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Making cycling irresistible in tropical climates? Views from Singapore

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ABSTRACT

In Singapore, cycling serves only two percent of daily commuter trips. Whenever cycling is discussed in relation to tropical settings, weather and climate are cited as major barriers to success. Commentators based in temperate climate zones assume that stifling heat, humidity, monsoon rains, and severe thunderstorms preclude the adoption of cycling in the tropics. Drawing on in-depth interviews with transport policy experts based in Singapore, we demonstrate that weather and climate are less important here than previously assumed. To people acclimatized to the tropics, the local climate and the weather variations therein pose less of a barrier than factors such as safety and convenience, which are nearly universal. It appears that, to make cycling irresistible in tropical climates, similar setups and approaches proposed or implemented in temperate climates are needed.

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Introduction

Urban cycling, one of the most sustainable transport modes available, has been gaining traction, especially among the Millennial generation. Somewhat counterintuitively, cold, grey, and rainy North European and North American cities – Copenhagen, Amsterdam, Vancouver, Portland – have been at the forefront of cycling policy (Pucher and Buehler 2008). Other places worldwide have sought to transfer the lessons from these cycling pioneers, with varying degrees of success (Pucher and Buehler 2008; Gössling 2013; Pojani et al. 2017; Butterworth and Pojani 2018).

In Singapore, cycling serves only 2% of daily commuter trips (Abdullah 2018b), and just 3% of the population above 13 practices cycling recreationally (SSC 2011). Whenever cycling is discussed in relation to tropical settings, weather and climate are cited as major barriers to success. Commentators based in temperate climate zones assume that stifling heat, humidity, monsoon rains, and severe thunderstorms preclude the adoption of cycling in the tropics.

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However, our interviews with transport policy experts based in Singapore suggest that weather and climate are less important here than previously assumed (Singh 2014; Bakker et al. 2018; Choo 2019). To people acclimatized to the tropics, the local climate and the weather variations therein pose less of a barrier than factors such as safety and convenience, which are nearly universal. This is because they have a higher tolerance to heat than residents of temperate climates. It appears that, to make cycling irresistible in tropical climates, similar setups and approaches proposed or implemented in temperate climates are needed (see Pucher and Buehler 2008).

Methodology

This study is based on 11 in-depth interviews with cycling experts based in Singapore. Located only 1.5° north of the equator, Singapore has high levels of rainfall, ranging from 113 to 319 mm per month, with the highest levels in November through January. It also has high relative humidity (82–86.5%) and high average temperatures all year round (26–28 °C) (NEA 2017). While lacking distinct seasons, Singapore experiences two monsoon seasons: the Northeast Monsoon (December–March) and the Southwest Monsoon (June–September). These figures are reported by the Meteorological Service of Singapore and the National Environment Agency (2017).

The interviewees for this study were selected based on a standard snowball method, where a few initial interviewees pointed to other experts from their professional network (Trochim 2006). The final sample included individuals with a variety of backgrounds: public sector, non-governmental organizations, and academics. Efforts were made to include representatives from bike-sharing companies but these were ultimately unsuccessful. (In a relatively closed culture, arranging the interviews was a major challenge). The interviews were semi-structured in order to allow for a level of control over the direction of the conversation without limiting the breadth and depth of the discussion (Silverman 2014). The questions centered around the themes identified in the literature on cycling determinants and their application to Singapore. All interviews took place face-to-face over a three-month period (December 2017–February 2018). Each lasted about one hour on average – for a total of approximately 700 recorded minutes. The recordings were transcribed verbatim and then edited to facilitate understanding (e.g. of Singapore-specific colloquialisms) and to protect participants' privacy. While editing, care was taken to retain the contextual integrity and the meanings which the participants intended to convey. The analysis was manual and iterative and followed a template of priori themes established through a review of the literature.

The main findings are reported below.

Findings and Discussion

Weather and climate

Among weather variables, research has identified temperature as the primary influencer of cycling rates (see Brandenburg, Matzarakis, and Arnberger 2007; Amiri and Sadehpour 2015; Heinen, van Wee, and Maat 2010; Nankervis 1999). Precipitation, or even the chance of it, has also been found to be highly detrimental to cycling rates

(Meng et al. 2016; Böcker, Dijst, and Prillwitz 2013; Flynn et al. 2012; Mateo-Babiano et al. 2016; Wadud 2014; An et al. 2019). In Singapore too, most interviewees identify high temperature, combined with high humidity or heavy tropical rains, as an important – though not crucial – factor in the decision to cycle. But they have mixed views on whether this truly deters people from cycling. As one interviewee notes, “Singapore’s weather will not change; whether you cycle or not, it’s hot anyway.” However, heavy rains during the monsoon seasons pose a safety risk as roads become slippery and even flooded, drivers cannot easily spot cyclists, and cyclists may hold umbrellas while riding.

