

Public transport deprivation in County Limerick and the development of an effective rural public transport network

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ABSTRACT: This study examines public transport in Co. Limerick by analysing the quality of public transport service offered in each census settlement in the county to identify any transport deprivation and opportunities for improvement. A number of metrics are proposed to benchmark the level of provision of public transport services in a rural context, and how this provision aligns with car ownership rates. A proposed bus network and timetable is outlined that would give an ‘every village, every hour’ service to every census settlement in Co. Limerick.

KEY WORDS: CERI/ITRN 2022; Rural Public Transport; Network Design.

1 INTRODUCTION

The availability of public transport in rural areas can have a profound effect on economic participation and quality of life for individuals, as well as impacting the wider issues of sustainability and climate change, yet has received comparatively less attention in the literature compared with urban contexts. To address this lack, this study investigates access to public transport in settlements in Co. Limerick in the Mid-West of Ireland.

The local government area of Limerick city and county has a population of 194,899 (2016 census), with the majority living in Limerick city (population 94,192) in the east of the county. Newcastle West is the largest town (population 6,619), 42 km to the west of the city on the N21. There are 10 towns with populations from 1,000 to 3,000, 13 settlements of 500 to 1000, and 21 settlements with population under 500. Excluding the city, there are 14 settlements where more than 20% of households own no car. There are no rail connections west of the city. The terrain is mostly flat or rolling hills, with most settlements easily accessible by road, with some higher land on the county boundaries. The city and county councils merged in 2014, bringing challenges and opportunities for management of the county as a whole.

The existing public transport is examined and metrics devised and applied to provide a quantitative measure of the level of service of the public transport network. A public transport network for Co. Limerick is proposed that would provide an improved level of service, based on the principles of interchange, serving every settlement, every hour. The proposed network and timetable are evaluated for quality of service.

2 LITERATURE REVIEW

Compared with urban contexts, rural public transport has received comparatively less focus in the international literature. Hansson *et al.* [1] found that there is a lack of focus on regional transport in the literature. In a review of 7,968 public transport research papers published between 2009 and 2013, it was noted that the keywords “regional”, “rural” or “interurban” did not

appear once in the top 59 keywords, nor did any of those 59 top keywords relate to regional public transport [1].

The challenges of providing good public transport in rural areas has been noted, for example “the question of access to bus services can be most problematical in rural areas where demand density tends to be lowest” [2]. Despite the greater challenge of providing good public transport, there is also evidence that the lack of public transport has a greater effect in rural areas [3].

Petersen [4] outlines how a network planning approach based on pulse timetabling and an integrated approach is implemented in rural areas Switzerland. He notes that “pulse timetable-based approach can deliver a viable, high-quality, fixed public transport network in a region with very low population densities”, even in an area with very low population densities and no significant urban settlements such as Lower Engadine.

Both Petersen [4] and Nielsen and Lange [5] acknowledge the contribution of Paul Mees to the development of public transport networks based on interconnection between different services, most memorably described in terms of his “Squaresville” example [6]. In this example he compares the effect of doubling service along unconnected lines with adding the same number of extra services to connect the lines instead, creating a network. While acknowledging that there may be a transfer penalty, Mees models an increase in ridership of 5.5 times with a two times increase in service provision. Although much of his research was focused on suburban areas with medium density, Mees did note that in the highly rural canton of Graubunden in Switzerland, a public transport network based on pulse timetabling and interconnection resulted in higher public transport ridership than most Australian or UK cities.

Although concerned mostly with public transport in urban areas, Walker [7] also notes that many of the challenges facing public transport network design are universal by nature, because they come down to geometry. He notes that whatever the population density of the areas being served, there are still fundamental questions of geometry involved that can only be

effectively answered by the use of connections between services.

Much of the research into rural public transport in Ireland has focused on the significant effect that poor public transport has on people in rural areas. This has been particularly noted for people on low incomes [8], people living with disabilities [9], and elderly people [10]. With reference to network design, it has been noted that the radial design of public transport networks in rural Ireland specifically hinders travel between smaller rural towns [9].

The main policy response to the lack of rural transport in rural areas has been to provide demand-responsive transport (DRT) through the Rural Transport Programme (now Local Link). Although this scheme has been shown to reduce car dependency where it operates [11], it is still the case that there are significant unmet transport needs in rural areas [12] even with the scheme in operation.

The appropriateness of DRT transport systems has been debated in the literature. It has been claimed that the effect of the actions of proponents of DRT is to mount a challenge to “conventional public transport” [4]. It has been noted that the aim of combating social exclusion has led to the fundamental unviability (in terms of ridership as well as operating costs): “By focussing on only providing rural services for minority groups and special groups, we have in fact put those services at a greater risk” [10].

