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Social cost of TOD: Evaluation on housing affordability along MRT corridor in Dhaka applying H+T index

Afsana Haque* Fatima Kabir Sharna[a] Asif Khan[b]

Department of Urban and Regional Planning, Jahangirnagar University, Dhaka, Bangladesh

Abstract

Globally Transit Oriented Development (TOD) has become predominant planning tool to bring the maximum benefit from transit-land use synergy. TOD is credited for its high-density development around transit station to combat urban sprawl, improved accessibility to reduce auto oriented travel behavior, good urban design and pedestrian facility to bring quality of life and drive the real estate through land value uplift. However, all the broader benefits allied with some social cost as well. This study tries to explore that social cost by the means of housing affordability, applying H+T index. The context of developing countries are quite different from the developed ones which have long history of successful TOD implication. This study explores housing and transport along the five case stations of MRT line 6 in Dhaka, Bangladesh where the development authority has no previous TOD experiences associated with weak planning practice. The findings reveal the critical challenge for the developing countries because a major part of the population already living below the affordability level. It is tough to offset the increasing housing cost through lower transport cost if the interventions are not taken in right time. This study argues about the challenges of housing affordability in TOD that the planning authorities should realize earlier as well as the policy intrusions that should critically draw at the very initial stage of TOD planning considering the socio-economic context and market forces.

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Keywords: TOD; H+T index; Housing cost; Transport cost; Affordability

1. Introduction

TOD is an old concept that formally bring to light by Peter Calthorpe in his book ‘The Next American Metropolis’. TOD is a denser, mixed-use, pedestrian friendly development close to the transit station (Calthorpe, 1993; Cervero &

* Corresponding author. Tel.: +852 51685823
E-mail address: afsana@juniv.edu

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Kockelman, 1997; Dittmar & Poticha, 2004; Suzuki, Cervero, & Iuchi, 2013). Spread of TOD concept in different geographical context has occurred in different circumstances (Doulet, Delpirou, & Delaunay, 2017) and had not the same political and scientific resonance (Doulet et al., 2017). Metropolitan areas in United States adopt the concept of TOD as attempt to regulate and manage the environmental and social impact that causes for dispersed growth pattern (Balz & Schrijnen, 2009; Marlon G. Boarnet & Compin, 1999; Cervero, Bernick, & Gilbert, 1994; Douglas, 1997; Ian, 2009). In case of Europe it seems rather stressed on the redevelopment of existing station area (Bertolini & Spit, 2005; Peek, Bertolini, & De Jonge, 2006). Currently few Asian governments are also trying to incorporate this concept in their planning policies to tackle their urban and transport problems (Cervero & Day, 2008; Chorus & Bertolini, 2016; Sung & Oh, 2011; Yang & Lew, 2009).

Broader literature of TOD reveal that, it has great influence for reducing automobile use, increasing transit ridership, and increase sense of community in a neighborhood (Bossard et al., 2002; Cervero, 1996; Newman & Kenworthy, 1999; Sung & Oh, 2011). Some studies also argue about the impact of TOD impacts on land value, surrounding built environment quality, economic activity (Cervero & Duncan, 2002a; Dubé, Des Rosiers, Thériault, & Dib, 2011; Thisse, 2009; Yeh, Wu, Huang, & Tasi, 2005). Annual report on emergence real estate trends in U.S. indicate that apartment with closer to work and mass transit are getting popularity (ULI & PW, 2012). However, all the broaden benefit coupled with few social cost. TOD has also suspect as the threat of displacement in few cities because of value uplift of land, which results in unaffordable housing for particular social groups. Transit investment can increase housing prices around the stations (Bartholomew & Ewing, 2011; Cervero & Duncan, 2002a; Grube-Cavers & Patterson, 2015; Kahn, 2007; Rayle, 2015) that potentially causes gentrification. Even private developers tend to avoid the urban location with lower value (Davison, Gurran, Pinnager, & Randolph, 2012). The increasing value of revitalised with additional amenity attracts high end development which can better absorb high cost development (CTOD, 2007) and exclude the lower incomes.

