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Tackling Yangon's mobility crisis

A political economy
perspective



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Tackling Yangon's Mobility Crisis: A political economy perspective

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Abstract:

The city of Yangon is home to over 5 million people, hosts Myanmar's largest port and produces a disproportionate share of national output. But a mobility crisis is undermining the city's economic potential and contributing to a deteriorating quality of life for its residents. The most obvious symptom of this crisis is acute traffic congestion. The proximate causes are clear: growing demand for journeys, a surge in vehicle numbers, a modal shift away from buses, and myriad 'flow disruptions'. However, solving this mobility crisis requires recognizing the underlying causes, including a 'congestion incentive spiral' fuelled by a lack of alternatives to bus and private automobiles, and the absence of an empowered transport agency with the authority and capacity to coordinate planning, investment and regulation designed to maximise mobility at the metropolitan scale. In this paper we offer a systematic analysis of both the proximate and underlying causes of Yangon's mobility crisis and provide a discussion of policy options and priorities to get the city moving again.

Keywords: Yangon, Myanmar, urban transport, congestion, mobility, urban

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1. Introduction

The city of Yangon is experiencing a renaissance after decades of relative international isolation and political neglect under military rule. Today the city is home to over 5 million people, hosts Myanmar's largest port and is the commercial heart of the nation. In this new era characterised by political and economic liberalisation, Yangon has the potential to serve as an engine of economic growth. But the city's potential to play this role is being undermined by a mobility crisis: as the economy speeds up, the city slows down. It has been estimated that average travel speeds at peak times have plummeted from 38 km/h in 2007 to perhaps 10-12 km/h in mid-2015 (ADB 2016).

Growing congestion is a significant constraint on both growth and poverty alleviation. Empirical research at the city and city-region level in other countries has shown that productivity suffers from congestion by raising the costs of doing business and generating friction in local labour markets (Cervero 2001; Weisbrod, Vary and Treyz 2003; Venables 2007). At the household level, congestion raises the costs of mobility thereby inhibiting access to livelihoods opportunities, diverting resources away from asset accumulation, and increasing exposure to harmful levels of pollutants that negatively impact upon health (World Bank 2002; Soe 2016). Sustainable, pro-poor urban development therefore depends upon the smooth functioning of a transport system that maximises mobility while minimising costs, particularly for the poorest and most vulnerable.

The proximate causes of Yangon's mobility crises include growing demand for journeys, a surge in the number of vehicles on the city's roads in recent years, and a concomitant modal shift among commuters away from buses and towards private automobiles. But the underlying causes are more complex. The city has become stuck in a 'congestion incentive spiral' that ultimately stems from a governance crisis: the historic absence of metropolitan-scale governance institutions with the authority and capacity to deliver integrated transport solutions for the city. We argue that current ad hoc efforts to relieve traffic congestion will not provide a sustainable solution. An independent, accountable transport authority with a remit to maximise urban mobility (rather than minimise traffic) is required. This may require political-institutional reform.

The paper is organized as follows: section two provides a systematic analysis of the proximate causes of Yangon's mobility crisis; section three considers the underlying causes linked to the broader political-institutional context and the incentives facing commuters; section four discusses various policy measures and reforms that might be considered to improve mobility; section five concludes.

2. The proximate causes of Yangon's mobility crisis

2.1 Understanding mobility and congestion

Yangon's current mobility crisis is a direct result of traffic congestion, but it is important to recognize the difference between mobility and free-flowing streets. Mobility refers to the ease with which people and goods move through the urban landscape. While much of this movement happens on roads, in most cities walking, cycling and fixed-line transportation networks (e.g. trains, trams and BRTs) provide equally important means of getting around. It is therefore possible to significantly increase urban mobility without necessarily reducing traffic congestion by providing citizens and businesses with viable alternative modes of transport (UN-Habitat 2013).

However, although mobility and congestion are not intrinsically linked, Yangon's residents rely heavily on motorised transport (i.e. buses, taxis and private automobiles). Worsening traffic congestion is therefore the most immediately apparent cause of the city's current mobility crisis. To understand why traffic congestion has increased so dramatically it is useful to outline a theoretical framework for understanding the problem.

Traffic congestion is essentially a function of three factors: demand for road space, the supply of road space and 'flow dynamics'. Demand is jointly determined by the number of journeys required to satisfy the mobility needs of a population and by modal choice. An increase in the number of people traveling by road due to population growth can create a situation whereby demand for road space exceeds supply at peak times, thereby causing gridlock. Similarly, a switch from public transport to individual automobile usage (i.e. modal shift) can also lead to excessive demand given that individualised automotive transport is less spatially efficient than public transit options such as busses: more road space is required to transport the same number of people by car than by bus. Recent research has highlighted the significance of modal choice by examining the effects of public transit strikes on congestion. The results indicate that the positive effect of public transport on reducing urban congestion has likely been underestimated in the past (see Anderson 2014).

The most common response to growing demand for road space (and hence rising levels of congestion) is to increase the supply of road space. While intuitive, extensive research has shown that there is a 'fundamental law of road congestion' whereby expanding road supply generates more demand and hence further congestion (Duranton and Turner 2011; see also Arnott and Small 1994; Gakenheimer 1999; Gwilliam 2003). This is not to say that some expansion of

capacity is not in order in rapidly growing cities such as Yangon, but simply generating more road space is unlikely to lead to significant increases in mobility. Indeed, there is now a consensus that improving mobility by encouraging and supporting alternative modes of transport is preferable to increasing the supply of road space (Buchanan & Gunn 2015; Mogridge 1997).

The third factor that influences the degree of congestion is the way traffic flows. Even minor 'flow disruptions' can result in gridlock. For example, 'irregularities in driver behaviour' can trigger traffic jams as the erratic action of a single vehicle produces a ripple effect that brings a whole mass of automobiles to a temporary halt (see Orosz, Wilson & Stépan 2010). Bottlenecks—i.e. where road capacity is reduced through, for example, the merging of three lanes into one—generate a similar effect (ibid). In such cases flow dynamics alone (rather than the balance between supply and demand) can be a source of congestion.

2.2 Population growth and economic growth contribute to rising demand

Although there is a dearth of reliable, time-series demographic and economic data for Yangon, we can infer substantial growth in raw demand for journeys in the city from a variety of sources.

According to official census data, the population of Yangon Region (including both rural and urban areas) grew from 3.97 million in 1983 to 7.36 million in 2014 (Ministry of Immigration and Population 2014). This represents a compound average annual growth rate of roughly 2%. Although this is not particularly rapid, it is substantially faster than the growth rate of the national population, which was roughly 1.2% over the same period. As a result, the Yangon Region's share of the national population increased over this period from 11.2 percent in 1983 to 14.3 percent in 2014 (ibid).

Despite the 31-year gap in census data collection, there are three other data sources that can be used to infer more decent demographic and economic trends. The first is a population data set produced by the WorldPop.org project, which combines census data with other ancillary data (e.g. satellite imagery) to model population distribution for countries around the world. For Myanmar, gridded population data are available for 2010 and 2015. As Figure 1 shows, analysis of these estimates indicates substantial population increase in all of Yangon's Townships over this five year period, with central Townships experiencing the most rapid demographic change (see Appendix A for details).

The second source of data that can be used to evaluate demographic and economic trends comes Landsat 7 ETM+ satellite imagery. High resolution images from 2003, 2013 and 2016 were processed to assess the extent, direction and rate of spatial expansion in the Yangon region over

these years (see Appendix A). The results show that the built-up area of the city increased from roughly 24,000 km² in 2003 to 64,500 km² in 2016—an increase of 169 percent. Between 2013 and 2016 alone the built-up area increased by 6.7 percent (see Figure 2).

