1. INTRODUCTION

The emergence of China as a global power is likely to represent one of the key economic, social and political developments of the twenty-first Century. Following the initiation of sweeping “open door” economic reforms in the early 1990s, the country is experiencing a scale of urban development without precedent in modern times; GDP is increasing at a current rate of up to 10% per annum, driven by strong exports and growing domestic consumption. These trends are set to continue for the remainder of the decade, with many remaining elements of the former centrally planned economy opening up to the control of market forces.

From a European perspective, the scale of the urbanisation process is staggering. According to United Nations forecasts, China’s urban dwellers will increase from 30% of the total population, around 319 million people (1995) to an estimated 49%, 712 million in 2020. If realised, this will be an increase of almost 400 million people in the space of a generation or, put into context, a rate of urbanisation around three times faster than that experienced by Europe or the United States in the nineteenth century. The Chinese Government at all levels is seeking to promote and manage this growth and has aspirations to build the necessary infrastructure quickly in support, looking to domestic and international best practice in design, technology, delivery and management.

There are now 36 cities in China with a population of 1 million or more, with Shanghai, Beijing, and Tianjin having populations of over 10 million. Whilst others, such as Wuhan, Guangzhou and Xi’an are also substantial, as shown in Table 1, around two-thirds of the urban population live in cities with a population in the range of 0.5-2.0 million.

The urbanisation agenda, its associated economic growth, and the emergence of a far greater range of choices, and opportunities for Chinese consumers compared to previous generations, is also driving a boom in levels of motor vehicle ownership. Over the period of 1995 to 2020, car ownership in China is projected to increase tenfold from an average of 10 cars per 1,000 people to over 100, with rates in some of the main cities likely to be at least double this\(^1\). By 2020, this could equate to around 130 million vehicles across China compared to around 27 million today. In the long-term towards 2050, there is the potential for European levels of car ownership in urban areas, of around 300-400 vehicles per 1000 people.

\(^1\) Precise forecasts of vehicle ownership are highly dependent on assumptions of economic growth over the period.
# Table 1 – Population of Key Chinese Cities

<table>
<thead>
<tr>
<th>City</th>
<th>Population (000s)</th>
<th>Area (Km²)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>13,800</td>
<td>16,800</td>
<td>2004</td>
</tr>
<tr>
<td>Shanghai</td>
<td>13,340</td>
<td>6,340</td>
<td>2002</td>
</tr>
<tr>
<td>Tianjin</td>
<td>10,110</td>
<td>11,920</td>
<td>2004</td>
</tr>
<tr>
<td>Chengdu</td>
<td>11,240</td>
<td>12,300</td>
<td>2000</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>7,010</td>
<td>2,050</td>
<td>2001</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>9,940</td>
<td>7,260</td>
<td>2001</td>
</tr>
<tr>
<td>Wuhan</td>
<td>7,860</td>
<td>8,960</td>
<td>2004</td>
</tr>
<tr>
<td>Nanjing</td>
<td>6,400</td>
<td>6,420</td>
<td>2005</td>
</tr>
<tr>
<td>Shenyang</td>
<td>6,940</td>
<td>12,920</td>
<td>2004</td>
</tr>
<tr>
<td>Xian</td>
<td>7,410</td>
<td>9,980</td>
<td>2000</td>
</tr>
</tbody>
</table>

Source: Atkins China data (Various studies)

The combination of population growth and increased private vehicle use is already severely straining the urban transport infrastructure. Problems of congestion, poor air quality and road accidents are now major concerns. In Central Beijing, the average traffic speed was 45 kilometres per hour in 1994, 33 kph in 1995 and 12 kph in 2003. During peak periods, around 20% of the central network is gridlocked where traffic speed has fallen below 5 kph. There is evidence of traffic speeds dropping in other major cities.

This is exacerbated by the fact that only around 10% of land area in Chinese cities is given over to transport infrastructure, compared to around 20-25% in Europe. Most cities are also currently reliant on conventional bus and trolleybus systems which are poorly matched with the changing demands of consumers or the rapidly changing pattern of development. There is frequently little integration between modes, in terms of their planning, operations and systems such as fares and ticketing. In order to overcome these problems, there is a strong case for major investment in infrastructure across all modes and in new and modernised transport management systems and processes.

Cities in China have historically had very high levels of walking and cycling use, indeed with these modes being dominant in terms of overall trip making at around 60-70% of the total. Cycle ownership has reached around 400-500 cycles per 1000 people or more in many instances. Before the current economic reforms, this was encouraged by the Dan Wei (literally "work unit") system whereby people were directed by the Government to live close to their location of employment. However, this is now breaking down with individuals having a far greater choice of where they live and work and a growing separation of land uses. There is also evidence that, with increasing conflict between cyclists and motorised traffic, many city planners view cycling as a low efficiency mode which is a temporary feature in the urban transition and which should be more tightly controlled. By contrast, the car is often treated

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2 Population and area forecasts for Chinese cities are generally unreliable. This is due to the speed of urban immigration, questions over precise urban boundaries and the present of "floating" populations without permanent residency. These figures provided must therefore be treated as approximate at the date provided rather than fixed.


