Potential Feeders' Areas selection based on the Land Use Factors

Saadia TABASSUM[1], Shinji TANAKA[2] and Fumihiko NAKAMURA[3]

[1]Doctoral Student, Graduate School of Urban Innovation, Yokohama National University,
(79-5 Tokiwadai, Hodogaya-ku, Yokohama, Kanagawa 240-8501, Japan)
E-mail:saadia_tabassum@hotmail.com
[2]Member of JSCE, Professor, Graduate School of Urban Innovation, Yokohama National University,
(79-5 Tokiwadai, Hodogaya-ku, Yokohama, Kanagawa 240-8501, Japan)
E-mail:stanaka@ynu.ac.jp
[3]Member of JSCE, Professor, Graduate School of Urban Innovation, Yokohama National University,
(79-5 Tokiwadai, Hodogaya-ku, Yokohama, Kanagawa 240-8501, Japan)
E-mail:f-naka@ynu.ac.jp

This paper aims to emphasize the importance of selecting the service area to start a feeder service in order to augment a core network of a mass transit system. The provision of feeders is considered to be one of the most supporting strategies for increasing the ridership and attracting more number of commuters towards public transport. Based on the close interaction of travel activities and land use factors, this paper considers few land use factors, that are found to be more influential for the feeders' supply. The land use factors of regional accessibility, density and mix are discussed in this research. The city of Lahore (Pakistan) is taken as the study area, where towns having potential for feeders to access an existing Bus Rapid Transit (BRT) are worked out. All the relevant data that is processed and analyzed is secondary type of data. From the analysis of city's land use pattern and the trip making statistics, it is found that higher the percentage of residential type of land use in a town more is its share in trip making. Lesser trips are noted from the towns far from the city center, due to the fact that most of the land use is developed in and around the city centre. Also the Gini coefficient (G) is calculated for each town that shows the non uniform distribution trend in some densely populated areas. Therefore not only the density but other associated land use factors are also analyzed. Based on the analysis and discussion, the areas proposed to have feeders are those, locating relatively nearer to the city centre, having less G value and have a mix of commercial land use in addition to the residential.

Key Words : *feeder , land use factor, mass transit system, density, gini coefficient*

1. INTRODUCTION:

Among the several strategies to support a mass transit system, provision of an efficient feeder service to supply demand, is one of the key factors that maximize the utility of the system. In other words it is evident that the ridership of mass transit system can be substantially multiplied by increasing the accessibility (ease of reaching) to it which further extends the opportunities of access to more industrial hubs, and places of interests to more number of commuters from a remote community. Therefore it is important to determine/ evaluate areas, prone to supply more demand, in order to start a feeder service. To assess the potential areas that must be served by the feeders, several factors need to be considered. This paper aims to highlight the most feasible areas that are expected to generate maximum supply to the mass transit system based on spatial distribution of the land use factors by analyzing the impacts of such factors on the ridership.

For this research, Lahore, the second largest metropolitan city of the country (Pakistan), with more than 9 million inhabitants, is chosen as the study area. With the growing population and economy the city's transport demand is consequently increasing and reached 13.5 million daily passenger trips by all modes of transportation.

It was highly recommended in the city's master plan that the only way to effectively meet transport demand is to provide the city with a high quality public transport system which must be developed in integration with urban development. The core network will be composed of urban rail and bus transit system, whereas the secondary and feeder services will be by buses (1). Based on these recommendations, a basic system of Bus Rapid Transit (BRT) was developed

on one of the suggested corridors (in the master plan),running in the midst of the city in N-S direction, catering almost 10,000 passengers per hour per direction.

But this system is not augmented with feeders and hence offers a limited access from the E-W sides of the city. A well-designed BRT with feeder integration would yield significant impact in terms of getting people out of their cars and onto public transit. Feeder connections would not only increase BRT capacity, but also improve the accessibility of communities around BRT stations (2).

In order to provide such a service, connecting to the main system, it is required to identify the areas having potential demand. In this study the areae are selected based on the land use factors. Various landuse factors such as density, mix, connectivity and walk ability affect the transport activity and vice versa (3, 4). In context of the study area, the land use factors that are found to be most significant for feeders are:

① Regional accessibility
② Density
③ Landuse mix

These land use factors are briefly described in Table 1. (3)

2. CASE STUDY:

Lahore city is divided into nine (9) towns, with administrative divisions (union councils) and one cantonment area (Figure. 2). The corridor for BRT is situated in the heart of the city and offers direct access to a wide range of alongside industrial hubs, commercial activities and offices,if provided with feeders, which in turns presents maximum opportunities of tertiary employment, as the city's major type of employment is tertiary.