[Insert Figures 1 & 2]

The third data source also comes from satellite imagery; in this case nightlights data from the USA Defence Meteorological Satellite Program. Recent research has demonstrated that the amount of light radiating from a geographical region at night can be used to get a rough indication of economic activity in that region (Chen and Nordhaus 2011; Henderson, Storeygard and Weil 2011; Henderson, Storeygard and Weil 2012). Figures 3 and 4 provide a graphic illustration of the change in the intensity and geography of luminosity (and hence economic activity) in Yangon Region between 2003 and 2013. Over this 10 year period the level of luminosity in greater Yangon nearly tripled. A rough estimate based upon the calculated elasticity of GDP with respect to luminosity indicates that this translates into an average annual growth rate in GDP of 8.5 percent. Between 2008 (when the constitutional referendum was held) and 2013 the estimated annual growth rate is 11.2 percent (see Fox and Verrucci 2017).

[Insert Figure 3 & 4]

Evidence of population growth, expansion of built-up areas and very substantial growth in nightlights collectively provide indirect evidence of increases in the raw demand for journeys in Greater Yangon. More people are spread over a wider area resulting in more commuters; and more economic activity can increase the demand for both passenger journeys and commercial vehicle activity (i.e. non-passenger journeys). However, demographic and economic changes alone cannot account for the speed with which congestion transformed from a minor nuisance to a matter of national concern.

2.3 A flood of vehicles and a modal shift

Growth in demand for journeys in recent years coincided with two important and interlinked trends: an abrupt expansion in the number of vehicles on Yangon's roads and a modal shift among passengers away from buses and towards the use private cars.

As Figure 5 illustrates, there has been an extremely rapid increase in the number of registered vehicles in the Yangon Region since 2011 when vehicle import restrictions were relaxed. Between 2011 and 2014 there was a 153 percent increase in the total number of registered vehicles in

Yangon, including a 93 percent increase in passenger vehicles (i.e. cars and vans) and 507 percent increase in light trucks. Perhaps most surprisingly, given that there is a strict ban on civilian use of motorcycles in Yangon, there was a 263 percent increase in registered “two wheel” vehicles over this period, from roughly 56,000 to over 200,000.

This explosive growth in the number of passenger vehicles and motorcycles on Yangon’s roads has coincided with a steep decline in the number of people using the bus system, even as the population has grown (see Figure 5). These two trends reflect a dramatic modal shift: more and more people are choosing to use private automobiles rather than buses, which significantly increases demand for road space even in the absence of increases in the number of road users.

[Insert Figure 5]

2.4 Flow disruptions

Navigating smoothly through Yangon’s increasingly congested streets is further complicated by myriad obstacles and bottlenecks that exacerbate the problem. One of the most often heard complaints has been the erratic behaviour of bus drivers, who weave in and out of traffic and make abrupt and un-signalled stops that lead to temporary jams and bottlenecks (Frontier Myanmar 2017). Due to the age, generally poor maintenance and constant abuse of these busses (e.g. overcrowding) breakdowns are common, leading to further bottlenecks.

Taxis are often cited as a serious problem. Idle taxis parked illegally take up road space while active taxis drive aggressively, make abrupt stops to pick up passengers and linger while negotiating prices, which are not regulated in any way (Tun 2015). Efforts to improve the situation through metering have failed in the past (Aung 2011).

In the central business district of Yangon, a lack of adequate parking and street vendors on roads are also perceived as major sources of bottlenecks. There are very few dedicated off-street parking facilities leading drivers to cruise for precious street parking, which itself can cause congestion (Shoup 2006). This is compounded in some areas by the use of potential parking spaces by street vendors, who are an integral part of the downtown economy (Satt 2016).

Finally, an issue that was raised by many formal and casual informants was the problem of the daily school run. There are no official school busses in Yangon, which has a large youth population traveling to and from school every day—sometimes very long distances. In the absence of a centrally organized system a private, ad hoc system has emerged comprising a fleet of perhaps

25,000 minibus shuttles, taxis and personal cars, which are all used to ferry children around, often at peak times (Naing 2016). Clusters of double- and triple-parked vehicles outside schools at the beginning and end of the day create bottlenecks in some areas, while the sheer number of vehicles involved in this daily migration adds significantly to the mass of vehicles on the roads at busy times.

There is one potential source of flow disruption that is largely absent, at least in central Yangon. Unlike cities such as Jakarta, where mobs of motorcycles weave in and out of traffic, contributing to total vehicle mass and the stop-start behaviour that creates ripples of congestion, there are virtually no motorcycles on the roads in Yangon due to a ban imposed in 1989 (Goldberg 2015).

2.5 A perfect storm for gridlock

The combination of a growing population, increased economic activity, a flood of vehicles and a modal shift away from public transportation options has created a perfect storm of congestion in Yangon; one that is compounded by a lack of alternative modes of transport to support urban mobility.

Until very recently little had been done to address Yangon's growing transport needs, apart from the lightly regulated network of private buses that emerged to meet demand (discussed below). The only noticeable infrastructure investment in recent years has been the construction of seven flyovers that do not correspond to broader transport plan and have had a negligible impact on congestion (Htet 2016). The only alternatives to cars and busses are a limited and poorly maintained circular rail line (built during the colonial era) and walking. Bicycles and trishaws have been banned from the CBD and virtually all main roads since 2003 (Long 2013).

While identifying these proximate causes is a useful and necessary first step in the search for plausible solutions, it is necessary to dig one layer deeper to understand why these conditions exist. The growth of Yangon's population and economy are unquestionably positive developments for the city and therefore undesirable targets for public intervention. This therefore leaves us with the following questions: Why has there been a surge of vehicles and what (if anything) should be done about it? Why have citizens been abandoning busses *en masse* and what can be done to reverse the trend? Why are the city's buses and taxis so ill-behaved and why are traffic laws more rigorously enforced? And why has Yangon, an emerging megacity, failed to invest in a mass urban transit system?

3. The political economy of gridlock

3.1 Congestion as a consequence of economic liberalization

The boom in private car use on Yangon's roads is a direct function of the broader process of accelerated economic liberalization that has accompanied Myanmar's political transition. Before 2011 the importation of automobiles was controlled by the military, with all imports going through either a military or government company channel. Non-affiliated auto traders would pay a premium to import vehicles and then turn and make a profit by reselling the car at a higher cost. Each time a car was sold a member in the chain could profit between 6,000 and 10,000 USD, which could bring the cost of a Toyota Land Cruiser to nearly \$500,000 USD by the end of a cycle (Kuhn 2012). The high price of imports kept the supply of automobiles highly restricted before 2011; most of the vehicles on the roads of Myanmar were built decades earlier, some dating as far back as WWII (ibid).

The slow shift away from a state-socialism towards a state-mediated capitalist model began in 1988 following the failure of the Burmese Socialist Programme Party's autarkic economic management over the previous two decades (Jones 2014). By the turn of the millennium the number of private firms had overtaken the number of state enterprises, but the state maintained a commanding role, in part by restricting trade and using foreign exchange and import licenses as tools of political patronage (ibid). The failure of the state (i.e. military) to respond effectively to the devastation wrought by Cyclone Nargis in 2008 revealed the extent to which the balance of power had shifted towards crony capitalists, who mobilized resources (including the business-financed NGO Myanmar Egress) to deliver aid and lead reconstruction efforts (ibid). The subsequent reforms to currency management and import controls—including on vehicles—can therefore be understood as part Myanmar's broader political-economic transition from state socialism to nominally democratic crony capitalism.

