

The University of Manchester

Urban Street Design in Modern China

Standards, Practices and Outcomes

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Abstract

This thesis investigates and discusses the current design approaches and development trends of urban streets in China. As the methodological focus, multiple case studies and interviews are used to examine actual street design practice to identify the development policy bias of local governments. Since the 1990s, the great economic achievement in most Chinese cities has evoked significant growth in the number of automobiles, as well as the increasingly serious problems of road casualties and congestion. The traffic-engineering-based design approach which used to be widely adopted and implemented in western countries has dominated the development patterns of urban streets in modern China. The conventional paradigm exclusively focuses on the traffic function in urban streets resulting in morphological changes to the urban circulation environment and keeps on neglecting non-vehicular movement and non-traffic needs. The automobile-dominated urban circulation environment has had negative economic, social and public health impacts. Thus, a paradigm shift which calls for a more inclusive design approach for urban streets which balances functions of place and movement is urgently needed in China. To determine the challenges and opportunities for the new paradigm, this research identifies the cultural, political and technical factors for the traffic-centred design trends and the policy bias. Based on this, policy recommendations and an agenda for revolutionary change for achieving better design practice for urban streets in post-modern China are suggested.

Glossary

Key standards and guidance

GB 50220-95	Code for Transport Planning on Urban Roads
CJJ 37-90	Standards for Urban Street Design
JGJ 50-2001	Codes for Design on Accessibility of Urban Roads and Buildings
MfS	Manual for Streets

Organisations

CABE	Commission for Architecture and the Built Environment
CfIT	Commission for Integrated Transport
CPECS	The Compulsory Provisions of Engineering Construction Standards
DfT	Department for Transport
ITE	Institute of Transportation Engineers
MoHURD	Ministry of Housing and Urban-Rural Development of the People's Republic of China
NPCSC	National People's Congress Standing Committee

Abbreviations

SSD	Stopping sight distance
BRT	Bus rapid transit

Others

<i>Yuan</i>	The currency of the People's Republic of China
<i>Xiang</i>	Minor street or alley

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CHAPTER 1 INTRODUCTION

We must kill the street . . . We shall truly enter into modern town-planning only after we have accepted this preliminary determination – thundered Le Corbusier at the ninth lecture of the Friends of the Artists in Paris on 18th October, 1929.

Streets are essential components in the urban fabric, they are places in themselves, they are the most immediate part of the public urban realm and we encounter them every day (CABE, 2002: 8).

As the basic organisational structure of urban topology traced out by the tracks of people moving, the arrangements and patterns of our cities were shaped by the paved linear paths that we call roads or streets. The above quotations represent two distinct concepts about urban streets over the last century. Today, the place function of urban streets, as well as the non-traffic needs of street users, is increasingly recognised and suggested.

However, many design and management practices of urban streets are still dominated by the requirements of motor traffic. In many Chinese cities, pedestrians and cyclists suffer from a deteriorating circulation environment since urban streets have been over-focused on motor traffic flows. Numerous public funds have been invested in road construction projects to facilitate increasing motor traffic. However, those mega-projects have failed to relieve road congestion or reduce casualties, but have generated new environmental and social problems.

This research asks why today's urban street development in China has persistently followed the old western paradigm which has been proved again and again to be a failure over the last fifty years. It is urgent to find answers and solutions to reduce automobile dependence and improve

the urban circulation environment as significant contributions to the national sustainability agenda¹.

1.1 PARADIGM SHIFT OF URBAN STREET DESIGN

Since the 1920s, the design of roads and streets has been strongly influenced by the increasing use of automobiles. As a response to growing congestion and accidents, traffic engineering had become the discipline that aimed to achieve traffic fluidity and road safety. Street design was then rigidly regulated by engineering-dominated codes and standards and universally adopted to safely integrate ever-increasing numbers of motor vehicles into pre-existing urban forms. Over time, street design focused primarily on motor vehicle movement, which resulted in “unsustainable land development patterns, fewer transportation choices, increased noise, pollution and greenhouse gases, as well as a decline in social, civic, physical and economic activity on streets” (New York City Department of Transportation, 2009:18).

