

Patterns of Demand

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TRANSFORMING CITY BUS SERVICES



Indicators of Public Transport Demand in Residential Areas

Chapter 2 of this report observed some geometric facts about how and where public transport can provide useful service to many people, efficiently. This chapter looks at Dublin's development pattern and demographics in greater detail.

Residential Population Density

As we observed previously, density determines how many people or jobs are within walking distance of any public transport stop. As a result, density is the most critical first-order measure of patronage potential.

The adjacent map of residential population density shows the number of people per square kilometre residing in different parts of Dublin¹. It is based on the Census Small Area data, projected to expected population in 2018. All other things being equal, the higher the number, the higher the likely demand for public transport.

Note that maps such as this one are sometimes distorted by the shapes and patterns of zones used in the Census Small Area data. For example, if a dense area happens to share a zone with a low-density or empty area, the high-density area may not appear because we see only the average area of the entire zone. This is an important caution in interpreting all of these demographic maps. Figure 40: Map of residential population density in Dublin (2018 projection) by Census Small Area.



¹ Due to space constraints, the demographic maps in this chapter focus specifically on the area bounded by the Airport to the north, Shankill to the south, Lucan to the west, and the Howth peninsula to the east. This covers the vast majority of the population and jobs in the Dublin metropolitan area, but not its totality. However, in designing the proposed network, we considered the demographics of all areas served by the public bus network beyond this map extent.

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Density of Households with No Vehicles

People with less access to a private car are less likely to rely on a private car for their daily travels, and more likely to rely on public transport.

This is true of anyone living in a household with fewer vehicles than adults, but even more so in households that own no vehicles at all.

The adjacent map shows the density of those with the least access to a car. Although there is clearly a higher concentration of such households in and near the city centre, certain suburban areas also figure prominently such as Ballymun, Finglas, Ballyfermot, and parts of Tallaght and Dun Laoghaire.

Figure 41: Map of density of households without a car (2011) by Census Small Area.



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Household Deprivation Index

The adjacent map shows a measure of average level of deprivation in different parts of Dublin, or the degree to which poverty is present.

Unlike the other maps in this chapter, this data is available to us as a rate, rather than a density. Zones that show up here as having high deprivation may have few people, so the effect may be exaggerated.

Deprivation is at best a marginal indicator of public transport demand, with significantly less power to predict patronage than other factors presented in this report. However, deprivation does suggest areas where public transport service is more important in meeting people's basic needs.

In suburban areas, deprivation is correlated with relatively low vehicle ownership (e.g. Ballymun, Darndale, Jobstown, parts of Finglas). This is less the case in areas that are more central, dense and walkable, where people of many levels of income and wealth choose not to own a car.





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Density of Public Transport Commuters

This map shows the density of persons who indicated that they commute to work by public transport in response to Census 2011.

Although existing commute behaviour can be a good indicator of demand for public transport service, this data should not be construed as an absolute measurement of public transport use, for a variety of reasons:

- This map shows only the home end of work commute trips: the commuters captured by this data are all headed to work somewhere else, and will also generate demand there.
- The journey to work is only one of the average person's daily trips, and not everyone takes this trip. Commute-related trips may be as few as 20% of total trips.
- Many people combine their commute with a variety of different purposes such as shopping, appointments, socializing, school, and many others. Public transport can be useful for all of these.
- Existing public transport riders are people for whom the existing network works well. There may be others for whom public transport could be a viable option if the network were different.

Figure 43: Map of the density of commuters using public transport by Census Small Area (2011).



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Where there are more people, there is higher demand – Part 1

Figure 44: Comparing the four maps presented shows us that sheer residential density is the strongest indicator of the density of public transport commuters in Dublin. In other words, how many people there are near a bus stop matters more than the details of their situations.















Identifying Regional Centres of Demand

Employment and Student Enrolment Density

The measures we have examined so far focus on the location of people's residences.

From a transport perspective, this means we have only examined the beginning and end of everyone's day. To understand what is happening in the middle of the day, it is useful to map the density of jobs and student enrolment, as we have done in the adjacent map.

This map shows that locations of employment and student enrolment are much more geographically concentrated than people's residences.

The greatest concentration of employment by far is found in the city centre. Nonetheless, there are strong suburban centres at Dun Laoghaire, Sandyford, Dundrum, Tallaght, and (beyond this map) at Dublin Airport and Swords.

Concentrations of students identify all the major universities throughout the Dublin area, but especially Trinity College, University College Dublin (UCD), Dublin City University (DCU), and (beyond this map) Maynooth University².

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Figure 45: Map of the density of jobs and student enrolment (2018 projection) by Census Small Area.

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² Note that the consolidation of several TU Dublin (formerly the Dublin Institute of Technology) campuses at Grangegorman may not be fully reflected in these data.

Combined Activity Density

The adjacent map combines residential, employment, and student enrolment densities to approximate the total effect of all densities in representing potential demand for public transport.

Because they are so much more concentrated than residences, centres of employment and student enrolment dominate this map.

Note that employment density is also a proxy for many non-commute trips. Retail jobs, for example, also imply customers.