4 Cherry (2005).

as a symbol of progress and modernity. Cycle use is therefore declining in many parts of urban China, despite the obvious sustainability benefits being promoted in Europe.

Table 2 – Mode Share for Walking and Cycling in Selected Cities

<table>
<thead>
<tr>
<th>City</th>
<th>Cycle</th>
<th>Walk</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>15%</td>
<td>11%</td>
<td>2003</td>
</tr>
<tr>
<td>Shanghai</td>
<td>25%</td>
<td>29%</td>
<td>2004</td>
</tr>
<tr>
<td>Tianjin</td>
<td>60%</td>
<td>28%</td>
<td>1993</td>
</tr>
<tr>
<td>Nanjing</td>
<td>39%</td>
<td>20%</td>
<td>2004</td>
</tr>
<tr>
<td>Wuhan</td>
<td>20%</td>
<td>41%</td>
<td>2004</td>
</tr>
<tr>
<td>Chengdu</td>
<td>44%</td>
<td>31%</td>
<td>2000</td>
</tr>
<tr>
<td>Fuzhou</td>
<td>37%</td>
<td>26%</td>
<td>2005</td>
</tr>
<tr>
<td>Xiamen</td>
<td>26%</td>
<td>38%</td>
<td>2005</td>
</tr>
</tbody>
</table>

Source: Atkins China data (Various studies)

2. CURRENT TRENDS IN VEHICLE OWNERSHIP IN CHINA

Compared to the West, China is at the early stages of the motorisation cycle. Figure 1 shows indicative rates of vehicle ownership between key Chinese cities and selected international comparators. However, whilst levels of vehicle ownership remains low by European and North American levels, registrations have risen by an average of 22% per annum in the last decade, making the country easily the fastest growing market in the World.

Figure 1 – Rates of Vehicle Ownership in Selected Chinese and International Comparator Cities

For example, car sales rose from a mere 377,000 units nationwide in 1996 to over 2.4 million in 2004 as China’s economic boom led to a dramatic increase

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in the number of consumers able to afford car ownership (Figure 2). Total registrations, including commercial vehicles, increased from 1.4 million per annum to almost 5.1 million over the same period, with the latter now representing around 8% of total global automotive output.

**Figure 2 – Projected Chinese Motor Vehicle Registrations 2005 - 2015**

Looking to the future, China’s population presents substantial prospects for growth; by 2015 car registrations are projected to triple in scale to 6.9 million per annum and commercial registrations increasing at a lesser rate from 2.9 million to 4.8 million.

National and city policies are serving to encourage increased vehicle ownership. The decline of the Dan Wei system has already been referred to above in encouraging greater separation of housing and employment. The Chinese Government also sees the automotive sector as strategically important in economic and political terms, including the attraction of foreign companies in the short-term for technology and expertise exchange\(^7\), and the long-term development of a competitive manufacturing sector to serve the domestic and export markets\(^8\). Hence, policies which significantly restrain general vehicle ownership appear unlikely at the present time.

Likewise, whilst examples such as Singapore and Hong Kong represent successful city policies to manage car ownership which may be relevant to China, most local administrations appear highly unlikely to seek to replicate them to the same intensity, at least in the short-term\(^9\). One of the greatest

\(^7\) The 2005 purchase of MG Rover by the Nanjing Motor Company should be seen in this context.

\(^8\) The 8th Five Year Plan (1991-1995) designated the motor vehicle industry as one of the “pillar” sectors of national economic development. The entry of China into the World Trade Organisation in 2006 is expected to further encourage growth in car ownership through the entry of foreign manufacturers, increased vehicle quality, lower prices and the increased availability of consumer credit.

\(^9\) One exception to this is Shanghai which has implemented a quota and auction system on vehicle purchase, similar to the Singapore system, to limit the growth of traffic in the metropolitan area.
challenges for Chinese transport planners is therefore controlling the growth
of traffic, and its associated impacts, whilst fostering the national economic
policy of developing the automotive sector.

3. THE RECENT EVOLUTION OF CHINESE TRANSPORT POLICY

Compared to European countries\(^{10}\), China lacks a strong central transport
ministry and policy responsible for all transport modes at national level\(^{11}\).
Indeed, until the late 1970s, the development of transport policy in China was
not considered a priority in any part of Government or the Communist Party,
and was largely focused on the movement of agricultural and industrial goods
rather than people. Little effort was spent on transport planning, development
and management, or the associated skills and techniques, until the economic
reforms in the 1980s and 1990s.

Significant powers are also exercised at provincial and city - rather than
national - level and often divided between a range of different planning,
enforcement and delivery agencies. This inevitably leads to variation in
transport policy between different parts of China, limited integrated of land use
and transport planning, and challenges of co-ordination between
organisations which may have separate but overlapping remits and
jurisdictions. This separation of urban transport responsibilities is becoming
increasingly untenable in the face of the increasing size and complexity of
urban areas and, in some instances, driving consideration of reforms.

Despite the decentralised pattern of decision making, some key trends in
transport policy can be discerned:

- **Highways**: China has amongst the sparsest highway network in the
World relative to population and land area. This is now being
addressed through major highway investment programmes. For
example, the development of the National Trunk Highway System, a
35,000 km national network, connecting all major cities, is almost
complete. Most cities are also investing massively in new radial and
ring roads to develop their basic strategic and urban distributor
networks.

