# Evaluating the Impact of Transit Service on Parking Demand and Requirements

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**Many jurisdictions in the United States typically set minimum parking requirements for residential multifamily developments based on old data that were collected in suburban settings with little transit availability. Such parking requirements applied to urban settings with adequate transit service often result in an oversupply of parking, which in turn creates a barrier to smart growth. Not only does the oversupply of parking encourage automobile use and reduce housing affordability, but it also increases development costs, consumes land and natural resources, and increases associated air and water pollution. This research examines the relationship of parking demand and transit service in First Hill–Capitol Hill (FHCH) and Redmond, two urban centers in King County, Washington. An alternative method to collect parking demand data is explored. The results show a strong relationship between transit service and parking demand. The FHCH urban center, which abuts downtown Seattle, exhibited higher levels of transit service and lower parking demand. Parking demand in FHCH was observed to be 0.52 parking space per dwelling unit, which was about 50% less than parking demand observed in Redmond, a growing mixed-use suburban center, and 50% less than data reported by the Institute of Transportation Engineers. After a review of the parking policies of each urban center, opportunities to improve regulations—including adjusting minimum parking requirements and allowing for reductions in required parking when developers implement solutions to reduce demand for parking—were identified.**

Parking policies affect urban land use patterns and are intertwined with automobile use, traffic congestion, housing affordability, and environmental impacts. Planners typically base parking requirements on parking demand data provided by the Institute of Transportation Engineers (ITE), although these data are often outdated and based on suburban developments where parking is free and public transit is limited (*1*). Local parking requirements in the zoning code are mostly not tied to actual use, which often leads to parking oversupply that can encourage automobile use and discourage transit use. Some cities have begun using progressive policies to manage parking supply and have been able to meet larger smart growth objectives. As cities look to increase transit ridership to achieve regional planning goals, it is important to consider parking policy in concert with transit service provision. High levels of transit service can provide a viable alternative to vehicle ownership, which lowers the parking demand for new developments. When cities set parking policies based on locally observed parking demand and provide the level of transit service accordingly, they can reduce the cost of development and encourage alternatives to owning and driving automobiles.

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On the basis of local transportation planners' experiences and the literature reviewed, the authors hypothesized that higher levels of transit service result in lower residential parking demand. The assumption is that higher levels of transit service will lead to higher transit ridership and lower automobile ownership. For this study parking demand counts at multifamily residential apartment buildings were conducted in two urban centers, First Hill–Capitol Hill (FHCH) and Redmond (both in King County, Washington), and their transit level of service was calculated. These urban centers were chosen because they represent two contrasting types of development, an urban and a suburban environment, yet they have the highest number of multifamily apartment buildings available to study among all centers in King County. Using the findings from this research, the authors analyzed the ability of current parking policies in each urban center to meet true parking demand. A Washington State Department of Licensing (DOL) database for registered vehicles was examined to assess its accuracy in determining parking demand.

Even though developers generally want to build parking to meet their intended market demand, they are limited by city parking requirements that raise development costs and influence affordable housing costs. This research addresses this challenge by exploring the connections between parking demand, transit level of service, and parking policy. Local, context-sensitive data on parking demand were collected, and their relationship to varying levels of transit service was analyzed to provide transportation planners with the information needed to determine an optimum level of parking that meets the true demand.

## LITERATURE REVIEW

The criticism of parking regulations was spearheaded by Shoup in his seminal work, *The High Cost of Free Parking* (*1*). He described several problems with modern parking regulations, including the flaws in parking regulation development influenced by ITE, the inability to provide the true market demand, and implications on planning for sustainable development. He states that the cost of parking requirements "is a serious problem because minimum parking requirements increase development cost and they powerfully shape land use, transportation, and urban form" (*1*).

