Public Bicycle Sharing in Asian Cities

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Abstract: Public bicycle sharing programs (PBSPs) is gaining worldwide attention as an important climate-smart, active transport alternative. Despite becoming permanent fixtures in the urban landscape of the West, PBSP implementation in Asia, except for China, has been relatively dismal. Many of the pilot models have been adaptation of Western examples that do not appropriately fit the distinct physical, cultural, economic and political context of Asia-Pacific cities (e.g. diverse set of land uses, the relatively dense urban centres and formal/informal transport interaction). This research explores the glocalisation of bikesharing schemes in five selected Asia cities. Drawing upon a systematic review of literature, this paper aims to building the evidence base to increase our understanding of PBSPs implementation as an important first step in planning for a low carbon society and advance the limited information to effectively inform low-carbon planning and policy especially from the perspective of active transport within the Asian context.

Keywords: Active Transport, Public Transport, Asia, Cycling, Non-Motorised, Bikesharing

1. INTRODUCTION

1.1. Background

Changing climate means that cities in Asia are bound to experience more frequent rainfall, sea level rises and higher numbers of extreme tropical cyclones (Christensen et al. 2007). This is further exacerbated by the fast-paced urban population growth and urbanization, wherein 70 per cent of the world population is expected to live in cities by 2050, and environmental pollution. As three of the five top emitters – China, India and Japan – are Asian countries (Siddiqui 2008), addressing climate change must be meaningfully undertaken within the Asian region. This requires the cooperation amongst members of the Asian community, from government, private sector and civil society. Moreover, urban transport must be able to keep pace with this changing context and demand for transport services, ensuring that people and communities have adequate transport, particularly the provision of alternatives, to be able to access social and economic opportunities.

Considered as a sustainable and inclusive urban transport alternative, a public bicycle-sharing program (PBSP) is seen as one sustainable transport strategy, which can alleviate some of these urban challenges. PBSPs are non-motorized transport services that provide point-to-point active travel for short distance trips without the need to own a bicycle. The idea is that an individual can take a bike from one station for a short trip (usually between 30 minutes to an hour) and return it to the same docking point or another docking point within the network. Bikesharing is considered as a public facility, being operated as part of an overall public transport network, along with public buses, ferries and trains. Implementation of PBSPs into the urban infrastructure of countries is perceived to provide a range of environmental, economical and social benefits, including flexible mobility, lower emission
levels, health benefits, reduced congestion, lower financial costs and support for more integrated transport connections (Shaheen 2013; Shaheen et al. 2010; DeMaio 2009; Cavill et al. 2007).

While PBSPs have become permanent fixtures within the urban landscape of Western cities, it was only recently that such schemes have been introduced in the Asian context. China’s Wuhan PBSP was considered the largest in the world in terms of fleet size with 90,000, however the system has recently been discontinued. Hangzhou has one of the densest bikesharing schemes with an average monthly use pegged at 9.75 million (International Business Times 2013; Shaheen et al. 2011). Figure 1 shows the increasing uptake of PBSP in the different regions around the world, displaying a steep rise in bikeshare implantation in Asia but largely driven by schemes in China. While more popular ones are generally the large-scale schemes (e.g. Hangzhou), a number of Asian cities also accommodate small-scale PBSPs, such as Kitakyushu’s PBSP. An NPO-managed and operated scheme, the Kitakyushu PBSP, Nakamura and Abe (2014a; 2014b) argue, demonstrates a unique model because while most business models are for exclusive use of bikeshare users, a possible model for operation and management of a public bikeshare is to allocate a number of bicycle docking points in a bikeshare station to be shared by both the private bicycle and bikeshare users. They further add that this arrangement is more appropriate in the context of a dense inner city area, or a special district within a locality, wherein the role of the PBSP is one that is of a public good, only being operated for the benefit of the community. However, limited study has been progressed to study different model types (e.g. privately operated, publicly operated, shared), bikeshare scale (e.g. large-, medium- and small-), and city size.

![Figure 1. Number of PBSPs by Region (adopted from Larsen 2013)](image)

**1.2. Rationalising the Diverse Asian Landscape for PBSPs**

There are a multitude of reasons why an examination of PBSPs in Asia is in order. Transportation systems in the Asian region address different set of urban challenges in comparison to its Western regional counterparts. For example, the Asian region exemplifies a diverse set of land uses while its cities exemplify relatively dense urban centers. Moreover,
the unique interaction between the formal (e.g. buses) and informal transportation (e.g. rickshaws, paratransits) as well as the relatively higher share of active travel (i.e. walking and cycling), although captive, meaning lacking of choice, may require a different model type that would be appropriate to its unique role to supplement the overall transport system. Moreover, the unique characteristics of the Asian urban landscape include: diverse climate, season and geography, accommodating diverse geography, climate and season; diverse land use mix and characteristics, as a result of a dramatic transformation in the use of its land, rapid urbanization and the consequent land use mix that evolved from this change; and diverse communities, from mega-cities to small and medium sized communities; diverse set of formal and informal public transportation system, while many Asian cities have been looking to Europe as an example to ‘green’ their transportation policies, it is also critical that consideration be given to a range of formal and informal transport modes, which are rampant within Asian cities; and diverse mobility culture, referring to the peculiarity and nuances of Southeast Asian travel behavior and practices.

