

Strategic Planning of Transit Oriented Development of Hyderabad Metro Rail

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ABSTRACT

Metro rail transit system in Indian urban areas is growing at a rapid rate, to enhance the public transportation and decongest the road transportation. Transit Oriented Development (TOD) is an approach of managing urban growth along transit corridor which has mixed land use, integrating infrastructure, transport and development focused around public transit area. Residential self-selection has been reported to perplex the relationship between the built environment and travel behavior. Therefore, it is essential to identify the dissonant groups of TOD, which might result in dissonance which refers to mismatch in land use patterns between individuals preferred residential neighborhood and the type of neighborhood in which they currently reside. Dissonant in TOD are likely to use private transport and less likely to use public transport. This study attempts to fill the gap by exploring the effect of socio demographic and mode choice behavior of individuals living in TOD and Non-TOD neighborhoods in Hyderabad.

This research uses Analytic Hierarchy Process (AHP) using Super decisions software in methodology based on pair wise comparison of criteria which is used to determine their weights considering the data obtained from the respondents. The living conditions of respondents are to be classified into TOD or Non-TOD based on cluster analysis. This study tests the residential selection bias of commuters living in TOD and Non-TOD neighborhoods using a regression analysis. Findings of this study will contribute to the necessary policy implications towards urban structure design and TOD policies to develop Indian context. The findings suggest that travel preference is relatively more influential in transport mode choice decisions compared with built environment features.

1. Introduction

Transit-oriented development (TOD) is a mixed-use residential or commercial area intended to maximize access to public transportation. Such neighborhoods often consist of a center with a public transit station, surrounded by high-density development with gradually lower-density development spreading outward from the center. TOD creates a vibrant community centered on transit access and reduced automobile dependence. Fast developing cities like Hyderabad in India has presented critical urban issues due to urban sprawl. This changing demand for varied housing options creates both promises and challenges. Transit zones today present real opportunities and choices for lower-income residents in their increasingly difficult search for affordable housing. Demographic shifts, such as, increased immigration, an increased percentage of the population contributes to the demand for denser communities with increased access to public transit. Multiple city departments and agencies have policies, goal and strategies that broadly and specifically address TOD. This strategies plan does not alter TOD plans; rather focuses these multiple efforts into a concise work program. To meet these growing demands for transit, many cities are embarking upon significant expansions of existing transit facilities while others are beginning to plan for transit development.

In order to ensure TOD adequately meets the needs of potential residents, it is important to ensure frequent, high-quality transit service, good connections between transit and the community, community amenities and a dedication to place making, and adequate review to ensure economic efficiency. Strategic planning is an important step to successful TOD implementation that is for the development for alignment of city departments approaches to TOD improves implementation efficiency and provision of transport to currently unserved areas might influence dissonance. In order for TOD to live up to its promise, it is essential that city planning departments allow for both customized zoning for unique transit integration projects while also minimizing planning review time for standard projects.

This research identifies the extent of socio demographic, mode preference residential self- selection, travel behavior, residential dissonance in Hyderabad with respect to dissonant living in TOD and Non-TOD areas. TOD principles have become influential among TOD policy makers, urban planners and transit officials. The findings from this research relate to the development of specific TOD policies in number of ways. Four groups of residents were to be identified (I) Residential

dissonant: The mismatch in land use patterns between individuals preferred neighborhood type and the type neighborhood in which they currently reside. (ii) Residential consonants: The residents who prefer to travel in available modes. (iii) Non-TOD dissonant: They often travel with a private vehicle due to inaccessible public transport. (iv) TOD dissonants: They travel more than TOD consonants due to private mode choice. The significance of this study with respect to policy is to highlight the importance of travel attitudes and behavior.

2. Literature Study:

Matthew Burke and A.L. Brown (2007). This presented the detailed information on the distances people walk for transport purposes in Brisbane, Australia. They reported the full distributions of the distances walked for transport from homes to other places, as well as the walk travel made between places other than homes. The walking distance functions were fitted with various functions using Easy Fit Software, these functions were best fitted by gamma distribution which features 2 parameters those are (a) a size parameter (b) a shape parameter. A-D statistic test examines how well the observed walking distance data are estimated by gamma functions. The results show that the walk trips distances observed for certain trips in Brisbane may be larger than observed in US cities and it shows that people in Brisbane are willing to walk significant distances, especially to access rail services.

Eric Pels, et al (2007). This paper attempts to find a systematic explanation for the variation in railway station impact findings by meta-analytical procedures. This paper presents two estimations based on proximity considerations which are:

1. Considering a local station effect by analyzing the effect of railway station on properties within a range of 1/4th mile from the station.
2. A global effect is analyzed based on a continuous measure of distance for a wider distance range.

The database for the analysis of this paper is a pool of studies on the impact of railway station proximity on property value. Throughout analysis, commuter railway station shows higher impact on property values compared to light /metro rail system.