- **Railways**: Whilst the network is relatively well developed, China
continues to expand network length, especially in the eastern part of
the country, to improve service for passengers and freight. There are
plans to expand the network from the current 46,000 miles to around
60,000 miles by 2010. The development of suburban passenger rail
networks, a feature in most European cities, is not common, however.
A particular current focus is the development of a high-speed rail
network\(^{12}\), such as that planned between Shanghai and Beijing, and

\(^{10}\) Although many European countries, including the UK, are increasingly favouring local and regional devolution of
transport policy and decision making.

\(^{11}\) National transport policy is split between the Ministries of Construction, Communications and Railways.

\(^{12}\) Maglev technology is being considered on some corridors; China is the only country to have a working Maglev
system in public service, linking Pudong Airport with Shanghai.
increases in freight capacity to serve the rapidly expanding ports on the east coast.

- **Urban Passenger Transport:** Despite the focus on the development of a national motor manufacturing sector, increasing emphasis is being placed on public transport, with urban rail systems either under construction or planned in the largest cities, a focus on developing Bus Rapid Transit (BRT) and public transport priority, and raising standards of interchange and overall system quality.

The most recent (11th) Five Year Plan for National Economy and Social Development (2005-2010) proposes substantial increases in road, rail, port and airport capacity and management systems at national, provincial and city levels. In the field of urban transport policy, the Government is seeking to give greater priority to public transport as set out above. In addition, the Plan places emphasis on:

- modernisation of public transport vehicles and interchanges;
- cleaner fuels for public transport;
- demonstration projects for Intelligent Transport Systems; and
- public transport priority over general traffic; and
- measures to improve transport safety.

Road safety is a growing political priority. China experiences over 110,000 road deaths and an estimated 560,000 injuries a year, many of which are pedestrians and cyclists. This is the World’s highest reported absolute number of road deaths, around 10% of the global total, and amongst the highest rates globally when set against current traffic levels, with an estimated annual economic cost of around US$ 400 million. Action on the design and maintenance of road infrastructure, specific engineering measures, driver education and enforcement is urgently required to address this situation.

To date, the focus of transport planning in Chinese cities tends to emphasise supply side approaches such as the construction of new highway and public transport networks, with less focus at present on the management, enforcement and integration of network operation, or the institutional arrangements required to achieve integrated transport planning and delivery. This contrasts with many international comparators where highway and urban rail networks are largely mature, and greater focus is now placed on making best use of existing transport assets, managing demand and institutional reform.

The financing of the new infrastructure requirements is also a key consideration for Chinese decision makers, with considerable interest...
developing in private finance in the face of the inevitable limitations in public sector funding. Build-Operate-Transfer and similar approaches are being encouraged, especially in the context of highway construction\textsuperscript{17}, funded mainly by Chinese banks and Hong Kong capital, but also increasingly under consideration for the resourcing of urban public transport systems.

It is a key debate as to whether China will continue to evolve a mature highway network and level of vehicle ownership to far higher levels before network and demand management become stronger strategic and operational imperatives and transport policy gives priority to objectives beyond urban development and economic growth. A few cities such as Shanghai, Guangzhou and Shenzhen are showing signs of moving in this direction, and recent policy statements from the Ministry of Construction are promising. However, many cities have still to show significant commitment to evolving a wider agenda, or the local skills to support it.

4. THE POLICY RESPONSE AT CITY LEVEL – THE CASE OF WUHAN

The example of Wuhan, the capital city of Hubei Province in Central China, provides a good illustration of the key transport issues in many cities across China and the responses taking place.

Atkins China Limited and Atkins Transport Planning UK have explored these issues through a range of studies, including a Comprehensive Transport Study (CTS) in 2003-2004 and a Travel Demand Management (TDM) Study in 2006 funded by the World Bank. This work provides a good evidence base from which to draw some overall conclusions at the city level.

4.1 Situation Analysis

Wuhan is located strategically at the confluence and as a crossing point of the Yangtze and Hain rivers in Central China. The city administrative area covers 8,500 km\textsuperscript{2}, with a population of 7.8 million in 2003. Around 4 million people live in the main urban area of around 2,500 km\textsuperscript{2}, including the three principal centres of Hankou, Hanyang and Wuchang.

In parallel with wider economic reform in China, the Wuhan Municipal Party Committee and Wuhan Municipal Government has defined a strategy to develop Wuhan into a “modern, international metropolis” by 2020. This builds on the city’s current position of one of the largest industrial, commercial and trade centres in Central China, and an emerging transport hub based on its strategic position as a river crossing and a meeting point for major north-south and east-west routes. Wuhan is also a major centre of vehicle manufacture with several factories located on the outskirts.

\textsuperscript{17} The first major private sector highway project in China, the Guangzhou-Shenzhen Expressway, opened in 1991.
Wuhan’s GDP is equivalent to US$3000 per capita and growing rapidly. The local economy is forecast to grow by 9% per annum between 2005 and 2010 and by 7% per annum to 2020. If realised, GDP in 2020 will therefore be 300% higher compared to 2004. The current population is also forecast to increase to 12 million by 2020, with people becoming wealthier and with access to a far greater range of choices and opportunities compared to previous generations.

