



# Evaluating accessibility to Bangkok Metro Systems using multi-dimensional criteria across user groups

Duangporn Prasertsubpakij<sup>1</sup>, Vilas Nitivattananon<sup>\*</sup>

Urban Environmental Management Field of Study, School of Environment, Resources and Development, Asian Institute of Technology, P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand

## ARTICLE INFO

### Article history:

Received 11 September 2011  
Received in revised form 23 December 2011  
Accepted 5 February 2012

### Keywords:

Built-environment  
Equity  
Metro system accessibility  
Sustainability

## ABSTRACT

Metro systems act as fast and efficient transport systems for many modern metropolises; however, enhancing higher usage of such systems often conflicts with providing suitable accessibility options. The traditional approach of metro accessibility studies seems to be an ineffective measure to gauge sustainable access in which the equal rights of all users are taken into account. Bangkok Metropolitan Region (BMR) transportation has increasingly relied on the role of two mass rapid transport systems publicly called “BTS Skytrain” and “MRT Subway”, due to limited availability of land and massive road congestion; however, access to such transit arguably treats some vulnerable groups, especially women, the elderly and disabled people unfairly. This study constructs a multi-dimensional assessment of accessibility considerations to scrutinize how user groups access metro services based on BMR empirical case. 600 individual passengers at various stations were asked to rate the questionnaire that simultaneously considers accessibility aspects of spatial, feeder connectivity, temporal, comfort/safety, psychosocial and other dimensions. It was interestingly found by user disaggregated accessibility model that the lower the accessibility perceptions—related uncomfortable and unsafe environment conditions, the greater the equitable access to services, as illustrated by MRT – Hua Lumphong and MRT – Petchaburi stations. The study suggests that, to balance the access priorities of groups on services, policy actions should emphasize acceptably safe access for individuals, cost efficient feeder services connecting the metro lines, socioeconomic influences and time allocation. Insightful discussions on integrated approach balancing different dimensions of accessibility and recommendations would contribute to accessibility-based knowledge and potential propensity to use the public transits towards transport sustainability.

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## 1. Introduction

Access to metro or any rail based transport system, including rapid elevated and underground transport, has become an outstanding issue for many societies in large cities as they aspire to shape the future with the use and implementation of efficient mass transport systems. Enhancing metro accessibility incorporates urban transportation policy and planning of cities to propagate sharing of alternative modes and to diminish car dependency. Coinciding with this, the conceptualization of “accessibility” for individuals has been defined [1,2] and has become an increasing criticism on long-term social sustainability [3]. Thus, the issue of equal access for all users has reached a crisis point in many expanding metropolises.

Unfairness in accessibility may be prevalent within Bangkok Metropolitan Region (BMR), Thailand – a metropolitan region including Bangkok and five surrounding provinces. BMR has two types of

metros; namely, Bangkok Mass Transit System (BTS-Skytrain) and Mass Rapid Transit (MRT-Subway), which are located at the heart of the city adjacent to business centers. Running north–south of the inner city, the BTS has two main lines and the MRT has one line; covering distances totaling over 45 km.

Disadvantaged groups (e.g. women, the elderly and disabled people) seem to bear the burden of poor accessibility caused by only promoting high usage volume for typical users. A gender-oriented focus has shown that women have less access and tend to have multiple purposes to their trips [4]. At the same time, specific efforts should be made to investigate the capabilities and limitations of the elderly and the disabled in accessing such systems particularly in the realm of transferring modes within an existing metro system.

Although, many researchers and practitioners have undertaken metro accessibility assessments, their efforts, in general, have been central to spatial-based accessibility [5–7] or the economic values and location-based accessibility [8–10]. These were usually measured by the three indices of distance, time and cost.

These endeavors have not specifically focused on metro accessibility performance across groups in a social context. In addition, traditional approaches lack capturing of other forms of access indicators

<sup>\*</sup> Corresponding author. Tel.: +66 8 5245601, +66 2 5245601; fax: +66 2 5246380.

E-mail addresses: Duangporn.Prasertsubpakij@ait.ac.th, honney.pra@gmail.com (D. Prasertsubpakij), vilasn@ait.ac.th (V. Nitivattananon).

<sup>1</sup> Tel.: +66 2 5245606; fax: +66 2 5246380.

regarding multi-dimensional aspects. Questions have also been raised about the seemingly intrinsic and insurmountable access barriers which have arisen due to the design of the metro system. Discussions about the opportunity to access metro services across user groups can be judged in terms of socioeconomic, temporal [11], and behavioral [12,13] aspects.

The socioeconomic factors that are often given the most attention are those of affordability and service usability. The total cost of metro travel may be high due to encountering enormous transport costs from cross-mode transferring, which should be regarded across user groups. Inconvenient usability and confusion are often dominant problems for user groups, such as the elderly with their limited capabilities. In addition, psychosocial access predictors such as safety, social usefulness, trust, and comfort also need to be given more consideration [14–16].

According to a temporal aspect, two key factors are important for accessibility performance evaluation; namely, activity engagement [17] and the time opportunity of different user groups. The interaction of these two factors highlights the trip-making behavior of different gender groups and other user groups. Moreover, opportunity and equality to metro accessibility among user groups often remain invisible within dominant transport policy.