1.3. Problem statement

Many examples of western-based PBSPs are implemented into developed urban areas that have sufficient transport and bicycle infrastructure, financial security and effective policy initiatives. This contrasts with the developing city setting. To successfully implement a PBSP into an Asian context, especially in developing Asia, it is therefore imperative to gain a better understanding of the local context and background before a PBSP is implemented. To date, no research has yet been undertaken to examine the adoption of a particular bikeshare model and scale and its effective localization of an inclusive mobility solution such as public bicycle sharing programs (PBSPs), particularly in developing contexts.

As such, this paper’s aim is to examine the different types and scales of PBSPs implemented in selected Asian cities with the end view of informing and guiding the way forward for PBSP research and potential implementation in developing Asia.

1.4. Significance and contribution

This paper contributes to knowledge in two different ways: practically, it shares the experience of early bikeshare adopters in the Asian context, particularly barriers or facilitators to its implementation; and conceptually, it examines bikeshare scale and model within a city context advancing the current limited knowledge and information about bikeshare schemes in Asia.

1.5. Paper’s structure

The paper consists of five sections: (2) A review of how bikeshare evolved in Asia; (3) Data and methodology; (4) Results and findings discuss about the five models; and (5) Conclusion.

2. PUBLIC BICYCLE SHARING PROGRAMS IN ASIA: A REVIEW

PBSPs have existed for over 60 years. However, it was only in the last seven years that a rapid uptake on public bikesharing schemes in various cities across Europe, USA, Asia and Australia ensued. From an estimate of 70,000 bicycles operating in 78 cities (2009 figures)
(Midgely 2009) it almost doubled to 139,300 bicycle units operating in 125 cities (2010 figures) (Shaheen et al. 2010). As of this writing, there are approximately a total of 668 PBSPs with 669,000 bicycles implemented across 54 countries worldwide (DeMaio and Meddin 2013; Ahillen et al. 2015). Of this, 10 countries in Asia have adopted bikeshares. While most of them are in East Asia, particularly in China (Midgley 2011). The first and second generation of PBSPs were predominantly adapted in Europe and the Americas. It was not till the third IT based generation of the program that it was introduced to the Asian market (Shaheen et al. 2011). While Asia joined later in the game, it remains the fastest growing market for bikeshare schemes (Shaheen et al. 2011).

2.1. Evolution of bikeshares around the world

Since its introduction, bikeshare programs can be categorised into four distinct generations. Each generation is characterised by specific technical, technological or physical attributes or innovations. The first generation public bicycles started in 1965, in Amsterdam with the program called “White Bikes”. These were normal bicycles, painted white and offered for public use. Cyclists were able to pick a bike in one of the stations, ride it to their desired destinations, and leave it for the next user. However, “White Bikes” was not a successful system since bikes were thrown into the canals and/or stolen. In 1995 the first large-scale second generation bike-sharing program called ‘City Bikes’ was implemented in Copenhagen, Denmark, with several improvements over the previous generation. While more formalized than the previous generation, with stations and a non-profit organization to operate the program, ‘City Bikes’ was still exposed to theft due to the anonymity of the user. Therefore, a new generation of bikesharing was created with an improved user tracking.

The first program of the third generation was ‘Bike about’ implemented in 1996 in England, where students could use a magnetic stripe card to rent a bike. The third generation of bike-sharing systems showed technological improvements, including electronically locking racks or bike locks, telecommunication systems, smartcards and fobs, mobile phone access, and on-board computers. Bike-sharing increased gradually in the following years, but it was not until 2005 that the largest bike-sharing program was established. It was called Velov’ and created in Lyon by JCDecaux with 1,500 bikes. By 2007, Paris put in motion its own bike-sharing program -called Vélib'- with approximately 23,600 bikes in the city and suburbs. Velib’s massive success changed the course of bike-sharing history and created global interest in this mean of transportation. In 2008, bike-sharing finally began to take hold, with new programs in Brazil, Chile, China, New Zealand, South Korea, Taiwan, and the U.S. A fourth generation system of bicycle share (4GBS) is being conceptualised to promote inclusion by incorporating new features into the location and design of existing bikeshares. Moreover, Gobike, a new public shared bicycle system recently introduced in Copenhagen, Denmark, marks the first attempt to incorporate ITS with non-motorized transportation (Jenken 2013).