The urban highway network has been developed over the years to accommodate growing demand and support economic development, with particularly notable expansion since the 1990s. Total network length is now 1,300 km. However, coverage remains low in relation to many comparable cities. The arterial network is incomplete and there are limited radial routes between the inner and outer areas to support urban function. The current focus of city planners is therefore on the construction of an enhanced express ring and radial road system. For the express road system, an Inner Ring has been completed with construction underway on two more ring roads as well as an outer route for regional-distance traffic.

**Figure 3 – Wuhan Urban Area**

The highway network experiences the following issues:

- the established city road plans in Hankou and Wuchang have limited capacity for through traffic and are also constrained by the severance effect of lakes and railways;
- the design of some roads is not compatible with their actual function. For example, sections of some primary routes are used by short-distance, local traffic rather than longer-distance trips.
Similarly, some secondary roads are used by through-traffic, despite their design and location;
- the secondary and branch route networks often have a low density, poor condition and traffic management arrangements which constrains their ability to disperse traffic from the primary roads with resulting congestion and delay;
- the upgrade of some sections has been substandard in their planning, design, and construction, and maintenance standards are variable and poor in some locations; and
- the Yangtze River, in particular, continues to impose a barrier to city development and integration. Whilst the addition of new bridges in the 1990s has eased the situation, there remains a lack of cross-river capacity, with resulting pressure on the existing corridors.

In addition:
- there are readily apparent and acute conflicts between motorised vehicles, pedestrians and cyclists;
- there is declining mode share for cycling trips, although from a much higher base than many other cities internationally; and
- vehicle emissions and noise cause consequent impacts on the environment, local residents and quality of life of the city; air quality is generally poor.

With regards to public transport, Wuhan has an existing network of over 200 bus and trolleybus routes covering 760 km. Daily patronage is around 4 million, a little under a quarter of all trips. Some organisations operate their own bus and minibus fleets for their employees. Bus lanes have been established in some primary roads, although have yet to be developed into a coherent network. Extensive plans also exist for an urban rail system, with the first light rail line completed in Hankou in late 2004.

Wuhan's public transport routes and passenger flows are relatively centralized on several main corridors. In general, the development of the bus network has failed to keep pace with the rapid pace of urban expansion and has low accessibility to large parts of the urban population. The bus network is also increasingly vulnerable to growing levels of congestion. In addition, methods of bus dispatching and information collection are poor, as is interchange and management of bus stops. Roles and responsibilities for urban transport planning and implementation are not always clear and frequently overlap.

Traffic management techniques are still developing. Wuhan currently adopts the following measures:
- signalisation of key junctions, including pedestrian phases as some locations. An Area Traffic Control system is being implemented in Hankou and is planned to be extended to the other two centres;
- traffic restrictions such as one-way streets and gyratory systems;
- re-allocation of road space to non-car modes, including some bus priority, cycle lanes and pedestrianisation of some streets, although
the extent of this is limited;

• restrictions on goods vehicles from the central area of Hankou during the day, including bridges across the Han River and two restricted access zones during daytime. There are also selective bans on smaller vehicles below a specified engine size;

• one of the older principal bridges over the Yangtze is regulated by an odd and even number plate system, which restricts vehicles on the bridge depending on the vehicle registration by day;

• tolls are levied on all vehicles from outside Wuhan on entering the city; and

• some limited on-street parking controls and enforcement.

There is no current coherent or integrated approach to traffic and demand management in Wuhan. Whilst the analysis above lists a number of measures which have an impact on the level and pattern of demand, current action tends to be ad hoc, reactive and largely co-incidental rather than complementary aspects of a focused strategy. As set out below, planning and operational responsibilities are split between a number of separate agencies, making the development of an integrated approach problematic.

4.2 The Future Transport Network

Proposals for the transport network in Wuhan have been determined from ongoing studies carried out since the late 1990s including urban general planning revision, urban rail transit route network planning, and strategic studies of urban transport development. Although these studies present some differences in the detail and phasing of transport infrastructure development, they do provide a broadly consistent picture of plans for the overall future network serving the city by 2020.

Highway Network

The main city road network in Wuhan is based on developing a fully planned system intended to result in an arterial transport network of ‘ring + radial’ type with three ring roads and ten main radial roads in order to:

• overcome imbalances in supply and demand across all three centres and the wider urban area;

• balance city development in each side of the Yangtze River;

• ensure that heavy cross-river and non-local traffic, is routed outside the Main City and via routes of an appropriate standard; and

• ensure that accessibility to the central areas is maintained.

A programme of junction upgrading and traffic management improvements is also planned for the improvement of network efficiency, safety and integration, especially in the central areas where potential for significant additional highway capacity is more limited and selective than the outer areas.

The crossing of the Yangtze and Han Rivers is a key determination to the through capacity of the network and transport policy is strongly focused on

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serving increasing cross-river demand and supporting the development of the three cities in an integrated and balanced way. Hence, there are proposals for up to 8 crossings of the Yangtze and 8 of the Han River by 2020.