TOD has recently recognized as an important planning tool in Dhaka primarily aimed to resolve the traffic problem (STP, 2005). Planning history of Dhaka has shown uncontrolled urbanization and spatial growth (B. Ahmed, Hasan, & Maniruzzaman, 2014; S. Ahmed & Bramley, 2015; Kabir & Parolin, 2012; Khan & Siddiqua, 2015; Mowla, 2012). The city accommodates almost 46% of the total urban population of the country (BBS, 2011) and has transformed from a rural settlement to a mega city without proper planning or regulatory measures (S. Ahmed & Bramley, 2015; Nilufar, 2010). There is a huge gap between demand and supply for affordable housing, which is predominantly controlled by the private sector. The share of public housing supply is only 7 percent, even private supply of housing is highly skewed and 53 percent of this come from informal sector (BIGD, 2017). Each year approximately 25,000 new housing unit are supplied in response to the demand of about 0.12 million (MTB, 2017). Because of high land price middle income group can hardly afford the rent in city. Around 56 percent of the city dwellers live in rented place and the number would be around 70 percent if the slum people are included (RAJUK, 2016). A single MRT line that will connect the northern peripheral area to the CBD through 16 stations (RSTP, 2015; STP, 2005) is under construction. The completion of the mass transit is expected to bring a huge land use changes around the stations. The draft Structure Plan (2016) proposes TOD around the stations along the line 6 corridor (RAJUK, 2016). However, there is no detail planning how to deal with the rapid impact of mass transit as well as combat with the social cost that TOD benefit is coupled with.

Few literature argue that, rising housing price that is underpin by mass transit may not displace low-income residents if the extra housing cost is offset by lower transportation cost (Rayle, 2015). However, the main point is how much the reduced transport cost really could do to offset the value uplift in the socio-economic context of developing countries. This study tries to enlighten two major issues: how affordable the existing housing along the MRT corridor and to what extent the transit will be able to offset the increase in housing cost within TOD precinct.

2. Literature review

2.1 Integrating housing affordability into TOD

A recent analysis of changes in rental affordability between 2000 and 2010 found that affordability worsened for households at the 20th and 40th percentiles of the local income distribution in 236 of the 238 largest metropolitan statistical areas and worsened in every metropolitan area studied for households at the 60th and 80th percentiles of the local income distribution (Schwartz et al., 2016). These trends have been in effect since at least 1990, making it clear that the housing affordability challenge is a longer-term concern (Schwartz et al., 2016). The debate about unaffordable housing and TOD emergence in American cities (Renne, Tolford, Hamidi, & Ewing, 2016). Affordable housing is frequently integrated into TODs because the two are perceived as complements for at least three reasons (Marlon G Boarnet, Bostic, & Williams, 2017). The first reason is affordable housing apparently helps to temper the displacement and gentrification. The second one is incentivizing or mandating the inclusion of affordable housing in TODs (not only to provide lower-income families with particular socio-economic opportunities, such as better proximity to jobs, lower transportation costs, etc. but also increases the available stock of affordable housing which is acutely needed in many communities). Finally, the third reason is focusing particularly on the reduction of vehicle miles travelled (VMT). A sizable literature has argued about the relationship between housing price and neighborhood amenities. Transit in particular is viewed as neighborhood amenity (Marlon G Boarnet et al., 2017) and in real much more than that. Atkinson-Palombo (2010) argue that value of single family homes and condominiums located near light rail transit are respectively 6 and 20 percent higher. Hess and Almeida (2007) found a positive value relationship for housing that located closer to transit station in Buffalo. Even commercial properties show similar association while proximity to transit station, ranging from 23 to 120 percent value premium (Cervero & Duncan, 2002b). it is not surprising, due to the presence of 'location efficiency' concept the land in or near an amenity rich development such as a well-planned TOD become more sought after and inevitably value uplift occurs (Dittmar & Poticha, 2004). Harrell, Brooks, and Nedwick (2009) reveal the concern expressed by American Retired Persons Association that demand to live near transit pressure on land prices, threatening the loss of existing affordable housing stock. Goetz, Ko, Hagar, Ton, and Matson (2010) found positive impact on values associated with the opening of the Hiawatha line in Minneapolis. Grube-Cavers and Patterson (2015) also discovered property value increase after examining three Canadian cases.