However, since the second half of the 20th century, the diverse aspirations of other street users such as pedestrians, cyclists and public transport passengers were gradually reappraised and valued. It had been well acknowledged that well-designed streets played a crucial role in the delivery of sustainable communities, as with the vision of the *place where people want to live and work, now and in the future* (DfT & CLG, 2007: 16).

There were increasing widespread criticisms of the conventional design approaches with sustainability principles being introduced into street design practices. Alternative paradigms have been steadily evolved and exercised in many developed countries. Many of those, such as traffic calming strategy, the New Urbanism Movement and the shared street concept, had effectively

¹ Sustainability strategy was first adopted by the State Council of P. R. China in 1994 as required by Agenda 21 in 1992 (United Nations, 1992).

helped to liberate modern cities from deeply-entrenched, automobile-oriented frameworks and traffic-engineering-based design regulations.

China, like other developing countries, has been facing a growing rate of motor vehicle ownership, as well as increasingly serious traffic problems since the 1990s. Tremendous expenditure on urban road construction failed to reduce the serious traffic congestion and large number of road fatalities experienced in Chinese cities whilst generating new problems including social inequity, city erosion, an energy crisis and air and noise pollution. The scientific set of national standards for road and street design failed to improve road safety and traffic fluidity, whilst creating an increasingly automobile-dependent city space.

There has been an increasing recognition of sustainability requirements in urban-rural development in China recently. A wave of significant growth in private motor vehicle ownership in China is projected, since it has experienced a rapid growth in the economy and real incomes over the last two decades (Chamon *et al.*, 2008). Previous statistics indicated that approximately 16% of the world's fatalities on roads occurred in China which had only 3% of the world's vehicles (WHO, 2009). It also predicts that the problems of street accidents and traffic congestion, as well as conflicts between motorists and non-motorists, will become increasingly significant as the numbers of motor vehicles increase.

Furthermore, there were many other problems which have not been fully recognised but are actually influencing people's daily lives. Historical contexts and distinctive aesthetics in most great cities appeared to be torn up and replaced by the "modern" street system that was primarily serving motor vehicle movement. From the micro-perspective, an automobile-dominated circulation system prevails at the expense of non-motorists' accessibility, convenience and opportunities for social activities that are 'pedestrian- or cyclist-hostile'; though it has still failed to achieve better conditions for traffic flow and safety (Vasconcellos, 2001: 206).

The western lessons have nevertheless failed to stop decision makers in China repeating their

predecessors' mistakes. There must be some critical factors driving design trends of urban streets in favour of motorists. As well as in other developing countries, alternative design practices have encountered great challenges in China. Automobiles are increasingly embraced by the emerging middle class in developing countries. Vasconcellos (2001: 156) emphasises the power of "class decision" in automobile preference which is in favour of the automobile-oriented street system.

However, the design trends of urban streets may be characterised by the distinctive conditions of China beyond the cultural and social preference for fast, motorised traffic. Urban street design is often subject to spatial organisation dominated by political-economic powers which, in China, are the basis for the prevalent logic of 'zoning' in development planning. This approach, relying on much more extensive land assembly powers, exploded the street into separate single-functional spaces to accommodate different modes and speeds of movement. Given the land collectivisation of the 1950-1970s, the rapid economic growth since the 1990s and China's imperial and socialist traditions and constraints, major Chinese cities are becoming the seedbeds for these super-block developments (Abramson, 2008).

The established professional practice with rigid and absolute standards provided by traffic engineers poses obstacles to new thinking and creativity in design practice. Since regulations have been profoundly embedded in the traffic engineering profession, as well as in the legal and even the financial structures that support development, they result in uniform developments that are unresponsive to their users and local contexts (Southworth & Ben - Joseph, 2003). Despite the hierarchical street system being developed by scientific means to cope with increasing traffic volumes, its natural deficiencies have been detected (Alexander, 1965; Jiang, 2009). Contemporary urban design which places a high value on the street environment asks urgently for a paradigm shift. Nevertheless, the engineering interest may prefer sticking to changing the existing norms of practice (Hebbert, 2005).