3 METHODOLOGY

3.1 Demographic data

The demographic data of 45 out of 46 census settlements in Limerick (Limerick City was excluded) were examined according to mobility factors, including the percentage of households that do not own a car and mode share for work and education trips. The population of the settlements ranged from 144 (Tournafulla) to 6,619 (Newcastle West). The driving distance and time to Limerick City was calculated for each settlement using Google Maps.

For two census settlements in Co. Limerick, Ballyhahill and Fedamore, the census data was suppressed by the Central Statistics Office (CSO) to protect against disclosure. For these settlements, an estimation was made based on the relevant Small Area statistics surrounding the village.

3.2 Bus network

The existing timetabled bus network was examined. The number of services along each route variation was counted for Saturday, Sunday and Monday–Friday using the timetables published on each operator’s website. Each route was mapped according to Google Maps and the distance for each service run was calculated. For routes that also serve settlements in other counties, the distance was calculated to the first settlement outside Co. Limerick. The number of services per week was multiplied by the route distance to calculate the total weekly route kilometres in the network.

3.3 Level of service calculations

For each of the 45 census settlements in Limerick, the timetables of all 33 route variations were used to calculate the average number of services per day, and the journey time by bus to Limerick City. The number of bus services per 1,000

inhabitants was calculated for each settlement to further investigate if any settlements were particularly underserved by public transport. The ratio of bus journey time to driving time by private car was calculated for each settlement as a proxy for the directness of the bus service.

A set of three quality of service metrics were chosen to assess the accessibility provided by the existing public transport services.

3.3.1 Departure time to reach Limerick City by 08:40

The employment accessibility metric chosen was the time of departure to reach Limerick City by 20 minutes before 09:00 to allow onward travel to the suburbs.

3.3.2 Departure time to arrive at a hospital appointment at 14:00

University Hospital Limerick (UHL) is on the western approach to the city. Buses travelling in from the west and south along the N20 (from Cork) and N21 (from Kerry) call directly at the hospital. For other services, although the journey time from Limerick Bus Station by bus is 16 minutes, arrival at the bus station is necessary before 13:25 to make a connecting bus to reach the hospital before 14:00.

This metric was chosen to reflect accessibility of essential services.

3.3.3 Existence of a bus back from Limerick City after 18:00

A test of whether or not a settlement had a return service back from Limerick City was used as a minimal proxy for the accessibility of socialisation and further education opportunities. The only cinemas in Co. Limerick are in the city and out of 40 evening courses listed on the government’s fetchcourses.ie website, all of them are in Limerick City, therefore a service out from Limerick City is necessary to access these opportunities.

The results of the above tests were highlighted, and settlements that are particularly poorly served were highlighted by sorting by each metric.

3.4 Selection of services to define the public transport network and rationale

The following services were chosen to define the public transport network:

- Bus Éireann Public Service Obligation (PSO) services
- Bus Éireann commercial Expressway services
- Timetabled Local Link services

The following services were excluded as part of the public transport network:

- Privately owned and operated services
- DRT services operated by Local Link

3.5 The rationale for exclusion of privately owned services

Commercial services were excluded because although they are licensed by the National Transport Authority, they are not under the overall policy direction of the Minister for Transport, as is the case for Bus Éireann and Local Link.

3.6 Development of proposed network: initial steps

A set of criteria was developed to underpin the development of a proposed public transport (bus) network for Co. Limerick:

- It should serve all 45 census settlements.
- While it should focus on Co. Limerick, routes should serve villages and towns in adjacent counties where logical.
- Interchange should be used to increase route efficiency.
- Direct routes should be favoured over indirect routes.
- While the primary objective should be to link all settlements to Limerick City, a secondary objective should be to link smaller settlements to nearby larger ones, especially for settlements at a greater distance from Limerick City.
- The network should be as efficient as possible, where total route km to serve all settlements is the measure of efficiency.
- The network should be scalable to an “every village, every hour” timetable where all services run hourly.

An initial network was sketched out based on the existing public transport network in Co. Limerick, the regional road network and the initial objectives outlined above. Distances between village pairs on the route were calculated using Google Maps and travel times were calculated based on looking up car driving time on Google Maps, applying a 50% increase and rounding up.