It hasn't been a smooth process. The first step in liberalizing auto imports was known locally as the 'cars for clunkers' program. This was intended to remove older cars from the road and replace them with more modern, but still second-hand, vehicles, mostly from Japan. Under the program, any car between 20 and 40 years old could be traded in by the owner in return for a license to import a newer vehicle built no earlier than 1995 (Tun 2011). The trade was not cheap and required handover of the previously owned car along with payment of the new car's sale cost, customs duty, registration fee and surcharge amounting to an additional 165 percent markup above the purchase price (Kuhn 2012). Nevertheless, between September 2011 and July of 2012, 60,000 cars were traded in for import licenses with a total of 70,000 cars imported by the end of

the program (Smyth 2014). This approach had some perverse consequences. First, a new class of brokers emerged who would purchase old cars at inflated prices from owners who were unable to afford the costs of a newly imported car. These brokers would then trade in the newly acquired used vehicle for an import license, import a new car, and sell it at a profit (Win 2015). Second, Myanmar-based car manufacturers began piecing together vehicles from old parts to sell to individuals keen to acquire import licenses (Thant 2015).

By 2012, anyone with a national identity card could import one car and businesses could import up to 50 vehicles per license (Win 2015; Win 2015b). Those who could not afford a car could (and did) sell their license to brokers who would open registered or unregistered dealerships on the streets of Yangon (Win 2015b).

The two government companies which had previously monopolized the import market now had to compete with 172 newly licensed private dealers and 14 international manufacture dealerships which had opened by 2014 (Myanmar Times 2014). At its peak Myanmar was importing 20,000 cars a month (Win 2015). Regular policy changes over the next three years led to such rapid reductions in the retail price of cars that newly imported vehicles were sometimes left at the port because the taxes owed were higher than the potential resale value of the vehicle (Win 2014).

The flood of new cars on Yangon's roads was, in short, a direct consequence of plummeting prices associated with Myanmar's broader trajectory of liberalization, and one which has created a constellation of new stakeholders invested in the auto import business, and a large new class of commuters on Yangon's roads.⁴

3.2 Perverse incentives in a competitive bus cartel

With automobile prices plummeting, the rapid modal shift away from buses noted above is easily understood. Due to an array of perverse incentives built into the system, buses became notorious for long waits, overcrowding, price-gouging, rude staff and reckless driving (ADB 2016; JICA 2014; Maung 2016; Myint 2017). With growing numbers of people opting for cars, these issues were compounded by longer and longer journeys.

⁴ Why import liberalization was pursued in 2011 is an interesting and unanswered question. It is worth noting that this policy came on the heels of the disputed 2010 election in which the military-backed party claimed a contentious victory and just before the 2012 parliamentary by-election, in which the opposition leader Aung San Suu Kyi was allowed to participate after her release from house arrest.

Most of the problems associated with the buses were a natural by-product of the incentives built into the system, which operated as a 'competitive cartel' in which thousands of bus owners joined an essentially independent organization that regulated entry but permitted competition on most routes.

This system emerged organically after 1974 with the growth of private sector bus operators who were allowed to operate under the supervision of the Motor Transport Management Committee. In 2009 this became the Yangon Region Central Supervisory Committee for Motor Vehicles and Vessels, more commonly referred to as Ma Hta Tha (JICA 2014; JICA 2013). Although nominally under the control of the Yangon Region government, Ma Hta Tha appears to have operated largely independently, overseeing a range of bus operators. These included two large private companies: the military-owned Parami Bus Line (operating as Bandoola Transport Co. Ltd) and Myanmar Golden City Link (Paing 2016). However, these firms accounted for a small fraction of the thousands of buses on Yangon's roads, the remainder of which were owned by small operators who were members of sub-organizations known as Bus Supervisory Committees (BSCs) and Bus Line Committees (BLCs). The role of Ma Hta Tha and the BSCs and BLCs were to regulate entry into the system and to regulate the behaviour of operators.

The result was something of a cartel, with restricted entry, but limited competition on routes was permitted and most drivers and conductors were paid on commission to incentivize revenue maximization. The result was competition for passengers, which led to dangerous driving, overcrowding on buses and price-gouging by the conductors responsible for collecting fares and managing passengers on board. In this cash-based system there were incentives all the way up the chain from the conductors to the regulatory organizations to under-report passenger numbers and the fares collected to capture marginal rents (Htun et al. 2012; Gwilliam 2003). At the same time, competition kept margins low, which encouraged owners to spend little on vehicle maintenance, which in turn led to deterioration of buses and frequent breakdowns (Htun et al. 2012). Without independent enforcement of standards and traffic laws, the buses became an inescapable nuisance for riders and other road users alike.

The persistence of this arrangement is likely due to the lucrative nature and dispersed interests involved. If official statistics are to be believed, the system was carrying an average of 2.5 million passengers a day at its peak in 2007. If we estimate a (minimum) average daily fare of 100 MMK (given that the cheapest one-way ride would have been 50 MMK) this represents an annual turnover worth 90 billion MMK—or roughly USD 71 million at the estimated real exchange rate in 2007 of 1296 MMK/1 USD (Kato et al. 2008; Kubo 2007). This revenue was being distributed

among—and therefore supporting the livelihoods of—thousands of owners, drivers, conductors and employees of the BSCs, BLCs and Ma Hta Tha.

With such a broad base of vested interests, improving the system has proven challenging. However, as discussed below, the depth of the mobility crisis coupled with determined leadership at the Region government level appears to have taken important first steps in reforming the system.

3.3 The congestion incentive spiral

With the price of automobiles plummeting and the de facto costs of using the bus system rising (in terms of fares, time and comfort), the stage was set for an unusually rapid modal shift in Yangon. Moreover, this shift is self-reinforcing and creates a classic ‘tragedy of the commons’ scenario—or a ‘congestion incentive spiral’.

As congestion worsens, bus users suffer more than car users because they must sit through periodic stops and rarely disembark at their final destination. By contrast, car users can go directly from origin to destination without stops. In other words, it is nearly always faster to use a car than a bus. This simple fact incentivizes those individuals who have the means to do so to abandon the buses. But in so doing they contribute to worsening congestion, which creates increasingly strong incentives to abandon the buses. This self-reinforcing cycle harms both the car users and the bus users, but it is a natural consequence of the fact that the social costs of increased car usage exceed the private costs (Gakenheimer 1999).

The situation can be made even worse in the long run by what is known as the Downs-Thomson paradox (Arnott and Small 1994). Simply put, if rising congestion is met with expanded road capacity, this could worsen congestion by undermining incentives to use public transport. The more attractive alternatives become, the less people opt for the public option. This reduces revenue, which in turn incentivizes reduced public services, which in turn makes public transport increasingly less attractive to commuters.

The seismic shift in the cost-benefit analysis of individual commuters that began with the liberalization of automobile imports now has a self-reinforcing logic that could make the situation far worse without public intervention designed to realign individual incentives with the public good.

3.4 A crisis of metropolitan governance

In many respects the underlying cause of Yangon's mobility crisis is a governance crisis. The city has suffered from a dearth of strategic, long-term planning and investment resulting in a generally ad hoc and reactive approach to managing city affairs rather than a proactive one. Lacklustre enforcement of existing rules and regulations—particularly in relation to driver behaviour and parking—has exacerbated the situation. At the root of the problem are defects of institutional design.