**Figure 4 – Current (2004) and Future (2020) Wuhan Highway Network**

*Urban Rail Network*

There is a proposed urban rail network plan consisting of 7 new lines, totalling 230 km. Of this, a total length of 70km is proposed for development by 2010, although this is highly unlikely to be achieved for engineering and cost reasons and BRT is now under consideration in a number of corridors.

This ambitious investment is aimed at establishing rail mode share as 35-40% of all public transport journeys in 2020, and around 50% by 2050. The investment proposed will provide 1-2 river crossing routes by 2020 and 3-4 further routes by 2050. The combined network aims to provide linkages for the three cities and across the rivers, integrate public transport within the cities and new development areas, and provide additional network connectivity.

**Figure 5 – Planned Future (2020) Wuhan Urban Rail Network**
4.3 Existing and Future Travel Demand

Current mode share for trips in Wuhan is shown in Table 4, although the robustness of surveying and data collection amongst the local agencies means that the figures must be treated with some caution.

Table 4 – Wuhan Mode Share

<table>
<thead>
<tr>
<th>Modal Share</th>
<th>1998</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>33.3%</td>
<td>40.5%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>28.2%</td>
<td>20.4%</td>
</tr>
<tr>
<td>Public Transport</td>
<td>21.9%</td>
<td>23.4%</td>
</tr>
<tr>
<td>Others</td>
<td>16.7%*</td>
<td>15.7%**</td>
</tr>
</tbody>
</table>

*: Company vehicle & taxi, not including private car
**: Company vehicle, taxi & private car (1.42%)

Walk, bicycle and public transport are currently the principal modes in Wuhan with private car use playing a minor role. Walking and cycling make up around two-thirds of all journeys, significantly greater than motorized modes. Walking appears to be showing an increasing trend, but cycling is declining. Whilst public transport share is increasing, its increase has been slower than that of private car use because of the network and operational weaknesses identified above.

Non-motorised vehicle ownership in Wuhan is 1.3 million, almost all of which are bicycles. With the improvement of urban infrastructure and bus services, there has been a switch to other modes, leading to the gradual decrease of bicycle ownership. Although cycle volumes remain significant, they are forecast to decline significantly in absolute and proportionate terms in the medium and long-term future.

In 2004, Wuhan motorised vehicle ownership totalled 623,000\(^\text{18}\), of which motorcycles were 251,000 (40%). There are around 118,000 private cars. Excluding motorcycles, vehicle ownership has risen from around 16 vehicles per 1000 population in 1994 to 43 in 2004, an increase of almost 270% in a decade. Average annual increase has been around 13-14% per annum since 1990.

Work by Atkins in 2004 shows that central area traffic flows and congestion levels have increased, with evidence of falling speeds, especially on secondary and local roads. There are now almost 50 major junctions in the city which experience peak flows sufficient to result in congestion. In addition, cross-river traffic has increased dramatically from an average 70,000 vehicles per day in 1995 to 143,000 vehicles in 1999 and 240,000 vehicles in 2004. With rising demand, such pressures will increase further in their spatial extent and intensity.

\(^{18}\) Compared to just 80,000 in 1980.
With rapid urban development, significant changes are taking place in the land use plan. Wuhan’s centre is extending and residential development adjacent to the third ring in particular is accelerating. This will, on the one hand, disperse the over crowded traffic flow from central areas. On the other hand, the relatively weak provision of road infrastructure in new districts is also resulting in inefficient transport connections, conflict between local and non-local trips, an inability to accommodate the shifts in traffic demand and rising congestion at key junctions and routes.

Considering future projected increases in GDP and current local policies towards establishing Wuhan as a centre of car manufacturing, future rapid increases can be expected some way into the future. Research by Atkins on current trends and future forecast growth in population and employment, led to the development of three future levels of car ownership, as set out in Table 5. This equates to an increase of a further 200-300% by 2020.

### Table 5 - Future Motorisation Scenarios for Wuhan

<table>
<thead>
<tr>
<th>Contents</th>
<th>2004</th>
<th>2020</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (Million)</td>
<td>7.8</td>
<td>12</td>
<td>53%</td>
</tr>
<tr>
<td>GDP (RMB Billion)</td>
<td>196</td>
<td>660</td>
<td>340%</td>
</tr>
<tr>
<td>Vehicular Ownership per 1000 People (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Scenario</td>
<td>80</td>
<td>160</td>
<td>200%</td>
</tr>
<tr>
<td>Medium Scenario</td>
<td></td>
<td>200</td>
<td>250%</td>
</tr>
<tr>
<td>High Scenario</td>
<td></td>
<td>230</td>
<td>288%</td>
</tr>
</tbody>
</table>

Note: 1 indicates all types of motor vehicles in Wuhan

This increase in car ownership, partially reflecting, and partially combined with, the dispersal of population and employment from the old districts of the central city to more peripheral locations, is likely to impose tremendous pressures on the urban transport infrastructure and present great challenges to the city in seeking to ensure sustainable development and transportation
policy. Total traffic volumes (as measured in vehicle kilometres) are expected to grow by between 300% and 400% between 2002 and 2020.