In the end, public transport is useful because it connects places where people live to places where people do other activities. So while residential density is less prominent in this image, it remains a critical element of the best public transport markets.



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Observed Demand – Weekday Boardings on Public Transport

The adjacent map shows observed average 2016 weekday patronage at every public transport stop in Dublin, including locations served by Dublin Bus, Luas, DART and Commuter Rail.

Larger dots on this map are indicative of location where more people board buses and trains. The highest boarding locations tend to be in the City Centre, near major universities (UCD, DCU), and at DART and Luas (especially Green Line) stops.

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Observed Demand – Bus Patronage Heatmap

The map on the previous page, showing bus boardings by exact location, is useful for detailed planning but not ideal for seeing a bigger picture.

To show the patterns of patronage more vividly, and remove distractions arising from the number and scale of stop-bystop dots, we can show the same data as a heatmap, as in the adjacent map

Heatmaps aggregate stop-level data by showing the number of boardings in each unit of area. As a result, the larger geographical patterns of patronage become clear. The heatmap also enables us to make a direct comparison between observed demand and combined activity density, as is done on the following page.

This map also shows the routes of the existing bus network according to their typical frequencies in the middle of the day. The data show the extent to which existing patronage is driven both by frequency of service and density of demand.

Figure 48: Map comparing the density of bus boardings to the level of public transit service available.

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Where there are more people, there is higher demand – Part 2

Comparing the activity density map to the bus boardings heatmap shows that the patterns of observed demand for bus services are very close to the patterns of demand suggested by density.

Note that the heatmap does not show patronage on the DART and Luas routes. This explains why certain major public transport boarding locations and known suburban centres around those corridors do not show up on the patronage heatmap, e.g. at Sandyford and Dundrum.

In general, though, the disparities between the two maps illustrate problems of linearity in the development pattern.

For example, Dublin City University's main campus generates patronage mostly 700m to the west of Ballymun Road. This reflects the fact that the campus faces onto an orbital road (Collins Ave) rather than a radial one, and the current service design does not emphasise frequent orbital service. As a result, the most frequent services, which are logically following linear radial corridors, skirt the far edges of the campus instead of passing the main gate.

Beaumont Hospital is a dramatic example of a major destination where public transport service is hampered by extremely poor \geq permeability. Serving this location requires threading circuitous roads, and it is relatively isolated from other centres of demand. As a result, Beaumont Hospital has only medium-frequency services, and patronage is lower than the site's high employment Odensity would suggest.

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On weekdays, service is proportional to patronage

In Dublin, as in many cities, public transport patronage is strongest during the morning peak, when the school and work commutes occur simultaneously. Patronage then drops in the middle of the day, before rising again in mid-afternoon when schools let out.

The afternoon peak is both less intense and longer than the morning peak, as people leave schools, universities and work at different times, and then spend the afternoon and evening embarking on multiple trips to socialize, complete various errands, and return home.

This pattern expresses itself very clearly in daily patronage on Dublin Bus, as is shown in the chart below to the left. The charts below to the middle and right show that this pattern of peaking holds largely true on Luas and DART/Commuter Rail as well.

Although the pattern of peaks and troughs in demand throughout the day is not unique to Dublin, the intensity of both the morning and evening peaks is notable. The chart to the right shows us that existing Dublin Bus services ramp up considerably during these peaks to meet demand. Because peak-only service is expensive to provide, the service peak does not fully match the boardings peak.

Figure 51: Chart of average daily patronage by hour for

Dublin Bus (2016)

Dublin Bus Patronage & Service Level Hourly Level vs. Daily Average 150% Patronage 100% nour 50% age aver 0% 4 AM **8** AM 12 AM daily PM to -50% -100% -150%

Figure 52: Chart of average daily patronage by hour on the Luas lines (2016)

Figure 53: Chart of average daily patronage by hour on DART and commuter rail (2016)

5,000

6 AM

4 AM

On weekends, levels of patronage may be suppressed by low service

In the existing bus network, weekday patronage is higher than Saturday patronage, which is much higher than Sunday patronage.

On the surface, this could appear to be lower demand reflected in lower service quantity. As of late 2016, Dublin Bus operated approximately 11,000 vehicle hours on weekdays, but only 7,400 vehicle hours on Saturdays, and 4,500 vehicle hours on Sundays. This number has since increased, but the proportion of weekday to weekend hours remains similar.

Higher levels of service typically generate higher productivity in terms of boardings per hour. In this case, **system productivity** is similar on Saturdays and on Sundays as it is on weekdays, despite much lower levels of service. Some routes even have distinctly higher productivity on weekends.

While this is not decisive, this finding is consistent with the idea that there might be some suppressed demand on weekends. Over recent decades, the level of activity on weekends has increased considerably, so existing service may reflect vestiges of out of date assumptions about weekend demand.

Figure 56: These maps compare the routes offering frequent service (every 15 minute or better) on the weekdays vs. Sundays, as of late 2016. The smaller number of frequent routes on Sunday reflects lower service overall. Service increases in 2017 and 2018 have increased frequencies, but the weekday vs. weekend contrast remains.

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Dublin Area Bus Network Redesign Revised Proposal - October 2019

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