an added monthly expense an inverse relationship appears to form.

Figure 4 - Average Monthly Rent

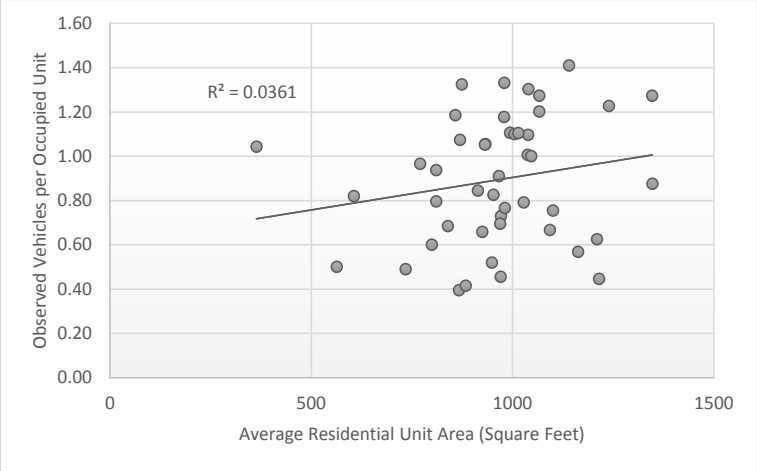


**In addition to the outliers, two more sites were omitted here due to rent being dependent on income.*

Average monthly rent, seen in Figure 4, was investigated next. Although the trendline shows a slight decrease in parking demand as rent increases, the high level of variability renders this relationship negligible.

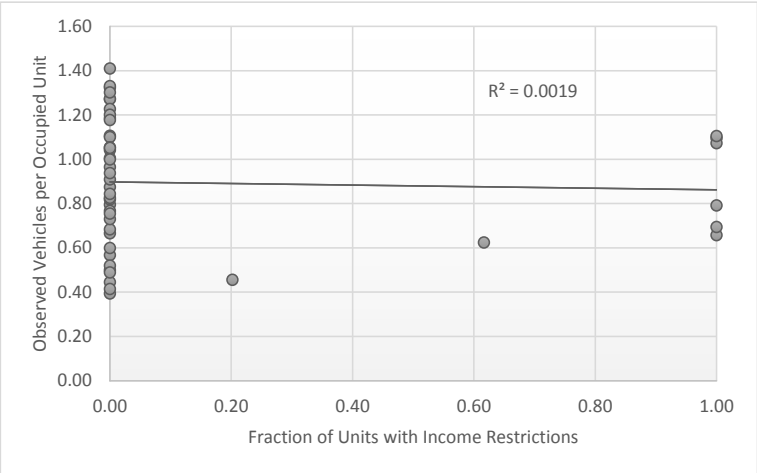
Figure 5 shows how average unit size, calculated by dividing each site's total residential area (square feet) by its total number of units, impacts parking demand. The high amount of variability here renders this relationship negligible as well.

Figure 5 - Average Unit Size



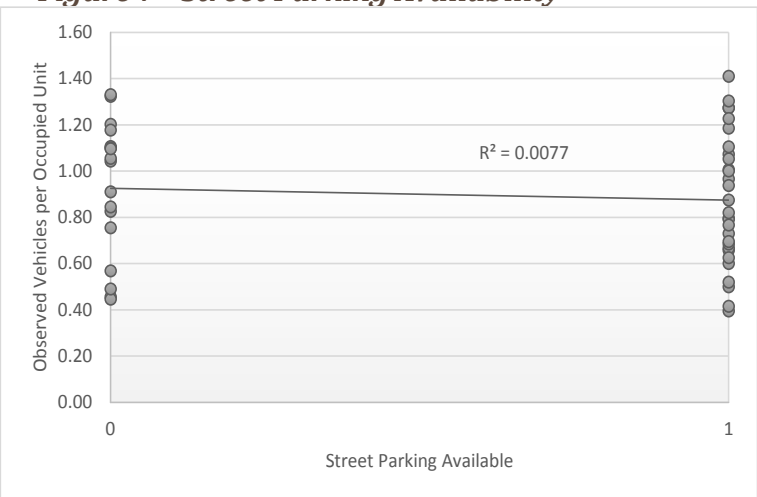
The majority of sites did not offer income-restricted units, but ten of them did. As seen in Figure 6, there is a negligible inverse relationship between having income-restricted units and parking demand. Perhaps increasing the number of sites with income-restricted units could provide more information.