1.2 RESEARCH AIM AND OBJECTIVES AND SIGNIFICANCE

Efforts to improve the quality of streetscapes are often compromised by rigid applications of traffic engineering solutions which primarily facilitate motor vehicle movement (CABE, 2002: 36; ODPM, 2002: 2). For example, it is indicated in China's national *Code for Transport Planning on Urban Roads* [GB 50220-95] that *the traffic flows should be distributed by different speeds; and the arterial geometry and traffic management should be majorly determined by the designed speed of vehicles* (MoHURD: 7.1.2; 7.1.6). It is even written in textbooks that the modern street and network planning and design should aim at developing fully-functional streets for motor traffic and achieving adequate street capacity in traffic flows (Wu & Shen, 2003: 4).

The deteriorating pedestrian environment and the dysfunctional impact of highway standards based primarily on the requirements of drivers and vehicle movement have become an urgent issue in most modern Chinese cities. This research is timely and important as very few studies have provided an overall picture or inclusive considerations of the urban circulation environment in China (Zhou, 1993; Qiu, S., 2006; Zhou & Zhu, 2007).

It is expected to determine practical applications for sustainable urban street design with balanced functions for both place and movement and for diverse needs in living and travelling. More specifically, a new practical vision for good urban street design is urgently needed and its development should attempt to apply real design practices balanced by concerns for safety, health, access, mobility, liveability, aesthetics and local distinctiveness.

This research study aims to examine the contemporary design trends and development approaches of urban streets in China, with a specific focus on real-world design processes through standards, practices and outcomes. Under this overall aim, four main objectives are proposed:

Objective 1: to develop a critical understanding of conventional design standards and the new design trends of global urban streets.

Objective 2: to investigate the current street design trends in China by exploring and identifying inconsistencies and discrepancies in design standards, practices and outcomes.

Objective 3: to identify factors affecting current design trends and barriers to alternative design practices within the Chinese political and technical conditions.

Objective 4: to make recommendations for decision makers to develop better practices in street design to deliver sustainability policies.

1.3 THESIS STRUCTURE

The thesis describes the research in ten chapters according to the empirical logic used by previous researchers. The overall chapter framework is listed as below to illustrate the basic structure following the research process (Figure 1.1).

