METHODOLOGY TO DEVELOP A FEEDER BUS NETWORK FOR A LIGHT RAIL TRANSIT SYSTEM:

A Case Study for Fort- Malabe Line

Balapuwaduge Harini Anasuya Mendis

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Degree of Master of Science

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Master's thesis under my supervision.

Name of the supervisor: G.L.D.I. De Silva

Signature of the supervisor: Date: 27/11/2021

ABSTRACT

The world is reaching towards the sustainable transportation and the public transport sector especially requires a better focus and attention. Public transport network can be better distinguished as mass transit systems and feeder systems. Mass transit systems strengthens the transport network as backbone transport systems. However, it does not enable the connection between the origins such as the residence or the work place and the mass transit access points. This connection which is a vital component is enabled by the feeder modes. There can be several variations in feeder modes. Especially it can be recognized as private feeders and public feeders. Without a proper feeder network, the maximum potential of a mass transit network may not be achieved.

In this research, the focus is on the Light-Railway transit which is the most recent mass transit system that is being introduced to Sri Lanka. As the first step of introducing the light railway system to Sri Lanka, Fort-Malabe LRT was planned to be implemented. Even though the plans by the Government have changed, in this research, Fort- Malabe LRT line is taken as the case study in order to carry out the objectives. The feeder modes that are supplying to the LRT line were recognized as private vehicle drop offs, para-transit modes and short length public transit modes.

In order to get an uninterrupted connection between the origin and the mass transit access station, the development of feeder network that will be serving the mass transit has to be parallel with the development of the mass transit system. However, the LRT orientated development also has to be limited by the necessity. In order to get a realistic estimation on the development required area, the spatial extent of access areas by different access modes have to be identified.

The spatial area where potential transit users will origin their trip to use the mass transit can be identified as the catchment area. Catchments for different feeder modes may vary depending on the distance that users prefer to travel by that particular feeder mode. Catchment areas for multiple access modes were recognized using the survey data which were available from a previously carried out survey.

In identifying catchment distances for different feeders, two methods were followed. First method was to consider each station and identify the preferred travel

distances by a certain feeder mode to reach that station and thereby calculating a weighted average catchment distance for the chosen station for that particular mode. To calculate a catchment distance value which justifiably represents all the stations for a certain feeder mode, an average value was calculated.

Second method that was carried out was to consider the LRT route aligned corridor and identify catchment distances for each feeder mode which will represent the Fort-Malabe corridor rather than each station. The individuality of stations was not considered. To identify the catchment distance for a specific feeder mode, all data records of trips originating from a catchment to reach any station by that mode were taken in to account. The frequency of access distances occurring was the basis of the second method. Therefore, the frequency of a certain access distances occurring was identified and thereby the cumulative frequency of access distances was taken. When the accumulation of frequency reached 85^{th} percent, the catchment distance at the point was taken as the catchment distance for that certain feeder.

In order to determine the geographical buffer area, two approaches were identified that can be utilized. First was the circular buffer approach which takes the Euclidean catchment distance from the LRT station locations. Aspects such as the geographical barriers and the non-availability of road network were not considered in this case. The other approach was to take the service area. In this approach the travel distance of the catchment is determined via the road network. Considering the pros and cons of two approaches and the accuracy of the results by each approach, service area approach was appointed to be used. Thereby the catchment areas were configured for the access modes. The catchment areas for each feeder type were visualized with the use of Geographical Information Systems (GIS).

In the case of the bus feeders, it was observed that the catchment area also depends on the bus route path layout. Areas which are parts of the bus catchment but does not get supplied with the bus network, can be identified separately. In this scenario, Conveyal analysis was used to identify the bus catchment which is limited by the availability of bus routes in the catchment which is bounded by the catchment distance. As per the first objective of the research, catchment area for multiple feeder modes were identified as above.

Further, it was observed, for a particular feeder mode, that there are certain areas that are not supplied by the respective feeder mode inside the catchment area which is due to the lack of road network or due to physical barriers such as water bodies. For each feeder mode type, the possibility of expanding the catchment area coverage was investigated. For walking and cycling mode it was identified that foot path implementation can expand the catchment coverage significantly. However, for the private vehicle and taxi modes, it was identified that the furthering the coverage is not practical. In the case of bus feeder, a detailed analysis on maximizing the coverage of catchment area was carried out.

For this step, two bus network design methods were identified. First method was to modify the existing bus network of regular routes in the catchment to accommodate the demand for feeder and include separate feeder routes for demand that is not covered by the regular routes.

The second design method was to implement a feeder network for the catchment, aiming to supply the full demand for the bus feeder, which will operate independent of the regular routes. In fact, aim is to dissolve the existing regular network and back the public transit completely by feeder routes and the backbone LRT transit.

The two design methods were thoroughly analyzed regarding the coverage by each and the practicality of implementation and the most suitable methods was selected. Thereby, an optimization procedure was carried out to optimize the designed bus network by methods such as route merging, breaking etc. From this procedure, an optimum route network can be identified.

Overall, this thesis contains a methodology for feeder bus network design for a LRT in Sri Lankan context, which takes the Fort- Malabe corridor as the case study sample.

DEDICATION

To My Loving Parents and Husband,

Who Kept Me Going on Through Highs and Lows

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B.H.A. Mendis
Department of Civil Engineering,
University of Moratuwa
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