Zoning codes often specify minimum parking requirements for off-street parking in new residential developments. These requirements are intended to ensure that a new development will provide an adequate number of parking spaces to avoid parking spillover onto adjacent streets and properties, to maintain traffic circulation, and to achieve the economic success of the development (*2*). The methodology behind creating parking standards is complex, and it is often difficult to determine the level of parking demand that a development will create. Literature focused on residential parking demand and its relationship to transit service is scarce, although the topic is gaining attention as cities reevaluate their regulations to meet new planning goals.

### Establishing Parking Requirements

Establishing parking requirements for multifamily residential developments can be a complex process for which few planners are properly trained. Further, municipalities avoid training planning staff to conduct the necessary research on parking demand in their jurisdictions. Planners usually follow neighboring cities' parking requirements or consult other published data. This practice may be inexpensive and noncontroversial, but it may not be the best method if the physical, economic, and sociodemographic characteristics of the neighboring city are not similar. In addition, if the current requirements of the replicated zoning code do not reflect the true parking demand, then a vicious cycle will continue. As a result, "copying other cities' parking requirements may simply repeat someone else's mistakes" (*1*).

ITE's *Parking Generation* is another frequent source for determining parking requirements (*3*). For this report transportation engineers surveyed the parking occupancy of various land uses to develop parking generation rates. The parking generation rate is defined as the average peak parking demand for a given land use. The present study focuses on how the third edition of *Parking Generation* illustrates parking demand for multifamily residential developments in King County. The study sites fall in the "Low/Mid-Rise Apartment" land use category within the report, which is defined as a "rental dwelling unit located within the same building with at least three other dwelling units . . . [with] one, two, three, or four levels" (*3*). The report's average parking supply ratio is 1.4 parking spaces per dwelling unit for both urban and suburban sites. For peak period parking the demand rate is 1.0 for the urban site and 1.2 for the suburban site (*3*).

Although ITE is the only national resource collecting and publishing parking demand data, there are limitations to its application. *Parking Generation* describes the limitations to the data it uses and warns readers that it is only an informational report that does not provide authoritative findings, recommendations, or standards. Since most of the data is from suburban sites with isolated single land uses with free parking, its application to more complex mixed-use urban areas is limited. The ITE report also suggests that more parking data, such as pricing, transit availability, mixing of land uses, and land use density, are needed to better understand parking demand (*3*). Considering this warning, it is important for users of *Parking Generation* to understand that the applicability of its rates may be of limited or no use, depending on the context in which they are applied.

### Impacts of Flawed Parking Requirements

By the end of the 20th century, planners began to observe serious implications from rampant parking facility growth within the context of urban sprawl such as excessive travel behavior, reduced housing affordability, environmental pollution, and transit service impacts. The prevailing parking requirements are regarded as contributors to a surplus of parking. Although extensive academic literature exists regarding the effect of employment parking supply and policies on travel behavior, few studies focus on the impact of residential parking on travel behavior. Recently, Weinberger et al. studied two neighborhoods, Queens and Brooklyn in New York City, with similar demographics and transportation service but different off-street parking supplies. They found that "households with onsite off-street parking are inclined to drive more than their neighbors" without access to off-street parking (*4*). In the neighborhood with more off-street parking residents' car ownership and vehicle miles traveled were higher. In contrast, residents who live near transit service make fewer vehicle trips than residents with less transit service (*5*).

Off-street parking requirements increase construction costs in residential developments that are often passed on to the resident. For parking structures built between 1961 and 2002, the average cost of building an additional parking space is $22,500 (*1*). These added costs have serious impacts on social and environmental equity concerns, especially to those residents who do not own a car but must pay for the external costs generated by off-street parking requirements. Current housing markets harm lower-income households by forcing them to choose between urban residential locations, which tend to be either in undesirable neighborhoods or expensive, and suburban residential locations, which have lower housing costs but much higher transportation costs (*6*). For residents who do own a car, there is little incentive to change their behavior and use a more environmentally friendly mode of transportation. Many lower-income households would be stronger financially if planners could provide affordable housing in areas where residents had access to multimodal options and their combined housing and transportation costs were lower. More flexible parking requirements can help provide more affordable housing by reducing housing development costs in areas with higher land prices (*7*).