Most of the land use is found to be located in and around the centre of the city, and hence generating and attracting more number of trips than the areas spatially far from the city centre (Figure. 2). The towns producing more than 600 ('000) per day trips

1) Ravi
2) Data GB
3) Samnabad
4) Shalamar
5) Gulberg and
6) Iqbal town

are those, which are located near the central part of the city so can be considered to supply more patronage to BRT, if facilitated by a feeder service, which can be further analyzed under the land use factor of *regional accessibility* (Figure. 3).

For the study area, residential land use type is found to be the most influential in trip making, when provided with commercial. However the percentage of residential type land use diminishes as the distance from the city centre increases hence less travel activities from far side towns.

On the other hand when it comes to the other land use factor like *density*, then it is not practical to consider all of these six towns for the provision of feeders (Table. 2). The towns like Iqbal town, where the density is much less due to the larger size of the town, though producing more trips, it will not be viable to provide a feeder serving the whole town. The other way is to calculate the percent of populated land or measuring Gini coefficient and set the extent of feeder accordingly.

Density tends to receive the greatest attention, although alone its travel impacts are modest and therefore associated with other land use factors also. The situation where a feeder service is initiated for the town having, non uniform distribution of population, can result in increased in-vehicle travel time.

As the travel time is the most important form of impedance for feeder service, since service quality of

Table 1 Target land use factors

Factor	Definition
Regional accessibility	Location relative to jobs or services
Density	People, jobs or houses per unit of land area.
Mix	Proximity of different land uses

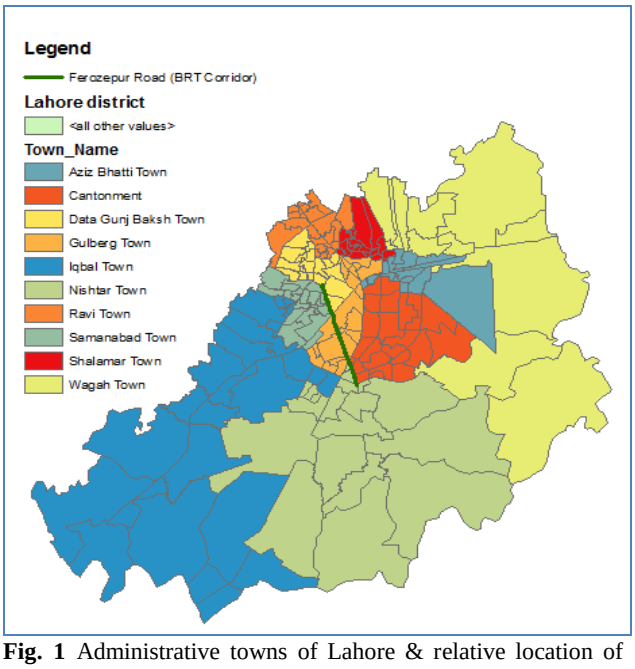

Fig. 1 Administrative towns of Lahore & relative location of BRT corridor

Table 2 Study area population by Town

Town		Area (km^2)	2010 Population (000)	Density (persons/ ha)
1	***Ravi***	31	1007	328
2	***Samnabad***	38	984	262
3	***Data GB***	31	970	317
4	***Iqbal***	520	960	18
5	Nishter	497	945	19
6	***Shalamar***	24	854	350
7	***Gulberg***	44	778	178
8	AzizB	69	667	97
9	Wagah	440	656	15
10	Cantt	98	831	85

transit is directly dependent on the in vehicle travel time of the passengers (4).

Therefore distribution of population within each town is also measured using Gini coefficient (Eq. 1)

$$G = \frac{1}{n}\left[n + 1 - 2\frac{\sum_{i=1}^{n}(n+1-i)y_i}{\sum_{i=1}^{n} y_i}\right] \qquad (1)$$

Where n = number of zone and y = density

A comparative analysis of Gini coefficient (G) for each town is carried out (Figure 4). Measuring the inequality in this way explains the fact that why some towns appear to be less dense even though

