Transit-Oriented Development and Accessibility

Case studies from Southeast Asian cities

Case-Specific Policy Analysis

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The International Transport Forum

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Case-Specific Policy Analysis Reports

Cite this work as: ITF (2023), "Transit-Oriented Development and Accessibility: Case studies from Southeast Asian cities", *International Transport Forum Policy Papers*, No. 124, OECD Publishing, Paris.

Acknowledgements

The authors of this report are Vatsalya Sohu, Dimitrios Papaioannou and Nobuyoshi Hasegawa, with contributions from Nicholas Caros, all of the International Transport Forum (ITF). Funding for this report was provided by the Government of Japan. It draws on the EC/ITF/OECD Urban Access Framework (UAF) developed through a joint ITF-OECD project on Access and Safety in European Cities.

Elisabeth Windisch (ITF) supervised the project and reviewed the report. The authors also thank Hilary Gaboriau (ITF) for editorial support.

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Executive summary

What we did

This report assesses the potential of transit-oriented development (TOD) to improve accessibility in three Southeast Asian cities: Bangkok, Ho Chi Minh City and Manila. It outlines the challenges of applying TOD practices in developing countries and presents three case studies of successful implementation of TOD, which capture the various forms that TOD can take.

The study uses the EC-ITF-OECD Urban Access Framework to identify which destinations can be reached on foot, by bicycle, public transport or by car within a certain time, e.g., 30 minutes, as indicator for "absolute" accessibility. It then measures how many destinations are close by as "proximity" indicator. The comparison between these two shows how well each transport mode performs and thus informs the "transport performance" indicator. The three indicators are calculated for schools and hospitals in the three cities. The report then assesses the impact of new infrastructure proposals with and without related TOD policies on accessibility in these cities.

What we found

In all three cities, cars and motorbikes provide better accessibility than public transport or walking. Public transport offers much lower levels of absolute accessibility, with 130 000 people reachable within 30 minutes in Bangkok and 390 000 in Manila. In comparison, the absolute accessibility by car is, respectively, 14 and 7 times higher in these two cities.

Only Ho Chi Minh City performs well in terms of public transport accessibility. In 30 minutes, the average city inhabitant can reach 900 000 people. However, the absolute accessibility by car in the city is still 3.8 times higher.

All three cities offer higher accessibility than their surrounding commuting zones for all modes. Naturally, as commuting zones tend to be less densely populated, they have much lower absolute accessibility in all modes.

As all three cities are very densely populated; people often live close to many destinations. Accessibility levels are therefore relatively high, despite congestion that often reduces transport performance. Accessibility levels can be increased by policies that improve transport performance and bring people closer to their destinations. This is also one of the underlying principles of TOD.

Introducing new rail infrastructure also improves absolute accessibility to people by public transport in all three cities. While the proposed new infrastructure in Bangkok and Manila sees an improvement of about 30% and 10%, respectively, the improvement is only marginal in Ho Chi Minh City due to the already high accessibility observed in the city.

Similarly, the impact of TOD policies is assessed. In this case, both accessibility and proximity improvements are observed. This affirms the positive impact that TOD can have on accessibility in cities.

Absolute accessibility to people within a 30-minute threshold improves by 16%, 18% and 54% in Manila, Ho Chi Minh City and Bangkok, respectively. Proximity in an 8 km radius (to people) improves by 13%, 14% and 40% in Bangkok, Manila and Ho Chi Minh City, respectively.

What we recommend

Ensure sufficient availability of public transport and infrastructure for active modes

Sustainable transport modes, such as walking, cycling, and public transport, must be prioritised. Ensuring the availability of quality public transport is essential. If public transport becomes more frequent and comfortable, people will be willing to walk further to reach it. Transport policies in Southeast Asian cities must promote sustainable modes by prioritising them in city budgets and urban design. By installing sufficient safe sidewalks and bike lanes, users are more likely to walk or cycle instead of driving short-distances.

Integrate transport planning with land use planning for co-ordinated implementation of measures

In many developing countries, inconsistent spatial policy objectives drive low-quality transport infrastructure and urbanisation. Consistent and co-ordinated transport and land-use policies are critical to ensuring the sustainable growth of urban areas. This can be achieved by integrating land use and transport agencies or by establishing a regional land-use and transport body that ensures institutional co-ordination of the two portfolios' goals. A long-term collaborative vision for transport and land use can aid the implementation of transit-oriented development.

Embrace disruptive mobility trends in ways that ensure improved accessibility

People in cities across the globe increasingly adopt new forms of mobility, aided by digital connectivity and electrification. New shared mobility services can improve the performance of the existing public transport system if suitably integrated. Authorities should encourage inter-modal trips where these can reduce overall energy use and greenhouse gas emissions.

Collect more and better-quality data on urban mobility to underpin transit-oriented development

Collecting reliable data is essential for cities to understand the current state of accessibility. Public authorities should inform their decisions by regularly gathering and analysing such quality data. For example, the often poor availability and quality of data on pedestrian and cycling infrastructure must be improved. Authorities must also collect data on the use and performance of old and new forms of urban mobility, such as traditional public transport services, carsharing, bicycle sharing, e-bikes and e-scooter systems.

Learn from international experiences with transit-oriented development and apply them locally

Local authorities should use international examples of successful TOD implementation as inspiration. At the same time, developing and finding solutions that account for specific local contexts is crucial for the successful implementation of TOD practices. These include local and regional planning approaches, the city's built environment and cultural specificities that impact travel behaviour.

Improving accessibility through transit-oriented development

Accessibility, or how people can easily reach their destinations, is one of the most important performance measures of a transport system. It provides information on how people's needs to move are met. It measures people's quality of life. Accessibility consists of two key elements: attributes of people – people's needs and magnitude, quality and character of activities – and attributes of traffic and spatial conditions – spatial distribution and the ease of reaching each destination (Hillman and Pool, 1997; Handy and Niemeier, 1997).

Some developing countries are experiencing rapid economic growth but often face the challenges of widening disparities, sustainability gaps, rapidly growing populations, inadequate social development, and political and economic instability. When it comes to transport, public transport tends to be low quality and inadequate. Subsequently, there is a predominance of informal transport, walking or cycling as the main modes of urban transport (United Nations Human Settlements Programme, 2013). In this context, building quality transport infrastructure is imperative for developing countries to achieve sustainable development.

Quality transport infrastructure is considered inclusive when the benefits are shared with the entire society, leaving no one behind. Today, several big cities in developing countries face heavy traffic congestion that hinders accessibility and leads to substantial economic and environmental costs. In Bogotá, for example, drivers spend 30% of their time in traffic jams, while in Bangkok, the average driver spends more than 60 hours per year stuck in traffic (INRIX, 2019).

Introducing public transport systems in these cities has not necessarily alleviated the congestion problem. Most cities in developing countries experienced car-oriented urban growth. In the face of economic growth, the focus has been on expanding the road system and catering to the increasing number of automobiles. For example, in San Paulo, some of the most important transport planning enlarged the streets and highway systems to create comprehensive spatial interconnections (Vasconcellos, 1997). Urban planning policies also contributed to enhancing the ease of car use. For example, new land-use laws allowed the building of middle-class housing and apartment complexes in newly occupied areas where governments provided adequate infrastructure and relevant traffic and parking conditions. These cities had not matured in urban infrastructure when developing public transport systems. This resulted in establishing public transport systems that were not based on access to key city facilities. The absence of quality pedestrian and cycling infrastructure are another common characteristic of car-oriented urban growth.

Transit-oriented development (TOD) can be an effective measure to help cities solve the issues that arose from their former growth strategy, including traffic congestion triggered by the growing population and the increase in private vehicle ownership. TOD is a type of urban development that maximises the amount of residential, business and leisure space within walking distance of public transport. It creates compact, walkable, pedestrian-oriented, mixed-use communities centred around high-quality train systems. TOD contributes to increasing transit ridership and housing choice, relieving traffic congestion, reducing pollution and creating a diverse and lively community. Studies have shown that TOD strategies such as high-density urban development along public transport networks and mixed-use urban design may reduce commuting distance, commuting time, and vehicle kilometres travelled (VKT) and increase the cumulative rail-based accessibility to inhabitants and jobs (Papa and Bertolini, 2015; Ambarwati et al., 2016;Fukuda, Satiennam and Oshima , 2006).

In the last few years, many cities in developing countries have introduced integrated urban development policies on different scales (neighbourhood, city and metropolitan) in alignment with diverse transit systems, which are rail-based, road-based, or both. Some examples are in cities like Curitiba, Brazil; Ahmadabad and Delhi, India; Shanghai and Guangzhou, China; and Johannesburg, South Africa. Applying transit-oriented development in developing countries seems an opportunity to go beyond isolated mobility improvement, aiming at implementing urban development policies that improve accessibility.

Southeast Asian cities are a good testing ground for exploring how TOD can improve accessibility. Southeast Asian cities are experiencing an acceleration of economic growth, motorisation and socio-economic progress. Despite its many benefits, the rapid development in the region raises challenges such as excessive congestion, poor accessibility by public transport and increased air pollution from vehicle emissions.

The remaining sections of this report look at the theoretical background of TOD. It highlights Tokyo, Japan; Randstad, Netherlands; and Denver, Colorado, United States, as three case studies of successful TOD implementation. Next, the report outlines the challenges that developing countries often face while implementing TOD. Finally, it uses Bangkok, Thailand; Manila, the Philippines; and Ho Chi Minh City, Viet Nam to illustrate how TOD can improve accessibility in Southeast Asian cities.

Transit-oriented development in theory and practice

The concept of transit-oriented development (TOD) first gained attention when Peter Calthrope, an American architect and planner, published *The Next American Metropolis: Ecology, Community, and the American Dream* in 1993 (Calthorpe, 1993). In this book, he describes TOD as:

> A Transit-Oriented Development is a mixed-use community within an average 2 000-foot walking distance of a transit stop and core commercial area. TODs mix residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot, or car. (Calthorpe, 1993)

TOD is a broad concept and is thus often confused with transit-joint development (TJD). While the two concepts are similar, they are different in terms of the size of the projects undertaken. TOD is usually bigger in terms of the scale of the projects as TOD measures are neighbourhood-wide. In contrast, TJD is a smaller version of similar policies that are often bound to a specific project on real estate development in a particular part of a neighbourhood (Cervero, Ferrell and Murphy, 2002). Cervero, Ferrell and Murphy (2002) highlight another critical difference between TOD and TJD: TOD is usually planned and implemented by public agencies. In contrast, TJD often involves a partnership between private and public entities.

Several definitions of TOD can be found in the literature that describe TOD as any sort of development centred on transport.

The available definitions of TOD usually share the aspects of mixed-use community development, proximity to transit services, less dependence on private vehicles and increased use of public transport (Maryland Department of Transportation, 2000; Center for Transit-Oriented Development, n.d.; Still, 2002; Boarnet and Crane, 1997; Bernick and Cervero, 1997). Most definitions of TOD only differ in their focus on pedestrianisation and increased bike use.

While the definitions provided above are more conventional ones, a more contemporary definition is offered by Delft University of Technology, Austrian Institute for Spatial Planning and Nordregio, which is as follows:

> Transit-oriented development (TOD) is generally considered to be mixed-use development near, and/or oriented to, public transport facilities. Common TOD traits include urban compactness, pedestrian and cycle-friendly environments, public and civic spaces near stations, and stations as community hubs. Typically, a multimodal TOD neighbourhood is built around a public transport station or stop (e.g. train station, metro station, tram stop, Bus Rapid Transit stop (BRT), bus stop, or even ferry stop), surrounded by relatively high density development with progressively lower-density development spreading outward from the centre. (Delft University of Technology, Nordregio and Austrian Institute for Spatial Planning, 2016)

TOD policies are often designed to encourage people to live near transit services to reduce their dependency on private vehicles (Still, 2002). More recently, TOD has emerged as a solution to a variety of issues like scarcity of residential spaces, increased traffic congestion and poor air quality in urban areas (Cervero, Ferrell and Murphy, 2002). At the most basic level, transit-oriented development refers to the integration of transport and land-use policies to reduce urban development's carbon footprint and make it more sustainable. The development comprises a mix of land uses like office spaces, residences, and shopping complexes around transit stations in a way that the distances between the stations and these spaces are either walkable or cyclable.

Belzer and Autler (2002) state six essential characteristics of TOD (Table 1). These characteristics form a performance-based interpretation of TOD. While defining TOD, it is important to highlight the role played by public transport agencies and other government bodies at different levels in developing mixed-use communities around public transport stations or designing public transit stations for existing communities.

Box 1. The history of transit-oriented development

The concept of transit-oriented development (TOD) has been around for over a century. At the beginning of the 19th century, when early urbanisation began in the United States and the United Kingdom, horse-drawn streetcars sprang up as a form of public transport. These were succeeded by electric streetcars later in the 19th century. The advent of electric streetcars served as a facilitator for the development of housing outside the city centres as streetcars provided access to jobs in the city from the periphery (Fogelson, 1993).

In their book "New Transit Town: Best Practices in Transit-Oriented Development", Dittmar and Ohland (2012) described the early 20th-century transit-related development as "development-oriented transit", and the transit-related development of the 1970s as "auto-oriented development". While development-oriented transit was characterised by the use of electric streetcars as the principal means of transport between the developing peripheral housing areas and the city centre, auto-oriented transit was characterised by the rise of facilities like park-and-ride, which primarily catered to the commuters using private vehicles.