Moreover, as people become increasingly dependent on automobiles, providing parking in urban areas becomes a significant expense and a deterrent to smart growth. Pragmatically, planners often try to encourage smart growth through their zoning codes by increasing density to promote compact new development or redevelopment of existing cores, limiting suburban sprawl, and encouraging transit-oriented development (*8*). As cities look to implement these strategies to meet their planning goals—such as carbon footprint reduction, transportation equity, and supporting compact, sustainable development—the current off-street parking regulations based largely on the ITE *Parking Generation* report present barriers. The oversupply of parking is of "particular concern for smart growth development in urban areas where the existing parking infrastructure can be better utilized and parking alternatives, such as increased use of public transit, can be more readily implemented" (*9*). Parking policies that favor automobile access and automobile-oriented land use planning discourage transit use (*10*). Not only will residents with ample free parking use transit less, but the resulting auto-friendly urban form will make transit service provision more difficult. It creates longer distances to travel between different land uses and reduces the transit ridership catchment area, making transit less efficient to operate. Requiring parking minimums that do not recognize the different types of urban development creates a barrier to smart growth. Generally, developers will target their new residential developments outside of dense urban areas because the land outside of these urban centers is more available and less expensive.

## METHODS

A combination of parking utilization counts and geographic information system (GIS) analysis at the FHCH and Redmond urban centers was used to compare and contrast parking demand of multifamily apartment buildings and transit level-of-service characteristics.

### Site Selection

FHCH and Redmond were chosen because they represent two distinct types of development and different levels of transit service. FHCH is an urban area close to downtown Seattle that has a high population density and robust transit service (Figure 1). Redmond is a growing suburban area about 15 mi east of Seattle with a lower population density and less transit service, focused mainly on peak hour commuter service.

To assess parking demand, eight apartment buildings (four in each urban center) were selected to conduct parking utilization counts. The sites were chosen using the King County Assessor's database for apartment complexes (*11*). First, the database was limited to buildings that had at least 40 dwelling units and were built since 1990. This filtering eliminated small apartments that do not have a big impact from the high capital costs of excessive parking requirements and to narrow the sites to developments subject to relatively recent parking requirements. Property managers at each development site were contacted in March 2010 to gain permission to use their site for this research. The final study sites were chosen based on property managers' willingness to participate in the study and if the property was at least 85% occupied. This filter helps standardize the parking demand calculations and conforms to the ITE methodology for conducting parking demand observations (*3*).

### Parking Demand

To assess parking demand at each apartment building, one parking utilization count was conducted for each study site. The methodology for conducting the counts was modeled after the ITE parking demand observations used to support the *Parking Generation* report (*3*). Parking demand is defined as the "accumulation of vehicles parking at a given site at any associated point in time. . . . This value should be the highest observed number of vehicles within the hour of observation" (*3*). Parking counts were completed during midweek days (Tuesday through Thursday) in March and April of 2010 at the peak parking demand hours for residential land uses (i.e., from 12:00 to 5:00 a.m.) (*3*). The parking utilization count consisted of counting the number of parked cars in the residential portion of the parking garage or lot at the time of the count. Cars parked in visitor- or retail-designated parking spaces were excluded. To ensure that cars in visitor or retail spaces were not spillovers from residential tenants, the vehicles were checked for each property's residential parking permit.

With the data collected from these parking utilization counts, a peak period parking demand calculation was completed for each site and then averaged for each urban center. The methodology for calculating peak period parking demand follows ITE methodology and is defined as number of vehicles parked divided by number of occupied dwelling units. A weighted average parking demand ratio for each urban center was calculated by dividing the sum of all vehicles parked in one urban center by the sum of all occupied dwelling units in that same urban center.