2.2. Evolution of bikeshares

Since the first generation of PBSPs in Europe during the 1960’s, PBSPs have rapidly evolved and adapted to changing environmental, technological and economical factors (Midgley 2011). The first and second generations of PBSPs were predominantly adapted in Europe and the Americas. It was not until the third IT based generation of the program that it was introduced to the Asian market. The introduction of PBSPs in Asia has gained substantial momentum with Asia now having the fastest growing market for PBSPs (Shaheen et al. 2011).

At present, there are a number of PBSPs operating in the Asian market. Majority is
located in East Asia. The first PBSP to launch in Asia was the Singaporean ‘TownBike’ (later renamed to SmartBike) scheme (Larsen 2013). This program was implemented in 1999, however, due to a lack of funding, the program was eventually stopped several years later (DeMaio 2004). However, there are currently two PBSPs in Singapore: one conventional and one run by a car-sharing company offering electric bikes (Larsen 2013). South Korea has implemented twelve PBSP systems. The one in Changwon accommodates 4,600 bikes while the Goyang PBSP has approximately 3,000. On the other hand, Taiwan has only two bike-sharing programs. Japan has nine bike-sharing programs, which were launched between 2009 and 2012 (Bikesharing goes Global 2013). Japan’s schemes range from small-scale pilot schemes to large-scale dense systems. The goals of these PBSPs range from providing a means for tourists to sightsee to changing inner city transport modes.

Interestingly, China, motivated by a noticeable decline in bicycle use over the last 20 years (Shaheen et al. 2011), is the most proactive in implementing a number of large scale PBSPs since 2008. Eight out of the ten largest PBSPs according to fleet size are located in Chinese cities. According to Tang et al. (2013), China is home to 79 bike-sharing programs in 2013, with a combined fleet of 358,000 bicycles. Additionally, transport initiatives by the central and local governments have prompted various Chinese cities to implement a PBSP, thus, planned expansions and projects may increase the total fleet to just under a million bicycles (Tang et al. 2013). Beijing’s municipal bike-share program, for example, which opened in 2012 with 2,000 cycles is designed to accommodate approximately 50,000 by 2015. Hangzhou launched mainland China’s first computerized bike-share system in 2008, integrating stations with bus and subway networks, allowing the same transit card to be used across all modes and granting extra free bike riding time with a bus transfer. It is expected that by 2020 Hangzhou’s system could grow to 175,000 bikes (Larsen 2013).

Moving to Southeast Asia, in the Philippines, a pilot PBSP has been implemented in Pasig City with plans of expansion. The Tutubi network, Pasig’s PBSP, is the first of its kind in the Philippines and was launched by the Asian Development Bank, funded by the Japanese Fund for Poverty Reduction and managed by Clean Air Asia. At present, there is currently one station that has 10 bicycles and is accessed through a card system at the station kiosk. A key aim of this PBSP is to demonstrate that the system can be affordable and sustainable in a developing Asian nation (Pasig City PBSP 2013).

In Bangkok, Thailand the implementation a PBSP named Pun Pun Bike consisting of 12 docking stations and 50 bicycles was introduced to curb traffic congestion and a high road traffic death rate in the metropolitan area. The introduction of the Bangkok PBSP has highlighted a number of issues in implementing a PBSP into a sprawling, densely populated urban environment; the introduction of bicycle lanes has been largely ignored by locals, monsoonal weather, high humidity and dangerous shared roads have limited uptake (Bangkok PBSP 2013). Studies have shown that weather and climate can sometimes act as a barrier to PBSP uptake (Corcoran et al. 2014), more bicycle riders on the roads is expected to usher a cycle riding culture to evolve in the city (Bangkok PBSP 2013).

The Indonesian city of Bandung implemented a PBSP in June 2012 named Bike.Bdg. Bandung’s PBSP was initiated by a local citizen and by the Bandung Creative City Forum. The aim of Bike.Bdg is to decrease traffic congestion and increase cycling share amongst its citizens. Through a marketing scheme on Instagram and Twitter, the Bike.Bdg has become reasonably popular, especially amongst younger citizens. The success of this PBSP has prompted the cities of Jakarta and Solo to consider adopting similar PBSPs (Bandung PBSP 2013). Some universities have adopted small-scale bikeshare schemes for their students. For example, the University of Indonesia has within its campus a first generation bikeshare scheme.
The Asian Development Bank was planning to implement three pilot schemes in Southeast Asia, in the cities of Davao (Philippines), Vientianne (Lao PDR), and (Indonesia), with plans to implement additional schemes in three South Asian cities, namely: Dhaka (Bangladesh), Kathmandu (Nepal) and Thimphu (Bhutan).

Within Asian cities, particularly Southeast Asian cities, the huge capital required to implement a PBSP has inhibited its widespread implementation. As such, smarter strategies must be considered to make the system more financially viable and, at the same time, determine ways to ensure that the system is also operationally sustainable.