Today's understanding of transit-oriented development emerged from a reappearance of TOD in the late 1980s when an interest sprouted in the relationship between urbanisation and environmental degradation. The development of suburban residential areas became linked with traffic and air pollution in cities as private car use to and from them increased (Cervero, 1986).

Urban developers realised that they could play an important role in addressing the issues of traffic congestion and air pollution by increasing public transport use, walking and cycling. They could encourage this shift by guiding the scope and type of development around transit stations. Transit agencies, especially in the United States, shifted their focus on transit development projects that not only increased public transport ridership and walking, thus reducing the use of private vehicles, but simultaneously contributed to revenue from land leased by transit agencies.

During this period, transit agencies partnered with private real-estate developers to develop land-use projects around these transit stations. The revenue from the lease acted as a financing tool for the transit agencies. Dittmar and Ohland called this type of joint development by real-estate developers and transit agencies "transit-related development" (Dittmar and Ohland, 2012), while Cervero (1993) called it "transit-supportive development".

Table 1. Characteristics of transit-oriented development

Characteristic	Description
Location efficiency	Implies that residents have more mobility choices that effectively convert driving private vehicles from an inevitability to an option (Belzer and Autler, 2002).
Value recapture	Implies that residents of location-efficient neighbourhoods spend less money on transit in contrast to those from neighbourhoods dependent on private vehicles for their daily commute.
Liveability	Refers to the subjective concept of the well-being and quality of life enjoyed by residents in neighbourhoods planned using TOD strategies.
Financial return	Implies that TOD must result in the generation of revenue for the public as well as for private actors involved in such projects while providing a more economical option for the residents.
Choice	Refers to the increased options to residents in terms of the type of housing, shopping complexes and a range of transport options.
Efficient regional land-use patterns	Refers to land-use characterised by less congestion, reduced loss of open spaces, reduced commutes and reduced air pollution.

Source: Belzer and Autler (2002).

Challenges to implementing transit-oriented development in developing countries

TOD presents an opportunity for policy makers in developing countries to ensure that, as cities expand, transit ridership improves, urban sprawl is avoided, and accessibility is enhanced. TOD can also equip cities to overcome car dependency (Goetz, 2013) and reduce air pollution (Loo, Cheng and Nichols, 2017).

However, there are some challenges to implementing TOD in developing countries. TOD is a complex tool that requires high levels of co-ordination between different agencies for it to be effective. Since cities in developing countries are rapidly expanding, there are inconsistencies in the co-ordination between land-use planning and transport planning. Their future visions and plans tend to be poorly co-ordinated between stakeholders. For example, despite improving public transport networks in Bangkok, urban development has focused on providing large car parks for a car-oriented lifestyle and not on planning for transit-oriented development around Mass Rapid Transit (MRT) stations (Rujopakarn, 2003). Banister and Berechman (2000) argue that co-ordination between regional and municipal agencies and favourable economic circumstances are pre-conditions for the association between transport and development.

Another constraint is the lack of pre-existing networks and infrastructure, such as public transport networks and sufficient roads, compared to developed countries. Many cities in developing countries face the challenge of limited supply or poor service quality of public transport, which, coupled with high levels of traffic congestion, has often led to falling public transport ridership (Pojani and Stead, 2017). Paratransit is a common part of the transport systems in such cities. While helpful in providing low-income populations with essential transport services, it can weaken the public transport systems, hindering the implementation of TOD (Salazar, 2015).

Urban density in developing countries has been traditionally higher than in developed countries. However, urban sprawl has led to falling density rates in the last few decades (Cervero, 2013). Policy makers aiming to maintain the lower density in city centres have spread development outwards into new areas (Suzuki, Cervero and Iuchi, 2013). This has resulted in excessive use of private vehicles, for example, in Kuala Lumpur, Malaysia (Kiggundu, 2009). With development spreading outwards and causing sprawl, attention is not paid to developing the areas around transit stations. Furthermore, the urban environment in such cities caters primarily to car users. Motorised vehicles have priority, with narrowed pavements, encouraging the use of subway bridges and tunnels instead of at-grade pedestrian crossings (Pojani and Stead, 2017).

Transit-oriented development in practice: Case studies of successful implementation

The concept of TOD is widely practiced, even if it is not explicitly called so. This study looks at Tokyo, Japan; Randstad, Netherlands and the US city of Denver, Colorado as examples of successful executions of TOD. The below examples show that successful implementation of TOD requires: 1) co-ordination among the institutional actors involved, 2) public transport systems that offer a sufficient range of destinations throughout the city and 3) improved regional and multimodal connections.

Tokyo, Japan

Historically, the concept of TOD is recognised as an essential theory of urban development in Japan. From 1910 to 1930, Ichizou Kobayashi founded an enterprise for railroad construction and real estate development in the Kansai area. This became the Hankyu railroad company. Eiichi Shibusawa and Keita Gotou carried out similar projects in Tokyo, which were later transferred to the Tokyo railroad company. Private transit operators in Tokyo built high-density areas along their transit lines to boost ridership. Each station is within walking distance of most daily services. The different high-density regions are interconnected by an efficient rail and bus system. TOD stations are also served by feeder buses, and the rail lines connect directly with subways, allowing seamless access to the city centre.

The high-density areas are fully navigable by foot, bus or subway. In many cases, the vast railway system allows for residents in TOD zones to access most leisure activities by mass transit. Transport demand management (TDM) further reinforces a transit-oriented lifestyle. Relatively high gas prices, expensive and limited parking, and narrow roads further reduce the impulse to drive and make the cheaper mass transit option even more attractive. Japan allows private industry and transit operators to develop denser, mixed-use areas around transit stations. This plays a crucial role in the success of these types of development. This private development has also led to the efficient use of stations, where transit operators provide non-transport-related services, such as shopping.

One of the latest TOD examples in Tokyo is Shibuya Station’s redevelopment. Shibuya is one of the busiest areas in Tokyo. The large crossing in front of Shibuya Station and various recreation facilities attract locals and tourists alike. Eight rail lines go through the central area of Shibuya, and crowds of passengers pass through the station daily. Shibuya Station and the area around it was defined as the Urban Renaissance Emergency Development Area in December 2005 (Reggiani, 2021). The Shibuya Station redevelopment encompasses the Shibuya area, and almost all services are set up around the transport hub. The integrated city-station development, which enhances accessibility among various urban spaces, enables people to easily and quickly arrive at their destinations. In these redevelopment projects, all new facilities and areas within and around stations are integrated with the pedestrian system, which makes the stations very accessible. The stations function not just as transport hubs but also as integrated city spaces.

Randstad, Netherlands

Zuidvleugal (South Wing) is a region of densely populated cities and towns in the southern part of the Randstad in the Dutch province of South Holland. In 2003, a council called Stedenbaan was formed to implement a TOD project in the region. The council was comprised of Zuid Province, five city regions of the Province, the municipalities of the Hague and Rotterdam, the Nederlandse Spoorwegen railway company and the rail infrastructure provider ProRail Stedenbaan was succeeded StedenbaanPlus, which is still ongoing.

The Stedenbaan project came about as a solution to the incongruity between the rate of urbanisation and the development of transport in the region (Padilla, Morote, and Aracil, 2017). Its goal was to improve the public transport landscape in Zuidvleugal by enhancing the quality and the number of connections. Stedenbaan’s two main objectives were to create a high-frequency public transport line on the current rail line; and to boost the land use around the stations on this line (Renne, 2016). The Stedenbaan project was based on the idea that the development of public transport and spatial development will trigger one another (Balz and Schrijen, 2009).

Land-use project in the vicinity of the train stations involved the construction of office spaces, residential spaces and other amenities, including parking spaces for cars and bikes The spatial development included plans to construct 40 000 new houses and 1 million square metres of office space. During 2006-2010, 45% of these new houses were built in the vicinity of the Stedenbaan stations (Staricco, 2016).

In 2011, the project was expanded and renamed StedenbaanPlus. The new ambitions called for increasing the percentage of new houses from 45% to 60%-80% during the 2010-2020 period. These ambitions were revised and reduced due to public finance cuts and the property crisis that affected the demand for new housing and office spaces. Despite this, by 2011, the number of cities involved in the project still increased from 11 to 47 (Geurs et al., 2012). In 2015, 79% of the total new homes in Southern Randstad were built close to high-quality public transport (Metropolitan Region Rotterdam The Hague (MRDH), 2016).

Stedenbaan is a typical example of a recent TOD project combining public transport development with mixed-use land projects. The project has improved accessibility by putting high-frequency transit in a place where it had not existed previously and promoted sustainable development in the region by encouraging public transport over privately owned vehicles. Both elements reflect the essence of contemporary TOD projects.

Denver, Colorado, United States

In 2004, the citizens of the US city of Denver, Colorado voted to adopt the FasTracks programme to “expand transit across the Denver metro region” by extending the light rail service, improving bus service, and adding new amenities, such as Park-and-Ride parking lots, to reduce traffic congestion (Regional Transport District, n.d.). The Regional Transportation District (RTD) opened the plan's first phase in 2013. Six of the 12 stations of the light rail project included parking access for commuting. The project also included the creation of 4.26 miles of bike paths for additional, non-vehicular transport options. The FasTracks programme has also focused on creating new bus rapid transit (BRT) between Denver and surrounding communities. The service offers express routes, dedicated rush-hour service for the community, and buses with daily morning-to-night service to replace the need for a car. By 2014, the metro area boasted 122 miles of new light and commuter rail, 18 miles of BRT, and 57 new transit stations (Goetz et al., 2016). The infrastructure reduces dependence on driving even as the area continues to grow and can reduce the environmental impact of new urban sprawl.

FasTracks improvements provide transport for TOD, one of Denver's Strategic Planning initiatives. Transit Oriented Denver, the city's TOD strategic plan (City and County of Denver, 2014), first proposed in 2006, uses TOD to address increasing demands for housing while mitigating congestion by adapting developments to different typologies, including dense urban centres and the metro area's suburbs. Transit communities provide residents with easy access by foot, bicycle, and transit to daily activities and maximise resident access to public transport by focusing activities near a major transit stop. The 2006 Plan included long-range planning for new transit, and subsequent plans have expanded the programme to include resources for residents, developers and public employees. Denver continues to promote TOD as a sustainable and desirable way to grow within Denver and the surrounding areas by providing residents with the mixed-use neighbourhoods and walkability they continue to prefer.

Transit-oriented development and accessibility in three Southeast Asian cities

Bangkok, Ho Chi Minh City, and Manila grapple with urbanisation challenges. Bangkok faces rapid expansion and traffic congestion challenges, calling for improved public transport integration with urban planning. Ho Chi Minh City, Vietnam, contends with motorcycle dominance, striving to enhance public transport to reduce congestion and improve air quality. Manila experiences high urban density, leading to severe traffic congestion. Initiatives include a Bus Rapid Transit (BRT) system and integrated land-use planning. These cities underscore the need for sustainable urban transport solutions to accommodate population growth, reduce traffic, and enhance overall quality of life. The latter sections of this chapter compare accessibility in Bangkok Metropolitan Region (BMR), Ho Chi Minh City, and metropolitan Manila using EC-ITF-OECD indicators. It assesses the number of people reachable within 30 minutes from any point in the cities, comparing these Southeast Asian cities to London, Paris, Mexico City Metropolitan Area, and Bogota.

Bangkok, Thailand

Bangkok, the capital of Thailand, is located on the Lower Central Plain over the Chao Phraya delta at the top of the Gulf of Thailand. It is home to almost six million people. The Bangkok Metropolitan Region (BMR) comprises the central area called Bangkok Metropolitan Area (BMA) and its five adjacent provinces. BMR covers 7 758 square kilometres. The total population of BMR in 2019 was over 14 million, or 22% of the total population of Thailand. (UNESCAP, 2020)

The rapid urban expansion of Bangkok resulting from population growth over the past few decades has left the city struggling to maintain pace with urbanisation trends and match it with the provision of the necessary public infrastructure. While the transport network has been expanding over the last few years, Bangkok still struggles with traffic congestion and poor air quality. Among other challenges, the transport system remains inefficient due to competing and fragmented modes of transport.

Despite recent investments, the funds dedicated to the public transport system are insufficient, impacting the mobility system as a whole. Table 2 provides a brief overview of the developments that have taken place in the transport sector and in land-use planning policies. While improvements have been made, the mass transit stations intended to decongest strategic areas have attracted high-rise developments that, without adequate provisions for affordable housing, have displaced low-income communities.

There is a need for increasing public transport ridership to alleviate traffic congestion and respond to urban growth trends. This can be done by integrating public transport networks and land-use planning, and improve public transport networks. To date, urban development has focused on providing large car parks for a car-oriented lifestyle. This might suggest that urban development strategies have not prioritised ensuring access to opportunities through integration between transport networks and land use planning.