Figure 6 - Income-Restricted Units



The availability of on-street residential parking, whether by permit or freely available, was also considered. As shown in Figure 7, sites with on-street residential parking scored a '1'. The high amount of variability seen renders this relationship negligible.

Figure 7 - Street Parking Availability



Finally, the Transit Score, Bicycle Score, and Walk Score for each site, sourced from the Walkscore[13] website, are visualized in Figures 8, 9, and 10, respectively. The results are quite similar for all three, showing an inverse relationship with parking demand.

Figure 8 - Public Transit Score

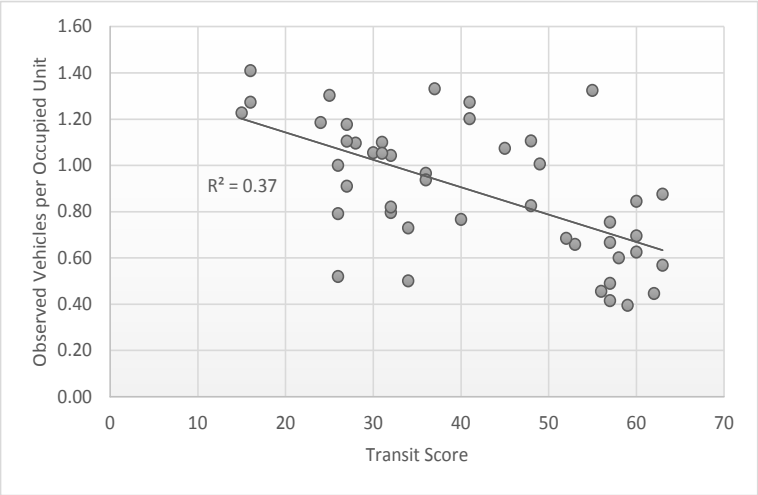


Figure 9 - Bicycle Score

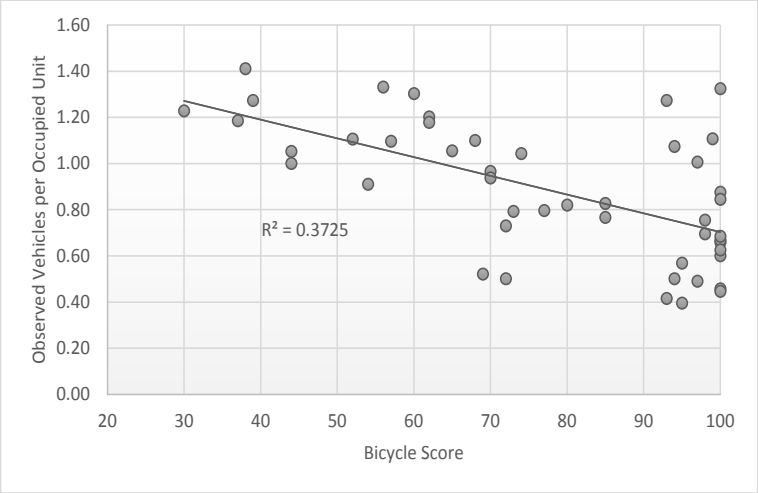
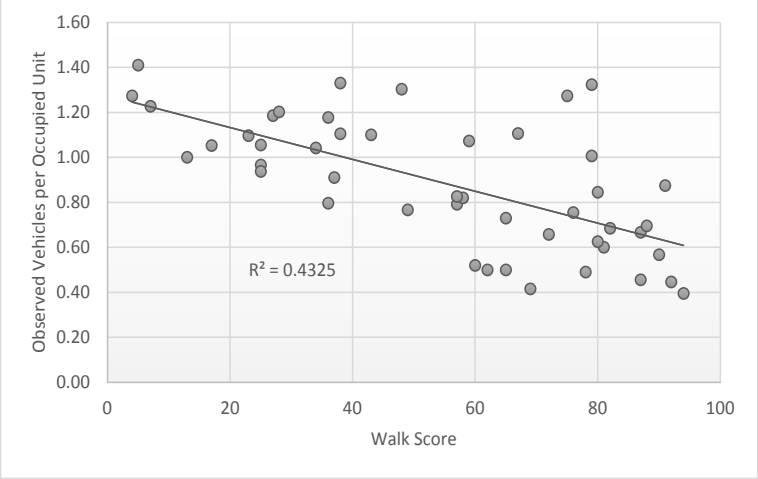


Figure 10 - Walk Score



[13] Walkscore.