2.4 Housing affordability and H+T index

Various strategies have defined affordability for people in different ways by considering different factors. The conventional way of defining housing affordability is housing for which the occupant(s) is/are paying no more than 30 percent of his or her income for gross housing costs, including utilities (Hulchanski, 1995; Linneman & Megbolugbe, 1992). The CNT and Center for Transit-Oriented Development released the H+T index as a key component in evaluating affordability in their report '*The Affordability Index: A New Tool for Measuring the True Affordability of a Housing Choice'*. They argue that, transportation cost should be considered in housing affordability (Development, 2006). According to the implications of the study of Victoria Transport Policy Institute, affordability analysis should consider housing and transportation costs together, transportation costs should be considered by consumers when evaluating housing affordability and by lenders when evaluating a household's borrowing capability and location-efficient development can be considered a transportation affordability strategy (Renne et al., 2016). Traditionally affordability measurement is conducted by focusing on housing costs as a share of income. Moreover H+T Affordability Index prices the trade-offs that buyers and renters make between housing and transportation expenses when choosing where to live (Technology, 2009).

Traditionally, a home considered affordable if its costs consume no more than 30% of a household's income. CNT has found that 15% of the Area Median Income (AMI) is an attainable goal for transportation affordability. By combining this 15% level with the 30% housing affordability standard, CNT recommends a new view of affordability,

one in which combined housing and transportation costs consume no more than 45% of household income"(CNT, 2018). The H+T Index and LAI have been important tools for a growing national policy focus on encouraging denser, mixed-use, walkable communities developed around transit nodes-otherwise known as TOD (Renne et al., 2016).

4. Data and methods

4.1 Case selection

The whole 20.1 km transit corridor that connect the CBD and old Dhaka to the northern periphery, includes numerous typology of land use around the different stations. The main goal of this study is to measure the extent of housing and transportation affordability along the MRT corridor by applying H+T index. 1 km radius around the first five stations, see fig. 1 (Pallabi, Mirpur 11, Mirpur 10, Kazipara and Shewrapara) are considered because of their predominant residential characteristics. TOD precincts usually delineate through the geographical distance from the transit stop ranges from 700m in the European context most of the previous study (Bertolini, 1999; Reusser, Loukopoulos, Stauffacher, & Scholz, 2008; Vale, 2015; Zemp, Stauffacher, Lang, & Scholz, 2011) to 800 m in U.S. (Atkinson-Palombo & Kuby, 2011; Austin et al., 2010; Schlossberg & Brown, 2004) and Australian (Kamruzzaman, Baker, Washington, & Turrell, 2014). However, draft Dhaka Structure Plan, 2016 considered 1km radius around transit station as the major influencing zone of transit (RAJUK, 2016). Therefore, this study considered 1km radius for defining the precinct of case study.