Interviewees report that the lowest cycling rates are observed during afternoon peak temperatures when the physical discomfort from the heat is the greatest. Singaporean cyclists generally prefer temperatures within a rather narrow range: 29.5–31.5 °C (Meng et al. 2016). Likely, this is due to Singapore’s relatively uniform annual temperatures. Never having to experience cold and snowy winters, cyclists do not look forward to spending time outdoors in warm weather – such as might be the case in temperate climes. Elsewhere, the “ideal” cycling temperature range appears to be between 17 and 33 °C, although in some cities with continental climates, cycling occurs in much wider temperature ranges, for example, –4 to 41 °C (de Chardon, Caruso, and Thomas 2017; Brandenburg, Matzarakis, and Arnberger 2007; Miranda-Moreno and Nosal 2011; Böcker, Dijst, and Prillwitz 2013).

More than the weather itself, perspiration might be the major problem for commuters who lack end of trip facilities, such as showers, in their workplaces. The interviewees point out that women commuters may need a changing room in which to redo their makeup or change into skirts once at work. Experienced cyclists are known to employ various mechanisms to cope with the less desirable aspects of the local climate. For example, when there is rain, they may delay their departure time or use protective clothing.

Some interviewees even argue that Singapore’s weather can be more conducive to bicycle commutes than to recreational trips since these trips necessarily take place during the cooler parts of the day: early morning and late evening. On the other hand, weather perceptions seem to affect non-cyclists in a major way. The interviewees report that people in this group, due to their lack of experience with cycling, tend to perceive Singapore’s weather as inclement. This appears to be the case in other climes too: utilitarian cyclists are less impacted by variations in temperature compared to recreational cyclists with choice (Böcker, Dijst, and Prillwitz 2013; Helbich, Böcker, and Dijst 2014; Tin et al. 2012; Brandenburg, Matzarakis, and Arnberger 2007).

While outside temperatures cannot be easily controlled, various cities around the world have introduced or proposed measures to make cycling more comfortable in different weather conditions, including sheltered, heated, or cooled bicycle paths and consistent road ploughing during snowy months (Böcker, Dijst, and Prillwitz 2013; Spencer et al. 2013; Tin et al. 2012; Dürr 2016; MVSA Architects n.d.). Similarly, our interviewees suggest that the discomfort of riding bicycles in hot and humid weather could be assuaged by creating shade along bicycle paths, especially at intersections where cyclists must stop and wait. Planting natural greenery is preferred to building manmade structures (shelters) as trees and shrubs are also more visually pleasing and

relaxing. This approach also fits with Singapore's plans to adopt biophilic urbanism (Newman 2014). However, shading is only considered as "good to have" rather than paramount to the adoption of cycling at a large scale.

Safety

Research has established that a lack of safety is the primary deterrent to cycling across the world (Pojani et al. 2017; Hull and O'Holleran 2014; Gössling 2013; Spencer et al. 2013; Pucher and Buehler 2008). Safety concerns come in many forms; for example, collusion with motorized transport vehicles, reduced visibility at night, slippery road conditions due to precipitation, and even bicycle theft (Spencer et al. 2013; Heinen, van Wee, and Maat 2010; Amiri and Sadeghpour 2015; Gössling 2013; Koetse and Rietveld 2009; Meng et al. 2016). Quality cycling infrastructure – in the form of reasonably wide, segregated bicycle lanes connected in a network – is seen as key in appeasing most safety concerns (Hull and O'Holleran 2014; Pucher and Buehler 2008; Gössling 2013; Pucher and Buehler 2008; Pasha et al. 2016; Hull and O'Holleran 2014; Marqués et al. 2015). Other measures, such as traffic calming, better lighting, bicycle priority designs at intersections, lower car speed limits, and traffic liability laws that favor cyclists are beneficial as well (Handy, van Wee, and Kroesen 2014; Pucher and Buehler 2008; Chataway et al. 2014; Hull and O'Holleran 2014; Castillo-Manzano and Sánchez-Braza 2013).

