

## Bus Rapid Transit Oriented Development: A Review of Modal Shift-Triggering Ability of a Bus Rapid Transit (BRT) System

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### ABSTRACT

This article reviews the passengers modal shift triggered by the provision of a bus rapid transit (BRT) system. Passengers modal shift is one of the transit oriented development (TOD) goal. This article was written through literature review processes, that are reviewing TOD goals and principles and reviewing BRT systems impacts that are relevant to TOD goals and principles. It was found that the provision of a number of BRT systems have triggered their passengers modal shift. However, the evidence is still limited, thus the BRT system's modal shift-triggering potential has not been adequately explored. Let alone the characteristics of the systems, passengers and respective cities. This article helps defining the relation between a BRT system and TOD and offers a new approach in planning a TOD and its respective BRT system.

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### 1. Introduction

Transit-oriented development (TOD) has been emerging as an urban development concept that is discussed and practiced widely. [1][2] The concept has been discussed and practiced as an alternative to urban development pattern widely took place during the 20<sup>th</sup> century that is argued having a number of drawbacks, such as consuming land in an inefficient manner, requiring extensive infrastructure provision and triggering massive air pollution. [3][4] Transit-oriented development (TOD) is essentially an urban development that depends on the operation of transit modes. The development of the area is triggered by the operation of the transit modes. The activities within the area are relying much on the operation of the transit modes.

Furthermore, the physical design of the area is also oriented towards the transit hubs. [5][6][7][8][9][10]

Meanwhile, bus rapid transit (BRT) has also been emerging as a transit mode that is discussed and practiced widely. BRT is widely agreed as an enhanced bus service having performance in par with a rail service but with construction and operation cost lower than a rail service. [11][12][13][14][15][16][17] In regards of TOD, BRT has been limitedly recognised as a transit mode able trigger and support TOD. [7][8][9] A number of researches have recorded that the operation of BRT systems able to trigger urban development around the systems. [7][18][19][20][21][22][23][24]

Nevertheless, I find that there has not been any research specifically study the influence of

a BRT system towards the urban development around it under the TOD framework. For instance, I find that there has not been any research specifically study the ability of a BRT system to trigger urban development around it that is in line with TOD principles and goals. I believe that it is important to study the influence of a BRT system towards the urban development around it under the TOD framework in order to develop the proper means to carry out TOD and strategy to achieve TOD goals.

In the meantime, researches relevant to developing BRT as a means to carry out TOD are also still limited [1][2]. The mentioned researches regarding BRT systems were not carried out specifically in regards of TOD framework, making them less useful to developing the proper means to carry out TOD and strategy to achieve TOD goals.

## 2. Methodology

This research intended to answer the question “How can a bus rapid transit (BRT) system help carrying out a transit-oriented development (TOD) and achieving TOD goals?” This research was carried out through literature review processes, that are reviewing TOD principles, goals and global cases and reviewing BRT systems influences that are relevant to TOD principles and goals. Literature review is chosen as the research method considering this research is a preliminary research intended to develop a concept that will be examined and developed in further researches.

## 3. Results and Discussions

### 3.1. *Transit-oriented development (TOD) principles, goals and global cases*

Institute for Transport and Development Policies (ITDP) [10] summarised eight transit-oriented development (TOD) principles and goals. I will elaborate and validate the principles and goals by considering global cases of TODs. [5][6][7][8][9]

#### 3.1.1. *Walk, cycle and connect*

TOD intends to develop an urban area that is walkable by wide spectrum of the society, including children, elderly and mobility aids-user such as people on wheelchair. It also intended to develop an urban area that is cycle-friendly. Cycling network must be available, safe and complete while cycle parking and storage must be ample and secure. The intended urban area is to have walking and cycling connectivity prioritised over private vehicle connectivity. [10]

In line with the mentioned goals, Cervero et al [9] also highlighted the importance of walking and cycling connectivity. He noted that the uneasily accessed bus rapid transit (BRT) stops by pedestrians and cyclists in Bogota, Colombia, hindered the optimum development of area around the stops.

#### 3.1.2. *Transit*

TOD intends to develop an urban area that has transit stops, in which the stops are served by frequent transit services. The stops are to serve significant number of activities near them. The stops are to be easily accessible by walking and

cycling. [10] Based on global, though limited, review, train stations are currently the most frequent kind of transit stop used for TODs [5][7]. Bus rapid transit (BRT) stops are getting more common used for TODs. [7][8][9]

### 3.1.3. Mix

TOD intends to develop an urban area that has mixed activities on its land parcels. The land parcels used for mixed activities are to be the norm of the area. [10] This goal is implicitly shared by city and county transit agencies in United States: by carrying out TOD they intended to provide for the availability of various type of residential choices (multipurpose housing, multifamily housing, etc) and to enhance the general liveability of the area. [6] Furthermore, the land parcels composition is to be in a way that trigger people to walk and cycle between parcels. [10]

In line with the firstly mentioned goal, Hong Kong, a city that is claimed as a city best practicing transit and urban development integration, [9] have a number of integrated single-massed multi-story buildings used as train station, bus interchange, shopping mall, park and housing. Figure 1 shows the example of mentioned kind of building.