The accuracy of an alternative method to collect parking demand information was explored. Parking demand calculations were compared with database queries from the DOL database for registered vehicles in King County. To count the number of registered vehicles at each site, the database was queried by the address of each apartment complex and the total number of registered vehicles at each site was counted. To assess the accuracy of this method, a regression analysis was conducted for the DOL vehicle counts against the observed vehicles counted at a 95% confidence level.

### Transit Level-of-Service Analysis

Indicators to measure the different levels of transit service were developed. There are numerous indicators, as noted in TRB's *Transit*

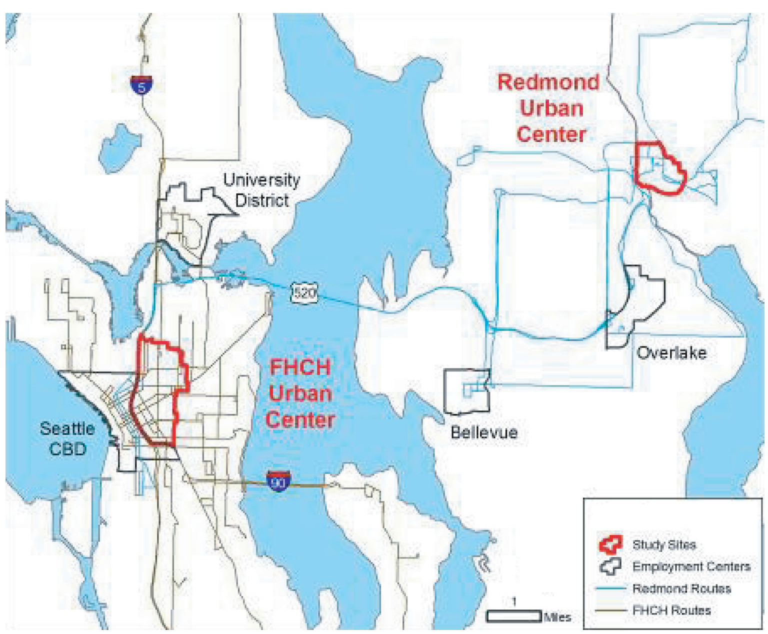


FIGURE 1 FHCH and Redmond urban center context map.

*Capacity and Quality of Service Manual*, but many of them require data not readily available, and some are not relevant because of the commonality of transit providers in each study site (*12*).

### *Geographic Frequency*

Geographic frequency measures the residential walking accessibility to transit stops with different transit frequency levels. This metric is determined by using GIS to calculate the percentage of the population in each urban center that is located within frequent transit service, or service that operates at 15-min headways, during the weekday afternoon peak. The routes with direct service from each urban center to each employment center were considered, excluding transfers. Four major employment centers, downtown Seattle, the University District, downtown Bellevue, and Overlake, were used to analyze geographic frequency to ensure a geographically diverse sample of transit service access. They were chosen because they are the largest employment centers and they have a geographic distribution in both east and west King County, similar to the geographic distribution of FHCH and Redmond. The final metric includes the average of residential access to frequent transit service to each of the four employment centers.

GIS application was used to capture the percentage of population living within frequent transit service, that is, a quarter-mile buffer around transit stops that contains frequent transit service. The buffer was applied because on average, 75% to 80% of North American transit passengers walk one-quarter mile or less to bus stops (*12*). Each buffer was then overlaid on U.S. Census blocks to calculate the total population within a quarter-mile of frequent service. Census blocks were considered only if the centroid (the geometric center of a feature) of the block fell inside the buffer.

### *Geographic Span*

Geographic span measures the residential walking accessibility to transit stops with weekday service that operates 16 h or more. The GIS analysis from the geographic frequency indicator was used to calculate the geographic span indicator (percentage of residents with walking accessibility to transit stops). All transit stops with all-day service were included regardless of the destination they served instead of using the average of the four employment center destinations.