As described above, the road network in Wuhan is gradually improving over time, in terms of both capacity and quality, as a result of the ongoing infrastructure programme. However, such is the pace of motorization, that the construction of highway capacity is likely to be unable to accommodate the rapid growth in demand. This is already resulting in problems of congestion and delay, which will almost certainly worsen over time.

4.4 Institutional Structure

The current institutional structure for planning, constructing, operating and managing the key transport networks in Wuhan, and ensuring their integration with the land use plan is split between a number of different agencies. This structure is shown in Figure 7 below.

The key organisations responsible for transport in Wuhan include:

- the City Government, operating in parallel with a number of Party bodies, responsible for overall land use and transport policy;
- the Construction Bureau, responsible for the planning and construction of new highway and public transport infrastructure;
- the Traffic Management Bureau, closely linked to the Police and security establishment, responsible for traffic management, signals, road safety and enforcement;
- the Wuhan Traffic Committee which is responsible for regulation of taxis, public transport and inter-urban coaches; and
- the Planning Committee and Bureau which develops the framework for the national Ministry of Railways, responsible for rail passenger and freight construction and management, including the development of high-speed rail services between Wuhan and other key cities.

There are also a number of other institutions which have varying degrees of influence and control over transport policy and delivery. The Bureau of Commodities, for example, regulates public transport ticket prices, whilst the fact that Wuhan is also home to the Hubei Provincial Government means that this tier of government also exerts a significant influence.

These agencies can be overlapping in their missions and goals, remits and modus operandi, and may also hold different transport information and analytical tools. A key challenge is for these agencies to co-operate and produce an integrated approach, address overlaps or gaps in responsibilities and develop common analytical tools and approaches. The creation of a new Reform and Development Commission and the work on developing a Comprehensive Transport Strategy and White Paper in 2002-2004 have been important steps forward in this respect, although co-operation frequently remains ad hoc rather than formally structured and sustained.
Figure 7 – Current Institutional Structure for Transport Planning and Delivery in Wuhan
4.5 Future Transport Challenges

The analysis shows that Wuhan’s transportation network is at an early stage in terms of the evolution between supply and demand. In the face of substantial increases in vehicle ownership and use, the highway network is relatively immature, public transport remains orientated around a conventional and uncompetitive bus network and network management is in a relatively unsophisticated state. There is a significant infrastructure deficit, which will increase in spatial extent and intensity, unless city planners commit a combination of targeted new capacity investment and the more effective management and control of demand.

Key challenges include:

- the need to accommodate additional growth in population and employment, including the spread of urban development out from the central city to the outer areas and the growing separation of housing and employment functions;
- ensuring that land use planning and transport provision are fully integrated in terms of accessibility, capacity and the phasing of new development and essential highway and public transport infrastructure to support it;
- providing for a high and continuing growth in ownership and use of private cars;
- providing for increasing regional transportation demand, including that linked to port and airport activity and the further development of Wuhan as a transportation hub;
- providing additional capacity for highway and public transport modes across the rivers;
- ensuring that transport network supply is increased in capacity terms, where appropriate, and managed to ensure accessibility, efficiency, safety and a suitable balance of demand between modes;
- managing and reducing the environmental impacts of traffic in terms of congestion, emissions, noise, severance, accidents and reduction of quality of life;
- significantly improving public transport efficiency, effectiveness and integration, including providing adequate protection/priority for buses from increasing traffic congestion and providing new public transport systems and technology in a cost-effective and affordable way;
- recognising the importance of, and maintaining, walking and cycling as significant modes for local tripmaking;
- improving integration of planning investment and decision making between the key organizations and agencies responsible for local and regional transportation; and
- developing existing demand management measures into a coherent and forward-looking strategy to maximise and maintain the benefits of new infrastructure provision.
These issues are not unique to Wuhan and fairly typical to many cities in Eastern and Central China.

5. INTERNATIONAL EXPERIENCE AND IMPLICATIONS FOR CHINA

Difficulties in obtaining reliable, up-to-date and consistent data across different countries mean that robust international benchmarking of key transport outcomes remains in its infancy. Nevertheless, there are solid grounds for using key experience from Europe and elsewhere to inform important lessons for China.

The trends set out in the previous sections have already been experienced by most Western cities in the twentieth century and they have all led to an increase in the demand for motorised transport such that the quality of life and economic growth may be compromised through rising congestion, severance and environmental degradation. A range of responses have been developed to meet this threat, as demonstrated by a number of international case studies and research19.

In particular, there is consistent evidence that shows a strong correlation between GDP growth and the movement of freight and passengers (by all modes) in the UK and most other European countries since the 1950s. Within this overall context of growth, the proportion of passenger travel made by car has increased massively, although more recent evidence suggests a gradual “decoupling” of the relationship with GDP. By contrast, the growth in public transport movements has generally been much lower, and walking and cycling have declined greatly over that time.

In many instances, national policies have often done little to discourage these trends, with significant investment in national and urban highway networks at the expense of other modes. Whilst some European countries, such as Germany and Switzerland, have maintained high quality urban and inter-urban public transport networks, others clearly have not, and only since the late 1980s has a new emphasis on sustainable transport and management of demand become more evident. In the UK, for example, the collapse of the “predict and provide” philosophy of the 1989 White Paper “Roads to Prosperity” was only followed by a new agenda for transport planning and delivery through the Integrated Transport White Paper in 1998, and the more recent Future of Transport in 2004.