The Yangon City Development Committee (YCDC) is nominally responsible for planning, infrastructure development and maintenance, water and sanitation, solid waste management, management of public spaces and associated amenities, and public health in the city. It also has legal authority to tax and spend and is financially self-sufficient (UNDP 2015). In practice, however, YCDC has become paralysed and disempowered, often coming into conflict with the Region Government and national ministries, which also have legal authority in many areas from land use planning to housing to infrastructure and transport. Since 2015 the Region has increasingly taken the reigns of city development, particularly with regard to transport.

While this is not inherently problematic given the geographic footprint of Yangon's transport system (which extends far beyond formal city boundaries), it underscores underlying institutional problems, including an unclear division of roles and responsibilities between YCDC, the Region and a wide range of Union-level ministries and departments. For example, while YCDC has some responsibilities for roads and bridges within its area, so too does the Region-level Ministry of transport, as well as several national ministries including the Ministries of Construction, Home Affairs and Transport and Communications (ADB 2016). This is a consequence of the way authority over key functions across different tiers of government are articulated in the Constitution (Section 96 and Schedule 2) and the various laws that empower the YCDC (see UNDP 2016).

This institutional mosaic is dysfunctional and represents a critical obstacle to efficient and sustainable management of urban transport in Yangon (ADB 2016; JICA 2014). Indeed, this is a classic example of the 'fundamental paradox of urban transport'—a situation in which demand for mobility is not met with concomitant supply due to coordination failures across those responsible for transport infrastructure, service delivery and financing (Gwilliam 2003).

In sum, the lack of a dedicated transport agency with the authority and capacity to coordinate metropolitan-level planning, investment, maintenance and regulation is a key underlying cause

of Yangon's current mobility crisis. This, in turn, is a consequence of defects in the political-institutional architecture of Greater Yangon.

4. Improving mobility and taming congestion

4.1 Prioritising mobility over congestion relief

Barring an unforeseen crisis, Yangon will continue to grow over the next decade and journey demand will continue to rise and exert further pressure on the urban transport system. While some of this demand might be met through an improved and expanded bus service, the congestion-incentive spiral that is driving growth in private automobile use will not be broken without more radical interventions.

When considering solutions, it is helpful to focus on maximising mobility rather than minimising traffic. Prioritising mobility encourages a shift away from focusing on congestion relief towards increasing the average speed that people move through the city. This in turn highlights the importance of enhancing alternatives to cars, including walking, cycling, motorcycles, buses and fixed-line networks insulated from traffic such as rail and bus rapid transit.

4.2 Supporting alternative modes: walking, cycling and motorcycles

There has been very little discussion—at least publicly—of promoting alternative modes of transport, including walking, cycling and motorcycles. Yet these could play an important complimentary role in boosting urban mobility.

According to a survey conducted in 2012 over 40 percent of all journeys in Yangon are on foot (JICA 2013). Provision for pedestrians varies widely across the city and could be substantially improved in many areas with modest investment. This could be particularly helpful in the city centre and around key transport hubs in greater Yangon.

Promoting bicycle usage could have an even more wide-ranging positive impact on mobility in the city. Bicycles are a highly efficient, sustainable and healthy mode of transport (UN Habitat 2013), and Yangon's relatively flat topography is very cycle-friendly. Reducing or eliminating restrictions on the use of bicycles in the city centre, as well as along some arterial routes, could rapidly increase individual mobility without exacerbating air pollution. It would also be a comparatively affordable option for many of Yangon's lower-income residents and an attractive one—particularly if investments were made in developing some cycling infrastructure such as dedicated lanes on the busiest roads. Embracing a city-wide cycling plan would place Yangon

among the world's leading cities in terms of promoting sustainable urban mobility. However, while permitting bicycles would boost urban mobility, it is unlikely to reduce congestion.

The same is likely true of permitting motorcycles in the city. Lifting current restrictions would almost certainly increase mobility without reducing traffic. In the short to medium run motorization rates would increase as new people who can afford a motorcycle but not a car take up this option. But it is highly unlikely that existing car owners would choose to invest in a new vehicle and switch having already invested in a car. Indeed, the evidence suggests that motorcycle usage is an intermediate step in motorization, with users eventually upgrading to automobiles (Gwilliam 2003). Moreover, allowing motorcycles might encourage some people to abandon the bus system, thereby stimulating the Downs-Thomson Paradox noted above and potentially undermining the financial viability of the bus system (ibid). Finally, motorcycles would likely lead to higher injury and fatality rates on the roads and could significantly increase flow disruptions (ibid). In sum, there is simply not enough research to make an informed cost-benefit analysis of the current motorcycle policy or the potential impacts of reform.

4.3 Reforming the bus system and reviving Bus Rapid Transit plans

In January 2017, the Yangon Region government pushed through a dramatic reform of the bus system by taking over Ma Hta Ta, forcing a consolidation of ownership in the sector and introducing a new route structure. Compensation has also been reformed: all drivers and conductors now receive fixed salaries rather than commissions to eliminate incentives for overcrowding and reckless driving. Although the change was abrupt and perhaps premature, resulting in a shortage of buses on the roads and frustrating both bus owners and passengers, it was not an unmitigated disaster. Moreover, the new hybrid system of public control combined with private operators in the Yangon Bus Service (YBS) resolves many of the market failures inherent in the previous competitive-cartel system and is more aligned with best practice in the sector (Estache and Gomez-Lobo 2005). It also represents a bold test of the government's ability to tackle intense vested interests established in the previous era of military rule, with the outcome likely to be interpreted as an indicator of the extent of substantive political change in Myanmar (Frontier Myanmar, Feb 5 2017).

In many respects the rollout of the YBS has already been a success. Against the odds the Region government has forced a restructuring of ownership and management of the sector despite the many vested interests involved. This may have been facilitated by securing buy-in from some key stakeholders, including Bandoola Transportation Co, Ltd (owned by the military); Omni Focus Co, Ltd (run by the grandson of former military leader Ne Win); and the Yangon Bus Public Co, Ltd,

which is a public-private partnership originally established to run the Bus Rapid Transit system. Several other companies—including several recently created by conglomerates of small scale bus owners—have bought in to the system, including Yangon Urban Public Transportation Co, Ltd; Power Eleven Public Co, Ltd; Sanwalela and San Raung Ni Co, Ltd; City Linter Bus Public Co, Ltd; Golden Southern District Co, Ltd.

Some bus owners have resisted the reform and refused to put their buses on the road under the direction and regulation of the new YBS authority (Soe 2017). This has led to a short-run capacity deficit. However, given the lack of alternative options for these owners it is likely that most will eventually fall in line. If not, expansion of capacity among those who have joined the scheme should make up for current deficits and yield a system with more transparent fares, safer driving and improved behaviour on the part of conductors. However, this reform is unlikely to significantly reduce congestion in the medium to long term given rising demand for journeys and the precipitous modal shift in recent years.

A very promising alternative was announced in 2015 in the form of a Bus Rapid Transit plan, with new buses set to ply key arterial routes. Although new buses did indeed hit Yangon's roads early in 2016 with BRT logos they did not benefit from dedicated lanes, which is the defining characteristic of a BRT system. Consequently, they were subject to the same traffic conditions as all other vehicles and made no obvious impact on commuter behaviour. The BRT plans appear to have been quietly shelved, with the buses now incorporated into the new YBS. This warrants reconsideration.

One of the only things that might arrest the 'uncontrolled haemorrhage' (ADB 2016, pg. 7) of passengers from the bus system will be an alternative to driving that is faster, reasonably priced and relatively comfortable. This in turn requires a fixed line network that is fully insulated from city traffic—particularly at peak times—and a BRT system would be the most rational option under the circumstances.