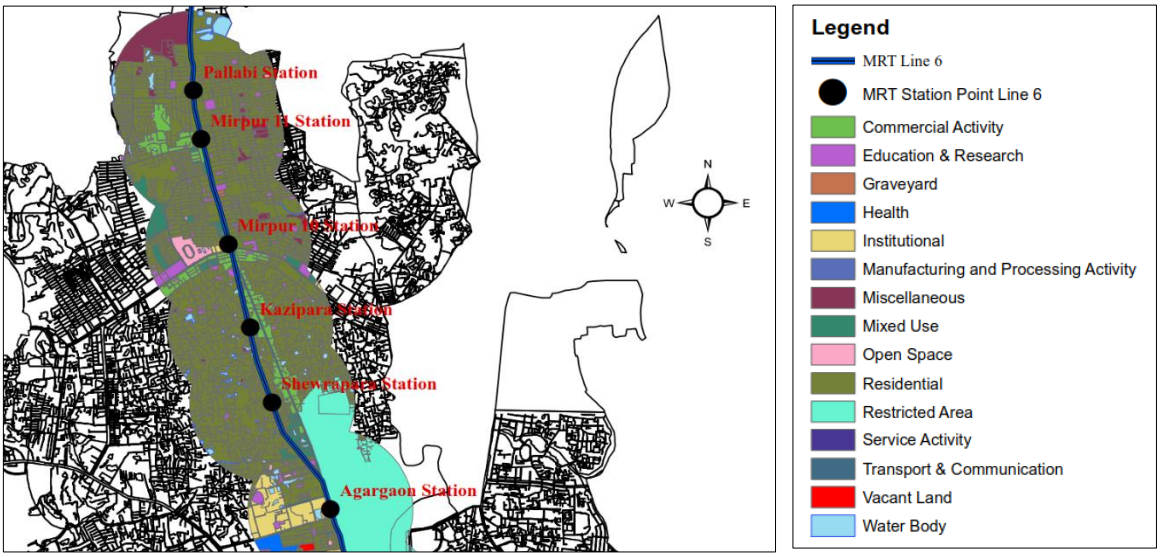

Fig. 1. Residential cases to measure housing affordability along TOD corridor

4.2 Developing H+T index for Dhaka

The study has applied H+I index to measure the affordability. Several improvements have been made to the H+T Index including a simplification of the transportation cost model and a new method to derive auto ownership costs. Previous versions of the H+T Index used a non-linear regression technique that made the model more difficult to understand. This version of the H+T Index uses the ordinary least square and simple variable transformations to accomplish the regression. The list of independent variables has also been simplified and excludes variables that are highly collinear to give greater significance to the remaining variables.

$$H + T\ index = \frac{Housing\ costs + Transportation\ Costs}{Income}$$

Total transportation costs can be calculated as the sum of the three cost components as follows:

$$Household\ Transport\ Costs = [C_{AO} * F_{AO}(X)] + [C_{AU} * F_{AU}(X)] + [C_{TU} * F_{TU}(X)]$$

Where:

C = cost factor (i.e. dollars per mile)

F = function of the independent variables (F_{AO} is auto ownership, F_{AU} is auto use, and F_{TU} is transit use)

The H+T index was constructed to estimate three dependent variables (auto ownership, auto use, and transit use) as functions of 13 independent variables (median household income, average household size, average commuters per household, gross household density, Regional Household Intensity, fraction of single family detached housing, Employment Access Index, Employment Mix Index, block density, Transit Connectivity Index, Average Available Transit Trips per Week, Transit Access Shed, and Jobs within the Transit Access Shed)." Indicators that are widely available in literature for H+T index are from American context, which are not suitable in the context of developing city like Dhaka. Considering the socio-economic context and data availability this study has drawn indicators in a very careful way shows (see table 1) after consultation of different experts: transportation cost is combined through all the factors like auto transport ownership, auto use and public transport use while household accommodation cost has been concluded by combining house rent and other relevant service charges.

Table 1. Context specific indicator to measure affordability using H+T index

Variables of H+T index	**Specific indicators and calculations**
Household Income	Total household income
Percentage of housing and other expenditure as a portion of total household income	Rent of the house
	Cost of other housing related expenses
Percentage of Transport expenditure as a portion of total income	Average commuters per household
	Travel distance (km travelled)
	Total household transportation expenditure from income (travel cost/km travelled)
	Mode of transportation use for travel (auto ownership/ auto use/ transit use)

Based on H+T index by CNT, 2018

5. Findings

5.1 Affordability scenario in the study area

44% households near the MRT line-6 is affordable in terms of only housing cost considering the benchmark of 30% share of income. From the consideration of transportation cost, the study identified 81% households near the MRT line is affordable comparing with the benchmark of 15% share of the total household income, see fig. 2 (a) and (b).