In the implementation of PBSPs within the Asian context, a number of business and governance models have been considered and adopted. Similar to Europe, majority has adopted a business model of partnership between local government and advertising agencies. Midgley (2009) explains that local governments operate approximately 27% of PBSPs whilst advertising companies operate approximately 39%. Other business models that have been adapted in the Asian market include public agency funding (e.g. provide services under the guidance of a public authority to enhance the public transportation system) such as the popular Hangzhou, China system. Not for profit models (e.g. provide services under the support of public agencies or local councils) is also a popular business-operating model, which is illustrated through the Wuhan (China) system and the Kyushu system.

While the motivation behinds its implementation differ from one jurisdiction to another. PBSP implementation in Asia is growing in popularity amongst public authorities and the community. The scheme promises to provide a sustainable transport option for people to help alleviate the transport and transport-related challenges in the Asian region, in general and growing Asian nations, in particular.

3. DATA AND METHODOLOGY

A case study-based research strategy was employed to address this paper’s aim of gaining a better understanding about bicycle sharing in Asia. Drawing mainly from secondary sources, and guided by the key question: What is the current trend and status of bikeshare in Asia?, this study utilised a three-step process which were: Step 1 was on systematic literature review; Step 2 focused on the case city selection process; and Step 3 was the appraisal of the PBSP schemes of selected case cities in Asia. The appraisal design is discussed in section 4.

Step 1, the systematic review, used a predefined customized filter search (i.e. bicycle or bike AND sharing or bikeshar*; AND Asia or China or other Asian countries) in key databases (i.e. Transportation Research Information System (20 articles, also includes non-Asia PBSP articles), Web of Science (11 articles)), and published in the past 5 years (2011-2015) to enable the identification, evaluation and interpretation of existing research evidence. There were only 11 peer-reviewed journal articles (China (5), Taipei (1), Asia (2)) between 2011 and 2015 which wholly or partly discussed bikeshare schemes in an Asian context. Given the limited scholarly literature on Asia-based bikesharing system, discussions were also drawn from unpublished literature, including government reports, bikesharing websites, grey literature, and email exchange.

Step 2, the factors considered in selecting the 5 bikeshare system were: (1) PBSP system size, (2) business model, and (3) PBSP location. A profile of the 5 bikeshare systems are provided in Table 1. Based on this, five models of Asian bikeshare schemes were identified for examination. These PBSP systems are those located in the following cities: New Delhi (India), Huangzhou (China), Kitakyushu (Japan), Kaohsiung (Taiwan), and Changwon (Korea). Given that there has not been a widespread implementation of bikeshare schemes in Southeast Asian cities, no bikeshare model was considered from this region.
Table 1. Comparison of selected PBSPs in Asia