### *Weighted Travel Time*

This indicator shows the extra door-to-door travel time spent on transit compared with automobile travel time. Travel times were calculated from each urban center to the four major employment centers used for the geographic frequency indicator. Travel time for both transit and automobiles used the Google Maps directions tool with the addresses nearest to the centroid of each urban center (*13*). A trip starting at 8:00 a.m. on a Wednesday was used for each sample trip to simulate the midweek morning peak hour commute trip. The travel times include time spent in traffic. Travel time for transit includes the total travel time from one's origin to destination as reported by Google Maps, which counts the walking and waiting time at transit stops. All travel times were weighted by the ratio of employment in each urban center to total employment to simulate the relative proportion of trips traveling to the various destinations. The final metric equals the average extra time spent on transit from each urban center to the four employment centers.

### *Reliability*

King County Metro's automatic vehicle location system was used to measure transit reliability as the average of on-time performance (actual arrival time at a destination versus scheduled arrival time) for bus routes at selected time points in both urban centers. To calculate the average, the absolute value of each sample was used. Automatic vehicle location data were collected between February 23 and May 18, 2009. Depending on the specific time point, a range of 100 to 500 samples was analyzed.

## RESULTS

### Parking Demand

The results show that parking demand is lower than the amount supplied in both urban centers, a finding which suggests that parking is overbuilt (Table 1). The samples sites are represented by identification codes because of confidentiality agreements. FHCH buildings are designated as FH1 to FH4, and Redmond, RD1 to RD4. The weighted average parking demand in FHCH is 0.52 vehicle per dwelling unit and the parking supply ratio is 0.74, showing a 0.21 vehicle per dwelling unit oversupply of parking. The weighted

**TABLE 1 Parking Supply and Demand Compared with Parking Regulations**

| | First Hill–Capitol Hill | | | | Redmond | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | FH1 | FH2 | FH3 | FH4 | RD1 | RD2 | RD3 | RD4 |
| Year built | 2003 | 2008 | 2006 | 2005 | 1990 | 1999 | 1999 | 2004 |
| Building size (total number of residential units) | 59 | 81 | 220 | 49 | 222 | 60 | 64 | 60 |
| Parking regulation (minimum spaces per dwelling unit, unless noted otherwise) | 1.15 | n/a[a] | 0.5 | 0.33 – 1[b] | 1+ – 2.25[c] | | | |
| Parking demand (vehicles per dwelling unit) | 0.82 | 0.76 | 0.40 | 0.33 | 1.12 | 1.01 | 1.08 | 1.05 |
| Parking supply (spaces per dwelling unit) | 1.17 | 0.81 | 0.65 | 0.49 | 1.68 | 1.58 | 1.47 | 1.83 |
| Weighted average parking supply | 0.74 | | | | 1.66 | | | |
| Weighted average parking demand | 0.52 | | | | 1.08 | | | |

[a]No parking requirement; n/a = not applicable.
[b]Low-income project requirement: 0.33 space for each dwelling unit with two or fewer bedrooms, and one space for each dwelling unit with three or more bedrooms.
[c]One space per dwelling unit minimum and 2.25 spaces per dwelling unit maximum. 1+ indicates that one additional guest space per four units is also required.

average parking demand in Redmond is 1.08 vehicles per dwelling unit and the parking supply ratio is 1.66, showing a 0.57 vehicle per dwelling unit oversupply of parking.

The observed parking demand found in this study is less than the parking demand data presented in the ITE report in both urban centers. The ITE report finds one space per dwelling unit demanded for urban multifamily apartment buildings and 1.2 spaces per dwelling unit for suburban locations. The observed demand in FHCH (0.52) is almost half of what ITE reports. In Redmond, the observed demand (1.08) is also less than the ITE findings, but only by 0.12 space per dwelling unit less. This finding confirms ITE's acknowledgement of a suburban bias in the data published in the *Parking Generation* report.