Figure 1: The Maritime Square residential-retail project developed by the Mass Transit Railway of Hong Kong SAR, China

Source: (Cerver et al, 2013)

### 3.1.4. Density

TOD intends to develop an urban area that has sufficient density to support the operation of transit modes. [10] Cervero et al [9] added that general area density regulation needs to be enhanced into density regulation considering proximity and walking and cycling connectivity to transit stops. In line with the mentioned goals, Copenhagen, Denmark and Singapore, two cities claimed as best practicing transit and urban development integration, [9] have city development plans that promote dense development around the train stations.

### 3.1.5. Compact

TOD intends to develop a region of urban area that trigger people not to commute long. [10] In line with the goal, Singapore has a city development plan that promotes the development of three ‘regional centres’ at the western, northern and eastern parts of the city-island in order to, two of which, provide sufficient employment opportunities at the mentioned parts and help citizens not to commute far to the central area at the southern part of the city-island to work. [9] Figure 2 shows the mentioned plan.

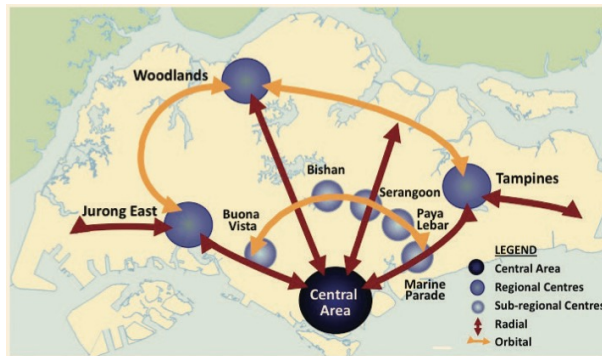


Figure 2: Singapore’s “Constellation Plan” for urban development  
 Source: (Cervero et al, 2013)

### 3.1.6. Shift

TOD intended to increase people’s mobility by triggering them not to travel by private motorised vehicles. [10] This goal is shared by Cervero et al [9], stating that the heart of a TOD is to create an urban area that reduce the need for travel by private motorised vehicles. This goal is also widely, though implicitly, shared by city and county transit agencies in United States: by carrying out TOD they intended to make more people taking transit, rather driving private vehicles, for their daily activities. It is found that under the right conditions, TODs can make more people taking transit in American cities. [6]

### 3.2. Bus rapid transit (BRT) system influence on urban development around it

A number of researches has recorded a number of bus rapid transit (BRT) systems influences towards urban development around the systems. There are three aspects that have been found influenced by BRT systems, that are traffic performance, property value and commuter behaviour. [1][2]

#### 3.2.1. Traffic performance

A large number of researches has found that the operation of bus rapid transit (BRT) systems influence the traffic along the systems. [21][22][23][24] The operation of BRT systems have been found increasing the operational performances of the buses of the systems. Most of the buses operate with higher passengers per route km (PRK), passengers per vehicle km (PVK) and passengers per hour per direction (PPHPD) figures as part of the BRT systems compared to the previous situation of not being

part of the systems. Most of the buses also operate with higher average speed, higher frequency and lower headway as part of the BRT systems.

### 3.2.2. Property value

A large number of researches has also found that the operation bus rapid transit (BRT) systems influence the property value around the systems. [7][18][19][20] The BRT systems have been found bringing premium to properties relative to proximity towards the systems. In general, properties located closer to the systems are priced higher than the properties located farther. The premium applied to residential and non-residential properties alike.

### 3.2.3. Commuter behaviour

A limited number of researches suggested that the operation of bus rapid transit (BRT) systems influence the commuter behaviour around the systems. [23][26] I believe that the body of knowledge presented by the researches in this topic is not yet sufficient to be concluded.

### 3.3. Bus rapid transit (BRT) modal shift-triggering ability

One of transit-oriented development (TOD) principle and goal that is shared by many academics and policy makers is to create an urban area that trigger people not to travel by private motorised vehicles, but by walking, cycling or taking transit. [6][9][10] In line with the other TOD principle and goal, such area requires the availability of transit hubs served

by frequent transit services. The transit hubs are to be complement by adequate walking and cycling network connecting them and other parts of the urban area. [5][7][8][9][10] Bus rapid transit (BRT) system is recognised as a transit mode that is able to trigger and support the development of the mentioned area. BRT stops are recognised appropriate as the mentioned transit hubs. [7][8][9]

Meanwhile, Currie and Delbosc [23] and Ernst [26] has started evaluating BRT systems' ability to shift commuter from driving private motorised vehicle to taking the bus that is part of the BRT systems. When doing comparative research involving the patronage of Australasian BRT systems, Currie and Delbosc [25] collected data on percentage of BRT systems passengers who previously drive for the same route of the BRT systems trips. Unfortunately, the data was not processed further. While the research presented findings regarding patronage of the BRT systems, the research didn't present finding regarding the relation of the patronage and the percentage of passengers who previously drive. Let alone the research discussed about the features of the BRT systems that make the previously-driving-passengers leaving their cars and taking the systems. Table 1 presents some data regarding Australasian BRT systems passengers.