The economic argument for such a system is strong: estimates suggest that constructing a BRT network would be far cheaper than the currently proposed alternatives. A BRT plan proposed by the Japan International Cooperation Agency (JICA) has an estimated price tag of 5 million USD per km. By contrast, the cost per km for modernizing the existing circular rail line is estimated at \$20 million per km (ADB 2016). Other proposed options are similarly expensive, with per km prices of \$10-25 million for a tram, \$15-40 million for light rail system, \$35-40 million for a monorail,

\$50-100 million for an above ground mass rapid transit system and between \$130 million and \$162 million for an underground MRT system (JICA 2014).

The sooner such a system is implemented the better given the strong 'path dependency' in commuter habits. In other words, once people shift towards using automobiles to get around the harder it will be to lure them back into using public transport options such as the bus system.

4.4 Restructuring incentives and raising revenue

Rather than lure people out of cars with a faster alternative (such as a BRT), policymakers can also try to incentivise commuters to consider alternatives by influencing the personal financial costs of each option. Two mechanisms that have proven effective in reducing private automobile use in other contexts are petrol taxes and congestion pricing. Both have the collateral benefit of generating revenues that can be re-invested in upgrading and maintaining transport infrastructure.

Myanmar has the second lowest petrol price of any Southeast Asian country after Malaysia (Globalpetrolprices.com). Low prices reduce incentives to use public transport and represent a forgone revenue opportunity: many countries use petrol tax as a means of financing transport related infrastructure investments. However, increasing taxes on fuel is politically challenging everywhere, and particularly in Myanmar. The 2007 'Saffron Revolution' began following an overnight doubling of petrol prices and five-fold increase in natural gas prices (BBC 2007). More recently there have been complaints that prices are in fact too high given that oil prices have fallen but prices at the pumps haven't changed (Phyo 2016), with some pointing out that station owners are profiting from the widened margin between global wholesale prices and local retail prices (Htwe 2016). Despite the political challenges, introducing a marginal tax on some types of fuel within the Yangon Region may be a useful strategy for incentivising the use of public transport while raising revenue for transport-related investment and maintenance.

An alternative (or complement) to petrol taxes could be the adoption of congestion pricing whereby drivers pay a premium to use city inner-city roads during peak hours. There are numerous examples from around the world that confirm the efficacy of this approach including Stockholm (Eliasson et al. 2006;); London (Prud'homme et al. 2005); and Singapore (Goh 2002). Moreover, Yangon is already in the process of introducing a camera mesh in the city centre that could potentially be used to implement such a plan (Aung 2017). However, this is also a politically challenging policy strategy and one that requires a high level of institutional capacity to

implement and manage successfully. Given the tenuous state of urban governance arrangements in the city this may not be a viable option in the short to medium run.

4.5 Governance reform

Current efforts to reform the bus system, introduce a CCTV equipped traffic control system and improve traffic enforcement are all welcome developments. And it is sensible to consider longer-term plans for large-scale infrastructure development, such as a proposed metro system. However, such projects and initiatives will not yield sustainable improvements without governance reform.

As an emerging megacity Yangon desperately needs an independent transport agency with a mandate to maximise urban mobility. Such an authority would need to have oversight of all modes of transport in the city and coordinate with other authorities involved in land use planning. This is complicated by presently fragmented nature of governance in Yangon. Creating a transport agency therefore may require deeper institutional reforms to establish a coherent foundation for integrated transport planning and delivery. This challenge is compounded by the growing mismatch between the de jure political-institutional geography of Yangon City and the de facto functional area of the city.

The 'functional area' of a city or metropolitan can broadly be defined as the area within which there is clear integration of housing and labour markets. For example, if a town outside of the formal boundaries of a city has a high percentage of residents commuting into the city on a daily basis, this settlement would be considered part of the functional metropolitan area of the city. In Yangon there is clear evidence that the functional metropolitan area is considerably larger than that controlled by YCDC, and is even stretching beyond the Greater Yangon planning area highlighted in recent urban development plans prepared by JICA (2013).

Figure 6 overlays our analysis of built-up areas in Greater Yangon in 2016 with population density estimates from 2015 that are calibrated to correspond to the harmonised definition of urban areas now used by the European Union.⁵ The purpose is to identify the de facto functional area of

⁵ Myanmar does not have clear legal guidance in defining what constitutes an 'urban' versus 'rural' settlement, and there is no international consensus on the matter. Every country has historically employed a unique definition based upon a range characteristics, such as population size, density, composition of employment, administrative status, etc. For the purposes of empirically identifying the de facto urban area the EU harmonised definition is convenient. It identifies any settlement with a minimum population of 50,000 living at a minimum density of 1500 persons per kilometre squared (ppkm) as a high-density urban core and contiguous areas with a minimum population of 5000 living at a minimum density of 300 ppkm as urban clusters.

the city rather than the legally defined area. The figure clearly shows that the formally built-up areas of the city have already reached the northern and southern edges of the Greater Yangon planning boundary while the actually settled areas extend well beyond this boundary.

[Insert Figure 6]

Further evidence that the functional area of the city doesn't correspond to formal city boundaries and the proposed Greater Yangon planning area can be found in the extent of the new bus network. According to the route map on ygnbuses.com, two lines run regular routes far north of these boundaries to Taik Kyi Township and Phaung Gyi in Hlegu Township. The fact that buses regularly ply these routes strongly suggests that these areas are integrated parts of Yangon's labour and housing market and need to be factored into metropolitan-scale transport planning.

Sustainable development and maintenance of Yangon's transport system will require the clarification and rationalisation of roles between different tiers and agencies currently involved in transport delivery, the creation of a dedicated authority to manage urban transport, and a reconsideration of the appropriate boundaries of this authority with reference to the functional area of Greater Yangon. This should be considered an urgent priority. Establishing the appropriate institutional architecture now could help Yangon avoid the fate of cities such as Jakarta, which are today suffering the consequences of coordination failures stemming from decades of fragmented urban governance arrangements.

5. Conclusion

As an emerging megacity Yangon will always have traffic. While efforts should be made to reduce the social and economic costs of road congestion, eliminating it entirely is simply unrealistic. The overarching goal of planners and policy makers should therefore be to maximise mobility (and accessibility) through a holistic approach to urban transportation delivery. Reducing road congestion should be a secondary objective and collateral benefit of improving mobility. Focusing on improving the experience of drivers will not ultimately yield the most efficient and equitable outcome.

In the short run improvements to urban mobility could be achieved with relatively modest expenditure by consolidating ongoing reforms to the bus system, strengthening traffic enforcement to reduce flow disruptions, relaxing restrictions on the use of bicycles in central Yangon, and investing in cycle and pedestrian infrastructure.

In the medium term developing a proper BRT system—with dedicated lanes on key arteries—should be a high priority. This is clearly the most cost effective option for creating an attractive mass transit alternative to private transport. Developing such a network does not preclude the possibility of a mass rail transit system in the future. In fact the corridors developed for buses could eventually be transformed into rail corridors when the demand and finance for such a system are realised. A BRT system would likely benefit from a parallel strategy of disincentivising car use either through some form of tax on petrol consumption in Yangon Region or congestion charging.

The most urgent priority, however, should be governance reform to establish the institutional foundations for sustainable urban transport delivery. This would involve creating dedicated transport agency to serve as the focal point for planning, facilitating coordinated investments and managing the delivery of services across the range of transport modes in Greater Yangon. Such an agency would also need to coordinate with land use planners to effectively manage Yangon's inevitable growth and expansion in coming decades. This, in turn, may require more than just the creation of a transport agency, but rather a comprehensive review and reform of metropolitan governance institutions in Greater Yangon, including a review of appropriate functional boundaries for such institutions.