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>NEW DELHI</th>
<th>HUANGZHOU</th>
<th>KITAKYUSHU</th>
<th>KAOHSIUNG</th>
<th>CHANGWON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>India</td>
<td>Eastern China</td>
<td>Southern Japan</td>
<td>Taiwan</td>
<td>Korea</td>
</tr>
<tr>
<td>Climate</td>
<td>Humid/Mild Subtropical</td>
<td>Mild Subtropical</td>
<td>Mild/dry</td>
<td>Wet Tropical</td>
<td>Warm/Temperate</td>
</tr>
<tr>
<td>Start Date</td>
<td>October 2009</td>
<td>May 2008</td>
<td>March 2010</td>
<td>February 2009</td>
<td>July 2008</td>
</tr>
<tr>
<td>Website</td>
<td>-</td>
<td>hzzxc.com.cn</td>
<td>-</td>
<td>c-bike.com.tw</td>
<td>nubija.changwon.go.kr</td>
</tr>
<tr>
<td>Current Bicycle Infrastructure</td>
<td>5.8 km long/2.5 m wide specific bicycle lanes</td>
<td>84% of secondary and main roads are physically separated between non-motorised and motorised traffic</td>
<td>-Specific bicycle lanes built in 2008 -Continuous plans to build more</td>
<td>-Current construction/improvement of 250km of bicycle lanes</td>
<td>-Improved bicycle paths -Improved security along bicycle network -Lowered vehicle speed at shared sections</td>
</tr>
<tr>
<td>Operator</td>
<td>Public/Privately</td>
<td>Public Bicycle</td>
<td>City Bike</td>
<td>C-Bike</td>
<td>Nubija</td>
</tr>
<tr>
<td>Operator Name</td>
<td>GreenBike</td>
<td>Hangzhou Public Transport Bicycle Service Development Co</td>
<td>Town Mobile Network Kitakyushu</td>
<td>Tung Li Development Corporation</td>
<td>Changwon Cycle Racing Corporation</td>
</tr>
<tr>
<td># stations</td>
<td>5</td>
<td>2435</td>
<td>10</td>
<td>50</td>
<td>165</td>
</tr>
<tr>
<td># bikes</td>
<td>50</td>
<td>66000</td>
<td>116</td>
<td>4500</td>
<td>3300</td>
</tr>
<tr>
<td>Operating time</td>
<td>8am - 8pm</td>
<td>630-8pm/Some stations are 24h</td>
<td>10am-530pm</td>
<td>24 Hours</td>
<td>24 Hours/365 Days</td>
</tr>
<tr>
<td>Age (min)</td>
<td>Open</td>
<td>Open</td>
<td>-</td>
<td>14</td>
<td>Minimum 15 y.o.</td>
</tr>
<tr>
<td>Free hire</td>
<td>NIL</td>
<td>1 hour</td>
<td>NIL</td>
<td>1 hour</td>
<td>2 hours</td>
</tr>
<tr>
<td>Membership Fees</td>
<td>$1.07</td>
<td>$30</td>
<td>$5.35</td>
<td>$1.13</td>
<td>$18.80/yr; $2.80 /mo; $1.80/wk; non-members: $0.94/day</td>
</tr>
<tr>
<td>Usage Fees</td>
<td>After free period, user pays $0.15 per hour</td>
<td>Per 30 min after free period charged $0.47. Non-members $0.94 per 30 min after free period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hires/month</td>
<td>-</td>
<td>9.75 million</td>
<td>1950</td>
<td>250229</td>
<td>131880</td>
</tr>
<tr>
<td>Hires/bike/month</td>
<td>1.1 (daily figure)</td>
<td>150</td>
<td>0.56 (Daily Figure)</td>
<td>180</td>
<td>147</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>-</td>
<td>$65 million</td>
<td>$1.149 million</td>
<td>$2.58 million</td>
<td>$12.5 million</td>
</tr>
<tr>
<td>Operating costs</td>
<td>-</td>
<td>-</td>
<td>$4930 per month</td>
<td>$1000 per month (2010)</td>
<td>-</td>
</tr>
<tr>
<td>Revenue</td>
<td>-</td>
<td>$1.46 million</td>
<td>-</td>
<td>-</td>
<td>$1.3 from government subsidies</td>
</tr>
<tr>
<td>Reported Problems</td>
<td>-Safety issues -Poor Technology</td>
<td>-Operating Hours -Availability -Lacks real time availability</td>
<td>-Participation</td>
<td>Operator claims usage &amp; depreciation causing loss</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: not all data (especially revenue and operating figures) could be sourced due to privacy/unverified information and this is marked with a (-). All monetary values are in $US and were calculated on 26th November 2013. (Shaheen et al. 2011)
4. RESULTS AND DISCUSSION: CASE STUDIES OF ASIAN PBSPs

The following section will consider 5 case studies of PBSP implemented in Asia. Whilst there are vast differences between Asian nations, these case studies will provide recommendations stemming from the challenges and successes of PBSP implementation in Asia.

4.1. Large Scale PBSPs - Hangzhou, China

The Chinese city of Hangzhou covers an area of 16,596 km$^2$ and is home to an approximate 6.78 million citizens. Hangzhou’s economic development over the recent years has resulted in the city becoming one of the wealthiest in China. This economic boom has affected the city’s transport network system through a rapid increase in motorization. For example, a comparison of statistics from 1997 and 2007 highlight an increase in public and private transport but a decrease in bicycling as the main mode of transportation (Shaheen et al. 2011). This growth in vehicular transportation has affected the environment and land use of Hangzhou due to an increase in congestion and road safety issues. To mitigate the problems associated with an increase in auto use, the Hangzhou government initiated a Public Transport Priority in 2004 with the aim of increasing public transport use. As part of this plan, the government also initiated a PBSP to provide a more integrated transport network.

The Hangzhou PBSP is publicly owned and operated system that consists of 66,000 bicycles and 2435 fixed stations. According to Shaheen et al. (2011) the implementation costs of the PBSP were approximately 65 million U.S dollars. This PBSP is an automated system that incorporates the use of smart cards (with a US$30 deposit) with recognisable bicycle and docking stations. Although at busier stations, ground staff are required to check in and out bicycles when space is unavailable. The main source of revenue is from advertising on the bicycles and at station billboards. Due to the high use of the scheme, a number of stations operate 24 hours a day but the majority operate from 6am - 930pm. In contrast to Western PBSP models, the Hangzhou scheme uses relatively cheap bicycles. On top of this the PBSP is also highly monitored with security cameras at each station resulting in little theft and vandalism. Due to the overall lower costs of the scheme, usage is less expensive which has enabled 90% of trips being free of charge (Shaheen et al. 2011). Table 1 provides more statistical information on the Hangzhou PBSP.