Location-Specific Data

Whereas the previous nine variables were characteristics of each site's property, four additional variables were collected that were descriptive of each site's location. Found in Table 3, they are all measurements at the Census Tract level; each site is assigned to the Census Tract that it falls within. A total of 32 Census Tracts were represented in this project.

Table 3 - Location-Specific Data Summary

Variable	Lower Bound	Upper Bound	Median	Mean
Population density (persons/square mile)	396.7	51,620.1	4,956.5	10,282.75
Employment density (total jobs by Census Tract)	200.0	11,936.0	1,831.0	2,933.13
Median household income (2014 Dollars)	$8,596.00	$90,000.00	$42,421.00	$45,333.65
Median age	19.7	65.9	30.9	31.34

Once again using 'Observed Vehicles per Occupied Unit' as the dependent variable and each location-specific observation as an independent variable, the following graphs explore how parking demand is influenced by these site-specific factors. The outliers removed from the site-specific analysis were also removed here. In Figure 11, population density can be seen to have an inverse relationship with parking demand however much of the data points fall within Census Tracts with less than 10,000 persons per square mile. Perhaps additional sites within Tracts over 10,000 persons per square mile could provide more information regarding this relationship.

Figure 11 - Population Density

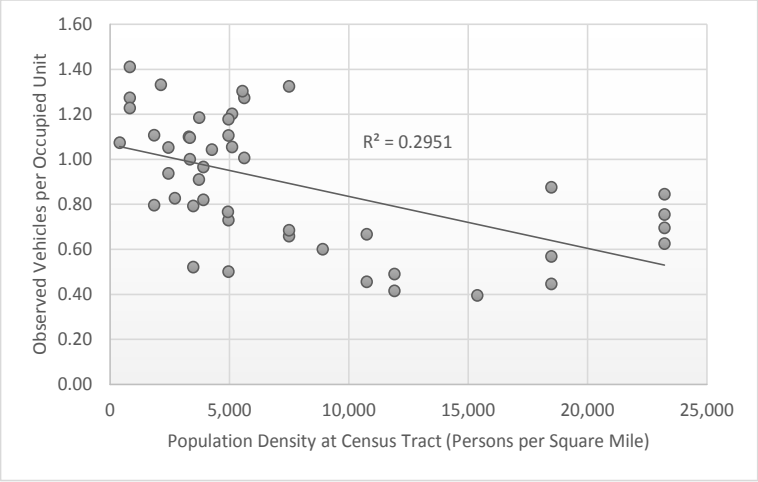
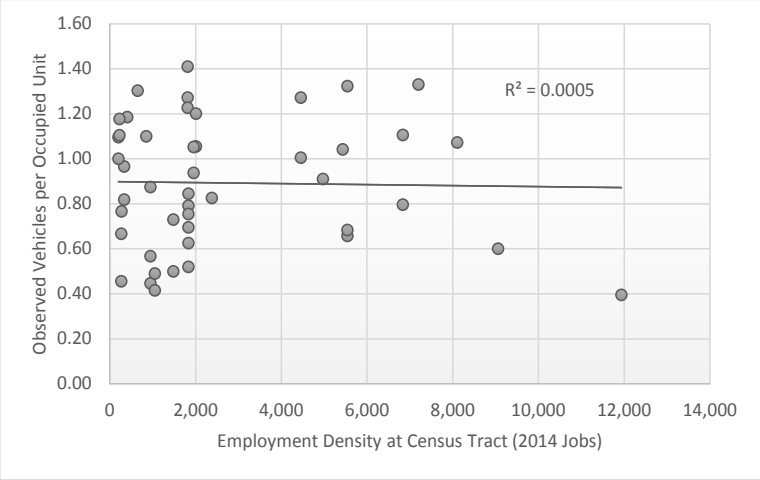
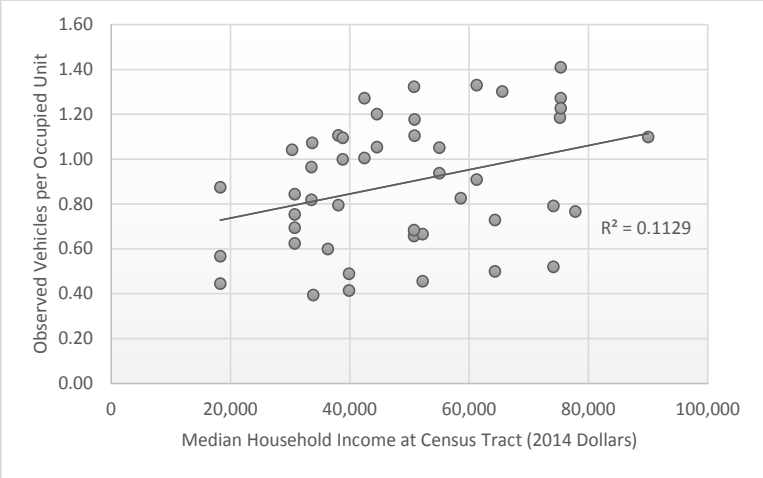