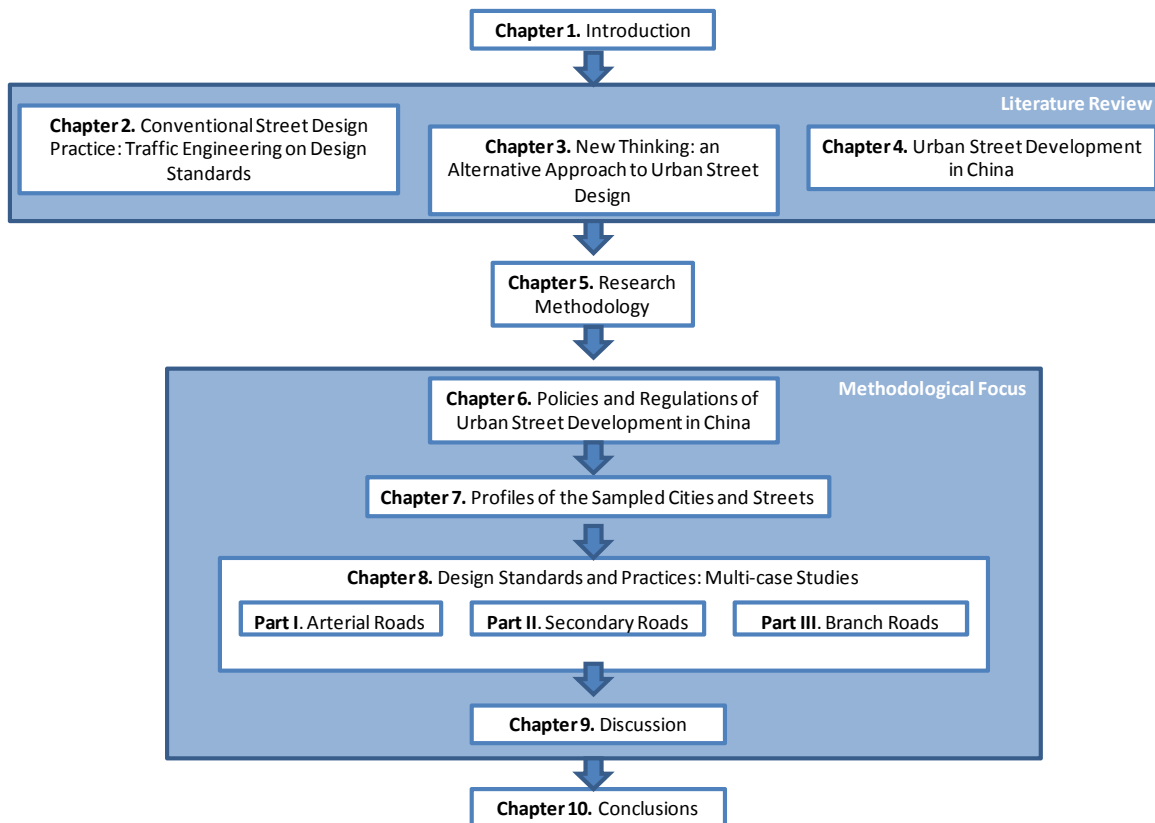


Figure 1.1. *Chapter framework*

This research begins with an introduction indicating the purpose and significance of the study. It outlines the study's extent, focus and context. Chapter 2 asks how the conventional street design standards are established by the traffic engineering paradigm and universally accepted. The answer is arranged in two parts: the factors for increasing use of motor vehicles and the development process of street design standards since the 1920s. It provides the research with a historical basis of the traffic-engineering-oriented street design and practice around the world.

Chapter 3 critiques the literature on conventional street design practice and new paradigms for alternative design approaches. The literature, largely from the UK and North American perspectives reveals flaws and deficiencies in the conventional approach and offers both theoretical and empirical support to the paradigm shift in urban street design. It stresses the problems of the 'traffic induction loop' (see the explanation on Page 41) in urban street development and questions the over-focus on traffic-flow concerns. At the end, the chapter lists a set of new alternative practices as the exemplars representing some new design trends in developed countries.

Chapter 4 transfers the focus to Chinese literature on the current street development in China. The literature identifies problems and factors of the current street design trends in many Chinese cities. The booming economy and family incomes in modern Chinese cities bring increasing numbers of cars to their traditional centres. The conflict between ever-increasing motor traffic volumes and limited urban road space evokes debates on different considerations which represent two distinct views on "good" design practice for urban streets. It indicates how the 'traffic induction loop' operates in Chinese cities and its negative social and environmental consequences.

On the basis of previous studies, Chapter 5 proposes a series of research questions and related methods for data collection and analysis. To investigate the current urban street design trends in Chinese cities, as well as inconsistencies between standards and practices, it draws a scheme for a multi-case study which focuses on a sample of nine urban streets in three cities. Furthermore, it develops a schedule of face-to-face interviews in a variety of disciplines to determine the actual

experience, perception and perspectives in real-world design practices for urban streets.

Chapter 6 examines street development policies and design regulations in China. The first half of this chapter provides the following chapters with the overall policy background and framework, as well as explanations of some specific design standards. The second half indicates the inconsistency between policies and their delivery and discusses factors in general for the discrepancies.

Chapter 7 summarises the basic information on the sampled streets and cities. It aims to offer the multi-case study the distinctive backgrounds and situations of the sample. This chapter involves three parts according to the selected cities. Each part illustrates the city's street development history and outlines the general conditions and parameters of its sampled streets.

Chapter 8 is devoted to the multi-case study which divides the chapter into three parts by the type of sampled streets. Each part includes two sections: 1) examinations and comparisons of the sampled streets with the related national standards and design codes and 2) an evaluation and analysis of the negotiations made between the different needs of users on the street. This chapter uses a large quantity of tables, figures, diagrams and photographs to illustrate the inconsistencies between the national standards and practices and the inequity problems of the street conditions for different street users.

Chapter 9 discusses the revealed inconsistencies and problems of urban street design practices in the areas of land control, street users' needs and political and technical issues, as well as the barriers to alternative design approaches. It quotes the opinions gained from the stakeholder interviews to indicate the policy bias of the current design trends and the key obstacles to the paradigm shift in China.

Finally, this thesis ends by summarising all the key findings and provides recommendations for further studies and practices. It revisits the research questions proposed earlier to determine the extent to which the research aims and objectives have been achieved.