The Hangzhou PBSP illustrates how a large scale PBSP can be successfully implemented into a highly dense urban area in Asia. The full roll out of a large number of strategically spaced docking stations produced a higher uptake of users from the beginning. In smaller cities a pilot scheme may be appropriate to PBSP implementation. Pilot PBSP schemes may need to be considered in other Asian areas due to the different distinctions amongst developing cities. Midgley (2011) suggests that pilot schemes in context to a particular region may help develop new approaches to implementing PBSPs in developing nations. If an Asian city was to implement a pilot scheme it would be worth looking at other similar size (in area and population) urban centers that have a PBSP already implemented to take note of any considerations that developed during and after that implementation.

Whilst the implementation of the scheme is by no means cheap, Hangzhou did manage to lower costs through a variety of methods. With implementing a PBSP into a developing Asian nation, where funds may be limited, the Hangzhou example can provide important information on how costs can be lowered. It may be worth an investigation into exploring different bicycle and station models and materials that can produce a cheaper bicycle standard needed for a PBSP.

Shaheen et al. (2011) point out that the implementation of this PBSP has resulted in a
decrease of automobile emissions and user satisfaction of the system is high. They do note however that due to the overall high use of the scheme that operating hours should be increased in more stations and bicycle parking availability needs to be increased at busier stations. An increase in operating hours would need to take into consideration maintenance timing (most maintenance occurs during non operating hours). In large scale PBSPs in Asia, it may be appropriate to increase operating hours at least at the busiest docking stations to ensure user satisfaction and appeal to minority groups (e.g. shift workers and university students).

Hangzhou’s PBSP has also been successfully integrated into the transport network of the city. This was taken into consideration before the full-scale implementation to ensure a seamless transaction from one mode of transport to another. The Hangzhou PBSP smart card is integrated within the public transport system. Users receive discounts to the transport network if they are a registered PBSP user (Shaheen et al. 2011). This form of incentive may attract more users to registering with a PBSP. There are a variety of incentives that could be trialed and perhaps a more innovative approach would develop from these.

Figure 2. Huangzhou public bicycle program in China
Source: http://en.wikipedia.org/wiki/Bicycle_sharing_system

4.2. Non-Profit Organisations (NPO) and Pilot Schemes PBSPs - Kitakyushu City, Japan

Kitakyushu, a city of 970 000 people in southern Japan, was once a polluted industrial zone. Community pressure since the 1960’s, has led to a remarkable reduction in air, land and water pollution. The city is now considered to be on the forefront of ‘green’ growth activity in Asia (OECD 2013) with a variety of urban policies to promote the use of sustainable technologies and improve community development. The local government contracted an NPO to implement a pilot scheme PBSP into the Kitakyushu transport network after repeated discussions between the NPO and local authorities. The purpose of a NPO is to “…create benefits and improve the quality of life of the general public rather than making profit” (Nakamura and Abe 2014a). The government has supported the NPO through subsidies throughout the implementation but the construction, operation and maintenance has solely been the responsibility of the NPO. Kitakyushu’s pilot scheme PBSP was introduced in March 2010 and consists of 10 docking stations (7 are located in the CBD) and 116 electric assisted
bicycles. Docking stations are located approximately 2.2 kilometers apart. Users must register to participate in the pilot scheme and there is a monthly fee of US$5.35 (all prices were at October 2013) (Nakamura and Abe 2014a; 2014b). Users then have to pay a fee of US$1.07 per hour of use or pay US$53.50 to use the system as much as they like for a month. It is possible to use the scheme on a once off basis for a fee of $5.09. The payment method is integrated into the transport network of the city. Table 1 provides more information on the Kitakyushu PBSP however accessing verified associated costs and revenue has proven difficult and are therefore not included.

The Kitakyushu PBSP demonstrates that a small scale PBSPs can be effective in stimulating bicycling activity in an urban area. This particular PBSP pilot scheme was implemented into the transport network of the city and created a network of connections between major transport hubs and public spaces. However the scheme has not been influential in getting users to switch transport modes from automobile to bicycle. Most registered PBSP users switched from public transport. In order to attract drivers to a PBSP, the system needs to be considered a cheaper, easier and quicker option than driving. In a small pilot scheme such as the Kitakyushu example, this is not always possible and therefore should not be seen as a failure but rather an opportunity to expand the network.

This PBSP case study also highlights how a NPO can successfully manage a PBSP. Cooperation between the local authorities and the NPO did play a major part in implementing the scheme. This reflects that maintaining a cooperative network between the two agents can provide a positive platform to PBSP implementation. In this manner, for any NPO’s who are considering implementing a PBSP to improve community needs, it would be highly recommended to engage with local authorities. This can provide the most integrated PBSP possible.