Table 2. Transport and land-use planning milestones in Bangkok

Year	Milestones
1962	First National Economic and Social Development Plan (NESDP) (Revised every five years since).
1962-1976	1st – 3rd NESDP focused on the Basic Road Infrastructure Development.
1975	Urban planning code was prepared in Thailand.
1977-1986	4th – 5th NESDP focused on major road and expressway projects since sprawling had already started.
1981	Floor area ratio was introduced into certain areas.
1987-1991	6th NESDP focused on the expansion of bus service and expressway network.
1992	1st Bangkok Comprehensive Plan was established by the Department of Public Works and Town and Country Planning of the Thailand Government (revised every seven years since).
1992	The floor area ratio for the high-rise building and large-scale buildings was increased to 10:1, which increased traffic volume in the city.
1994	Mass Rapid Transit System Master Plan (MTMP), which was the first plan for the urban mass transit network, was approved by the Cabinet. MTMP envisioned the creation of more than a dozen new subway and rapid urban rail lines and proposed a 135 km mass transit network.
1997	Financial Crisis.
1999	Thailand's government announced a new regulation to give management power for a comprehensive plan to local administration.
2000	MTMP was revised as the Urban Rail Transportation Master Plan in Bangkok and Surrounding Area (URMAP), which combined the four trunk lines and two feeder lines.
2006	The Office of Transport and Traffic Policy and Planning (OTP) published "The Intermodal Services Integration for the Improvement of Mobility, Accessibility and Livelihood for Bangkok Metropolitan Region (BMR) and Surrounding Area (IMAC study)" as the latest MTMP.
2010	Mass Rapid Transit Master Plan in the Bangkok Metropolitan Region (M-MAP), which was the last version in a series of Thailand Government plans for the development of an urban rail transit network serving the Great Bangkok area, was endorsed in 2010 with eight primary routes (two commuters, one airport rail link, five transit lines) and five feeder lines.

Source: Johnstone (2007), Rujopakarn (1992), Peraphan and Sittha (2017), Resilient Cities Network (n.d.).

Ho Chi Minh City, Viet Nam

Ho Chi Min City (HCMC) covers 30 000 square kilometres (ADB, 2010). Its total population of 8.4 million exceeds that of Viet Nam's capital Hanoi. The Ho Chi Minh City metropolitan area's population exceeds 20 million, of which 16 million live in urban areas (General Statistics Office of Viet Nam, 2018). In 2018, HCMC accounted for 23% of Viet Nam's gross domestic product (GDP) and 20% of its foreign direct investment (UN Habitat, 2018). HCMC currently faces many issues caused by rapid population growth and subsequent land-use change, notably, poor access.

HCMC's urban transport is characterised by the domination of motorcycles, a limited supply of public transport services and low reliance on public transport for mobility within the city; only 4% of residents used buses in 2015 (Arup and Siemens, 2015). Starting in 1994, efforts to revitalise the city's bus system by increasing supply and improving service quality to boost ridership have had minimal success. In 2000, reforms to HCMC's bus system were introduced, along with the procurement of new vehicles by the city for Saigon Bus and the private co-operatives, but utilisation rates have remained low.

The low utilisation of public transport services contrasts with the HCMC's heavy reliance on motorcycle mobility. Motorcycles provide flexible, on-demand, low-cost, door-to-door mobility for a wide variety of trips, well-suited to HCMC's year-round moderate climate. Besides adversely affecting the financial viability of public transport services and overall urban development, the heavy reliance on motorcycles is highly detrimental to the city's air quality and traffic safety.

Motorcycle ownership has rapidly increased to serve the increased travel demand. Car ownership also continues growing quickly as personal income rises. Despite accelerated motorisation, the road network lags behind, and public transport services are still under development. HCMC's government has enacted a plan to address these problems.

HCMC holds a pivotal role in the national economy. As such, in 2010, Prime Minister Nông Đức Mạnh approved the Master Plan for HCMC up to 2025 (UN Habitat, 2018). The Master Plan indicates the basic development direction of HCMC as a multi-core urban structure with satellite towns and sub-centres to alleviate the present saturation in the city centre. It designates specific recommendations for future growth and indicates new transport routes that should be implemented. The Master Plan seeks to accommodate the growing population without building on flood-prone land or encroaching the historic neighbourhoods. It also emphasises improving the city's quality of urban infrastructure and services, including developing sustainable urban transport systems (Dapice, Gomez-Ibanez and Thanh, 2010).

HCMC needs the Bus Rapid Transit (BRT) and Mass Rapid Transit (MRT) systems to serve the increasing travel demand and reduce motorcycle use (Tuan, 2012). The Master Plan for Transport Development in Ho Chi Minh City to 2025 seeks to raise the capacity of the public transport system to meet 25% of the city's total travel demand, encouraging the use of public transport, reducing motor vehicle use and improving traffic safety. (UN Habitat, 2018)

The Master Plan for HCMC proposes new satellite cities around HCMC to relieve the pressure on the urban core, and the proposal includes new ring roads around the urban centre of HCMC. This could result in an increased dependence on private vehicles if no efficient public transport system is in place by the set date and if the satellite cities are well planned as autonomous centres.

Manila, the Philippines

Metropolitan Manila, or Metro Manila, the capital region of the Philippines, comprises 16 cities and one municipality. It covers an area of 636 km^2, barely 0.2% of the total land area of the country (National Statistics Office, 2012). The total population of Metro Manila in 2020 was 13.5 million, 8% of the total population of the Philippines (Philippine Statistics Authority, 2020). It produced over one-third of the nation's GDP in 2019 (DTI, 2019).

Like many cities in Southeast Asia, urban development in Metro Manila has generally been unplanned, resulting in the sprawl of the metropolitan region. Planning institutions have been weak and lack the effective control needed for better spatial growth (Sajor, 2003). Unlike in most developed countries where urban sprawl has resulted in higher private motor vehicle travel, public transport remains the principal means of mobility in Metro Manila despite the sprawl. Table 3 provides a brief overview of the public transport projects and land-use planning integration that has been undertaken in Metro Manila since the early 1980s.

The urban density of Manila is one of the highest in the world, and the motorisation rate far exceeds the street capacity to handle traffic (Boquet, 2013). The number of vehicles increases every year in the Philippines, resulting in severe traffic congestion on major roads in Metro Manila (Bondoc et al., 2018).

The system's overall capability must be improved by introducing and devising new policies to strengthen the resilience of the Metro Manila transport system.

Table 3. Transport and land-use planning milestones in metropolitan Manila

Year	Milestone
1984	The Light Rail Transit (LRT) system began operation.
1990s	The Philippine Government began a programme to use private sector forces to provide infrastructure, including urban rail. Accordingly, LRT development has been undertaken with the active participation of the private sector.
2011	A national environmentally sustainable transport (EST) strategy was released to guide the development and implementation of a master plan for the country’s transport system. This EST strategy envisions an integrated, efficient and effective transport system that moves more people through low-emission transport modes and reduces greenhouse gas emissions. Under the national EST strategy, the government should shift to non-motorised forms of transport (such as walking and biking) and an improved public transport system (such as BRT, and an expanded urban rail system).
2013	The National Economic and Development Authority (NEDA) proposed the mass transit network.
2015	The Philippines’ Department of Transportation and Communications (DOTC) developed plans to improve public transport networks.
2017	NEDA Board approved the National Transport Policy (NTP) as well as 11 projects, including railway projects which envision a safe, secure, reliable, efficient, integrated, intermodal, affordable, cost-effective, environmentally sustainable and people-oriented national transport system that ensures improved quality of life of the people.
2018	NEDA released the draft implementation rules and regulations of the NTP. The framework sets guidelines for the integration of land use and transport planning.
2018	Public Utility Vehicle (PUV) Modernization Program of the National Government through DOTr. A large-scale transformational initiative and flagship project of the National Government supported by the proposed Comprehensive Tax Reform Program of the Department of Finance. It envisions a restructured, modern, well-managed and environmentally sustainable transport sector where drivers and operators have stable, sufficient and dignified livelihoods while commuters get to their destinations quickly, safely and comfortably.

Source: Newman and Kenworthy (1996), Pacheco-Raguz (2010), Pontawe and Napalang (2018), Regidor and Aloc (2017).

Current accessibility levels

This section compares accessibility in BMR, Ho Chi Minh City and metropolitan Manila by mode using the EC-ITF-OECD indicators that analyse the average number of people reached in 30 minutes from any point in the city. The three chosen Southeast Asian cities are compared to the cases of London and Paris – the two largest cities in Europe (with a population of around 9 million and 12 million, respectively), and with Mexico City Metropolitan Area (21 million people) and Bogota (7 million people) – the two largest Latin American cities. The comparisons draw on the previous work conducted by the ITF for these latter cities (“Benchmarking Accessibility in Cities: Measuring the impact of proximity and transport performance” (ITF, 2019); “Developing accessibility indicators for Latin American Cities” (forthcoming)). Access to the population can be used as a broad proxy for access to opportunities. That is, places that have access to more people are assumed to have access to a larger number of desirable destinations of all kinds. Access to people is used as a baseline and control in comparing accessibility to the specific destination types examined in later chapters.

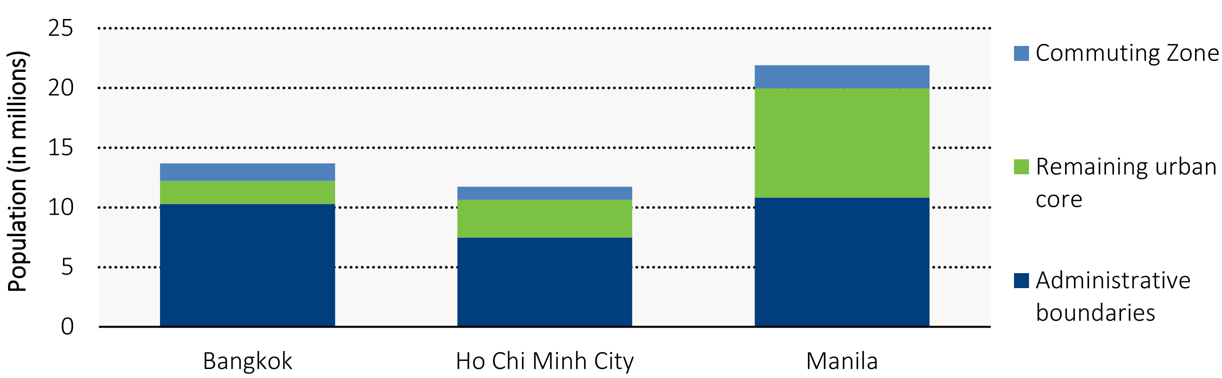
The indicators used to assess access levels in the three cities include:

1. **Absolute accessibility**: Number of people reachable within fixed time thresholds by a given mode (i.e. number of people reachable in 30 minutes by a certain transport mode);
2. **Proximity**: Total number of people available within a certain radius (i.e. number of population within a 16 km radius).
3. **Transport performance**: The ratio of people located within a pre-defined radius that can be reached in a set time by a given mode, i.e. the ratio between absolute accessibility and proximity. This indicator allows determining to what extent the transport service efficiency and the network connectivity affect the absolute accessibility levels. For car travel it reflects the combined effects of road network configuration, speed, congestion, detour and time spent searching for parking on access levels. For public transport trips, frequencies of operation, long walking and waiting times due to excessive queuing, and overall quality of public transport service are among the factors influencing public transport performance. For walking and cycling trips, the performance is determined by the availability of non-high-density roads.

The three cities compared are different in size, structure and urban form. To allow for meaningful comparisons between cities, the OECD and the European Commission have developed a harmonised definition of functional urban areas (FUA), which includes cities and their commuting zones based on functional connections between localities. This FUA consists of municipalities or local units that form a densely and contiguously inhabited "urban centre" – a city of at least 50 000 inhabitants – and its less-densely populated commuting zone from which at least 15% of the local workforce commute to the city (OECD, 2013).

The populations of the administrative areas of the three cities range from 7.48 million people in Ho Chi Minh City to 10.83 million in Manila (Figure 1). The remaining urban area has fewer people in Bangkok (2 million) and Ho Chi Minh City (3 million), whereas in Manila, 9.15 more people live in the urban area outside Manila. Overall, city size is a significant factor in determining how many people can be reached in 30 minutes, but density, availability of infrastructure, etc., also influence the result.

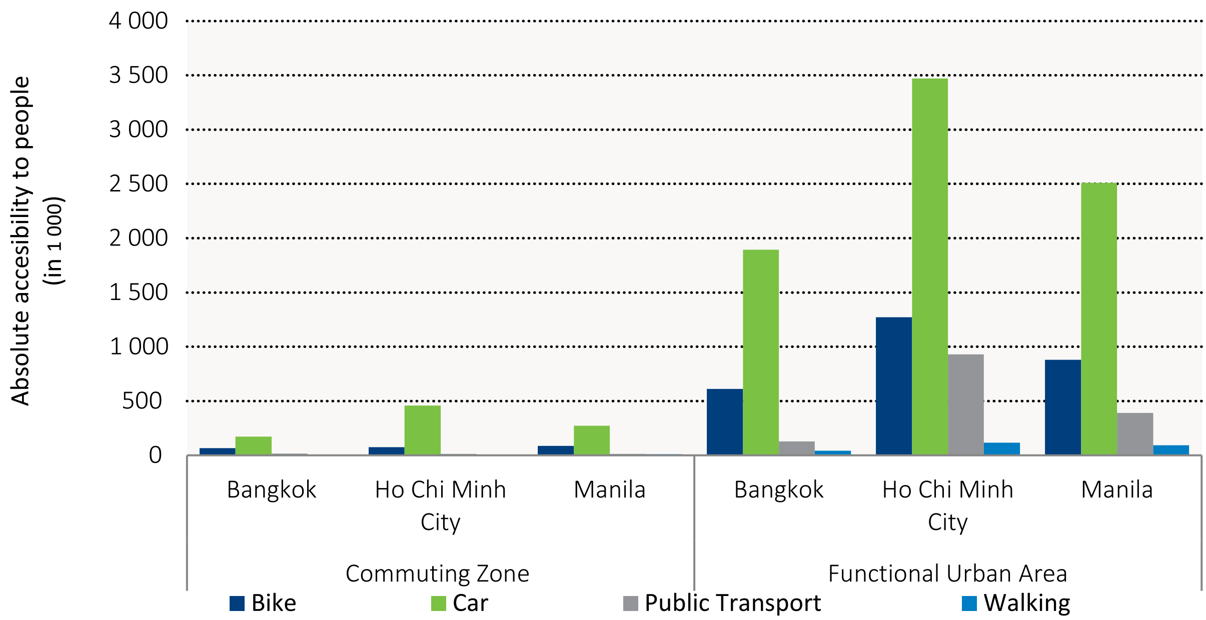
Figure 1. Population by administrative region, remaining urban core and commuting zone



Absolute accessibility by different transport modes

In all three cities, in the FUA, as well as in the commuting zones, cars provide absolute accessibility to a significantly higher number of people than the other modes, as shown in Figure 2. When analysing the accessibility in Bangkok's FUA, travel by car allows citizens to access 14 times as many people as travel by public transport. In Manila and Ho Chi Minh City, absolute accessibility by car is almost six times and four times higher than by PT, respectively. A similar trend in terms of accessibility has been observed in European FUAs, where an average car driver reaches twice the number of opportunities reachable by public transport (ITF, 2019).