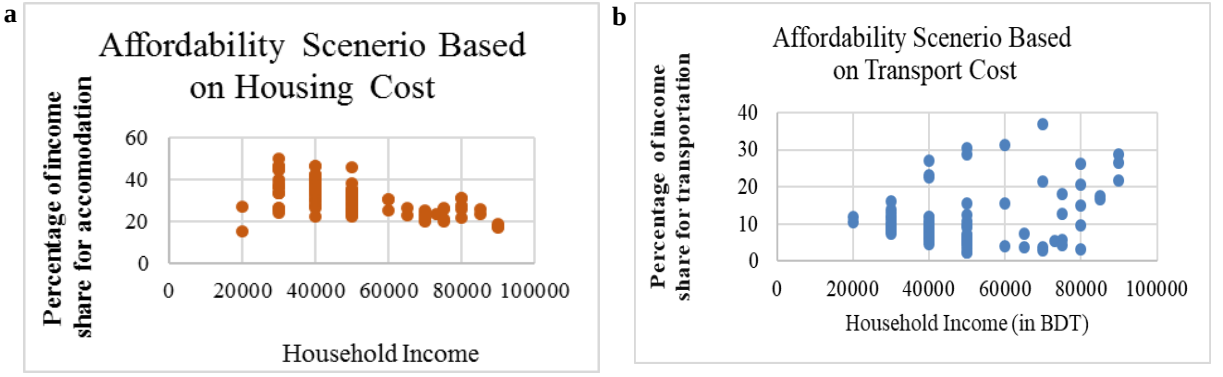

Fig. 2. Affordability scenario considering monthly (a) housing cost and (b) transport cost

Application of H+T index found that, 64% of the household fall within affordable limit, considering the combined share of housing and transportation expenditure from the total monthly household income. It means that they are within the benchmark of 45% share of income for the combined purpose which is making them affordable. However, the rest of the household go behind the 45% benchmark due to their higher housing and transportation combine cost (see fig. 3).

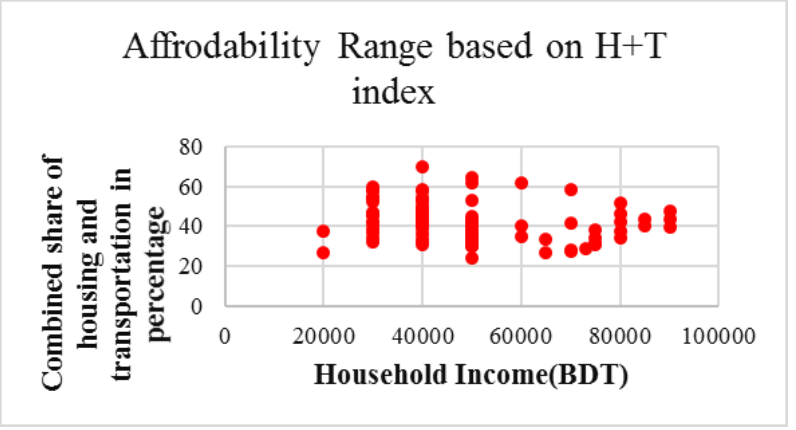

Fig. 3. Affordability range based on H+T index

5.2 Does the reduced transit cost enough to offset increased housing cost?

According to H+T index method, household transportation cost is determined by different modal choice of households. The study explores that 82% of people are using public transports where, 11% owned the personal automobile and the other 7% people rely on the use of auto transport like app-based services e.i. Pathao, Uber, Shohoj, as well as rickshaw, auto rickshaws named CNG, see in fig. 4.

