OSEL LTD – Transportation Organization of Nicosia District

Optimizing bus routes in urban Nicosia

The Transportation Organization of Nicosia District (OSEL) is a privately owned organization that holds an exclusive 10-year contract with the Cyprus government for providing public transportation in the City and the whole district of Nicosia. (Nicosia is the capital of Cyprus with a population of 240000.) OSEL employs around 400 people and utilizes a fleet of 300 buses.

The organization provides connections to the urban area of Nicosia and more than 104 villages across the whole district. The service is provided through 26 Urban Lines, 55 Rural Lines and 9 nighttime lines which together sum up to more than 36000 km on every weekday. On the weekends and holidays there is a reduced frequency reaching 17500 km on Saturdays and 14500 km on Sundays and holidays. Overall, OSEL covers around 11.5 million km per year. On a daily basis there are around 1600 regular routes. (1047 Urban, 566 Rural). OSEL is also performing 226 student routes per school day, carrying more than 5000 students to their schools in the morning and 7000 schools back to their homes in the afternoon.

Note: The absence of a passenger counting system or an automated ticketing system does not allow us to have an exact number of passenger rides. However, based on the ticket sales, it is estimated that more than 8 million passenger rides are provided every year.

The challenge:

The basic approach in designing bus routes is by considering data that describes the movements of people within the city, which is collected through the analysis of road traffic data. While this approach is certainly rational, it may also be necessary to take into account some additional considerations. Our current bus route network was put together using a "layman's approach" which used the older bus routes as a basis and added additional routes where it was thought to be appropriate (see the attached document "map of the bus routes"). While the current bus route network is certainly better than the one that existed in the past, it needs to be improved through the usage of a more scientific/mathematical approach, which could prove to be very beneficial especially in cases where "common sense" may be pointing in the wrong direction. Please note that this problem concerns only the 26 urban routes within the City of Nicosia. The routes that service the various villages follow a much simpler logic which is not part of the scope of this problem.

Facts:

- People in Nicosia do not like to walk too far to reach the bus stop. Preferably, they would like the bus stops to be outside their front door.

- The road network of Nicosia is not designed to support the number of private and public vehicles that are currently moving around the city. As such, there are a lot of traffic congestions mostly in junctions (with or without traffic lights). There is also a big gap in "tools" to facilitate Public Transport movement, such as bus lanes, bus priority rules, and generally an absence of mentality to help the bus from the other drivers.

- Nicosia is divided in half (due to occupation of the other half by Turkey since 1974) and the division line (border) cuts through the city center, making the city's landscape resemble a disc

cut in half. The city center is where the main bus station is, which is the final start and end point for most of the routes that extend outwards as circle radii.

- Consequently, the areas furthest from the center are served by routes which have a large distance from each other and therefore at any point the nearest bus stop can be quite far. To resolve that, the bus routes going out of the center become more wavy in order to reach more people.

Near the city center, there are several buildings that are used by hundreds of people (e.g. Ministries, public offices etc). These are main destination points for morning commuters and start points in early afternoon when they return home.

An optical way we thought in order to depict the density of people in Nicosia would be to color code the map of Nicosia (see attached) as follows, using grayscale: e.g. with black color we represent buildings with a high concentration of people (e.g. a Ministry building with 500 people), while gray or light gray areas could represent housing areas with high and low density housing developments respectively.

The question

We need to establish an approach that will help us choose the ultimate route so that it will pass very near (or through) the high density areas, but at the same time limit the time it takes to reach the destination. The outcome of this exercise could be the calculation of a "convenience factor" that correlates the effectiveness of the bus route (based on how close it gets to "areas of interest"*) in correlation with the time it takes to reach the destination. E.g. if a bus gets to a destination quickly but does not pass through areas of interest then this is no good. On the contrary, if the bus spends too much time going through densely populated areas but reaches the destination very late, then this is also not proper.

(*) "areas of interest" can be densely populated areas which can be represented on a map with gray color (the darker – the more densely). Also, for example, black dots on a map can represent large buildings with lots of people, e.g. public administration buildings, large companies etc. that have a high concentration of people. (See also above.)

An additional complexity should be considered by removing the assumption that main streets are always the best route to travel since they are wider and pass through interesting areas. It may be that main streets do not pass from interesting areas and they are commonly congested.