Figure 2. Absolute accessibility by transport modes in functional urban areas and commuting zones



Note: Commuting zone defined as within 30 minutes travel time.

Absolute accessibility is always better by car and bike in all three cities. As the road network is denser than the public transport network, a person will always be more flexible in a car or on a bike. The difference in accessibility by car and public transport (PT) is starker when looking at the commuting zones compared to FUAs (Figure 2). This is because a low density of services characterises commuting zones, are remote from the city centres and have a low supply of public transport services. On average, an inhabitant of Bangkok can reach almost 1.9 million people, compared to 3.5 million in Ho Chi Minh City and 2.5 million in Manila in the FUA by car. In the commuting zones, accessibility is reduced to approximately 172 000 people in Bangkok, 458 000 people in Ho Chi Minh City and 273 000 people in Manila, which is 8 to 10 times less than in FUAs.

Public transport offers much lower levels of absolute accessibility, with 130 000 people reachable within 30 minutes in Bangkok and 390 000 in Manila. Only Ho Chi Minh City performs well in terms of public transport accessibility. In 30 minutes, the average city inhabitant can reach 900 000 people.

Absolute accessibility by bike is usually better than public transport, for the same reasons as for the car. However, given the slower speed of the bike, it is relatively lower than other modes. Walking provides very low accessibility, allowing a person to reach only nearby destinations.

When looking exclusively at the administrative areas, absolute accessibility is the highest for all modes, including public transport. The high density of the administrative areas also contributes to this result.

Figure 3. Public transport's proximity, absolute accessibility and transport performance

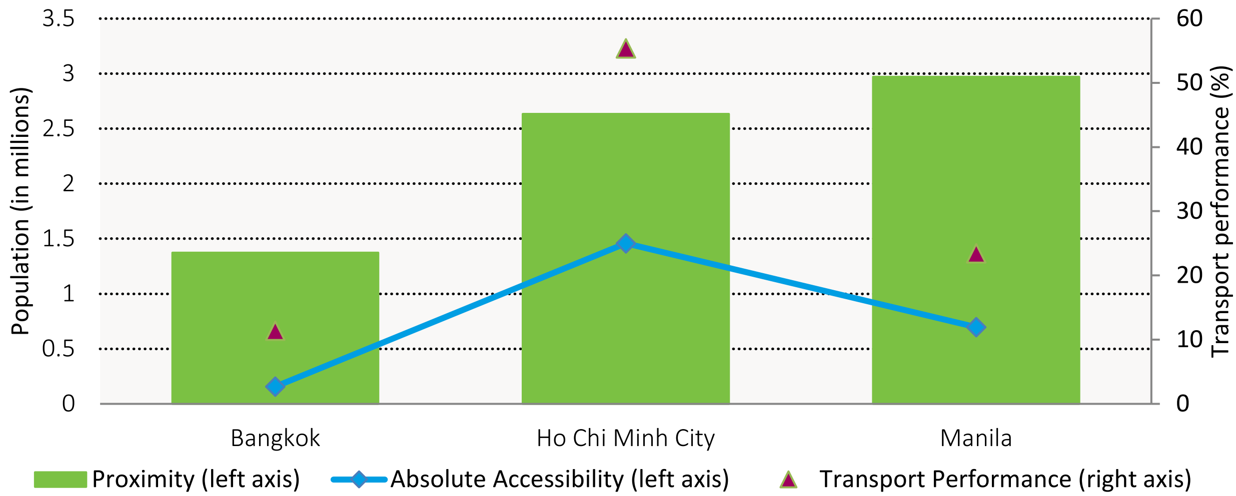


Figure 3 shows the effect of proximity and public transport performance on absolute accessibility within administrative areas. While Manila and Ho Chi Mihn City have similar levels of proximity (2.9 and 2.6 million people within 8 km, respectively), Ho Chi Mihn City has much better public transport performance, around 55%. That elevates its absolute accessibility to over 1.5 million people in 30 minutes. Conversely, Manila has a lower public transport performance score of 23%, which naturally reduces absolute accessibility. Ho Chi Minh City's transport performance by public transport would compete with the transport performance of the best European cities.

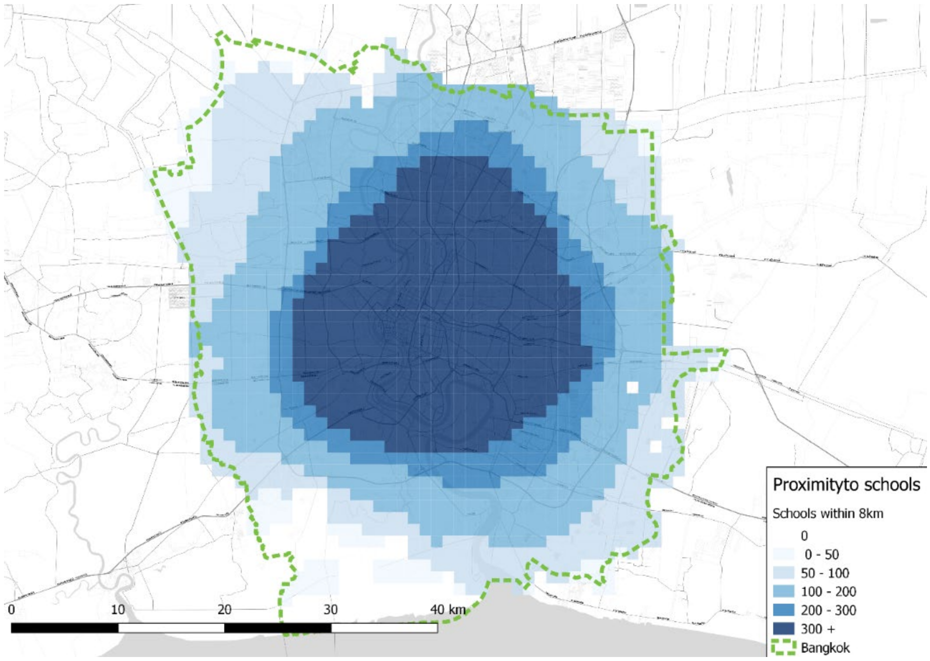
Bangkok has slightly lower proximity than the other two cities (1.4 million inhabitants). It also has the lowest public transport performance score of 12%. It should be noted, however, that Bangkok has the highest public transport coverage. Almost everyone living in the city and over 70% of people living in the commuting zone have access to public transport, a percent that is better than in many cities in Europe and North America. On the other hand, this may contribute to the lower transport performance score, as it is more challenging to provide frequent services on the network.

Access to schools and hospitals

Bangkok

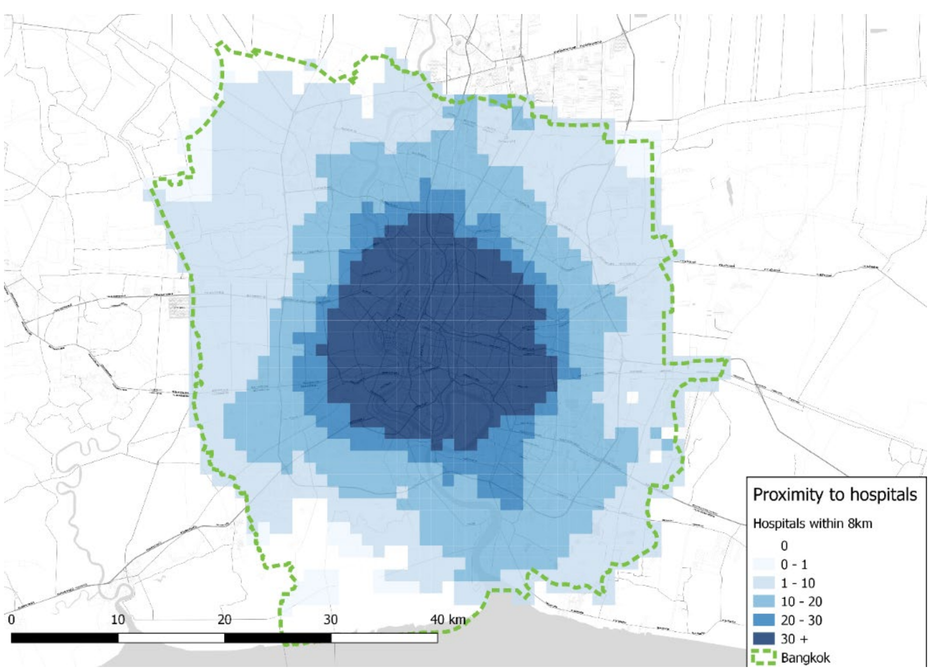
The proximity of schools in Bangkok is relatively high, with nearly 300 schools located within 8 km of the average inhabitant. This is driven primarily by the city of Bangkok, which has the proximity of 330 schools, while the commuting zone has much lower proximity to only 33 schools. Most people living in Bangkok have at least 100 schools within an 8-km radius, as seen in Figure 4 below. Moving toward the city's fringes and the start of the commuting zones, the number of schools decreases, but most locations have access to more than one.

Figure 4. Average number of schools within an 8-kilometre radius: Bangkok



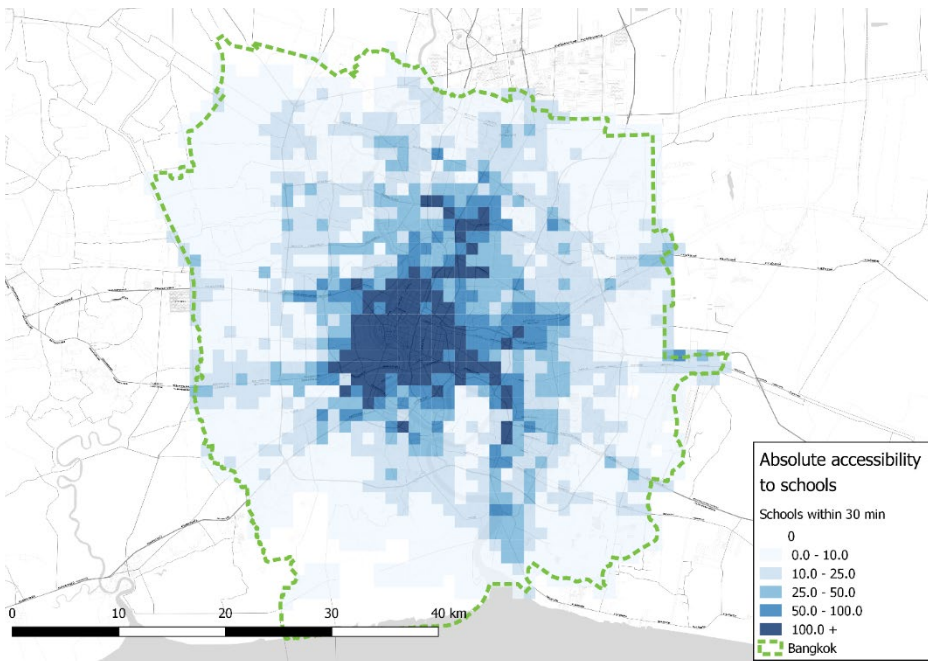
Hospitals follow a similar distribution to schools, as shown by the proximity indicator in Figure 5. Naturally, hospitals are fewer than schools in absolute numbers, but people living in Bangkok will nearly always have hospitals within an 8-km radius. The average proximity to hospitals in the city is 25. The commuting zone, on the other hand, has a proximity value of 2.