3.7 Timetable development

Once the initial network and journey times had been constructed, timetables with a single run in both directions for all routes were developed. The objective of developing the “single run” timetables was to identify and synchronise interchange opportunities where different routes served the same settlement. Synchronisation at this stage of the process was in terms of services arriving and departing at the same “minutes past the hour”.

An iterative process of changing departure times to enable interchange was followed: as some single routes interchanged with more than one other route, a large amount of “rechecking” was needed to see how changes in the timing of one route would cascade down to affect interchange in other routes.

Different combinations of radial and orbital routes were experimented with, to improve interchange and journey time on individual routes, as well as reducing the overall route km of the network.

Once a number of iterative network development passes had been carried out, full timetables for all services were written based on the hourly timetable pattern identified, between 06:00 and 22:00, giving 16 services a day.

3.8 Reduced 2-hourly timetable

To assess the potential impact of a less significant increase in route km, the timetable was cut to a 2-hourly service, or eight services a day between 06:00 and 21:00. The reduced timetable was worked through to make sure all previous interchanges between routes were possible, and additional services were added if needed to re-establish interchanges for services to Limerick City. The reduced network was assessed again in terms of 2-hour morning commute and 14:00 hospital appointment time.

4 RESULTS

4.1 Current public transport provision in Co. Limerick

A total of 947 services a week were counted, giving a total of 12,046 km per week or 614,366 km per year. A total of 17 advertised services were analysed (14 Bus Éireann, three timetabled Local Link), with a total of 33 route variations being taken into account.

The analysis of the bus network in Co. Limerick showed that a total of nine settlements (20%) in Co. Limerick are not served by any timetabled public transport whatsoever, and a further nine are served by an average of four or fewer services in any direction per day, defined as a very low level of public transport provision. Table 1 shows the settlements in these categories together with population, percentage of households with no car, and average number of services per day.

Table 1. Settlements with no or very low timetabled public transport.

Settlement	Population	Average services/day	% households no car
Ballingarry	521	0.0	13.8%
Athea	369	0.0	24.0%
Fedamore	329	0.0	9.6%
Broadford	276	0.0	16.5%
Mountcollins	201	0.0	8.5%
Ballyagran	179	0.0	10.0%
Kilteely	171	0.0	18.8%
Ballyhahill	146	0.0	8.9%
Galbally	251	1.4	15.2%
O'Briensbridge–Montpelier	396	1.7	8.9%
Ballylanders	308	2.1	20.2%
Knocklong	256	2.1	18.9%
Doon	516	2.6	21.4%
Bruree	580	2.9	16.7%
Ardagh	266	3.0	18.4%
Kilfinane	789	3.4	18.5%

A further 17 settlements have an average of between four and 11 bus services daily and the final 11 settlements have over 11 bus services on average daily.

For each settlement, three metrics were measured: whether it is possible to depart at 07:00 or later in order to reach Limerick City at 08:40 to facilitate travel to suburban employment areas before 09:00 (less than 2 hours journey time), whether it was possible to depart 3 hours or less before a hospital appointment for UHL at 13:00, and if a service departing Limerick City after 18:00 existed. Table 2 gives the proportion of the 45 settlements in Co. Limerick that meet each of the three criteria.

Table 2. Effectiveness of existing public transport network according to selected criteria.

Metric	Percentage
Work <2 h	60%
Hospital <3 h	29%
Return >18:00	22%

4.2 Network development

The network development started by sketching out in a table the spatial distribution of settlements in Co. Limerick. From this initial draft a grid network was laid out, following the path of regional and significant tertiary roads. The initial network designed consisted of eight radial services and nine orbital services, giving all settlements a connection to Limerick City with at most one interchange. The initial network included adjacent settlements in neighbouring counties where appropriate.

The expected travel time between settlement pairs was calculated with reference to existing bus timetables. For shorter links, the journey time was calculated as 150% of the car journey time, rounded up. For longer links, a time of 10 minutes was added to the journey time by car.

Once the journey times had been calculated, a timetable was constructed for each service in each direction. Once the first route had been timetabled, the timetable for route that intersected with the original route, syncing the time of intersection. This was repeated to build out the timetable for the whole network.

To simplify the task of timetable synchronising, as the network was highly connected, a decision was made to prioritise interchanges that would allow settlements without a direct service to Limerick City to transfer to a service that served Limerick City.

After a number of iterations of shifting timetables to facilitate interchange, a number of interchanges were still not synchronised. The network was then changed to see if a change in network structure could improve interchange at certain points. The iterative process of syncing interchanges was then restarted.

4.3 Final network design and timetable

After a number of passes of timetable syncing and network redesign, a final network was produced as shown in Figures 3 and 4.