Yangon is thriving, but it is also suffering from a legacy of underinvestment, political neglect and fragmented governance arrangements. To reclaim its historic place as one of Southeast Asia's great metropolises Yangon will must consolidate effective and accountable urban government at a metropolitan scale.

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Figure 1 | Population growth in Yangon, 2010-2015

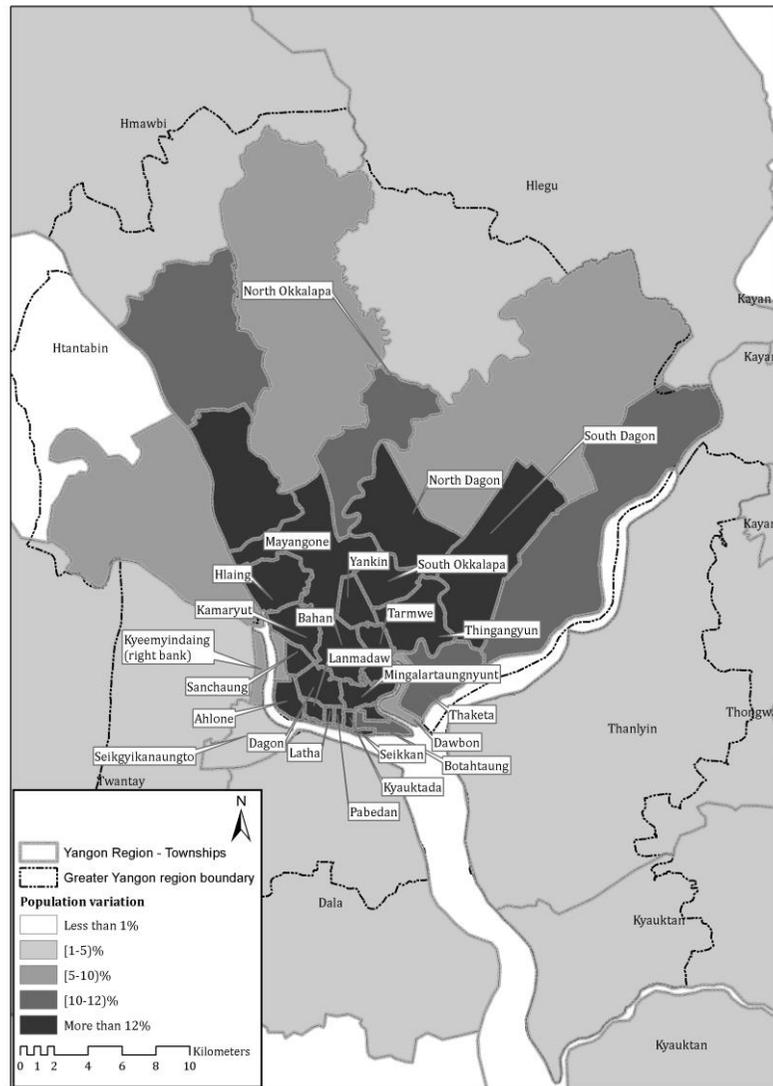


Figure 2 | Expansion of built-up areas in Yangon, 2003-

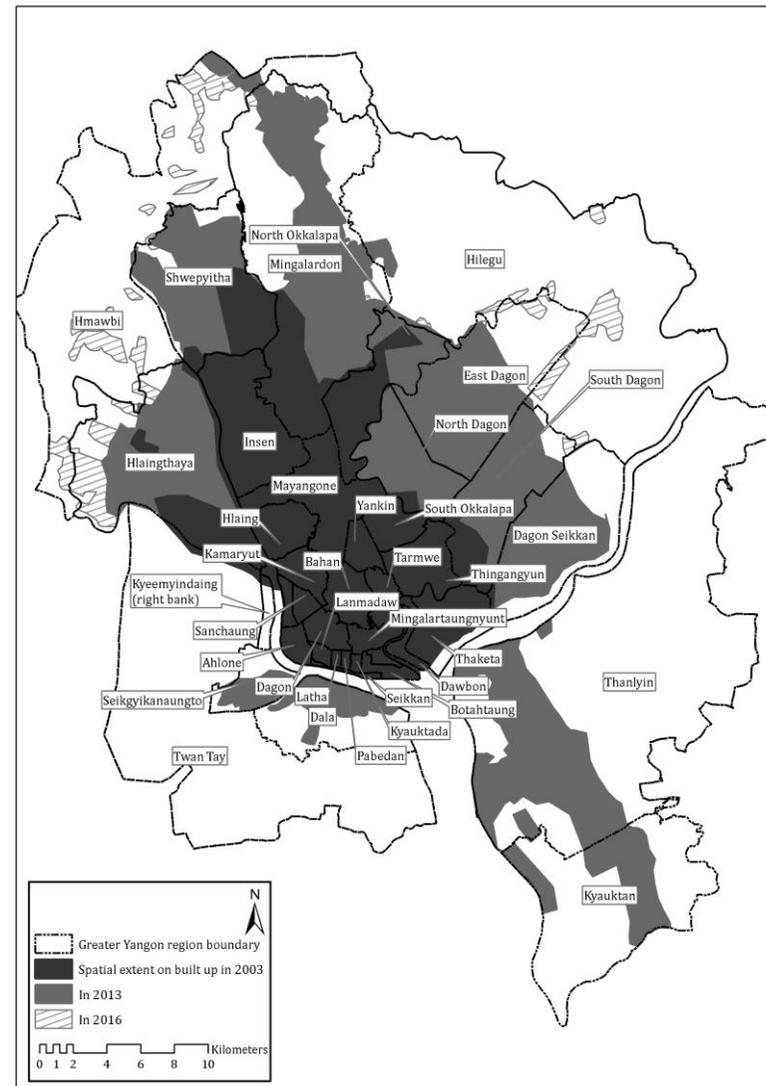


Figure 1 Luminosity in Yangon Region, 2003

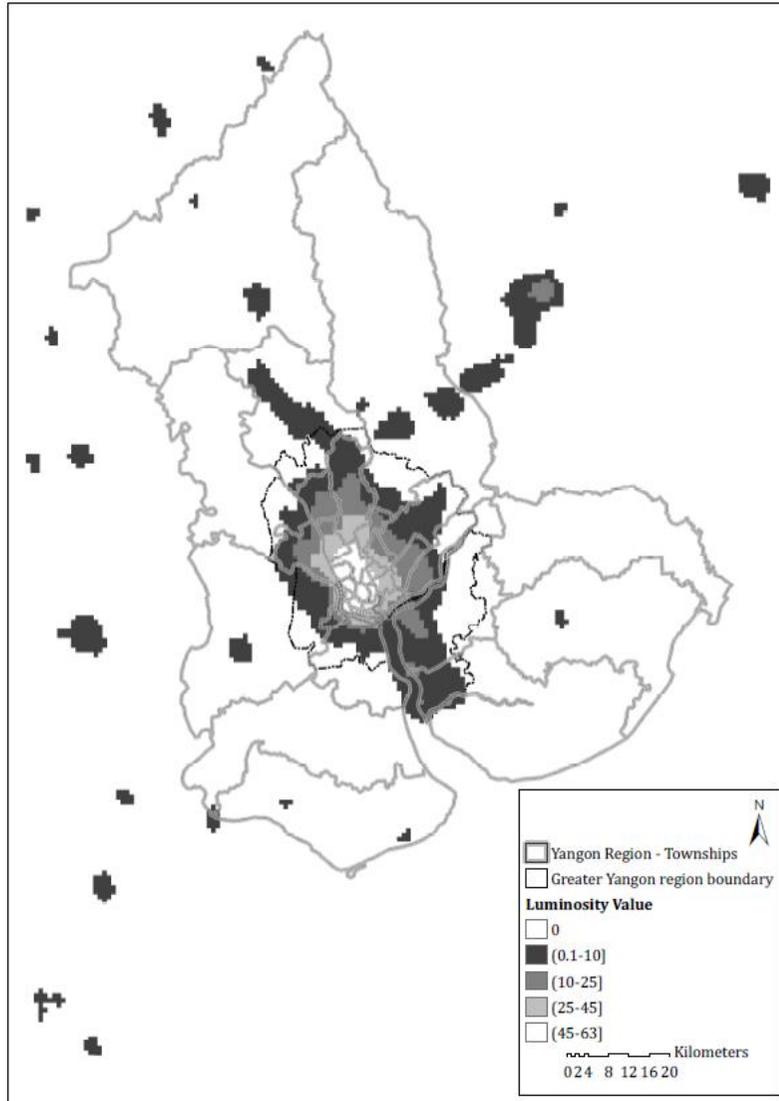


Figure 2 Luminosity in Yangon Region, 2013

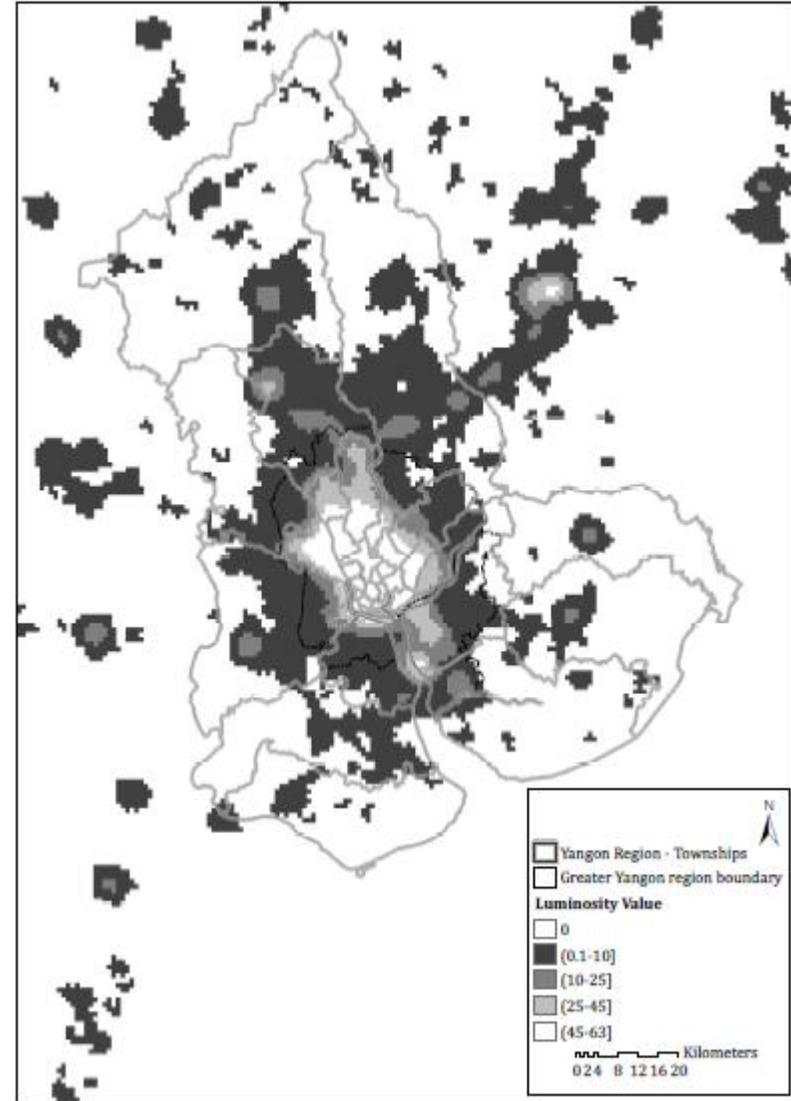
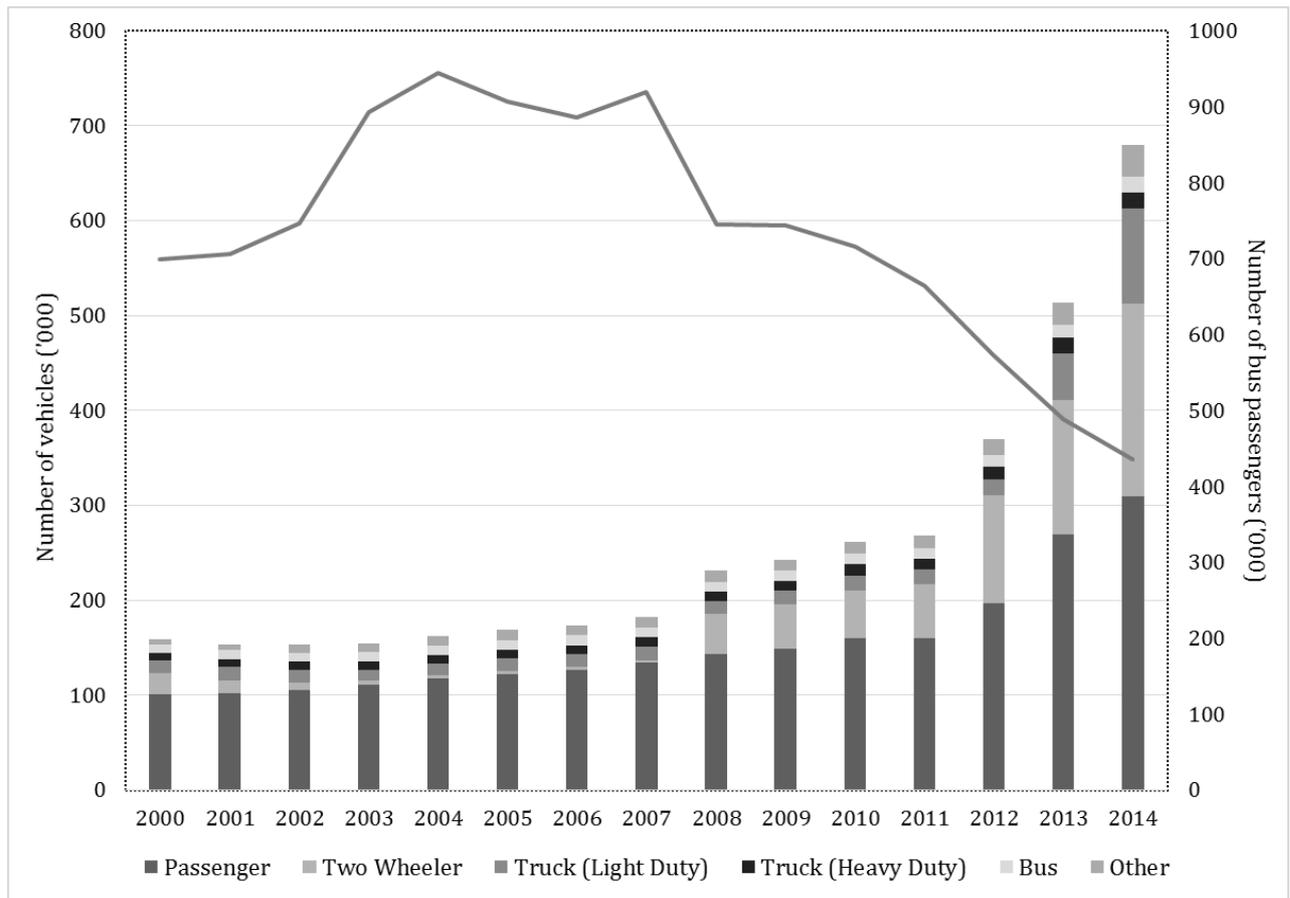
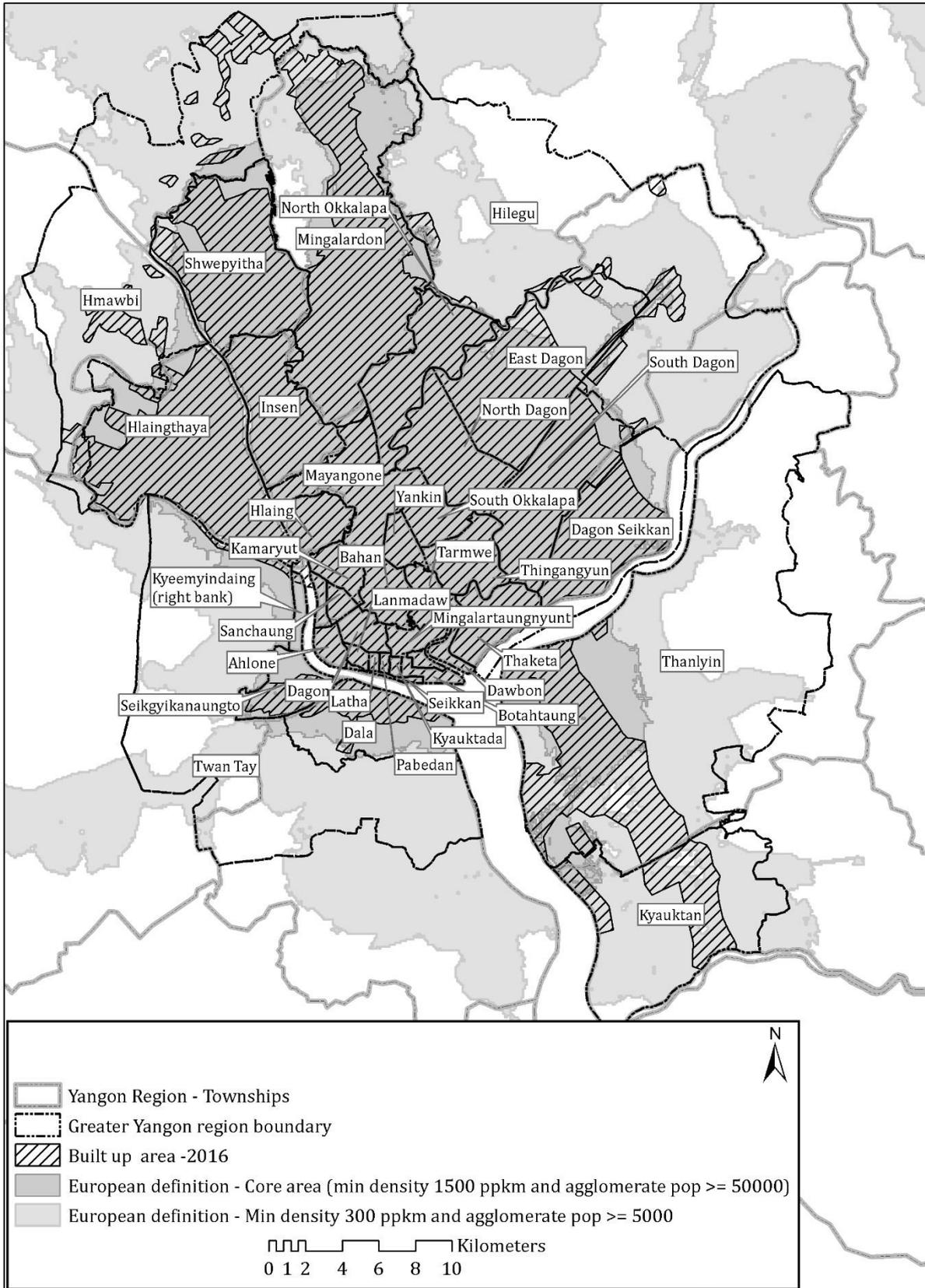