Figure 5. Average number of hospitals within an 8-kilometre radius: Bangkok



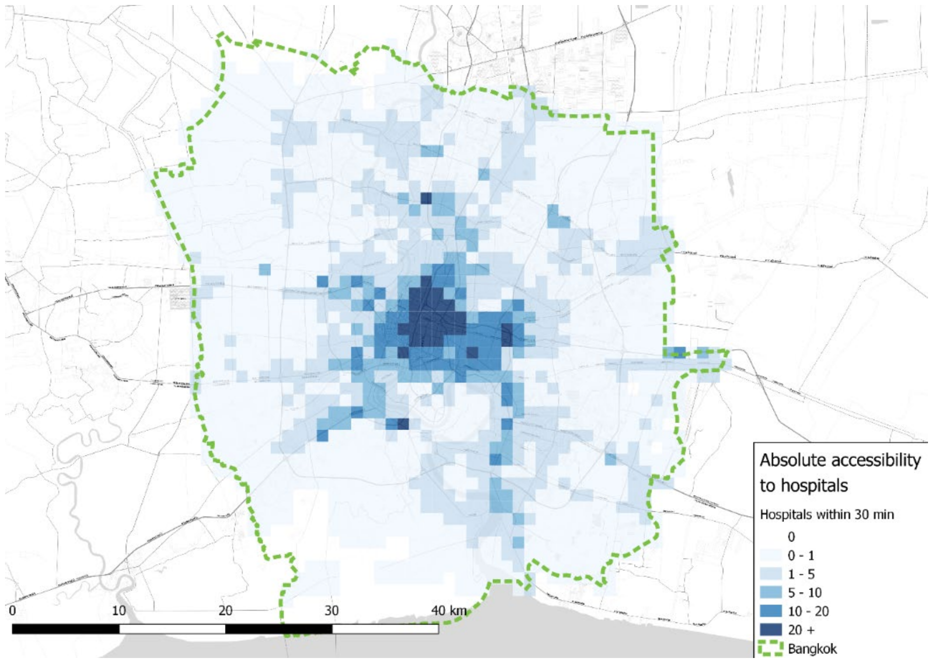
The absolute accessibility indicator has some differences. The rolling average of schools and hospitals showcased by proximity is no longer evident in Figure 6, as the public transport network is not as dense. The effect of high capacity lines can be identified in the city's south and southwest edges, which have slightly higher accessibility scores than areas in the north. Within the city, the average person can access 42 schools within 30 minutes by PT, compared to 3 in the commuting zone. As schools tend to be quite evenly distributed, most people with access to public transport will be able to reach several destinations. For many, however, accessing a school is more easily done on foot. All of the city and large parts of the commuting zone have access to schools by PT, but only the centre of the city has high accessibility scores.

Figure 6. Number of schools accessible within 30 minutes by public transport: Bangkok



The absolute accessibility to hospitals by public transport in the FUA of Bangkok is 3.4 in 30 minutes. This figure is slightly higher in the city, 3.8, and much lower in the commuting zone, 0.14. As most of the hospitals and the bulk of the transport network are located within the city boundaries, 71% of Bangkok inhabitants can reach at least one hospital in 30 minutes. On the contrary, only 12% of commuting zone residents can reach a hospital in 30 minutes by public transport. As seen in Figure 7, the spatial distribution of accessibility to hospitals is similar to the one of schools.

Figure 7. Number of hospitals accessible within 30 minutes by public transport: Bangkok

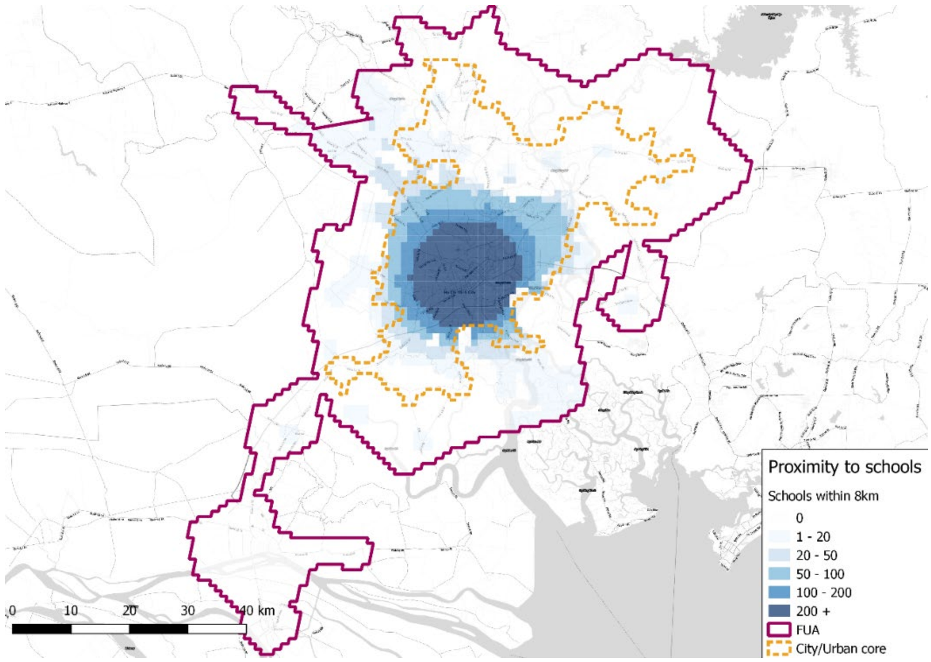


In summary, accessibility is very closely correlated with proximity and availability of high-capacity public transport systems. People living close to high-capacity public transport stations benefit significantly from them, reaching many more destinations such as schools and hospitals within reasonable time thresholds. For people living further away from such public transport systems, accessibility is primarily defined by what exists nearby.

Ho Chi Minh City

Ho Chi Minh City has a more centralised distribution of destinations than Bangkok. The proximity of schools and hospitals is much higher in the city centre. The average values, however, are slightly lower, with the average FUA inhabitant having 170 schools and 29 hospitals in an 8-km radius. Naturally, these values are somewhat higher in the city (183 and 31) and much lower in the commuting zone (seven schools and 0.6 hospitals).

Figure 8. Number of schools within an 8-kilometre radius: Ho Chi Minh City



Both figures 8 and 9 show high proximity in the city centre. It gradually reduces as moving further away from the centre. Large parts of the city and the commuting zone show no proximity to either amenity. However, this is likely due to missing data on the availability of amenities in these areas.

Figure 9. Number of hospitals within an 8-kilometre radius: Ho Chi Minh City

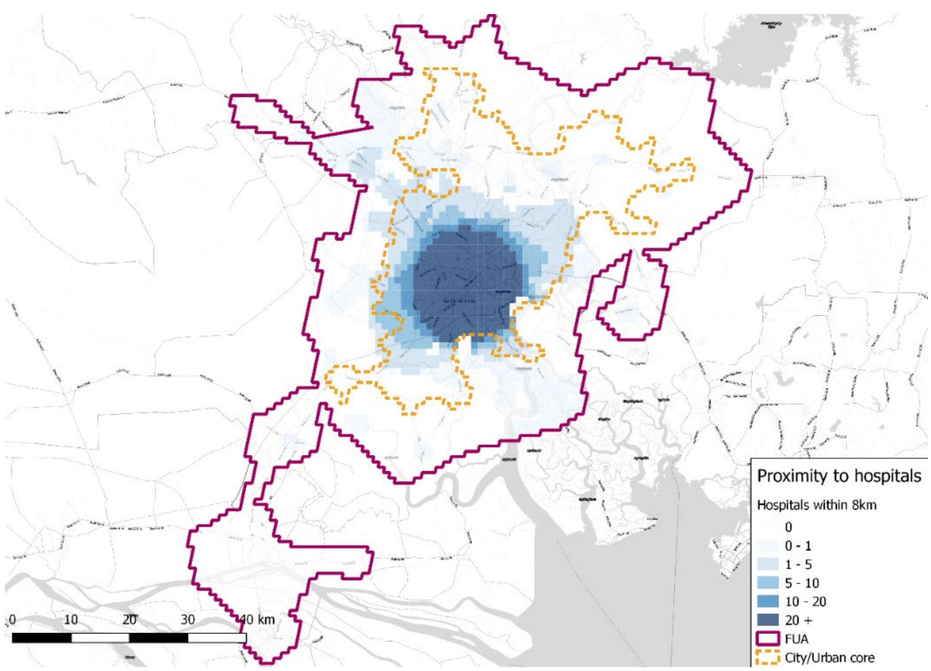


Figure 10. Number of schools accessible within 30 minutes by public transport: Ho Chi Minh City

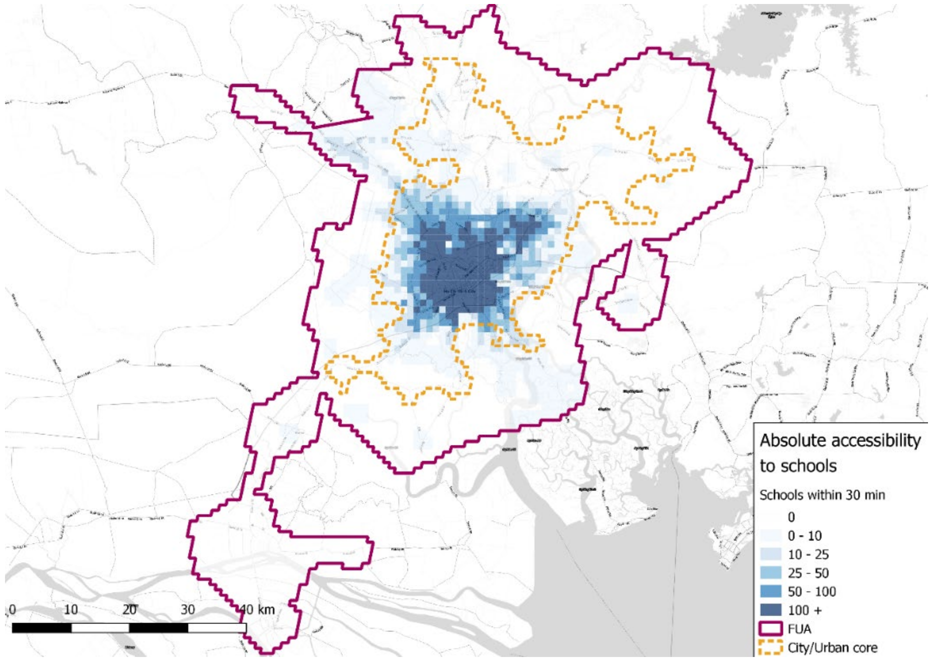
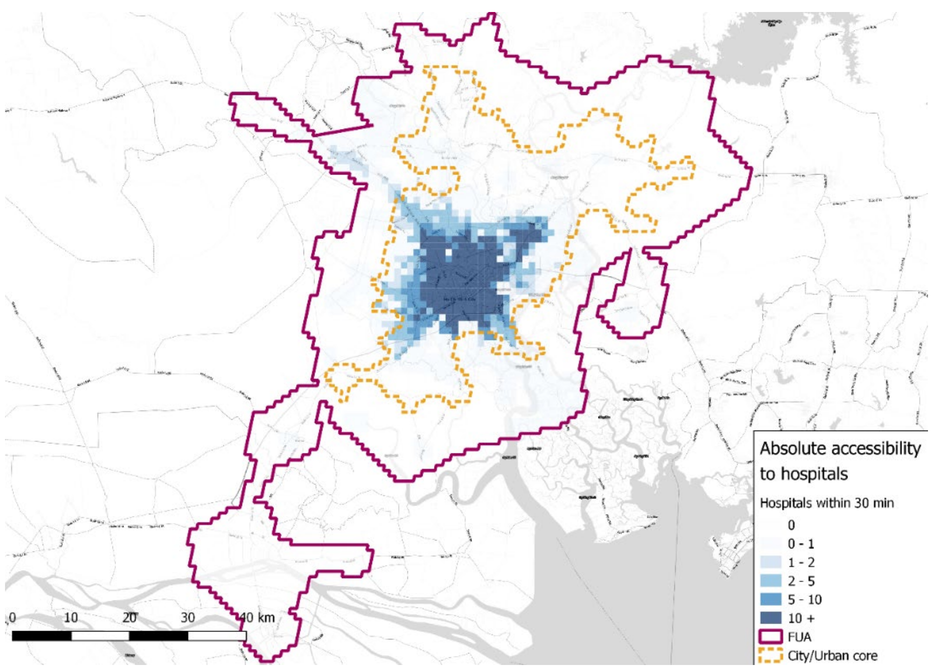


Figure 11. Number of hospitals accessible within 30 minutes by public transport: Ho Chi Minh City



Analysing the city centre, Ho Chi Minh City has excellent accessibility levels by public transport. Despite having lower proximity than Bangkok and Manila, it has a good public transport system that allows the average city inhabitant to reach 128 schools and almost 21 hospitals in 30 minutes. These values are much lower in commuting zones, where low proximity and low public transport performance reduce accessibility levels. As evident by figures 10 and 11, almost everyone living within the city's centre can access many schools and hospitals within 30 minutes. This extends along corridors on the city's northwest and south parts, giving fast access to the city centre.

Manila

Manila has a similar picture as the other two cities. Schools and hospitals are concentrated within the city, particularly in the centre. In contrast with Bangkok and Ho Chi Minh City, Manila has very low proximity to schools. The average proximity to schools in Manila's FUA is 53. This probably means that there are educational facilities that might not be accounted for and therefore are not counted in this analysis.