All our interviewees in Singapore concur that the local built environment is perceived to be unsafe for cycling. A lack of safety is considered as the primary deterrent to cycling here, regardless of travel purpose. Singapore hardly differs from the rest of the world in this respect. The provision of high-quality physical infrastructure exclusively for cycling is a recurring theme in all interviews. As one interviewee opines, "ideal safety levels are achieved when parents allow their children to cycle independently on the roads."

However, interviewees also highlight the complexities of implementing traditional forms of on-road bike paths. On-road paths would potentially conflict with existing bus lanes and bays; creating an extensive network would require a major redesign of the road network and possibly even bus rerouting. Therefore, most bicycle paths are relegated off-road. The Singaporean public has been highly disapproving of that approach, not least because off-road paths are often narrow and shared with pedestrians.

On the other hand, the redesign of busy main streets (e.g. in Ang Mo Kio and Bencoolen) with segregated pedestrian and bicycle traffic paths has been applauded (Cheng 2016). However, the interviewees suggest that, apart from color and signage, the segregation can be enhanced further using physical features such as a raised curb or even vegetation that ties in with Singapore's green urbanism narrative. But with more e-bikes and e-scooters on the road, cycling paths must become wider. This may be difficult to achieve in already built-up areas without taking away a substantial amount of space from cars.

In Singapore, discussions about safety revolve around the potential conflict between cyclists and pedestrians, in addition to the usual conflict between cyclists and motorists

because the city contains many shared spaces. Allowing cyclists to use footpaths has been strongly opposed by the public, as it sends a message that it is preferable to inconvenience pedestrians over cars. However, according to some interviewees, sharing has been obligatory given high population densities. Also, one interviewee notes that cyclists had already been using footpaths illegally for years, and legislation to legalize sharing was simply a pragmatic step forward.

Under these circumstances, cyclists tend to be regarded as a “black sheep” both on the roads (by drivers) and on the sidewalks (by pedestrians). With the rapid uptake of electric vehicles (e-bikes, e-scooters), which move at higher speeds than conventional pushbikes, safety concerns are becoming more salient. To deal with the problem, the Singaporean government has legislated lower speed limits (10 km/h) for bicycles and electric vehicles on footpaths – effective starting in early 2019 (*Channel NewsAsia* Abdullah 2018a).

In addition to legislation, the interviewees suggest that education on how to negotiate space and share respectfully with others is key to dealing with the safety issue. Other safety issues which come up elsewhere, such as unsecure bicycle parking or cycling at night-time, are less important in Singapore. Extensive street lighting and relatively low crime rates contribute to a feeling of safety while outdoors, day or night. And the advent of public bicycle sharing has allowed people to cycle while not owing a vehicle, thus alleviating both the need for storage and any fear of theft.

Convenience

Convenience is the product of several factors. Cycling in steep topography is perceived as more strenuous and less convenient. Hilly terrain, especially when interrupted by harbors, bays, and rivers – is a deterrent, particularly among inexperienced cyclists (Heinen, van Wee, and Maat 2010; Rietveld and Daniel 2004; Mateo-Babiano et al. 2016; Pucher, Buehler, and Seinen 2011; Vandenbulcke et al. 2011). Long distances between destinations (which are in turn affected by the mix of land uses) are also a barrier to cycling (Bakker et al. 2018; Heinen, van Wee, and Maat 2010; Handy, van Wee, and Kroesen 2014; Pojani et al. 2017). While certain individuals are willing to cycle up to 20 km for their commutes, 5 km is the limit among the general population – although the advent of electric bicycles promises to extend this average (Pojani et al. 2017; Heinen and Bohte 2014; Gebhart and Noland 2014). People who need to run errands before or after work are less likely to view cycling as the most convenient travel option. In places where additional supplies/equipment are needed to cycle (such as bicycle helmets, raincoats, or formal work clothes) cycling is also seen as less convenient. A lack of showers or secure parking at work adds to the inconvenience (Hull and O’Holleran 2014; Heinen et al. 2013; Mateo-Babiano et al. 2016; Pasha et al. 2016; Nkurunziza et al. 2012; Tin et al. 2012). On the positive side, the simple fact of owning a bicycle adds to the perceived convenience of cycling. Tax exemptions on employee bicycle purchases or bicycle donations are vital here (Heinen, Maat, and van Wee 2013; Handy, van Wee, and Kroesen 2014). For those who cannot own bicycles even where these are given away for free (e.g. because they live in small flats), public bike-share schemes offer alternative access to cycling. However, the most devoted bike-sharing

members tend to be those whose start or end destinations are in close proximity to stations (Mateo-Babiano et al. 2016; Castillo-Manzano and Sánchez-Braza 2013; Gebhart and Noland 2014).