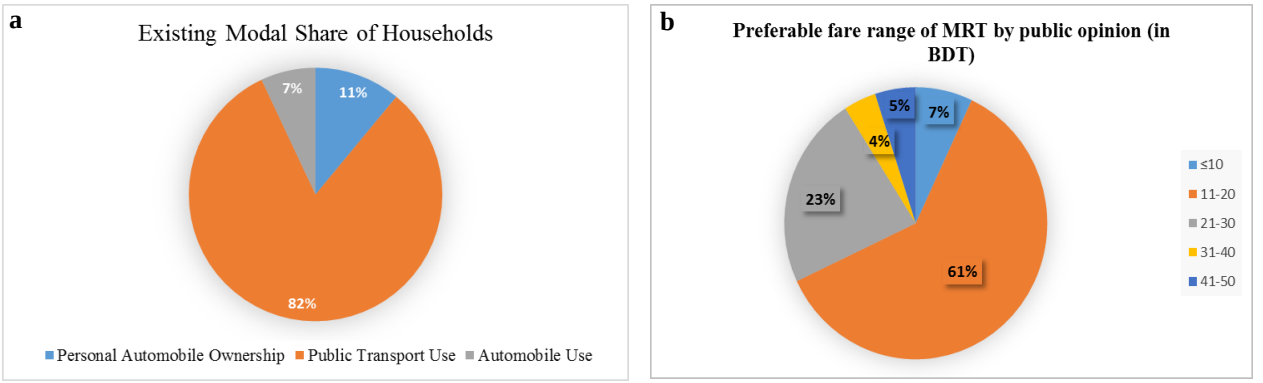

Fig. 4. (a) Modal share and (b) willingness to pay for MRT

According to Bangladesh Road Transport Authority, the minimum per kilometer fare in public bus is 0.025 USD (approximately). For study purpose, 5 ranges of fare have been categorized and people perception is taken in this regard. Highest attractive affordable range was asked to determine the travel demand via MRT line. Study found 61% people are agreed with the range of 0.12 to 0.25 USD (converted from local currency: 1USD = 80 BDT) per kilometer. This is the most attractive range for accessing the metro rail for frequent use of MRT. Moreover, 7 % people want the fare less than 0.12 per kilometer.

Empirical cases with similar socio-economic context reveals that the fare of mass rapid transit systems as BRT, MRT or metro rail has been fixed by considering different factors like establishment costs, productivity and energy costs,

its investments and subsidies, loans, operational costs, supply of electricity and other services etc. According to Metro Rail Rules 2016 of Bangladesh, following aspects will be considered while fixing the fare range (DMTC, 2016b):

- Route and covered distance
- Segregation of adult, students, disabled and special facility needed people.
- Socio-economic aspects
- By integrating with other modes' fare

According to Dhaka Mass Rapid Transit Company Limited (DMTCL), the construction cost in Bangladesh is higher than India. From DMTCL report, on an average, per kilometer metro rail construction cost in India is $50-60 million, however Bangladesh is building the first metro rail project at a cost of $135 million per kilometer. Bangladesh is constructing 20.1km long metro rail at a cost of 2.7 billion USD or 22 thousand crore (DMTC, 2016a, 2016b).

Since, the fare of MRT line 6 has not been fixed and still it is undetermined that which factor will contribute most in fixing the fare range, a marginal fare has been calculated from the example of two Asian countries: India and Singapore and from the willingness to pay (see table 2) of dwellers from the interview.

Table 2. Fare of MTR in Asian context

Country Name	Singapore	India	Bangladesh
Fare (converted in USD) per kilometer	1.1	0.15	0.12

Adopted from The Indian Express (2018) and Baker (2015)

It is obvious that, property value near MRT line 6 areas is going on hike after the completion of MRT. Boarder literature of TOD reveal that new transit line has a significant impact on value uplift on land around ½ to 1 km of the station. Cervero et al. (2004) argue that, house rent is higher approximately 6 to 45 percent near transit stations. Debrezion, Pels, and Rietveld (2007) found that residential properties located within ¼ mile of public transit stations consist of 4.2% higher price than other land uses. Tracking of land value during the land release stage in Western Australia's first green-field TOD reveal a rapid rise in less than a year that is from about $170 to nearly $270 per square metre (Hemsley, 2009). A majority of the residents in the study area already living under affordability level, see fig. 5. Income group that fall at the bottom level indicate more vulnerability according to the H+T combine cost. Only reduces transit cost could not be a solution to offset the housing cost uplift rather there need for strategic actions to control the market force which is a real planning challenge for the transit and planning authority. Therefore, the affordability situation will not remain the same as now. If the present available public transportation cost is compared to the probable marginal MRT fare, there will be a huge threat on affordability of the existing dwellers.