Overseas experience therefore points to China experiencing a dramatic increased potential demand for vehicle ownership in coming decades, and also increases in traffic, especially private car use. The issue facing Chinese policy-makers is how far to limit the growth in private vehicles within the context of national economic policies, and whether to manage the use of these vehicles, learning some of the most effective techniques and experiences from Europe and elsewhere.

19 For example, See European Best Practice in Integrated Transport. Atkins for the Commission for Integrated Transport (2001).
In this respect, different cities internationally have attempted to address the issues that traffic growth raises in different ways. Some have been more successful than others. In particular, the evidence generally confirms that when “carrot and stick” measures are introduced as complementary elements within an integrated package, then an effective mode shift from car use to more sustainable modes can be achieved; and the combined effect is greater than the sum of the individual policy instruments.

For example, significant progress has been made in London where the introduction of congestion charging and significant investment in public transport has led to a significant decline in car use in the central area. Other cities which have imposed substantial controls on car use – Singapore, Barcelona and Rome – and combined these with investment in public transport and local measures for pedestrians and cyclists, have also seen positive results. Initial results from the recently introduced trial of congestion charging in Stockholm since the beginning of 2006 appear encouraging, although more evidence is required to confirm the scheme’s ongoing effectiveness and public acceptability.

Investing in improving the coverage and quality of public transport has been shown to be successful in improving patronage in most cases and can be seen from a number of French, German and Dutch cities. However, without demand measures to “lock in” the benefits that this brings, the vacated road space resulting from mode shift may be filled up with new generated traffic. It is those cities which have combined this policy with land use approaches, parking restrictions and enforcement and traffic restraint where there appears to have been most success in achieving a sustained shift from car to alternative modes and successfully enhancing the quality of life of their people. This conclusion also highlights the importance of retaining inner city populations and mixing different types of land use to ensure that it is feasible to cycle or walk to destinations or support economically viable public transport systems.

There are a number of city examples in developing countries which offer potential lessons for China, such as successful urban planning and public transport initiatives in South American cities such as Curitiba, Bogota, Quito and Santiago. The importance of port development on the eastern and southern coasts of China also point to the need to learn the lessons from successful international examples, such as Rotterdam, Hong Kong, Singapore and Dubai, in such areas as modern logistics, integrating port activity with urban development and ensuring efficient and comprehensive landward connections. Finally, examples such as Hong Kong, London, Dublin and Copenhagen demonstrate successful attraction of private sector capital to support construction of urban public transport infrastructure, in some instances funded by increased land values relating to accessibility.

Other international experience which may offer useful lessons for Chinese transport planners include:

- integrated fares and ticketing across all modes;
• lower and simplified public transport fares;
• improving the density, integration and reliability of public transport, for both rail and bus-based modes;
• effective policies for managing freight traffic, such as dedicated strategic routes for access to ports and industrial areas and intermodal transport operations;
• parking policies, including managing supply, charging for use and reallocating spaces from car use to increased provision for public transport, pedestrians and cyclists;
• implementing management of development impact through the planning process, including requirements for developer contributions and increasingly the promotion of travel plans and other “smart” measures;
• restricting or reallocating roadspace, either physically or financially, from general traffic to other modes;
• using revenue streams from parking, congestion charging and land value capture to finance transport improvements;
• enforcement of parking and driving behaviour; and
• transport telematics (ITS) for passenger and freight traffic, multi-modal interchange and support for demand management policies.

International experience highlights the importance of focused, clear and action-orientated institutional arrangements, a major weakness in transport planning and delivery in China. The examples of Singapore’s Land Transport Association, the UK’s Transport for London and the various public transport co-ordinating bodies in Spain, France, Denmark and Germany are instructive in this respect, especially where combined with effective use of the private sector to support infrastructure construction and operation. Hong Kong is notable for its strong integration of land use and transport planning in its new town programme.

International experience also illustrates the importance of the public being given adequate and appropriate support and information about transport policies, and becoming actively involved in key decisions. Such an approach would have key benefits, but present significant political and practical difficulties, in Chinese cities at the current time. The evolution of public involvement in decision making, as well as a more market and customer-led approach, is linked to the wider democratisation of Chinese society and development of appropriate engagement techniques.

6. EMERGING CONCLUSIONS

Although the relationship between economic growth, greater consumer choice and vehicle usage is a long established one, there are a number of implications for China. It is generally accepted that whilst greater accessibility offered by road-based modes have delivered significant economic and social benefits, the resulting traffic growth has led to acute problems for many cities in Europe and elsewhere. These problems arise from more people living in urban areas that are becoming larger and less dense, and becoming more dependent on car use as a significant proportion of the urban travel market.
The key issues are well documented and include traffic congestion and delay, inefficient use of space and resources, traffic pollution, noise, severance and concerns over road safety. Looking to the future, the finite nature of global oil supplies and the impact of the transport sector on climate change are two considerations likely to become central to the policy agenda in future.