In Singapore, along with safety, convenience is another key determinant of cycling, especially for commuting purposes. According to the interviewees, cycling is regarded as inconvenient due to the extra effort and fitness level needed – although the island is mostly flat. Gaps in the cycling network (e.g. bridges with stairs) and a lack of end of trip facilities, such as bicycle parking racks, changing rooms, and showers, add to the inconvenience. Parents face additional barriers as their trips are often not linear and include multiple stops before reaching work (e.g. to drop children off at school and run other errands). Where trip speed is important, other commute options such the metro, taxis, or cars are more attractive. Due to the fact that the utilitarian cycling scene is dominated by short trips and feeder services to metro stations, the interviewees regard trip distances as unproblematic. Meanwhile, the uptake of e-bikes in Singapore is easing the physical demands of long distance travel. The advent of dockless bikesharing in 2018 (oBike, Mobike, ofo) promised to add to the convenience of cycling as a feeder mode (Baharudin 2018). But despite gaining traction in the market, dockless bikesharing systems were prone to vandalism and, as such became subject to criticism. More recently, due to difficulties in meeting Singapore's licensing requirements, the companies are declining (Abdullah 2018a; Yang 2018; Youjin 2018).

Other factors

A host of other demographic, socio-economic, and psychological factors has been found to affect cycling rates around the world. For example, women are more safety-conscious and therefore tend to cycle less than men. Where cycling is perceived as a mode for the poor or for children, it is less likely to be adopted by the middle-classes. However, because bicycles are affordable, they are more likely to be used by people who are impoverished, even if only temporarily (such as students). Those who view themselves as too frail, unfit, old, or ill to take up cycling, are less likely to do so. On the other hand, living in a city with an established cycling culture and with high levels of environmental awareness increases one's propensity to cycle. Finally, experience and enjoyment of cycling is more likely to lead to cycling adoption (Aldred and Jungnickel 2014; Castillo-Manzano, López-Valpuesta, and Sánchez-Braza 2016; Heinen et al. 2013; Pucher and Buehler 2008; Pasha et al. 2016; Handy, van Wee, and Kroesen 2014; Pojani et al. 2017; Hull and O'Holleran 2014; Spencer et al. 2013; Winters et al. 2007).

Most of these factors (which might be significant elsewhere) are not deemed to be vital in Singapore. For example, cost is negligible, Singapore being a wealthy country with very affordable public transportation services. As such, little money can be saved via cycling here. Also, the interviewees do not believe that health considerations are a major push for cycling uptake in Singapore because people increasingly use e-bikes instead of conventional pushbikes to commute, and this eliminates health benefits. Enjoyment of cycling may play a role, but only for recreational trips. While demographic variables are not easily modifiable, education and awareness-raising campaigns show some promise here.

The way forward

To sum up, recommendations to improve cycling in Singapore (and other tropical settings) include the following:

Infrastructure	<ul style="list-style-type: none"> • Physically segregated bike paths sufficiently wide to cater to both cyclists and small motorized vehicles along major roads • Traffic calming at intersection points • Path connectivity in residential neighborhoods • Shaded cycling paths (through tree planting or awnings)
Soft policies	<ul style="list-style-type: none"> • Shower facilities in workplaces • Safe cycling education in schools • Fair laws prioritizing bicycles on roads and pedestrians on footpaths • Fair laws prioritizing bicycles on roads and pedestrians on footpaths • Financial incentives to employers and employees

Two local agencies involved in cycling, the Land Transport Authority and the Urban Redevelopment Authority, should take these interventions into consideration while upgrading cycling policies and infrastructure.

Singapore already contains 240 km of cycling paths and a Park Connector Network – a web of cycle and footpaths that link green spaces and national parks (Figure 1). Cycling rates are poised to increase as the government has promoted a series of “car-lite” initiatives, developed a National Cycling Plan, and strengthened the legal framework related to active transportation and user safety (LTA 2017a, 2017b). One major objective is to extend the cycling network to 700 km by 2030 (URA 2018a, 2018b). Real estate developers are now required to submit a “walking and cycling plan” that accounts for bicycle connectivity and parking when seeking building permits.