A problem facing the city of Kitakyushu is that of a declining and aging population. Since 1971 the population has declined by 10.5%. The city also has one of the highest percentage of people aged >65 with a 21.1% share of the population (OECD 2013). One of the key aims of the Kitakyushu PBSP to improve the quality of life in the community. In doing so, the NPO employed older residents to train others on bicycle safety. This inclusion of community members, demonstrates the positive and inclusive influence that a PBSP can have. In other developing nations it may be possible to include minority groups, such as low income and the unemployed into the system. A PBSP with a NPO business model can provide employment, community involvement and a positive experience to minority groups.

4.3. Medium Sized PBSPs – Changwon, Korea

Korea has generally had a low level of bicycle use with a 2005 census discovering that only 1.2% of total trips were through cycling. To curb this low level of use, the national government has actively promoted bicycling policies such as the compulsory installation of bicycle facilities in particular areas. However, these policies failed to significantly increase ridership as predicted. Therefore in 2008, the Korean government decided to support PBSPs through designating 10 model cities and investing an average $US8.3 million per city for implementation. Most of these PBSPs are small in scale but except for two, Changwon and Goyang. These two can be considered medium sized PBSPs with both containing a fleet of 3300 and 3000 bicycles respectively (Lee et al 2012). Changwon will be the focus of this case study as it was the first one implemented in Korea.

Changwon, a city of approximately 500 000 residents (Park 2010), implemented the rollout of their PBSP (called Nubija) in 2008 under a public/private business model (Changwon PBSP 2013). The pilot scheme began with 450 bicycles at 20 stations. The city
rapidly increased the system over the next three years to include 3300 bicycles at 163 stations with an coverage area of 292.7km². The network is provides destination and origin points that were examined before implementation to provide urban workers access to areas with high levels of employment. Lee et al (2012) notes that the system is not properly integrated within the transport network with access to Nubija often requiring the user to walk to the docking stations. Nubija is an affordable PBSP in comparison to the average public transport expenses in the area. Users can register with an $US8 membership fee which allows for 2 hours of free use. It is possible to get a one day card but only with the use of a cell phone.

The Changwon case study provides relevant information into implementing a medium sized PBSP into an Asian city. At first the implementation of the Nubaji system relied heavily on benchmark’s obtained from the European models of Paris and Barcelona. As the Nubaji PBSP was the first to be implemented in Korea, decision makers found it difficult to acquire the relevant information on PBSP information due to confidentiality laws, establishing a budget pertinent to Korea and a lack of skilled personnel and experience. Due to this, the Nubija PBSP was designed and developed with the aim of being a unique scheme relevant to Korea drawn from bicycle related specialists in the country that would constantly be improved where it was noticed that problems were occurring (Changwon PBSP 2013).

Lee et al (2012) provides a comparison example between two Korean PBSPs to highlight the difference that docking station placement can impact on age group use and key outcomes of the PBSP. Nubaji provides a variety of destination and origin points at a number of high use areas within the city, resulting in users from all age groups having access to the PBSP. Due to these docking stations being located in areas of high activity, there has been a change in transport mode from automobile to bicycle amongst a high percentage of the users. The PBSP in Daejon (under public operation) mostly provides docking stations near educational institutes. This has resulted in 80% of the users being under 20 years of age. As the age to obtain a driver’s license is 20 in Korea, there has been very little shift in automobile use within the city. This comparison between these two PBSPs highlights that a PBSP needs to be accessible to a wide range of groups in significant areas for it to be a sustainable transport mode.

4.4. Medium Sized PBSPS - 2) Kaohsiung, Taiwan

Kaohsiung, a city in southern Taiwan, is home to 1.5 million citizens and its economy is dominated by the service and manufacturing industries. The city has approximately 41 kilometers of a public transport system but the main mode of transportation is motorcycle trips at 63.8% (Shiau and Peng 2012). Due to the high private vehicle ownership and the city’s economic industry, the government has introduced policies that aim to reduce vehicle ownership and increase public transport modes (Wei and Kao 2010). From this initiative, the Kaohsiung government implemented (to be privately operated) a PBSP called C-Bike in 2009 in the aim of establishing the a healthy, lively and cosmopolitan city.

The first phase of the C-Bike implementation established 20 docking stations and 1500 bicycles near all major transport hubs in the city. Four months later, the second phase started with 30 more docking stations and a total of 4500 bicycles located at major activity points. The stations are automatic, unmanned and open 24 hours. This third generation system has increased bicycle ridership in the city with total riding time in April 2009 being 5433 hours to an increase in December 2009 of 30 000 hours. A user can either use a credit card to access the C-Bike (which does not require membership) or use a smart card that has been integrated into the wider public transport network.

Whilst there are very little studies on why C-Bike has been successful in Kaohsiung, it
must be noted that the city does have an extensive, wide and safe bicycle network. The bicycle network is marketed as ‘diverse’ with recreational lanes, river lanes and work lanes. In comparing PBSPs in other nations where cycling infrastructure is low/non existent (New Delhi) to a PBSP where cycling infrastructure is high it can be assumed that without an appropriate bicycle network, a PBSP will not be successful. This would need to be further studied before this claim can be verified.