Figure 12 - Employment Density



Following population density is employment density, as seen in Figure 12. The amount of variability in the data render this relationship negligible, however the majority of the data points fall within Census Tracts containing 2,000 jobs or fewer. Perhaps additional sites within Tracts that contain more than 2,000 jobs could provide more information.

Figure 13 - Median Household Income



Median household income was explored, with Figure 13 showing a positive relationship forming with parking demand. There is a notable amount of variation present however, meaning this relationship is also negligible.

Figure 14 - Median Age

The final location-specific variable in this analysis is median age, visualized in Figure 14. Similar to employment density and median household income, average age has a considerable amount of variability across the data points, but a positive relationship can be seen taking form.

Discussion

After sorting through the data, there are two overarching takeaways to discuss. First, on average throughout Madison 30 percent of multifamily residential parking spaces are vacant during their peak demand time. The demand data collected is by no means a definite measurement since it can fluctuate on a daily basis, but it's important to note that these findings support the argument found in the literature that cities are oversupplied in their parking. Second, parking demand across the city does not exist as a single, static number. Many of these variables are related, potentially influencing each other on how they impact parking demand. For example, location appears to play a significant role in the demand for parking. This makes sense, denser areas have more people inhabiting less space, more destinations in closer proximity to each other, and higher rates of walking, biking, and transit. Monthly parking expenses, also more likely to be found in denser locations, appear to bring demand down further by acting as a disincentive for tenants to keep a vehicle. These variables each contribute to dynamic demand patterns throughout the city.

With regards to parking as a land use and political issue, these findings indicate that developers are oversupplying parking at the expense of the tenants, increasing housing costs and potentially nullifying more productive uses of valuable land. The City appears to recognize this within its Zoning Code, encouraging the "reduction of off-street parking in favor of transit or other travel modes,"[14] however the challenge of balancing opposing goals remains: how to provide enough parking while simultaneously managing and influencing current and future demand? Further research will hopefully help create a tool for addressing this challenge. Continued work will include an expanded sample size, a correlation analysis for all independent variables, data transformations where applicable, and a multivariate regression model.

Finally, it is important to acknowledge that some methods for measuring variables could be improved upon for further analysis. More rigorous methods for measuring transit and bicycle accessibility, population and job density, as well as a differentiation between permit-required and freely-available street parking could each provide more detailed information. The current methodology for collecting demand data during site visits does not account for people who work at night, an issue that could be fixed with a third visit to each site during early morning hours. Additional studies could investigate the tenants' side of the story as well.

Conclusion

This project set out to observe peak parking demand for multifamily residential developments throughout Madison and to explore the relationships between that demand data and various site- and location-specific variables. The results indicate that 30 percent of the observed parking spaces are vacant during the peak demand hours of 7 p.m. through 10 p.m., Mondays through Thursdays. Further analysis shows the significance of site location, monthly parking price, and total parking supply on the observed parking demand. These initial results also show that more sites are needed to fill in gaps that appear in several variables. Once additional sites have been completed, further research will seek to analyze how these site- and location-specific variables collectively impact observed parking demand, moving towards a model of the likes of Right Size Parking and Park Right DC.