The local Land Transport Authority is currently working with community organizations to introduce a “Travel Smart Grant”, which provides seed funding to employers for small projects such as building shower stalls within the workplace, or teaming up with neighboring gyms that already have showers. Preliminary feedback suggests that this grant scheme holds promise, especially among “undecided” or occasional bicycle commuters. But several interviewees opine that to persuade non-cyclists, employer-based monetary rewards, or bikesharing subsidies might be more effective.

Some grassroots initiatives have been beneficial too. For example, local residents have initiated dollar-for-dollar fundraising events (with the government matching community funds) to create or revamp cycling paths in their community. Education and information campaigns have been launched through the press and “Move Happy”, a website containing a personalized cycling journey planner, has been set up (LTA 2018). However, several interviewees believe that outreach efforts and safe cycling education should focus on schoolchildren rather than adults, so that pro-cycling attitudes and behaviors are established early on.

While the interviewees are optimistic about Singapore’s opportunity and ability to enhance commuter cycling, nearly all point out that recent efforts to curtail car ownership have had no effect on cycling rates. This might be due to already low growth rates in car ownership, which, in turn, have been the result of heavy automobile taxation

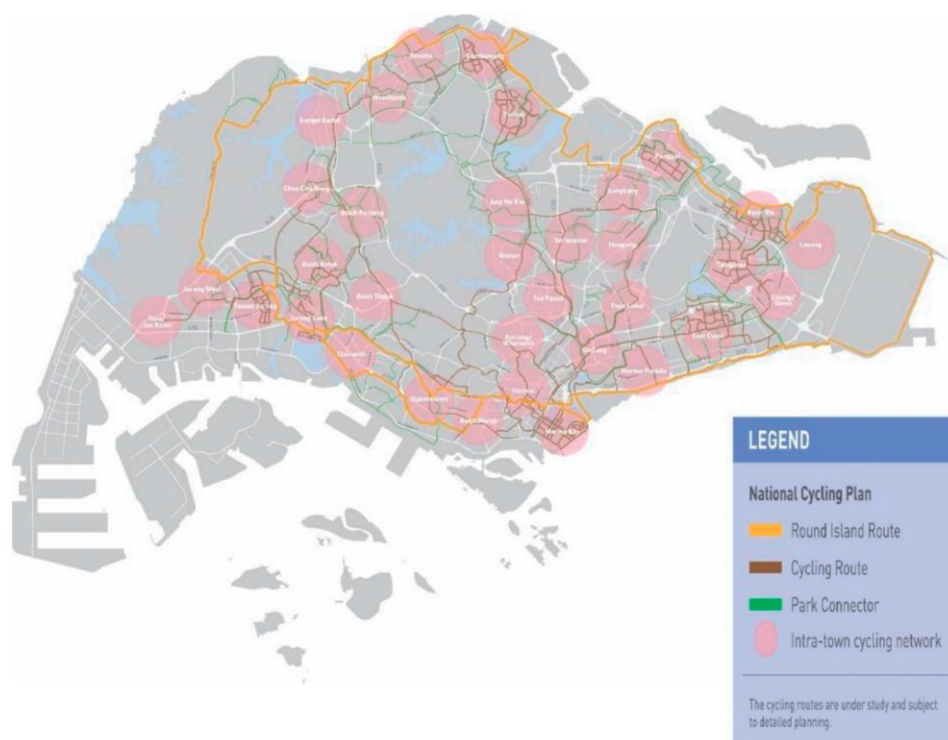


Figure 1. Proposed cycling plan in Singapore. Source: URA.

employed for years in Singapore. At this point, new policies might need to center on parking – for example, by increasing parking fees in the CBD or physically reducing the amount of available parking.

Notably, many cycling initiatives have come to fruition in Singapore due to close collaboration and coordination among governmental agencies. The country's stable political climate and centralized institutional setup, which other places in the tropics typically lack (see Stead and Pojani 2017), allow for this integrated approach. Warm-climate cities with fewer resources – for example, in the Indian subcontinent, Sub-Saharan Africa, Central America, the Persian Gulf, and elsewhere in Southeast Asia – might need to create specialized agencies or public companies within their local or regional administrations, which bypass the established regulatory agencies. These can advocate for pro-cycling policies, lobby to increase cycling-related budgets, and ensure the continuity of cycling issues in institutional agendas. Single-issue agencies have proven to be successful in overseeing the implementation of other sustainable transport concepts such as pedestrian malls and bus rapid transit (see Pojani 2008, 2014). Given the current climate emergency, such agencies are far from wasteful: on the contrary, they are paramount if cycling rates are to match car and/or public transport ridership.

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