Figure 12. Number of schools within an 8-kilometre radius: Manila

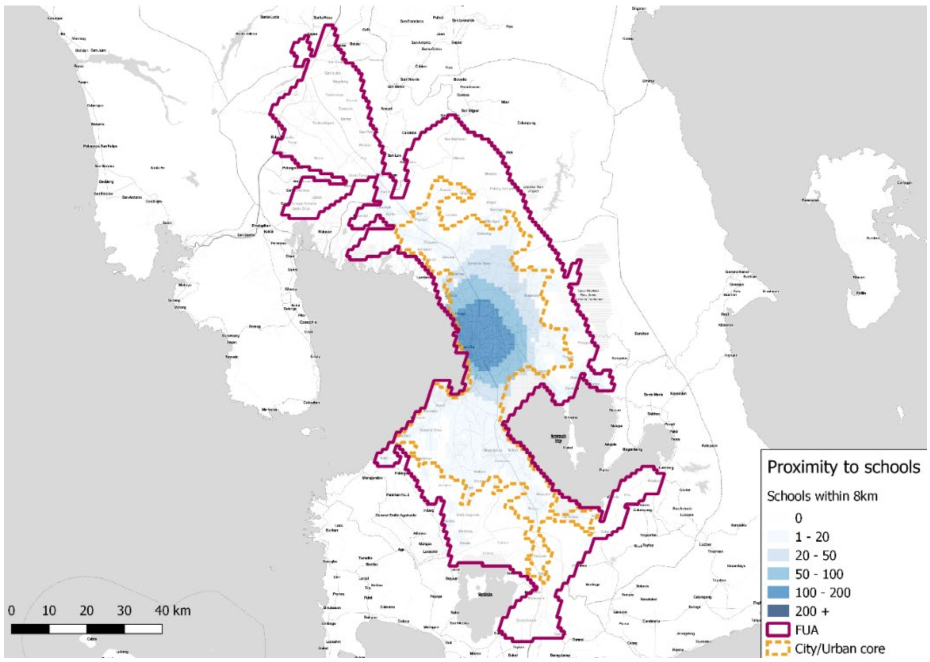
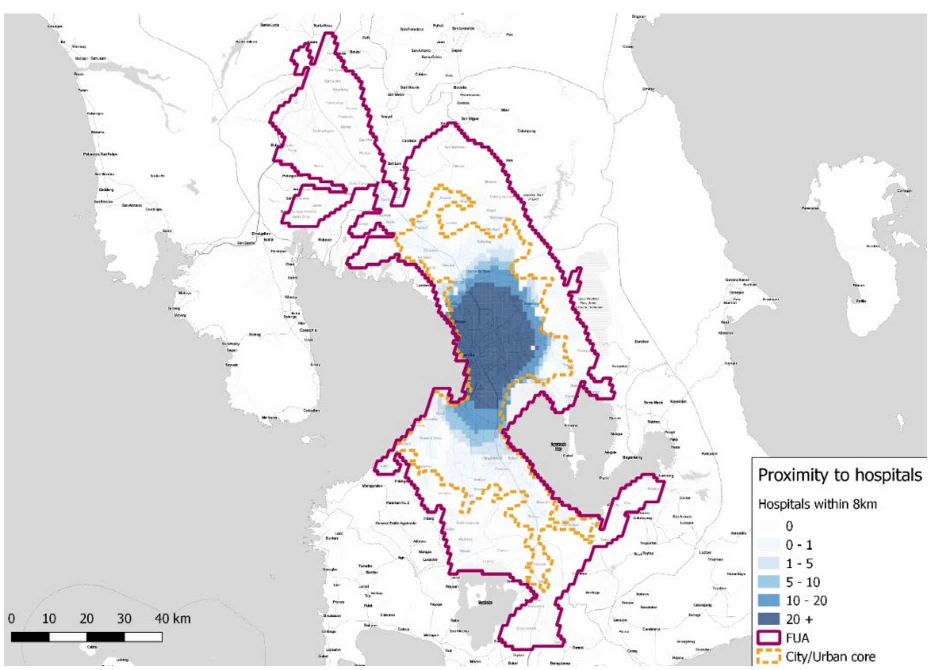


Figure 13. Number of hospitals within an 8-kilometre radius: Manila



Regarding hospitals, on the other hand, Manila does appear to have more facilities than the other two cities. However, both proximity and accessibility are relatively lower, which signals that most hospitals are located in the central part of the city.

Figure 14. Number of schools accessible within 30 minutes by public transport: Manila

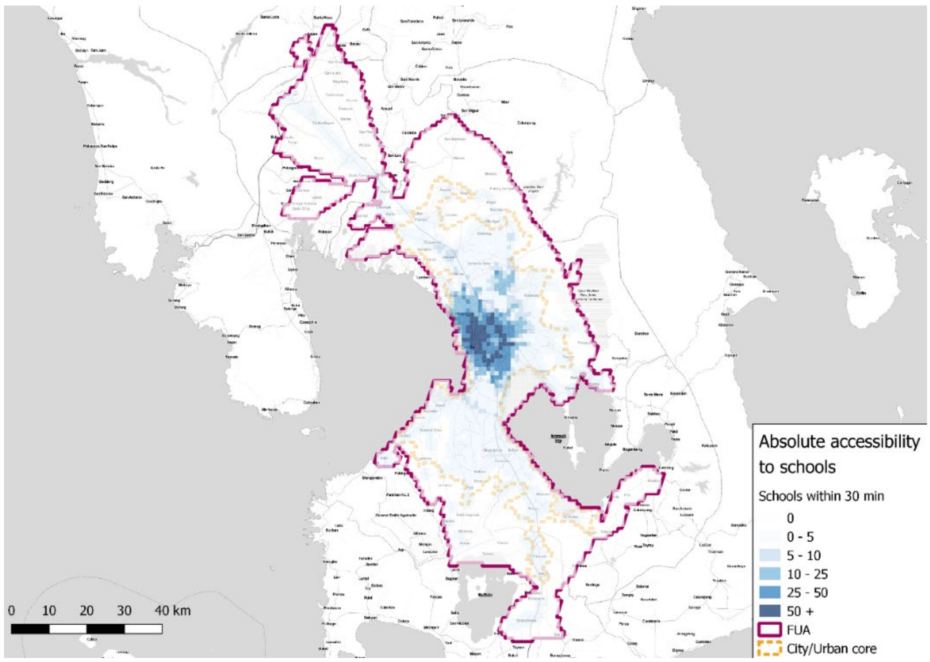
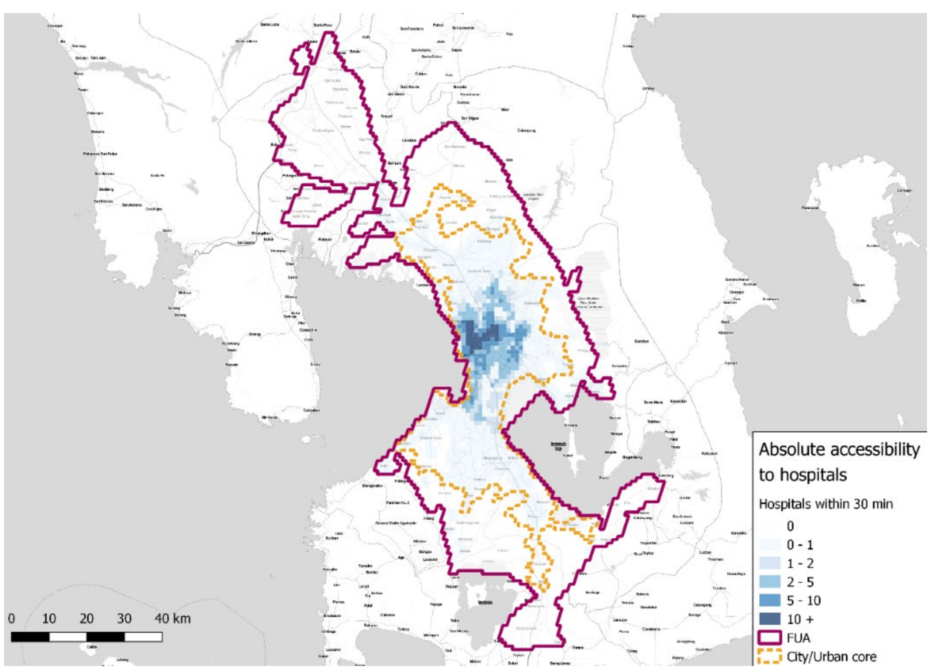


Figure 15. Number of hospitals accessible within 30 minutes by public transport: Manila



Accessibility has a more scattered pattern, as the public transport network affects what is easily reachable. Nonetheless, only the Manila city centre has decent access to schools and hospitals. The average inhabitant of Manila can reach 13 schools and 7 hospitals by public transport. As the data is limited for the commuting zone of Manila, it is not easy to make assessments about the accessibility levels they provide.

Enhancing accessibility by new rail infrastructure

The introduction of new rail systems has the potential to increase accessibility levels. Local experts from the three cities provided information on potential new infrastructure developments and information about anticipated operating speeds and resulting travel times. With this information, it is possible to assess the impact of the new infrastructure and related services on accessibility levels in the respective cities. Table 4 summarises the cities' future infrastructure improvements evaluated by the accessibility analysis. The new infrastructure was included according to the most recent route design and anticipated schedule available.

Table 4. Future public transport infrastructure improvements

City	Project name	Length (km)	Project status
Bangkok	BTS Light Green Line Extension	19	Completed in 2020
	MRT Purple Line Extension	24	Under construction (2027)
	MRT Blue Line Extension	8	On hold
	BMA Gold Line	3	Under construction (2027)
	SRT Light Red Line	36	Under construction (2025)
	SRT Dark Red Line	26	Completed in 2021
	MRT Yellow Line	30	Under construction (2023)
	MRT Pink Link	35	Under construction (2023)
	MRT Orange Line	36	Under construction (2024)
	BMA Grey Line	16	Proposed
	M-MAP2 Future Rail Lines (5 total)	131	Proposed
Ho Chi Minh City	Line M1 (Sài Gòn line)	19	Under construction (2024)
	Line M2 (Bà Quẹo line)	48	Under construction (2030)
	Line M3A (Tân Kiên line)	19	Proposed
	Line M3B (Thị Nghè line)	11	Proposed
	Line M4 (Gò Vấp line)	36	Proposed
	Line M5 (Cần Giuộc line)	23	Proposed
	Line M6 (Đầm Sen line)	5	Proposed
Manila	MRT Line 1 Extension	12	Completed in 2021
	MRT Line 2 Extension	4	Under construction (2027)
	MRT Line 4	16	Under construction (2028)
	MRT Line 7	23	Under construction (2025)
	North-South Commuter Railway (PNR Clark 1)	38	Under construction (2024)
	Metro Manila Subway (Airport Alignment)	23	Under construction (2027)
	19 Future Bus Routes	358	Proposed

It is important to note that in this analysis, the current public transport system is kept in place. In reality, new infrastructure will likely change the existing network. The upcoming analysis will focus exclusively on the cities, not the entire FUA. As identified, the vast majority of the new infrastructure is located within the city boundaries. Commuting zone accessibility is also marginally improved but to a lesser degree.

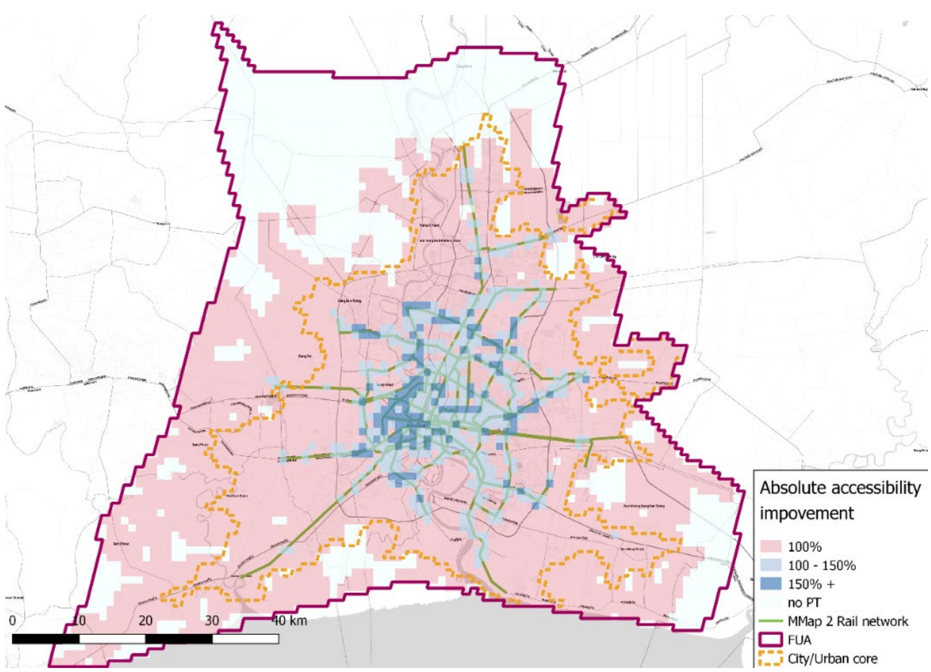
Table 4 shows the absolute accessibility by public transport for the existing and future networks for the three cities. The biggest potential improvement in percentage values comes from Bangkok, followed by Manila. Ho Chi Minh City, on the other hand, has an almost marginal improvement. This is due to the higher accessibility scores that Ho Chi Minh City achieves with the existing network already. In terms of improvement in absolute numbers, the average inhabitant in both Bangkok and Manila will be able to reach 50 000 more people in 30 minutes.