Robert Cervero (2008). In this paper the author states the impact of office development around rail station on transit mode choice in California largest metropolitan areas. The influences of factors like trip distance and street connectivity on mid-day travel choices of those working near rail stations are examined. A sensitivity test was conducted using Logit model. This research found that around one out of five workers in office outside of large downtowns in California commuted via transit, nearly three times transits market share of commuters for all workers in study regions.

A.Hoback, et al (2008) states that this research shows people riding transit in the city of Detroit walk on average of 1.3km per round trip. The straight-line walking distance was found by buffering the bus stop locations and comparing them to weighted US Census blocks. A Monte Carlo simulation was performed in geographic information system (GIS) with random addresses. The simulation was performed over several addresses until convergence was achieved. The distances were converted to straight line walking distances and compared to the US National Household Transportation Survey (NHTS). The true walking distance is found by selecting random set of houses and finding the ratio of true walking distance to the straight-line distance. All walking distances for entire trip were summed up using statistical analysis of trip behaviors. It was found that the people riding transit walk on average of 1.27km per round trip, these results were compared to NHTS which predicted a longer distance than GIS analysis. Therefore, the GIS analysis was lower bound estimate and survey was upper bound estimate for walking distance.

Ganesan-Lim, et al (2008) According to the author it is important to understand the relationship between the customer's perception of service quality and demographic information, such as age, gender, education and income level. This information is useful for ensuring there are suitable products available for the target market. Service quality seems more important to women than to men for traditional bank service, although men also find certain aspects of quality to be highly important. Service Quality Index is used to analyze the user preference based on 25 private bus operators and concluded that gender characteristic is a factor that influences the user preference choice related to relative utility, such as treatment effect, trip purpose, and access mode. Thus, analysis of the gender perceptions of service quality may assist public transport providers in much more detailed market segmentation by delineating what service quality attributes are optimum for which group of travelers.

Justin Jacobson, et al (2008) This paper analyzes seven TOD projects in US using six different types of urban design assessment tools in order to evaluate existing guidelines for TOD and reformulate a series of "best practices" for urban design. The six methods for analyzing are: (1) Urban design score sheet (2) Urban design inventory (3) Design workshops (4) Community representative workshops (5) GIS based analysis (6) Photographic visual assessment. This paper demonstrated that there are many options for creating a well-designed transportation environment and multiple solutions site specific problems, variety of TOD's show successful elements of urban design that other projects may adapt in part for design and development process

Marshall Lindsay (2010) The paper focus on the proximity of rail stations to trip origins/destinations as a factor affecting mode choice for work trips. The use of privately-owned vehicles (POV) contributes significantly to US energy consumption (EC) and greenhouse gas emissions (GHG). Using household travel survey data from Chicago, they evaluated the profile of journey-to-work (JTW) trips, assessing mode share and potential for more travelers to use rail. For analysis, several groupings of trips were created based on household distance from commuter rail (Metra train system) and Rapid rail transit trips Chicago transit authority (CTA) stations. The result shows that the potential energy savings associated with this mode shift were greater for the Metra case, as a greater number of trips were considered in comparison to the CTA case. The estimated maximum energy savings was 24% which was exhibited when combining the systems for the case where both origin and destination were within 1 mile of stations. This value represented the percent reduction in total energy associated with all JTW POV trips in the survey.

Becky P.Y LOO, et al (2011) The study examines residents travel behavior in three Hong Kong new towns against transport development strategies. The integrated transport and development strategies are examined by various travel indicators under the broad categories of spatial distribution and modal split. The results suggest that difference in transport sustainability can be explained by built environmental, land use and transport characteristics associated with transport development strategies.

Md.Kamruzzaman (2013) According to the study, individuals were segmented based on their actual neighborhood type: TOD and non-TOD. Spatial analyses were conducted to derive five environmental indicators including net residential density, land use diversity, intersection density, cul-de-sac density, and public transport accessibility level (PTAL). Net residential density was measured using the number of residential units located within a unit area of residential zoned lands. The Simpson's diversity index was used to calculate land use diversity in this research. Intersection density was measured based on the number of 3 or more way intersections located within a unit area of the buffer whereas cul-de-sac density was calculated using the number of dead ends located within a unit area of the buffer. The PTAL approach was used to measure accessibility level to transport for each individual. Two-step Cluster Analysis was conducted in order to identify natural grouping of the individuals with similar environmental profiles. Factor analysis is a commonly used method to derive travel attitude variables. The factor analyses were conducted based on polychoric correlations matrix in order to consider the ordinal nature of the variables. A special SPSS program was used to conduct the factor analyses. Different parametric modelling techniques have been used by researchers such as the multinomial logit model (MNL) in order to identify mode choice behavior). Two regression models were estimated (1) Respondents living in TOD areas (2) Non-TOD areas. A new multichotomies 'mode switch' variable was created to understand the dissonant travel change behavior over time. It is possible that mode shifts occurred, yet a 'primary' or 'main' mode did not shift for a respondent. Thus, these omissions suggest that the results are conservative, and that potential changes could be larger than those observed in this study.