Figure 3 Growth in registered vehicles by type and number of bus passenger, Yangon Region 2000-2014



Source: Government of Myanmar (2017) Myanmar Statistical Information Service. Central Office of Statistics. Available at: <http://mmsis.gov.mm/>

Figure 6 | Built-up areas and urban population of Yangon in 2016 (EU definition)



Appendix A

Summary of geospatial analysis methods

Analysis of population variation and urban definition

WorldPop datasets for 2010 and 2015 were used for the analysis of the population variation in the Greater Yangon region, both at township and ward level. The same data were also used to identify possible density thresholds for the definition of extent of the urban areas based on the population data.

The raw 2010 and 2015 raster WorldPop data were initially analysed by means of the zonal statistics algorithm using a reference grid covering the full extent of the Greater Yangon region with cells of the same spatial resolution as that of the WorldPop rasters (i.e. hectare). The zonal statistics algorithm calculates the sum of pixels value (population) for each of the cells in the grid, thus allowing us to define population densities and population counts for urban settlements.

For the mapping of the population variation at township and ward level, the zonal statistics algorithm was reapplied to the raw raster scenes using as the spatial unit of reference the administrative boundaries of each of the townships and wards of the Greater Yangon region. For the townships, the estimated population counts have been checked against the available census data.

For the urban definition masks, three thresholding systems were utilised and compared. The first two derived from the natural breaks analysis of the 2010 and 2015 raw datasets which indicated a “cut-off” in the distribution of the data at an approximate density of 500 people per square km for the more sparsely populated and irregularly residential areas and at approximately 1000 people per square km for the denser and more regular residential areas.

The last thresholding system was derived directly by the European urban definition, which is given by a fusion of two density thresholds which are also contiguous spatially. The European definition distinguished between a core dense area (which has a minimum density threshold of 1500 people per square km and an agglomerated population of 50000 people) and a suburban areas (identified by a minimum density of 300 people per square km and an agglomerated population of 5000 people, and spatially contiguous to the core urban area).

For each of the thresholding systems, the first step consisted in sorting the grid cells for which the population count at sq km level was greater than the minimum threshold of 300, 500, 1000, 1500 people per square km. After this step, contiguous cells are agglomerated to distinguish separate urban settlements. The boundaries of the settlements can be used again as unit of reference for a second zonal statistics operation that counts the agglomerated population for each of the settlement.

Analysis of urban expansion

In order to evaluate expansion of built-up areas in Greater Yangon over a period of 15+years, a 3 scene mosaic Landsat time-series was acquired and pre-processed to a resolution of 15 meters for the years 2003, 2013, and 2016. Urban areas were then manually digitised and validated by means of visual interpretation.

To establish the ideal years and intervals of acquisition for the scenes the following factors were taken into account:

- For the first scene, conditions of cloud cover, luminosity, and the necessity to work with Landsat 7 ETM+ (which has the same resolution of Landsat 8 OLI), determined the choice of 2003 as the baseline year;
- The second scene was acquired 10 years from the first to allow for a reasonable timeframe for the analysis of urban expansion;
- The 2016 scene was chosen to provide the most recent possible “snapshot” of the state of urban expansion.

The three urban masks resulting from the process of manual digitisation were used to assess the extent, direction, and the rate of the spatial expansion of Greater from 2003 to 2016. They have been also compared against the urban definition masks extracted by means of incremental thresholding of the WorldPop datasets for the years 2010 and 2015, for validation purposes.

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