Figure 1. Geographical map of proposed network

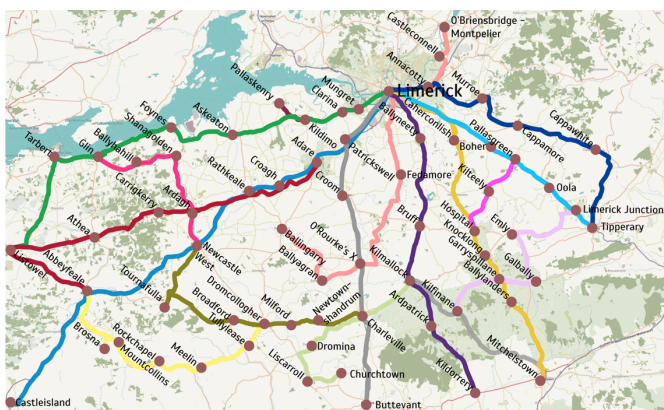
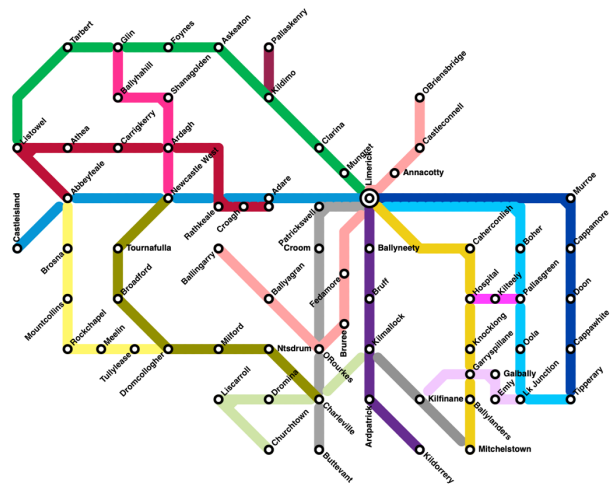


Figure 2. Symbolic map of proposed network



4.4 Hourly timetable and total route km

The new network was then analysed in terms of route km and buses needed. The route km for each hourly “pulse” is 1,156 km for the portion of the network within Co. Limerick. Based on a 7-day hourly service between 06:00 and 22:00 (16 services a day), the total route km of the network would be 129,472 km a week, which is 10.7 times the current route km of 12,046 per week.

4.5 Two-hour timetable

To investigate a less significant increase in route km, a 2-hourly timetable was modelled between 06:00 and 22:00. It was found that the timetable could shift to 2-hourly and all connections to Limerick City could be kept, apart from services on three of the 17 lines. To simplify the interchange modelling, these three services were kept at an hourly frequency and all other services were changed to eight 2-hourly services a day. This would then be 75,040 route km a week, a 6.2 times increase on current service provision.

5 ANALYSIS

5.1 Significant public transport deserts in Co. Limerick

The study identified nine settlements that can be classified as public transport deserts as they are not served by any timetabled public transport service. A particularly notable case is the village of Athea, which has the second highest rate of households without a car in Co. Limerick at 24.0%, behind only Rathkeale. It is also notable that Athea has a higher proportion of households without a car than Limerick City and suburbs. This is a significant case of transport deprivation and it is suggested that Athea be prioritised for any future public transport provision. Overall, the proportion of households with no car in this settlement classification ranged from 8% to 24%.

All of these settlements with the exception of Fedamore are in the West of Co. Limerick and all nine settlements are not on significant roads travelling through the county. While some of these settlements were straightforward to serve in a new network, a few (notably Ballyvaughan and Ballyvaughan) were a challenge to incorporate into the network and needed a comparatively circuitous service to serve them.

5.2 Transport deprivation exists in most towns

The nine settlements that had some public transport service could not be said to be well served by public transport, having between one and four services a day in any direction. The rate of households without a car ranged from 8.9% to 18.9%. None of these settlements had a service back from Limerick after 18:00, denying residents without a car the opportunity to socialise or take advantage of night classes. Only three out of the nine settlements in this category are served by a bus service that arrives by 08:40 that would be suitable for accessing many employment opportunities. Bus services to this category of settlement also have the characteristic of having a high journey time by bus compared with the private car: with settlements such as Ardagh (2.7 times) and Doon (2.6 times) particularly poorly served in this regard.

5.3 Overall level of performance provided by the network

The current public transport network in Co. Limerick plays some role in enabling people to access employment on an office timetable, with people in 60% of settlements able to get to Limerick City in time for starting work at 09:00, but it does not facilitate people who do not work 9–5, as the network only allows people in 29% of settlements to travel to a middle of the day hospital appointment within 3 hours, and only 22% of settlements have a service from Limerick City after 18:00.