This study proposes to assess individual metro accessibility performance across user groups by applying multi-dimensional indicators. A new accessibility assessment framework was developed in this study based on a participatory and a sustainability approach. The chief goal of this paper is to investigate and to compare accessibility performance across groups, as the concern of equitable access (the opportunities and benefits of access to services across groups regarding multi-dimensional criteria are considered appropriate and satisfactory). The findings can be useful for improving ongoing metro projects and similar types of transit services in the study area and other cities. The assessment framework of this study can provide practical guidance for investigating accessibility performance of metro systems and other transport modes.

## 2. Metro accessibility systems in BMR, Thailand

BMR is a metropolitan region, which is comprised of the Bangkok Metropolitan Area (BMA) and five surrounding provinces (Samutprakan, Nonthaburi, Nakhonpathom, Pathumthani and Samutsakhon), covering roughly 7583 km<sup>2</sup> with an estimated population of about 10.4 million (around 16% of the total population of Thailand).

In December 1999, two skytrain (BTS) routes started operating in the BMR. The Bangkok Metropolitan Authority (BMA) assigned a 30-year concession, which was to be privately financed, to Tanayong Plc. Five years later in 2004, the second metro system, the Mass Rapid Transit Subway (MRT) was officially launched. The Mass Rapid Transit Authority (MRTA) granted the Bangkok Metro Company Limited (BMCL) a 25-year concession to operate the service. Both the skytrain and the subway systems were built in the Central Business District (CBD) of Bangkok, which includes downtown areas of Siam, Silom, Sathorn and Sukhumvit Road.

Consideration needs to be given to the item inventories of both metro systems in the prospect of the availability and quality in enhancing metro accessibility. Regarding facility design and ticketing systems, Table 1 presents the existing conditions of metro access facilities, fare rates and incentives of selected stations.

As for ticketing, present fares for the BTS Skytrain and the MRT Subway are operated and calculated on a different basis. The fares are high when compared with buses and vans, and there is no fare transfer between the systems. The BTS offers passengers a 'Smart Pass' in four types: *BTS SKY Smart Pass*, *30-Day Smart Pass* (for students and adults), *Magnetic Pass* (1 day pass), and *Single Journey Ticket*. The MRT offers two types of ticket: *Single Journey Token* (for adults and children) and *Stored Value Card*. Both ticketing schemes have been designed for various time

durations. Disabled people can use the service free of charge, provided they hold a disabled I.D. card.

Walking access facilities at stations are unfriendly for all user groups, but especially for the aged and the disabled. The design limitations are not only found in walking conditions, but also in the availability of basic facilities, such as elevators or any other instrumental support. Parking services are available at some stations and fees are high, with the exception of BTS – Mo Chit station where parking services are offered free of charge.

## 3. Approach and methodology

### 3.1. Approach

This study contributes to the balanced integration of multifaceted concepts of accessibility, such as built-environment, transport connectivity, socioeconomic, psychosocial, temporal and equity dimensions, for assessing metro accessibility performance with sound theoretical and empirical methods. In addition, accessibility assessment concerns not only typical user groups but also disadvantaged groups, such as women, the elderly and the disabled, through mixed-tool investigation and multi-stakeholder involvement by using the case study of metro systems in BMR, Thailand. Actions start at the clarification of questions such as, 'how do all user groups properly access the metro systems?' and 'what are the differences in their accessibility performance across user groups?' The evaluation process of the study is in combination with various aspects of metro accessibility based on a proper set of indicators, together with a well-structured study and concept, to manifest appropriately the metro accessibility performance.

### 3.2. Methodology

#### 3.2.1. Selection of site stations

The key criteria used for selecting site stations was the ability for each station to give the expected example of all user groups, especially the elderly and disabled people. This is a limitation because such groups were found only in a small proportion of all users. In addition, they would demonstrate the various characteristics of functions of stations (terminal, interchange and typical stations), built-environment and facilities that can be visibly measured and provide adequate data supporting the research process. After the pre-survey, three BTS Skytrain stations (*Mo Chit*, *Saphan Taksin*, and *Chong Nonsri*), and three MRT Subway stations (*Chatuchak Park*, *Hua Lumphong*, and *Petchaburi*) were selected to assess the metro accessibility performance in BMR, Thailand.

#### 3.2.2. Selection of indicators

First, a tentative set of indicators was conducted by reviewing and interviewing the representative stakeholders from various sectors such as local authorities (BMA), metro businesses (Bangkok Mass Transit System Public Company Limited (BTSC) and Bangkok Metro Public Company Limited (BMCL)), Mass Rapid Transit Authority (MRTA), Office of Transport Policy and Planning (OTP) and other interested groups. Second, a set of hypothesized indicators was adjusted and categorized into sustainability criteria. In this stage, 30 questionnaires comprising the indicator set were sent by email and by post to interdisciplinary experts related to multi-dimensional accessibility, in order to weigh a score using a five-point Likert item [18] to give the researchers a suggestion of selected indicators for assessing metro accessibility in the BMR. At the second stage, a total of 20 indicators and criteria were left as shown in Table 2. Third, factor analysis and reliability tests were created [19,20]. Initially, Kaiser–Mayer–Olkin (KMO) [21] and Bartlett's tests were applied to measure the sampling adequacy and to indicate the suitability for such analysis [22]. To check the validity of this structure, a reliability test was carried out to

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