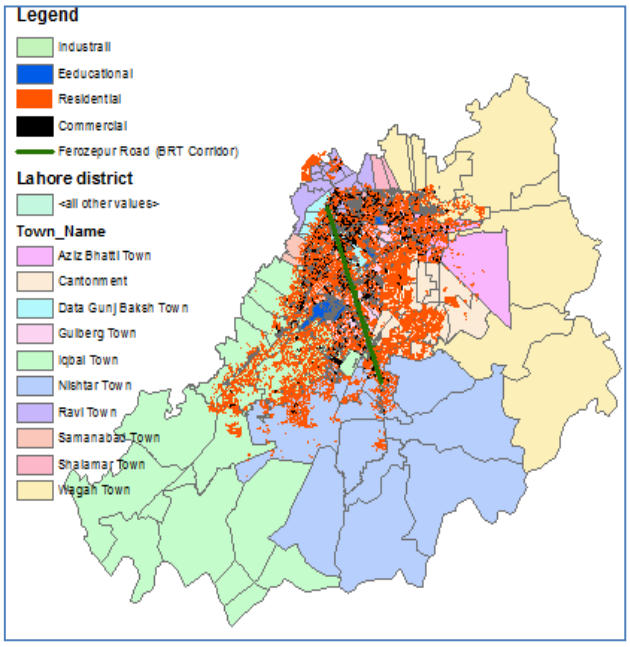

Fig. 2 City's Land Use Pattern

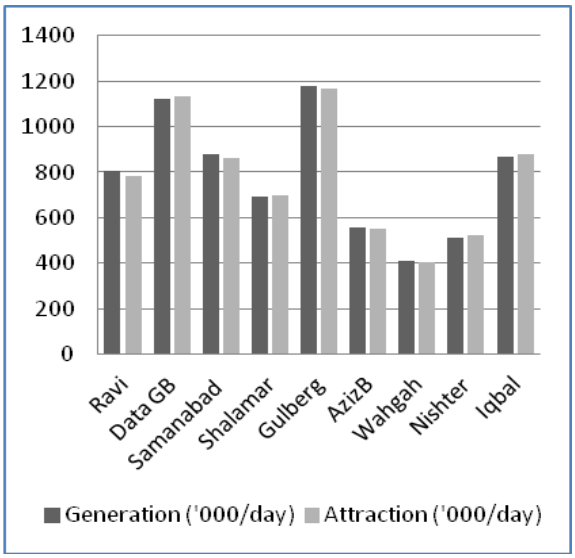

Fig. 3 Trip Generations/ Attraction by Town

their population density is high. Higher value of G represents greater variation in population density. The towns receiving high G value have less potential for feeder due to the non uniform distribution of population. It is observed that the towns far from the city center tend to have higher value of G.

Data GB, Gulberg, Samnabad and Ravi towns are having less G value owing relatively uniform distribution of population within the town. Therefore not only the density but the non uniform distribution of population within a town can greatly affect the decision of providing feeders and setting the location of one high demand corridor in a town.

Under the other land use factor of Mix, towns of Gulberg, Data GB,and Smanabad offer a well mix of residential and commercial land use types. A strong impact of land use type is observed when compared with the other towns that are producing lesser trips.

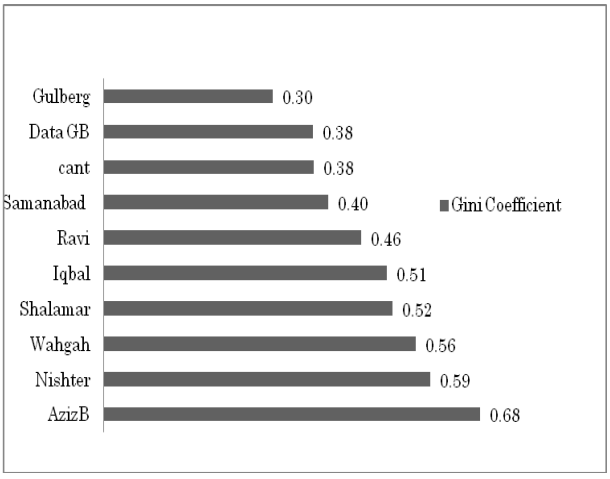

Fig. 4 Gini Coefficient for each Town

An exception is made to the Cantonment area (Cantt), as this area is designated for the army officials, and can be considered for feeder due to security concerns. After analyzing each land use factor, the most feasible areas for starting a feeder service are found to be those located nearer to the city centre, having less G value and well mix of land use types mainly residential and commercial.

It is concluded that not only the density and land use mix but the the way population is distributed within a town must be evaluated prior to provision of feeder service.

3. FUTURE WORK

Further, more number of land use factors can be considered like connectivity, roadway design and management and walking conditions, for a more precise decision making. Also some of the mobility indicators like transit mode share can be incorporated in future.

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