To investigate the demand and supply imbalance, it is important to understand the parking regulations under which each apartment building was constructed. Because parking regulations often change, the legislative history of each urban center's zoning code was researched to find the applicable requirements. Table 1 gives the year each apartment building was built, the building size, and the parking requirements of the master use permit approval.

The parking requirements for FHCH are very different from those in Redmond. Redmond requires off-street parking for residential uses in its downtown district to be built within the range of at least one space and maximum 2.25 spaces per dwelling unit. In addition, Redmond requires one guest parking space per four units for projects with six or more dwelling units (*14*). In FHCH, multiple amendments to the zoning code have occurred during the time in which the sample sites were issued permits. Before 2005, multifamily residential projects without low-income housing were required to provide from 1.1 to 1.5 spaces per dwelling unit depending on the size and number of bedrooms in the project. Low-income housing projects were required to provide from 0.33 to 1.0 space per dwelling unit depending on the size and number of bedrooms in the project (*15*). In May 2005, the zoning code for multifamily projects in FHCH was amended to require a minimum of 0.5 space per dwelling unit in the First Hill Urban Center Village and 1.0 space per dwelling unit in the Capitol Hill Urban Center Village (*16*) (Urban Village is a planning area designation used by Seattle). After December 2006, parking requirements were removed for multifamily residential projects in all urban centers in the City of Seattle, including FHCH (*17*).

The observed weighted average parking demand found in Redmond (1.08) is on the low end of the parking range of 1 to 2.25 required by the zoning code. Although developers built at an average of 1.66 in the sampled projects, the demand remains much lower than the supply. This finding indicates that Redmond's required parking maximum of 2.25 could be lowered to more closely meet the demand. Even the largest parking supply provided in the Redmond sample, RD4's 1.83, is much lower than the maximum of 2.25.

The observed weighted average parking demand in FHCH (0.52) is also on the lower end of the range required by the existing zoning codes (0.33 to 1.15) of the sampled projects. FH4 is a low-income housing project, which is assumed to affect the weighted average parking demand for the FHCH urban center.

The two urban centers in this study exhibit different characteristics that could influence parking demand. Table 2 describes the urban context and demographic makeup of each urban center. FHCH is more urban than Redmond, with higher population and employment density, small blocks producing a highly connected street network, and a more even mix of land uses. Although both urban centers have similar rental rates and household sizes, households in FHCH earn about half the income of those in Redmond. These factors are likely to influence transportation choices, such as mode split and vehicle ownership. FHCH has about half the drive-alone and vehicle ownership rates of Redmond, which is not only consistent with the urban form and demographic data presented, but is also consistent with the observed parking demand results found in this study. Finally, all of these factors are likely to influence household costs for housing and transportation, as reported by the Center for Neighborhood Technology (*20*). Residents in FHCH, who benefit from higher transit service, spend about 20% less of their income on housing and transportation combined compared with Redmond.

**TABLE 2 Study Area Urban Context and Demographic Information (*18–20*)**

| Datum | FHCH | Redmond |
|---|---|---|
| Persons per square mile | 23,293 | 3,119 |
| Housing units per gross acre | 24 | 2.8 |
| Employees per gross acre | 39 | 12.4 |
| Average block size (gross acres) | 2.1 | 9.0 |
| Average parcel size (net acres) | 0.28 | 0.75 |
| Intersection density (intersections per acre) | 0.39 | 0.12 |
| Land uses (percentage of urban center) | | |
| Commercial | 13 | 39 |
| Residential | 22 | 13 |
| Parks and open space | 0.4 | 3 |
| Other | 65 | 45 |
| Car ownership (vehicles per household) | 0.71 | 1.37 |
| Median household income (1999 dollars) | 31,865 | 67,270 |
| Average household size (persons) | 1.34 | 1.24 |
| Population living in rental units (%) | 66.3 | 72.1 |
| Household income spent on housing (%) | 17.8 | 30.5 |
| Household income spent on transportation (%) | 16.2 | 19.8 |
| Household income spent on housing and transportation (%) | 34 | 50.3 |
| Mode split (journey to work) (%) | | |
| Drive alone | 30 | 77 |
| Rideshare | 6 | 8 |
| Transit | 26 | 8 |
| Bicycle | 3 | 0 |
| Walk | 30 | 5 |
| Other | 5 | 2 |