Meanwhile, when doing evaluative research on Transjakarta, Ernst [26] quoted the result of a 2004 survey of Transjakarta passengers. The survey, one of which, was asking about the previous transport mode used by Transjakarta passengers. Unfortunately, the quoted data was also not processed further. For instance, while

Ernst also quoted data regarding general transport mode used by Jakarta citizens classified by income, he didn't present the relation between passengers' income and decision to shift to taking Transjakarta. Figure 3 shows the data regarding previous transport mode used by Transjakarta passengers.

Table 1: Australasian BRT systems passengers data

Australasian Bus Rapid Transit system	Ridership	Implementation travel impacts	
	Annual (M)	Direct corridor ridership growth	% Pax who Previously Drove
Adelaide Busway (ANEB)	8.4	24%	40%
Sydney L-P Transitway (SLPT)	2.8	56%	9%
Sydney Blacktown-Parklea Busway (SBPT)	1.1	DK	DK
Sydney Parramatta-Rouse Hill Busway (SPRHT)	3.3	DK	DK
Brisbane South East (BSEB)	46.7	56%	26%
Brisbane Inner Northern (BINB)	32.4	DK	DK
Brisbane Eastern Busway (BEB)	25.9	DK	DK
Melbourne SmartBus (MSBN)	19.3	25% <sup>a</sup>	16% <sup>a</sup>
Melbourne DART (MDART)	3.5	DK	DK
Auckland Northern Busway (ANB)	5.8	DK	DK

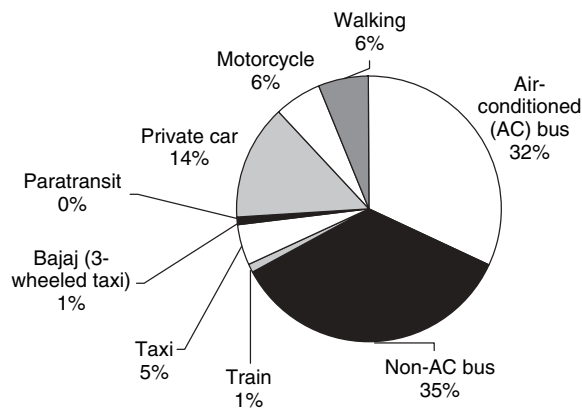


Figure 3: Previous mode used by Transjakarta passengers  
 Source: (Ernst, 2004)

### 3.4. Bus rapid transit (BRT) modal shift-triggering potential

A number of researches [27][28][29][30][31][32][33][34] showed that the operation of a transit mode, including a bus rapid transit (BRT) system, may trigger a modal shift. The operation of a transit mode, in most cases complemented by a number of other policies and actions, may trigger people to shift from driving their private motorised vehicles to taking the mentioned transit mode for their daily activities. Batty [29] categorised the operation of a transit mode as the 'pull' factor of shifting private vehicle users to transit passengers; 'pull' and 'push' factors are two interrelated groups of factors that are needed for the modal shift to occur.

A number of researches [30][31][32] have started explaining the modal shifts triggered by various transit modes and elaborating the distinct characteristics of each. It was found that the magnitude of each modal shifts is related to, two of which, the transit modes' level of services and passengers' perception regarding the transit modes. Mainly due to the nature of modal switch that is triggered not only by the 'pull' factors, including the transit modes' level of services and perceived quality of the transit modes, but also by the 'push' factors that have less relation with the transit modes, the relation between the mentioned pull factors and the magnitude of the modal shift has not been elaborated. [30] Furthermore, Satiennam [32] have started explaining the extent and spread of the modal shift. We can infer from his work that the magnitude of the modal shift is related to the demographics characteristics of the respective society.

#### 4. Conclusion

It can be concluded that a bus rapid transit (BRT) system can help carrying out a transit-oriented development (TOD) and achieving TOD goals by, one of which, triggering people to shift from driving their personal motorised vehicles to taking buses that are part of the BRT systems for their daily activities. This argument is shared by Cervero [7], Curtis, Renne and Bertolini [8] and Suzuki, Cervero and Iuchi. [9] In line with that matter, [9] Currie and Delbosc [13] and Ernst [26] have started to look into the BRT modal shift-triggering ability when evaluating a number of BRT systems. However, the mentioned argument is not yet supported by sufficient empirical data. There is not yet sufficient empirical data showing a modal shift (from being a private motorised vehicle driver to a BRT system passenger) taking place after and due to the operation of a BRT system. The mentioned concluding argument needs to be researched further. As an assumption, the argument needs to be supported by empirical data to prove its validity.

Furthermore, under the intention to develop the means to carry out TOD principles and strategies to achieve TOD goals, the BRT modal shift-triggering ability needs to be elaborated. The context in where the modal shift takes place needs to be paid attention. The things related to, or even affecting, the magnitude of the BRT modal shift (for instance, the BRT systems level of services and passengers' perception regarding the BRT systems quality and affordability) need to be explained further. An in-depth view of the demographics characteristics the BRT

passengers needs to be included in the mentioned research.

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