As well as these universal issues, the distinct local characteristics of cities also need to be taken into account in defining any appropriate policy for China. These include the national importance of the motor industry, a less organised urban structure, high levels of population size and growth, an inherited infrastructure deficit, current high dependence on bus-based public transport, walking and cycling and weak institutional integration and co-operation. These features provide a local context against which future urban policies and practices for cities such as Wuhan should be considered and articulated.

The analysis set out in this paper supports the following conclusions in respect of the development of a future transport strategy for Chinese cities.

- **The demand for transport is increasing and is set to continue to increase in future years.**

Continued urban expansion is set to drive a massive increase in demand for passenger and freight movement. Failing to forecast and effectively accommodate – and manage – this demand risks growing pressure on all transport networks, increasing latent demand and may undermine the future prosperity, quality of life and competitiveness of Chinese cities.

- **The level of motorisation is set to increase at an unprecedented rate.**

Given the established relationship of growth in GDP and traffic that has been demonstrated internationally, it is clear that much of the increase in demand for travel in and around Chinese cities will be by private car and road-based freight. Whilst efforts should be made to encourage sustainable modes, by almost any measure, traffic volumes are forecast to increase by between at least three and four times current levels for many cities by 2020. Without action, this will lead to a worsening of congestion, poor air quality and environmental degradation, as already experienced across many city transport networks.

- **Chinese transport planners face a policy conundrum**

There is a real tension between the need to support sustainable urban development and encourage appropriate car use whilst reflecting the national policy towards growth of the motor industry. This looks likely to lead to a focus on measures which manage car use rather than vehicle ownership per se.

- **The current highway and public transport networks in many cities are poorly developed and managed in terms of their physical infrastructure and management.**
Chinese cities face infrastructure and transport service deficits, including gaps in the basic arterial road network, a fragmented public transport system, elementary traffic management technologies and practices, and limited integration between land use and transport planning. Substantial capital investment is needed to overcome these deficits and fully address existing and future problems in a manner which reflects the principles of sustainable development and cost effectiveness.

Innovative funding approaches, including wider use of the private sector, and conducive regulatory conditions to facilitate this must be developed if this investment is to be brought forward.

- **Chinese cities cannot build their way out of congestion.**

Many cities are set to experience a substantial highway construction programme over the next few years. However, there is no city in the world which has successfully solved congestion by expanding highway capacity at a faster rate than traffic growth, especially under the conditions of rapid economic growth being experienced in China. Indeed, new roads in urban areas have been shown to generate new vehicle trips, which over time erode the benefits of the capacity provided. This supports the case for demand management on car use as traffic increases.

- **Proactive policies should seek to maintain walking and cycling at high levels and mode share**

Giving secondary treatment to non-motorised modes, an increasingly common practice in many Chinese cities, is incompatible with the principles of sustainable development. Approaches should be found to provide for these modes as essential elements of urban accessibility, mobility and equity between different parts of society, with proactive planning and transport policies at national and city level leading the way.

- **Institutional integration and co-operation is vital to success**

Transport planning and delivery in China faces major institutional fragmentation and weakness. International experience shows that an approach, which includes substantial improvement in urban public transport, integration of land use and transport services, and demand management, in combination, is able to support balanced and sustainable urban growth over time. Inevitably, this will require focused policy development and joint action across the various responsible agencies, with a need for organisational reform in the medium term, backed up by an appropriate funding structure, in order to reflect more complex and multi-modal transport challenges now being experienced.

- **Long-term sustainable development requires the environmental impacts of the transport sector to be fully accounted for and mitigated**
The energy, air quality and climate change implications of Chinese urbanisation will have global implications. A combination of new fuel and vehicle technology, demand management and land use – transport integration will be essential to avoid acute negative consequences for future generations.

- Effective transport planning capacity and competencies must be developed as vital tools to policy, capital investment and management decisions

The development of a comprehensive transport planning profession in China is a relatively recent phenomenon. Whilst great progress has been made in developing effective data collection, analytical, appraisal and design methodologies, the relevant Design Institutes and other arms of national and local government need to further evolve competencies further so that key decisions are supported by robust evidence, demand forecasts and analysis which stands up to international scrutiny. Achieving inclusive and effective public engagement is also a key challenge. In this context, the increasing presence of international firms and other organisations in China offer a potential channel by which the necessary skills and technology transfers can be achieved.

China would do well to learn some of the lessons from international examples, such as Singapore and Hong Kong, over the past forty years. As has been demonstrated, the country is still at the beginning of the motorization cycle, and this provides an opportunity to avoid many of the mistakes made by other countries in developing their own transport policies and systems in response to rapid growth in car ownership and changing social attitudes. In particular, demand management needs to be developed and pursued now in order to manage the growth in car ownership, counter-balance national economic policies, and “lock in” the benefits of the substantial infrastructure investment under way.

Equally, UK and European policy makers should be concerned with the outcomes of China’s evolving approaches to urban transport. The competitiveness of Chinese cities is likely to become an increasing influence on the health of the global economy and trading system over the next two decades. China is also likely to be a key influence on emerging debates on energy consumption, and development of policies to address the causes and impacts of climate change. These issues can be expected to dominate the global transport debate in future years.

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