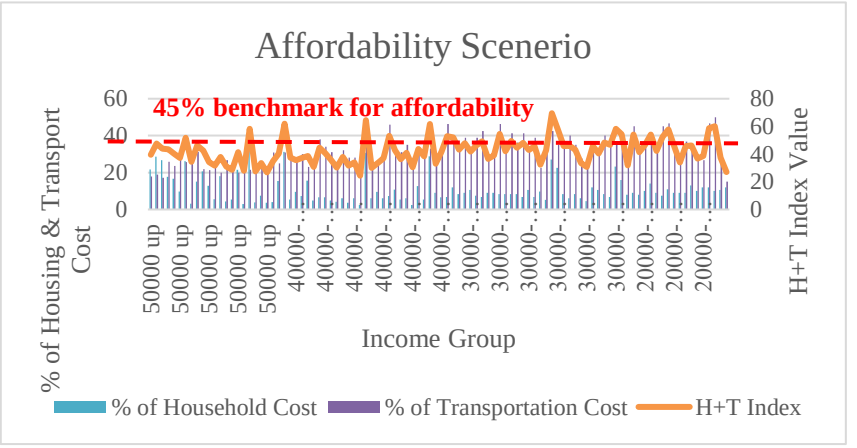

Fig. 5. Affordability threat on different income group

6. Discussion and conclusion

According to the conventional location theory, residents near the city center pay comparatively more for housing and less for transportation, and they choose the location through trade off housing cost for commuting cost (Alonso, 1964; O'sullivan, 2007). Similarly, they could also spend less on transport by avoiding high cost of automobile ownership and use (Becker, Bernstein, & Young, 2013). Market forces associated with the introduction of new infrastructure could trigger increases in housing prices and rents, as the neighborhood becomes appealing to a broader, more affluent population (Marlon G Boarnet et al., 2017). Therefore, if the new transit improves accessibility then the existing residents will need to pay less for their transport or they may have greater access to jobs that will increase their income. This effect may not always sufficient to offset the increases in housing cost (Rayle, 2008) and will depend on the market response and socio-economic feature of that particular context. According to NCST 2017, Transit oriented development can only be successful when affordability of housing is also incorporated with it (Bernstein & Makarewicz, 2005). There are several reasons for this, such as; tracking housing affordability may reduce the possibilities of gentrification and urban sprawl, inclusion of affordable housing creates opportunities for lower income people by promoting lower transportation costs and creating employment options. As discussed above the context of Dhaka is quite vulnerable in terms of housing affordability. TOD literature quite strongly proof that the introduction of rail transit likely to be underpin the upward pressure on house prices (Marlon G Boarnet et al., 2017) meaning that the 36 percent housing that are affordable now probably will not be affordable in future after introducing the MTR. Policy makers need to focus from benefit cost perspective to minimize this social cost of TOD at the earlier stage of the project. Travel behavior pattern and the willingness to pay of transit user reveals that in the context of Dhaka reduced transport cost will not help enough to offset the increasing housing price. A key element of this challenge is the land use decision or land market control. At the local level, inclusionary policies with appropriate density allowance could be a solution. TOD with high density and low inclusionary percentage bring larger positive impact in terms of housing affordability (Marlon G Boarnet, Wang, & Houston, 2016). Price of land may increase in TOD area but increasing density can reduce cost per housing unit and by allowing more accessible infill development significant transport savings could be ensured. In the effort to craft a solution to the affordable housing in TOD area, the most commonly suggested approach is subsidy. However, in the context of developing economy, obviously the question is where to find the finance for subsidy. Empirical cases identified land value capture mechanism as a best way to get back the cost of constructing and operating transit. Policy makers can review this as a mechanism for subsidy from capturing the additional value. As Dhaka is spontaneous city with already existing higher population density and imbalanced housing supply, TOD implementation in this context is more challenging than other cities. Moreover, there is no previous TOD not even mass transit experience before. the whole area could be turned into haphazard and chaotic way and cause huge gentrification if the policy interventions are not addressed in right time. Before diving into TOD implementation, it is useful to review housing affordability and the structure of the affordable housing sector so that the nature of these challenges and the potential solutions can be better illuminated.

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