5.4 Performance of proposed hourly and 2-hourly networks

The developed hourly network has the following qualities:

- All settlements have an hourly service 06:00 to 22:00.
- All settlements can reach Limerick City by 08:40.
- 91% of settlements can reach Limerick City by 08:40 by setting off after 07:00.
- 73% of settlements can reach a hospital appointment for UHL by setting off after 12:00.

Table 3 shows a summary of the effectiveness of both the proposed hourly and the proposed 2-hourly networks, together with the existing network.

Table 3. Comparison of existing and proposed networks under effectiveness metrics.

Evaluation of efficiency	Hourly	2-hourly	Existing
2-hour morning commute	91%	91%	60%
2-hour hospital appointment	73%	11%	29%
3-hour hospital appointment	100%	89%	29%
Service from Limerick after 18:00	100%	100%	22%

5.5 Journey times

The new timetable was compared to the existing timetable to see whether the time of departure for the morning work journey and the afternoon hospital appointment had improved. For the

work trip, 65% of journeys enabled a later departure time (including where journeys are not possible in the current timetable). For the hospital trip, 76% of journeys enabled a later departure time. The 35% of work journeys that would be slower is a significant dis-improvement from the current timetable. The reason for this is that the new table is optimised for interchange, which means services may depart and arrive earlier in the hour so their connections with other routes are synchronised.

5.6 Use of interchange

Out of the 45 settlements, 30 are served with direct services to Limerick City in the final network. This is a significant level of interchange in an Irish public transport context but it is much less than in earlier network designs, due to the practicalities of synchronising timetables at interchange points outlined earlier. Of the remaining 15 services requiring a transfer to reach Limerick City, nine of these transfer from and to one line.

Overall, there are 25 interchanges between different pairs of the 17 lines on the network (where three lines intersect, this will result in three line-pairs of an interchange). Of these, 12.5 of the interchanges are timed in at least one direction. That is, two buses will arrive and depart at the same time. The other 12.5 interchanges are not timed.

Because only half of the interchange points are synchronised in the timetable, the network may result in user confusion. This is potentially exacerbated by the use of a London Underground-style network map. A user may expect to be able to transfer between different services at any interchange point without having to wait

Finally, although some extra padding was put into the timetable to facilitate interchange between services, it is possible that the network will not be reliable enough to consistently offer interchange. This is a risk to the viability to the network.

6 SUMMARY AND CONCLUSIONS

Significant transport deprivation was found in Co. Limerick. Many settlements in Limerick have a high proportion (above 15%) of households with no car and some of these settlements are served by no timetabled public transport at all. The current timetabled public transport network does not serve nine census settlements at all.

Three basic metrics were developed to measure the quality of service provided by the network: the departure time to reach Limerick City for 08:40 for transfer on to suburban services for employment for a 09:00 work start time, the departure time for a hospital appointment for UHL at 14:00, and whether a service after 18:00 from Limerick City exists. Under existing timetables, 60% of settlements are served for work with a 2-hour threshold, 29% are served for the hospital trip with a 3-hour threshold, and 22% are served for a service from Limerick City after 18:00.

A public transport network and timetable was developed to serve every census settlement in Co. Limerick with an hourly bus service between 06:00 and 22:00. The network was developed from a comprehensive grid with many orbital services to a network where two thirds of settlements had a direct connection to Limerick City and one third had to make use of interchange.

The proposed network has a weekly route km of 129,472 in Co. Limerick, which is 10.7 times the current route km per week of 12,046. The proposed network would need 53 buses to operate it, not including driver breaks. It would give every census settlement in Limerick an hourly connection to Limerick City.

Using the same criteria as previously, 91% of settlements are served for work with a 2-hour threshold, 91% are served for the hospital trip with a 3-hour threshold (and 73% with a 2-hour threshold), and 100% are served for a service from Limerick City after 18:00.

The 2-hourly route km total in Co. Limerick (with three routes being kept on an hourly timetable to facilitate interchange) would be 75,040, or 6.2 times the current route km, needing 37 buses. 91% of settlements would be served for work with a 2-hour threshold, 11% are served for the hospital trip with a 3-hour threshold (and 89% with a 2-hour threshold), and 100% are served for a service from Limerick City after 18:00.

The proposed network was critically examined and it was noted that although relying on interchange brought some efficiency benefits, there may be barriers to significant modal shift on the network.

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