## Alternative Parking Demand Methodology Analysis

The DOL registered vehicle database counts ranged from 40 vehicles below the observed counts to 25 above, with an average difference of −4.88 for all sites. Although this analysis suffers from a small sample size and a large standard deviation, the DOL registered vehicle method has a strong association with the field-observed method. Using regression analysis, the eight study sites exhibit an $r^2$ value of .92. This indicates that 92% of the field observation counts can be explained by the DOL registered vehicle count. However, the large standard deviation shows that further investigation is necessary to determine whether the DOL data can be used as a proxy.

### Transit Level of Service

The result of the transit level-of-service indicator analysis shows a clear difference in the type of transit service available to residents in each urban center (Table 3). Transit service is more accessible and frequent in FHCH: 52% of residents have access to frequent service compared with 30% in Redmond. Residents have similar walking access to all-day transit service in each urban center, but residents in FHCH benefit from 70% of all their transit service operating all day, compared with 46% in Redmond. Interestingly, on average travel from Redmond to major employment centers is a half minute faster in transit compared with the automobile; from FHCH transit to major employment centers is 2 min slower than by automobile. This finding is likely a result of Redmond's geographic location at the end of a highway with intense congestion at peak hours. The transit service uses high-occupancy vehicle lanes and has an advantage over automobile traffic. Transit travel times from FHCH to major employment centers take an average of 8 min less compared with Redmond. Finally, transit service is generally more reliable in FHCH, with better on-time performance.

FHCH scores better when alternative components of each metric are explored. For example, although 100% of residents in both urban centers are within walking distance of all-day transit service, 24% more of FHCH transit routes operate all day than in Redmond. This difference is mostly the result of the high demand for transit use during off-peak hours in FHCH, where many residents do not own or use a car. The urban centers had similar differences between average transit and automobile travel times, but transit trips from FHCH to major employment centers take 8 min less than from Redmond. The difference in transit travel times is mostly related to the central location of FHCH and its proximity to both downtown Seattle and the University District, home to a large student body at the University of Washington.

## LIMITATIONS

A few limitations exist in this study. First, the parking demand estimates are based on a small sample size because of limited time and difficulties in gaining permission from property managers to conduct the research. Often times property owners were either unresponsive to research requests or were concerned about security issues during the early hours needed to complete the data collection. In a similar study investigating ITE trip generation rates, Daisa and Parker also encountered difficulty in engaging property managers (*21*). Their study suggests that future research efforts should be strategic when seeking permission from properties, including partnering with organizations that understand the benefits of the research and are willing to promote it to their constituents, associates, and peers, such as professional or industry organizations (*21*). Although ITE often reports parking demand figures based on a small sample size, it is important to collect parking demand information from additional sites to ensure statistically significant findings, especially when information is aggregated at the urban center scale or larger. The findings from the DOL analysis also suffer from a small sample size and should be expanded to better understand the use of this alternative method. Second, although urban context and demographic factors are mentioned in the discussion, this study mainly focuses on the relationship of transit level of service with residential parking demand. Local government and other interested parties should allocate more resources to conduct more empirical research on parking and its relationship between land use, demographics, and other transportation characteristics.