Table 5. Citizens' absolute accessibility to people in 30 minutes with existing and future public transport system networks (in 1 000s)

Cities	Existing network	Future network	Improvement (%)
Bangkok	144	185	29%
Ho Chi Minh City	1 395	1 410	1%
Manila	492	542	10%

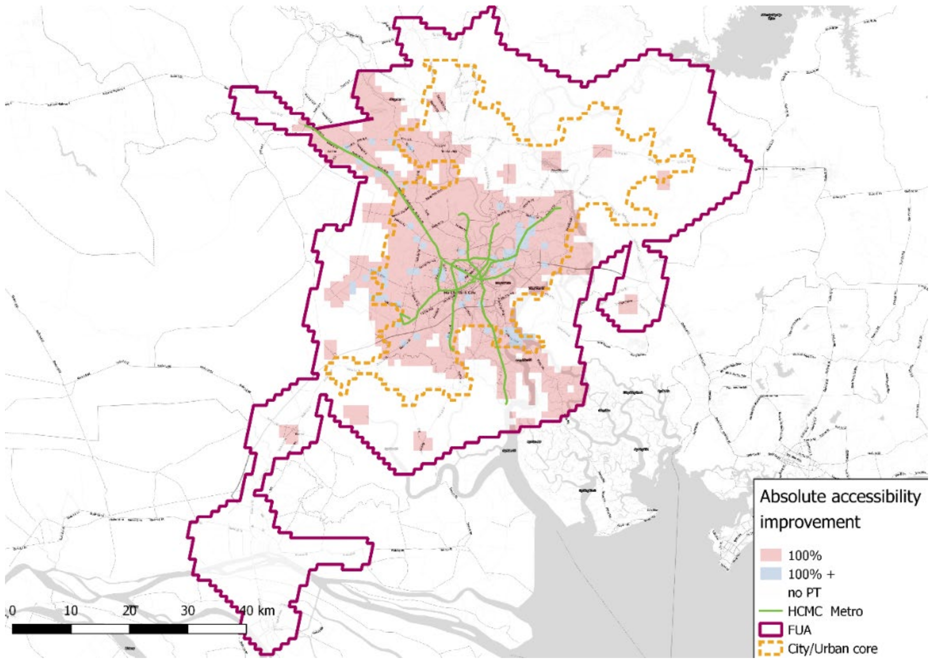
The localised effects are likely to be much more significant. The values shown in Table 5 are the average values for the entire city. Figure 16 shows the improvements in absolute accessibility to people in 30 minutes by public transport brought by the new infrastructure in Bangkok. Most of the gains occur in the central part of the city, with the biggest gains evident where more than one new line is introduced. Proper planning could create feeder lines that serve this new network, expanding accessibility benefits in other parts of the city.

Figure 16. Change of absolute accessibility by introducing new rail infrastructure in Bangkok



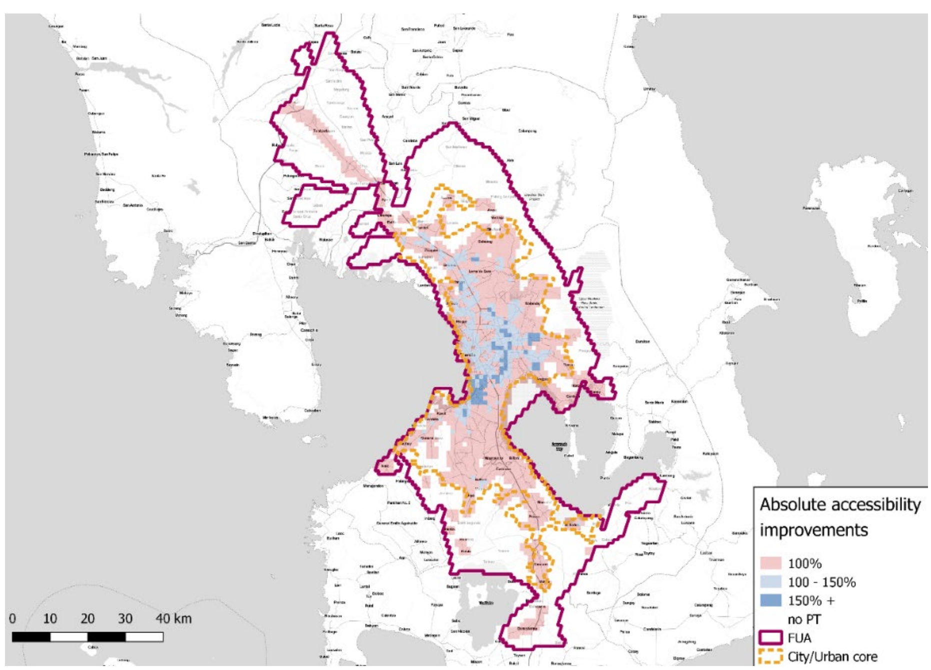
Ho Chi Minh city has significantly smaller benefits from the new public transport infrastructure. As the levels of accessibility are already high, the new system does not bring significant improvements. Some areas, mainly along the new lines, do see some marginal improvements.

Figure 17. Change of absolute accessibility by introducing new rail infrastructure in Ho Chi Minh City



Manila will also see significant improvements with the new infrastructure. The new lines will boost absolute accessibility around and within the city centre, especially in the south and east parts of the city.

Figure 18. Change of absolute accessibility by introducing new rail infrastructure in Manila



In Bangkok and Manila, the new lines will also significantly increase transport performance, measured as the ratio between the absolute accessibility for a given mode and proximity to potential destinations. In Bangkok, the public transport performance in the city will increase from 12% to 15%. In Manila, it will grow from 25% to 27%. No significant change is observed in Ho Chi Minh City.

Enhancing accessibility by transit-oriented development measures

TOD enables denser residential development along public transport stations and lines, enabling more people to live close to high-capacity public transport systems. In reality, this is done by allowing the development of denser residential projects.

This analysis explores three scenarios:

1. Scenario 1: A reference scenario reflects no changes to the existing public transport network or to land use and related population densities.
2. Scenario 2: In the first alternative scenario, new infrastructure is introduced but not coupled with TOD measures. Results of this scenario were already presented above.
3. Scenario 3: In the second alternative scenario the new infrastructure is assumed to be coupled with TOD measures. It is assumed that new transport infrastructure will lead to a 20% population increase around new station areas resulting in an overall increase in the city population.

In Ho Chi Minh City, the 20% population increase around new stations leads to a total population of 12.3 million (an increase of 620 000). In Bangkok, the total population reaches 14.5 million, increasing by 840 000 people. In Manila, the population increases by 300 000 people, with a resulting total population of 18 million.

Table 6 provides the accessibility indicators under the three different scenarios. The absolute accessibility indicator increases in all three cities under the TOD scenario as more people live in areas with good public transport access. The proximity indicator also grows as the population increase drives this indicator, especially in Ho Chi Minh City. Transport performance grows marginally in the cases of Manila and Bangkok, while it drops in the case of Ho Chi Minh City. The division of absolute accessibility and proximity estimates transport performance. Therefore, as proximity grows much more than absolute accessibility, transport performance decreases.

With the TOD network, absolute accessibility in Bangkok, Ho Chi Minh City, and Manila increase by 54%, 18% and 16%, respectively. Proximity improves by 13%, 14% and 40% in Bangkok, Manila and Ho Chi Minh City, respectively. These improvements clearly highlight the benefits that TOD policies can bring to accessibility in cities.

Table 6. Indicators for access to people by public transport in the different scenarios

		Scenarios		
Indicator	City (city – urban core)	Scenario 1: Existing network	Scenario 2: Future network without TOD measures	Scenario 3: Future network with TOD measures
Absolute accessibility in 30 minutes (to 1 000 inhabitants)	Bangkok	144	185	221
	Ho Chi Minh City	1 395	1 410	1 643
	Manila	492	542	572
Proximity in an 8-kilometre radius (to 1 000 inhabitants)	Bangkok	1 224	1 224	1 381
	Ho Chi Minh City	2 075	2 075	2 913
	Manila	2 012	2 012	2 290
Transport performance (in 30 minutes within an 8-kilometre radius)	Bangkok	12%	15%	16%
	Ho Chi Minh City	67%	68%	56%
	Manila	24%	27%	25%

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Annex. Assessment methodology

Firm evidence is required to show how TOD may be utilised to enhance accessibility in developing countries. This study compares three cases. The analysis consisted of two parts:

1. quantitative analyse of the current situations of accessibility in the selected three cities
2. simulations to assess the effects of applying TOD measures on enhancing accessibility.

Before implementing the analysis, this study looked at the previous analyses on accessibility and TOD use and provided an overview of accessibility indicators.

Previous analyses of accessibility related to transit-oriented development measures

Papa and Bertolini (2015) explored the relationship between TOD and rail-based accessibility in a metropolitan area. The study selected six Western European metropolitan areas (Amsterdam, Helsinki, Munich, Naples, Rome, and Zurich). The GEOSTAT 1A project population grid, which provides a homogeneous grid population dataset, was integrated with datasets from national census data and used for the land-use analysis. The rail, metro and tram networks were derived from OpenStreetMap (OSM) geographical databases. Travel time datasets were constructed by taking the travel time between transit stops, accessible at the public transport agencies' websites. These were added to the walking times along the street network from the centroid of each Accessibility Zone to the nearest rail stop, assuming an average walking speed of 1.4 m/s. This study performed a correlation analysis using the cumulative rail-based accessibility to inhabitants and jobs, and the TOD degree of the urban structure of a study area. The latter is defined as the extent to which the distribution of urban densities is or is not developed along rail infrastructures (tram, metro and regional rail).

Ambarwati et al. (2016) examined the potential of an integrated approach on space-transport development strategies to increase accessibility in the case of Surabaya, Indonesia. The 2010 Census data have been used to analyse population, employment, attractiveness variables and land use for each of the 163 sub-districts in the city. Transport data was collected employing an extensive survey and the video recording of traffic. This study assessed the minimum average commute distance for public transport, motorcycle and car in the case of the current trends and, in the case of the compact zone, spatial intervention with an added improvement of public transport.

Fukuda, Satiennam and Oshima (2006) evaluated some strategies, such as high land-use density allocation along Bus Rapid Transit (BRT) corridors, to support BRT implementation in Bangkok Metropolitan Administration (BMA) in Thailand. The personal trip and model parameters were provided by the Bangkok Metropolitan Region-Extended City Model (BMR-ECM) in the project of Transport Data and Model Center 3 (TDMC3). This study applied the demand forecasting model, the System for Traffic Demand Analysis (STRADA3). This study assessed total travel distance and total travel time in the scenario of typical BRT implementation and in the scenario of an integrated BRT system with decreasing number of local bus parallel and adjacent to BRT corridors, high land-use density allocation along BRT corridors, and paratransit system feeder along BRT corridors.

The perspectives of the previous analyses can be summarised by the framework from Karst T. Geurs (2018), which breaks down existing accessibility indicators into four categories: location-based; infrastructure-based; person-based and utility-based – and discusses the characteristics, advantages and limitations of each group.

Table 6. Overview of accessibility indicators

Indicator type	Description	Examples
Infrastructure-based	Indicators that quantify the observed or simulated performance of the transport system. These indicators can also potentially reflect interpersonal differences (e.g. access to public transport varying by social group).	Congestion levels, travel times, average travel speeds, travel costs, proximity to public transport.
Location-based	Indicators that measure the number of opportunities that can be reached from a fixed location using a specific mode within a specified time. They can also potentially reflect individual characteristics if the data used are differentiated accordingly (e.g. by number of jobs available to people in a certain age range or income group).	The number of jobs or other opportunities that can be reached within 30 minutes from a given place by car or public transport.
Person-based	Indicators that analyse accessibility at the detailed individual level based on time-space geography (i.e. on a micro level).	Indicators showing travel times varying according to ownership of a vehicle at different times; access to specific types of jobs depending on level of education.
Utility-based	Indicators that measure welfare benefits people derive from access to spatially distributed opportunities.	Log sum indicator – consumer surplus ("willingness to pay") under a range of transport planning scenarios.

Source: ITF (2019).

Table 7. Accessibility indicators employed in selected previous analyses

	Infrastructure-based	Location-based	Person-based	Utility-based
Papa and Bertolini	—	✓	—	—
Ambarwati	✓	—	—	—
Fukuda, Satiennam and Oshima	✓	—	—	—

Source: Ambarwati et al. (2016), Papa and Bertolini (2015) and Fukuda, Satiennam and Oshima (2006).

Geurs (2018) indicates that some categories are more suitable for specific purposes than others. For instance, infrastructure- and location-based metrics may be more suited for the relatively simple analysis of regional transport policies. At the same time, utility-based indicators are more valuable for an economic appraisal (i.e. cost-benefit analysis) of transport investments. Each category of indicators can have varying degrees of complexity. Infrastructure-based and location-based measures are easier to operationalise within the different types of indicators as they are easier to interpret and communicate (Geurs, 2018). Policy makers and planners have more widely used these types of indicators. For instance, Transport for London uses Public Transport Access Levels (PTAL) – a relatively simple infrastructure-based indicator that measures accessibility to the public transport network across Greater London – as a central component of London's planning framework.

As Geurs and Van Wee (2004) argue, the choice of an accessibility indicator depends on the study's goal, the importance of the theoretical basis, the ease of operationalisation, interpretability, communicability and usability in social and economic evaluations. This report explores how TOD could be utilised to enhance accessibility. As such, the report focuses on infrastructure-based and location-based indicators, and less on on person-based and utility-based indicators as these metrics demand data, a critical issue in developing countries.

The Urban Access Framework: How accessible is your city?

Between 2016 and 2022, the ITF developed the Urban Access Framework tool to measure global accessibility. The first stage of this work was presented in the 2017 ITF Transport Outlook (OECD/ITF, 2017). In 2019, the ITF joined with the European Commission, experts and international policy makers to develop a database with accessibility indicators and a visualisation tool for all European capitals and metropolitan areas of more than 500 000 inhabitants. The tool, entitled How Accessible is Your City? is available online via the ITF website (ITF, 2022).

The indicators consider different modes of transport (walking, cycling, public transport and private car) and the number of opportunities (services of various categories) people wish to reach. The framework acknowledges that accessibility is the product of the proximity of valued destinations (the result of land-use policies) and the performance of the transport system (the result of transport policies and investments in infrastructure). By controlling for the spatial distribution of destinations (discussed further), the proposed indicators allow for comparing access levels between cities regardless of their size, and better identify underlying factors influencing the results.