Thomas Lavery, et al (2013) In this paper, they report the results from an integrated urban model (IUM) which characterizes the relationship between the land use, transportation and activities in order to project what impacts light rail transit (LRT) line will have on Canadian case study. Land use and transportation policy alternatives are tested on the bias of relationship by using IUM. Integrated model for urban land use, transportation and environmental analysis (IMULATE) is used to assess the effect of land use and transportation policy alternatives on the form and structure of the city vice versa. The results from scenario tested in IMLUATE support research and warn that by adding LRT cannot cause real estate investment.

Luc Honore Petnji Yaya, et al (2014) This paper proposes scales to evaluate customer's perceived service quality in public transport then identifies the demographic characteristic factors that may influence customer perceived service quality, as well as identifies any customer perception differences between the subcategories. The manager interview and random sampling method were used to survey 288 consumers of public transport buses. Exploratory and confirmatory factor analyses were used to confirm the scale validity. Thereafter, structural equation modelling, Mann-Whitney *U* and Kruskal-Wallis tests were used to assess the causal paths and service quality perceptions differences among the subgroups. Age and owning a driver's license are factors that directly and positively affect service quality, whereas education was negatively related to perceived quality. In this paper structural equation modelling (SEM) was used to examine service quality dimensions and their reliability and validity. The best fit of the psychometric properties of the item was assessed through a comprehensive confirmatory factor analysis (CFA) using partial least squares (PLS), CFA is also performed by using EQS 6.1 software to confirm robustness of the scale. The results also showed that younger commuters appear to have lower perceptions of service quality compared to adults.

Marc T. Smith, et al (2014) This paper examines the impact of the development of Miami Metro rail system on residential property values proximate to its station location. This study compares repeat sales indices and applies hedonic regression methods which yield consistent results. Two alternative empirical methods are employed to examine size and timing of price impacts of the rail station development. The first method constructs a repeat sales index using the pooled sample of the properties surrounding the metro rail station and compares it to an identically constructed index for entire country. The second method employs hedonic regression to evaluate the variation in property value before and after the announcement of the development of metro rail system. The metro rail system weakly increased the value of existing properties proximate to stations in higher priced neighborhood's experiencing growth, relative to neighborhood's in decline.

Huang, et al (2016) Using the 2014 data from Xi'an in China, this study explores the interaction effect between metro transit and the propensity of living in neighborhoods with metro transit on transit use. This study employed a case-control observational design. It is ideal that case and control corridors have the same location context and built environment characteristics except for the presence of metro transit. In this study, we chose two parallel corridors. A survey is conducted where the respondents were allowed to choose between the five-point scale. Following the survey, they created a variety of built environment variables using ArcGIS 10.0. In this research, residents were classified into two types:

- (1) Residents of neighborhoods with metrotransit (treatment group)
- (2) Residents of neighborhoods without metrotransit (control group).

They estimated a binary logit model to predict the propensity score (PS), using demographic characteristics, residential preferences, and travel attitudes as independent variables. The high score means strong propensity for living in metro transit neighborhood. For dependent variables (transit trip frequency) which do not follow a normal distribution they chose a log transformation model. Since the dispersion factor, Alpha, is larger than zero, the variance of transit trip frequency exceeds its mean.

Accordingly, we adopt a negative binomial regression. They developed three models

- (1) For non-work travel frequency by transit (including both metro transit and bus)
- (2) For commute frequency by metro transit, and
- (3) For commute frequency by bus.

One-way ANOVA was used to identify significant differences among the four groups of resident's least square difference (LSD) comparison tests were used to identify which categories are significantly different from other. The results clearly indicated that respondents living in metro transit neighborhoods tend to use transit more frequently than those with weak propensity.

Runjie huang, et al (2017): In this paper, a transit-oriented development (TOD) typology was developed based on built from indicator to identify the roles of different types of nodes play with in transit network. The study area is the Arnhem Nijmegen city region in Netherlands. This study applies the latent class cluster method (LCCM) for developing a TOD typology, based on the TOD typology a correspondence analysis was conducted to measure the potential complementarities effect of TOD network system. The results identified three types of roles; (i) Suburban Residential (ii) Urban Residential (iii) Urban Mixed Core. Which illustrated that differentiation among the TOD nodes in terms of residential housing prices and building uses contributes to a more diversified offer in terms of activities and functions of the TOD region indicates complementarities between stations.

3. Conclusions:

Transit oriented development (TOD) is the most accepted strategic plan that collaborates the land use and transportation functions. This study tried to estimate the effect of socio demographic, travel attitudes and urban structure characteristic on mode choice in TOD and Non-TOD neighborhoods of Hyderabad, lurking its relationship with residential dissonance. Travel behavior data of Hyderabad Metro Rail commuters are considered for investigating their behavioral attitudes and dissonant. From the previous studies showed commuters are more likely to use the public transport in TOD areas and private transport in Non-TOD areas for longer trips. Mode choice models estimates the limited access to private transport which increases the choice of public transport. Understanding the composition and nature of dissonance within the urban form can provide a useful tool for both implementing policy and improving urban as it impacts transport sustainability.

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