**TABLE 3 Transit Level-of-Service Indicator Results**

| Indicator | FHCH | Redmond |
|---|---|---|
| Geographic frequency (%) | 52 | 30 |
| Geographic span (%) | 100 | 100 |
| Travel time (additional minutes spent on transit compared to automobile travel) | 2 | –0.5 |
| Reliability (minutes transit arrived after scheduled arrival time) | 2.58 | 3.67 |

## CONCLUSIONS

For decades the belief of residential parking practice was that a generous supply of off-street parking would help to reduce traffic congestion and limit spillover of parking into surrounding neighborhoods. However, the requirements that many cities place on developers to build an excess parking supply encourages automobile use, increases development costs, decreases housing affordability, consumes more land and natural resources, increases air and water pollution, and prohibits smart growth. As planners better understand the relationships between parking, transportation choices, land use, and environmental impacts, it is important to evaluate how parking policies can be modified to achieve the optimal balance of off-street parking.

A hypothesis of this study is that greater levels of transit service will yield a lower parking demand for multifamily residential developments in urban centers. The combination of mixed-use development, shorter distances to many destinations, higher jobs-to-housing balance, and more frequent and diverse transit services may provide people with viable alternatives to owning or driving a car. Such a shift would result in less demand for residential parking spaces than the isolated, single-use suburban environment used by the ITE report. FHCH has half the parking demand of Redmond and a higher level of transit service, performing better on at least two of the transit level-of-service indicators.

Since transit level of service was not quantified in aggregate, the relationship between the two variables cannot be measured. Additionally, none of the individual indicators for transit level of service exhibit a difference between the two urban centers to the same magnitude that parking demand did, which was less than half in FHCH. Geographic frequency scored 22% better and reliability scored 30% better in FHCH. These figures illuminate that transit level of service is not the only factor influencing parking demand. As depicted in the urban context and demographic information for each urban center, the characteristics of FHCH (e.g., population and employment densities, block size, land use mix, and household income) are also likely to contribute to lower parking demand. Further complicating this analysis, many of these characteristics often support the decision to provide additional transit service in an area like FHCH. Considering the reciprocal nature between transit service and these additional factors that affect parking demand, further research is needed to better understand the variables influencing parking demand in urban centers. Future research could provide valuable information for planners looking to increase mobility in urban areas while improving affordability.

Parking policies were reviewed in each urban center to assess their ability to meet the observed parking demand. In FHCH, all parking requirements have been removed, leaving the parking supply decisions entirely up to developers. This market-oriented policy is supported by many academics because it tends to result in a supply that is closer to the actual demand of the targeted tenants and can reduce the amount of parking oversupply (*1, 9*). The effect of having no parking requirements in FHCH is still to be determined, but it is anticipated that the parking supply will be close to the observed parking demand ratio of 0.5. Often the actions of developers (or their lenders) are risk averse after a regulation change, even if the new regulations provide more opportunity for development. Developers may not want to build the first property in the neighborhood with low parking capacity, fearing a future shift in parking demand. Providing up-to-date context-sensitive information on parking demand will help developers understand their market and provide a parking supply that not only meets demand but also promotes the use of alternative forms of transportation.

In Redmond, the average parking supply rate is much larger than the minimum requirement, at 1.66. Redmond has an opportunity to adjust its parking requirement to meet demand by lowering either the parking minimum or maximum. In addition to reducing the minimum parking requirement ratio, both urban centers should implement additional reductions to the required parking in their zoning codes. For example, cities offer reductions to required parking when developers build near frequent transit service, implement carsharing programs, adopt transportation management programs, design for pedestrian and bicycle access, and share parking between land uses that have different peak period demands. In addition, both cities could benefit from requiring parking costs to be unbundled from the cost of residential parking, allowing residents to rent as many parking spaces as they choose for a cost separate from their rent (*22*).

Parking policy has a key role to play in facilitating a shift away from auto-oriented communities to ones that are conducive to alternative transportation options, like transit use. FHCH and Redmond provide an important example of the complexities involved with managing off-street parking supply. Since every community is unique, it is critical for planners and developers to have access to up-to-date information on parking demand. When planners and developers better understand parking demand and its relationship to transit level of service, among other variables, they can make more informed decisions about shaping development that improves the quality of life and enhances the vitality of its communities.

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