[14] City of Madison Zoning Code Ordinance, Chapter 28.141(1).

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13. Walkscore. www.walkscore.com. Last accessed: April 8, 2016.

Appendix A - Property Manager Survey

The following is a copy of the survey sent via email to each site's property manager.
A note: the final question is a drop down menu and all three options are not visible so I've provided them here:

1. Please choose…
2. Yes. The research team can include our property in a case study.
3. Maybe. But I'd like some more clarification first.

Madison Parking Study

Madison Parking Study

If you can, please take 10 to 15 minutes to answer a few questions about your property. We've already collected some data on parking and building use for many buildings in Madison, but we appreciate your help filling in the rest. This survey is completely voluntary, so you can skip questions or leave at any time. We will keep specific information about your property confidential unless you grant us permission to use it for a case study.

See the letter below for more information about this study or, if you have any questions, contact Chris McCahill at 608-262-7797 or mccahill@stti.us.

Department of Planning & Community & Economic Development
Planning Division
Katherine Cornwell, Director

Madison Municipal Building, Suite LL-100
215 Martin Luther King, Jr. Boulevard
P.O. Box 2985
Madison, Wisconsin 53701-2985
Phone: (608) 266-4635
Fax (608) 267-8739
www.cityofmadison.com

Dear Property Owner or Manager:

We appreciate your cooperation in helping a team of researchers from the University of Wisconsin-Madison better understand parking issues in Madison.

This summer, a research team will be gathering information about hundreds of properties throughout the city to understand how much parking there is, how it's being used, and what are the best ways to meet current and future access needs. Some of the information is available from existing records and public information, but the researchers will also be surveying property managers and observing parking use.

This study will provide valuable information about how factors like parking fees, bus service, and land use patterns affect parking demand in the city. The findings will be made publicly available, but new information about specific properties will be kept confidential unless permission is given to include it in case studies.

Again, if the research team approaches you, we appreciate your cooperation. Please direct any questions about the study to research team leader Chris McCahill at the State Smart Transportation Initiative at UW-Madison (mccahill@ssti.us or 608-262-7797).

Sincerely,

David Trowbridge
Principal Planner
Transportation Policy & Planning

Basic Information

Contact information:

Property name (if applicable):	
Property address:	
Your name:	
Phone number:	
Email address:	

Property uses:

Check all that apply.

- [ ] Residential
- [ ] Retail/commercial
- [ ] Office
- [ ] Food/drink service
- [ ] Entertainment
- [ ] Medical/health care
- [ ] Other:

Parking Information

Do you charge residents for parking spaces?

- ◯ yes
- ◯ no

Please describe the parking you provide.

Answer "0" for any that do not apply to your property.

	Total number of spaces	Number occupied	Price per month ($)
Parking garage:			
Parking lot:			
Off-site:			

Which of the following does your property offer?

- [ ] Waitlist for parking stalls
- [ ] On-street parking
- [ ] Discounted bus passes
- [ ] Carpooling services
- [ ] Shuttle service or guaranteed ride home
- [ ] Parking cash-out (selling the rights to your space)
- [ ] Lockers or showers for bicycle users
- [ ] Car share programs (e.g. Community Car or Zipcar)
- [ ] Flexible work schedules or telecommuting (for employees)
- [ ] We do not offer any of these programs

Residential Information

Property details:

Total number of residential units:	
Number of renter-occupied units:	
Number of owner-occupied units:	
Number of income-restricted units (affordable or supportive housing):	

Please describe your units.

Answer "0" for any fields that do not apply to your property.

	Total number of units	Number occupied	Average area (sq. ft.)	Average price ($)
Studio units:				
1-bedroom units:				
2-bedroom units:				
3-bedroom units:				
4-bedroom units or larger:				

Please indicate if your property serves any of the following.

	One-third or less	About half	Two-thirds or more
Families:	○	○	○
Seniors:	○	○	○
Full-time students:	○	○	○
Disabled or special needs residents:	○	○	○
Other:	○	○	○

+1

Other information

Is there anything else you'd like to say about parking issues, parking policy, or the development process in Madison?

May we name your property in a case study?

Please choose...

Thank you for completing this survey.

If you have any questions or you'd like to follow up, please contact Chris McCahill at 206-262-7797 or mccahill@ssti.us.

» Redirection to final page of eSurvey Creator