As with the Hangzhou case study, the successful implementation of a PBSP into the transport network was taken into consideration before the C-Bike construction. The C-Bike smart card integration into the wider public transport network has made the transport network of the city user friendly and it is possible for a smooth transaction between one mode of transport to another.

In comparing the two medium size PBSPs of Korea and Taiwan, both have a similar bicycle fleet yet very different amounts of docking stations (Changwon (pop. 500000) - 165 stations and 3300 bicycles, Kaohsiung (pop. 1.5 million) - 50 stations and 4500 bicycles). The average monthly usage is vastly different with Korea at 131 880 bike hires a month and Taiwan at 250 229 a month even (taking into consideration the one million population difference). The usage for both PBSPs is high and seems to be continuously increasing. In the case of Kaohsiung, it may be worth constructing more docking stations to ease possible future congestion and user competition.

4.5. PBSPs in a Developing Nation-A Small PBSP In New Delhi, India

In order to address the challenges of a rapidly growing private vehicle ownership and a falling public transport usage, the Delhi Government introduced the Delhi Integrated Multimodal Transport Vision 2021. This vision is aimed at introducing an extensive and integrated transport network into the city, including high quality bicycle systems. Due the large proportion of commuters who use bicycles and the lack of infrastructure for bicycling in New Delhi, the government acting under the DIMTV 2021, piloted a 5.8 km stretch of 2.5 meter wide segregated bicycle lanes. In 2009, the government initiated the first New Delhi PBSP, named GreenBike, and commissioned a private company to build and operate the system.

This PBSP is located at public transport stations in New Delhi and is relatively small in nature with 5 docking stations and 50 bicycles. The docking stations are supervised and in order to rent a bicycle the user must provide a valid Indian identification card, which will then be kept as a deposit. This system means that the user will have to return the bicycle to the station it was rented from. Rental fees are priced at $US0.15 for 4 hours and additional $US0.07 for every hour after that. There is also an annual membership fee of $US1.60. On average, 45 people use the system daily. The construction, operation and maintenance of the PBSP is conducted by a private advertising company who pay a concession of $US450 per month, per station to the government. The use of technology in the system is almost non-existent.

Dhingra and Kodukula (2010) discuss the various challenges faced by the New Delhi PBSP for its successful integration into the transport network. One of the major issues faced by the GreenBike is the lack of government support in policy initiative, a lack of a strategic plan, failure to upgrade/create promised bicycle infrastructure and a general lack of enthusiasm by government officials in promoting the PBSP. These issues, along with poor maintenance, have resulted in a PBSP that does not suit the needs of the community nor does it provide the adequate network in order to create a sustainable transport mode alternative for the wider population. This case study does provide clear examples of some major questions that will need to be addressed before a PBSP is implemented:
Current levels of bicycling infrastructure. Many developing nations have little and often poor quality bicycle infrastructure. For a PBSP to be successful there needs to be a safe, quality and integrated bicycle network. What is the current level of bicycle infrastructure?

Government input. The government can play a pivotal role in PBSP success through policy direction, promotion and funding. How will the government aid PBSP implementation?

There needs to be a clear goal of a PBSP in order to rate its success or failure. What are the PBSPs goals?

The PBSP implementation into New Delhi did highlight some cultural perceptions that were not considered. In India, non-motorized or active forms of transport (cycling, rickshaws) are often seen as a lower class transport mode. Therefore very few middle or upper income people are using the scheme. As the majority of those using the GreenBike are in the lower income brackets there is that perception that this particular PBSP is for the use of ‘poor people’. Dhingra and Kodukula (2010) suggest that a way to change people’s perception in India is to upgrade the GreenBikes to a third generation PBSP with advanced technology and bicycles. However, in order to accomplish this will require a large financial investment, which may increase the user cost and force lower income users away from participating in a PBSP.

5. CONCLUSION

Asian cities exemplify unique and diverse set of land uses, geographies and mobility cultures. Given the challenge posed by the increasing share of private car use has led to a pronounced shift in transportation policies towards encouraging the development of a more sustainable and inclusive transportation system. The growing concordance on the benefits brought about by active transport, particularly cycling, makes it crucial to investigate the feasibility of public bicycle sharing scheme design, implementation and operation within the Asian landscapes. This paper examined five different PBSP systems within Asian cities. Public bicycle sharing has gained currency because of the need to better manage the growing demand for transport and at the same time, to maximize transport choices. Asia’s PBSPs have evolved and motivated by various reasons. Nevertheless, transportation planning and policies must balance environmental, economic and social issues to provide an urban area where sustainable and inclusive mobility is a right rather than a privilege.

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