One challenge to comparing access levels is that the administrative boundaries of a city are often determined by history rather than by the daily reality that people experience. In some cases, the central historically-bounded town contains only a fraction of the population, while most citizen live outside the city centre. The results' comparability is ensured by using a harmonised definition of an urban area developed jointly by the OECD and the EU. Functional Urban Areas, or FUAs, are defined as an urban area that consists of a densely populated urban centre and a wider periphery that is identified using data on commuting patterns. Functional Urban Areas consist of densely populated "urban cores" (with the population of at least 1 500 inhabitants per km^2 in Europe, and a lower threshold of 1 000 people per km^2 in Canada and the United States) and "peripheries", areas whose labour market is highly integrated with cores (all areas with at least 15% of their employed residents working in a certain urban core). In this analysis, "urban centre", which refers to a high-density urban cluster corresponding to 1 500 inhabitants per km, is used as a unit for comparison.

Box 2. Five advantages of the EC-ITF-OECD Urban Access Framework

1. **Independent of city size.** The EC-ITF-OECD Urban Access Framework finds a middle-ground between absolute and relative accessibility by comparing the absolute number of opportunities that can be reached within a given time with the potential number of opportunities within a fixed distance from the point of origin. This fixed area of reference overcomes the small- and big-city bias.
2. **Multi-modal accessibility.** The framework covers active modes of mobility (walking and cycling) and accessibility by car. Where data is available, the framework also includes public transport.
3. **Access to opportunities.** The typical view is that transport flows from everywhere to everywhere (e.g. Cervero and Hall, 1989). But the points where traffic originates, and the places where people want to go, are not evenly distributed within the city. The framework considers a detailed population density grid to weigh the origins of traffic flows and uses a range of "points of interest" to capture different uses of the city as destinations for the transport flows.
4. **Comparable cities.** The framework adopts a harmonised definition of "cities" – the functional urban area concept developed by the European Commission and the OECD – to allow for benchmarking within and across countries.
5. **Flexibility and adaptability.** The EC-ITF-OECD Urban Access Framework was developed to allow for international comparability while adapting to country-specific needs or preferences and allows for further refinements as data improves.
6. **Visualisation.** The framework can be combined with new data visualisation techniques and thereby help reach a greater audience and enrich the social dialogue about transport policies.

Accessibility Toolkit

The accessibility indicators use harmonised measurements of infrastructure capacity and transport service efficiency to characterise the accessibility of each point in a 1x1-km grid of the urban centre. The analysis is based on three main indicators: **absolute accessibility**, **proximity** and **transport performance** (Table 1).

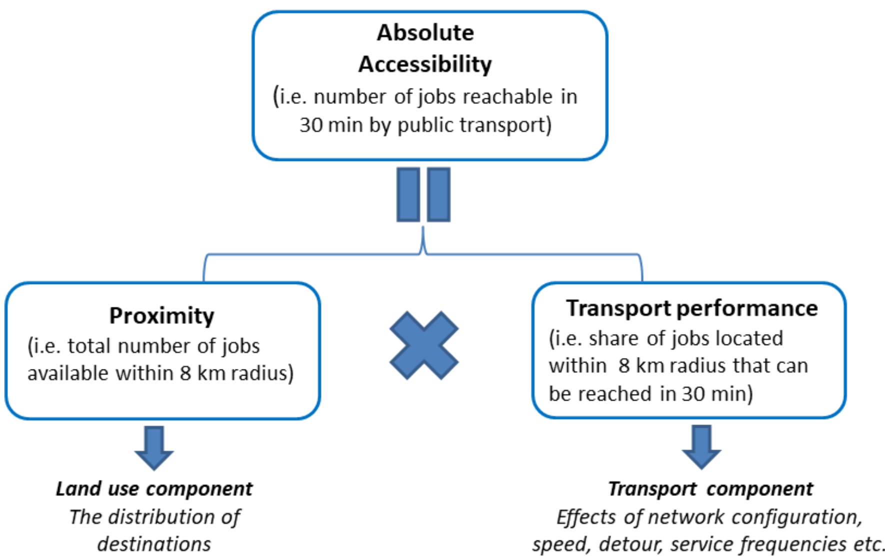
Table 8. Indicator types in the Urban Access Framework

Indicator	Description of the indicator
Absolute accessibility	Number of destinations reachable within fixed time thresholds by a given mode. Example: 30 schools reachable by public transport in 30 minutes
Proximity	Total number of destinations available within a certain radius. Example: 60 schools are located in an eight-kilometre radius.
Transport performance	The share of opportunities located within a pre-defined radius that can be reached in a set time by a given mode (the ratio between absolute accessibility and proximity). Example: 20% of schools (out of 60 schools on average located in an eight-kilometre radius) can be reached by public transport in 30 minutes.

Absolute accessibility reflects the absolute number of opportunities (e.g. schools, hospitals, jobs) that can be accessed by a given transport mode within a set travel time. This general indicator highlights the differences in access levels across a selected territory. It helps to determine areas that lag in providing good access, i.e., where people can reach only a few or none of the opportunities. This indicator also compares the levels of access delivered by different transport modes.

The absolute accessibility indicator, however, does not provide information on the respective contribution of land use or transport supply and infrastructure to the ultimate access levels. To strengthen the understanding of underlying factors to accessibility, two additional indicators – proximity and transport performance – were developed and added to the analysis.

Figure 19. Absolute accessibility: Proximity and transport performance



Proximity reflects the concentration of activities in space. It shows the number of opportunities available to an average user in each cell within a set radius (typically 4, 8 or 16 km). This indicator does not take into account travel time or mode choice. Thus, the proximity indicator allows for determining the extent to which the dispersion of population and destinations affects the ultimate accessibility levels.

Transport performance shows the proportion of nearby opportunities, i.e. opportunities located within a pre-defined radius (4, 8 or 16 km) that can be reached in a set time by a given mode. This indicator results from a ratio between absolute accessibility (overall number of opportunities reachable in a defined time threshold) and proximity (number of opportunities located in a defined radius). This outcome ratio reflects the mode's performance.

For instance, in city X, public transport provides access to 24 schools in 30 minutes on average. Yet, on average, there are 120 schools available in proximity, i.e. in an 8 km radius. The transport performance outcome ratio is: 24/120 = 0.2. This means that out of all schools available in proximity (120 schools), public transport provides access to only 20% of them, indicating that the mode performs relatively poorly.

A ratio of more than 1 means that all and more destinations located in a pre-defined radius can be accessed by a given mode, indicating the chosen mode performs well. For example, a ratio of 2.5 means that, by a given mode, one can access 2.5 times the number of points of interest compared to the number of points of interest located within 8 km. As such, transport performance is a synthetic, unitless measure of the performance of a given transport mode. By controlling for the spatial distribution of destinations, this indicator allows determining to what extent the transport service efficiency and the network connectivity affect the ultimate accessibility levels.

For car travel, the indicator reflects the combined effects of the availability of the road network and its configuration, speed, congestion, detour and time spent searching for parking.

Table 9. Variables factored into the access computation by car and public transport

Variables factored into the computation of access by car	
Availability of road network and its configuration	The road network is extracted from OpenStreetMaps (OSM). The road network contains the geography of the roads, intersections and types of roads.
Speed	The road network is extracted from OSM and contains information on legal speed limits on each road segment.
Congestion	Accessibility is computed in relation to a congestion coefficient, which is different for each urban area. The data coefficients are derived from the TomTom congestion index.
Detour and time spent searching for parking	Up to 10 minutes are added for the time spent looking for parking and for the time required to reach the final destination.
Variables factored into the computation of access by public transport	
Availability of public transport and frequency of operation	The public transport network is recreated using schedule data under General Transit Feed Specification (GTFS) standards. It contains information about public transport stops, routes, frequencies and stop times. The computation is based on peak-hour travel times.
Walking and waiting times	The indicators consider: a) walking access time both at trip origin and destination (using the road network to access the public transport stop); b) waiting time (equal to half of the headway); and c) transfer time where necessary.

For public transport trips, the indicator reflects the combined effects of the availability of public transport, frequencies of operation, and walking and waiting times.

Important to note is that the indicator does not consider factors such as the capacity of each public transport mode, crowding or comfort, nor does it consider elements linked to user perceptions on the public transport service level. The pathway length determines the performance of walking and cycling trips to the selected destinations. Highway and trunk roads are excluded from the analysis when access by walking and cycling is considered. The indicator used is a simplified representation of accessibility by walking as it does not consider such factors as availability and connectivity of pavements, slopes, availability of cycling infrastructure, safety perception or comfort.

Data and computation of indicators

Data from multiple sources is required to compute accessibility and the impact of TOD on accessibility accurately. The homogeneity of data, i.e., information coming from the same or similar sources, is also essential to ensure comparability of outcomes. For this study, data was collected from multiple data sources.

The boundaries of each city are obtained through the functional urban area definition (Moreno-Monroy, Schiavina and Veneri, 2020). This definition characterises urban areas as a functional economic unit combining a densely populated city (urban core) and a commuting zone.

Population information comes from the Joint Research Centre of the European Commission's Global Human Settlement database (Freire, Halkia and Pesaresi, 2016). The database has population information per square kilometre for the entire world. The information extracted from the database for the functional urban areas of the three cities in this study are divided into 1-km^2 grids.

Computation of indicators

All indicators are computed using a multistep approach (Box 3). Travel time is calculated for all modes (car, public transport, biking, walking) between an origin and a destination cell using a Dijkstra fastest path algorithm. This means that all possible paths between the two points are examined, and the one with the shortest travel time is chosen. Travel time is computed from one origin to all possible destinations in a city. Door-to-door travel time includes elements such as:

- delays from congestion and time spent looking for parking when using car
- access time, waiting time and transfer time when using public transport.

Having travel time to all destinations, one can estimate how many grid cells are reachable within a certain time threshold. The total number of destinations reached is the absolute accessibility of that origin cell. To cover the whole city, accessibility is measured from all origin points of a city. This is repeated for every destination cell. This results in travel times from all origin cells to every destination cell, i.e. to all the opportunities the cell contains. The number of opportunities that can be reached in a pre-set travel time is the final absolute accessibility score for every cell in the selected city.

A population-weighted average is used to obtain average values. This means that the average is adjusted according to the weight of each cell based on population. This is done because some cells can have thousands of inhabitants within cities while others only have ten people. As such, the aggregated indicators represent the accessibility of that area's average inhabitant.

Box 3. Step-by-step computation process for accessibility indicators

Step 1: Develop a grid

A city is split into 1 000 m x 1 000 m cells. Weighted centroid is calculated for each cell population. Each cell represents the sum of the population and services that are located within the cell. Accessibility is measured between all cells. Each centroid is then used as the origin of a trip and as a location of potential destinations. Destinations (schools, hospitals, jobs) are also aggregated at the cell level. This means that reaching a destination cell means reaching all the opportunities the cell contains (e.g. 12 schools, one hospital, etc.)

Step 2: Connect cells to the road network

All centroids (whether it is an origin or destination) are then connected to the existing road and public transport networks. Public transport is considered an option when the public transport stop is located within a maximum distance of 1 km from the cell centroid. To determine the number of destinations of interest in proximity to each cell, the model assigns fixed average straight-line speeds to each mode based on typical average speeds: 16 km/h for cars, public transport and cycling, 4 km/h for walking.

Step 3: Calculate travel time for different transport modes

Travel time is computed from origin centroids to destination centroids. This is done using a fastest-path algorithm, i.e. the route chosen is not necessarily the shortest in terms of distance. The travel time between cells is the average time a person needs to go from an origin to a destination using a chosen mode. Travel time is always considered door-to-door, following certain mode-specific assumptions:

- For car trips, the travel time is computed using free flow speeds that differ on different road segments reduced by peak-time delay (based on congestion data). Two delay coefficients are used: a higher coefficient for roads in the city and on high-capacity roads (based on density); and a lower one for other types of roads in the periphery. The data coefficients are derived from the TomTom congestion index. Up to 5 minutes are added for car trips to compensate for the time spent accessing the vehicle at the trip's origin. Up to 10 minutes are added for the time spent looking for parking, as well as for the time required to reach the final destination. The additional time at both the origin and the destination depends on the population density of each.
- For trips on public transport peak-hour frequencies derived from GTFS data, public transport schedules are used to adjust travel time. For this analysis, peak hour travel times of a random weekday are estimated. Public transport travel time includes: a) walking access time at both the trip origin and destination (using the road network to access the public transport stop); b) waiting time (equal to half of the headway); and c) transfer time where necessary. A transfer is considered possible when two public transport stops are located within 200 metres of each other.
- For walking trips, a walking speed of 4 km/hour is used and high-capacity roads (highways and trunk roads) are excluded.
- For cycling trips, a riding speed of 16 km/hour is used and high capacity roads (highways and trunk roads) are excluded.

This results in an origin-destination matrix (OD Matrix) with travel times by different transport modes between all the centroids of a chosen city. This matrix is used for computing the accessibility indicators. City averages are derived from an aggregation using population-weighted averages.

Transit-Oriented Development and Accessibility
Case studies from Southeast Asian cities

This report assesses the potential of transit-oriented development (TOD) to improve accessibility in three Southeast Asian cities: Bangkok, Ho Chi Minh City and Manila. It outlines the challenges of applying TOD practices in developing countries and presents three case studies of successful implementation of TOD, which capture the various forms that TOD can take.

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Published: 10/2023 | Photo credit: Eo naya/Shutterstock