CHAPTER 2 CONVENTIONAL STREET DESIGN

PRACTICE: TRAFFIC ENGINEERING ON DESIGN STANDARDS

A standard for urban planning or design, no matter how subtle, can have a tremendous impact on shaping our built environment. A design code, even if it is insignificant, can direct the performance of the whole sense of a city by its hidden powers and procedures. As the main response to the growing demands for traffic flow and road safety generated by the increasing use of automobiles, today's street design standards were gradually established during the last century and then universally duplicated and adopted regardless of variations in land, natural preferences and other diverse social needs (Ben-Joseph, 2005).

The vehicle-based street design standards and traffic management approaches have had a significant impact on the forms of the urban street network, district layout and streetscape, and caused intense debates in the social and environmental fields. The conventional paradigm, particularly the system of street hierarchy, has been widely recognised and believed to be the most scientific approach to deal with the increasing road congestion and accidents since the advent of automobiles. The traffic engineering convention, entrenched through design standards and building codes, has powerfully influenced the practice of urban street design all over the world.

This section explores the standardisation and globalisation process of urban street design during the twentieth century. It asks how the standards have been raised through the conflicts between the engineering convention, social equity and environmental sustainability.

2.1 DRIVERS OF CHANGE: THE AUTOMOBILE DEPENDENT CITY

Automobiles are often conveniently tagged as the villains responsible for the ills of cities and the disappointments and futilities of city planning. But the destructive effects of automobiles are much less a cause than a symptom of our incompetence at city building (Jacobs, 1961: 7).

The 1920s was the decade in which the automobile became increasingly pursued as a necessity rather than a luxury by the majority of American families and became an object which was commonly seen as a part of traffic, with a set of consequences embracing proposals to speed up motor traffic, drive pedestrians off the streets and provide motorists with a relief from legal, financial, and moral liability for overcrowded and dangerous streets. Streets are presented as a contested public space threatened by automobiles and the powerful drivers that put those machines on the street (Norton, 2008). Thus, the streets and networks had to be funded and redeveloped to adapt their constructions and facilities to the increasing demands for speed and safety.

2.1.1 Historical trends in car ownership

For the last half century, historical data for car ownership and transport patterns has been collected by a wide range of international organisations, such as the World Bank Statistics (WBS), the World Health Organisation (WHO) and the International Road Federation (IRF). There were considerable studies devoted to the reporting, analysing and forecasting of traffic growth trends (Mogridge, 1967 & 1989; Tanner, 1962 & 1978; Bates *et al.*, 1978). In 1920, there were approximately 7 million cars in the United States. By the middle of the same decade the number was approaching 20 million, which meant that more than 10% of Americans owned cars (Figure 2.1). After World War II, the number of car owners sharply increased. In the 1980s, the level of car ownership was above 50%, which was three times that of the 1920s.

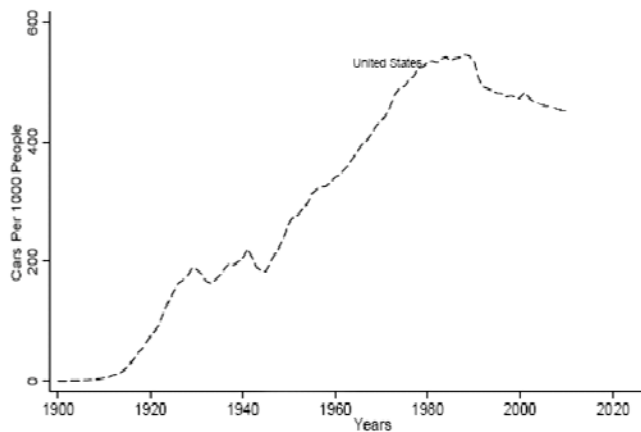


Figure 2.1. *Car ownership in the United States, 1900-2008*

Source: Chamon *et al.*, 2008: Figure 3.

In terms of European countries, automobiles have been pervasively used since the 1950s. For example, there were only 2.3 million cars in the UK in 1951. Then the number of automobiles increased by an average annual growth rate of 3% and reached over 31 million in 2007 (The Society of Motor Manufacturers and Traders Limited, 2008). This trend was also widespread in other European countries (Figure 2.2).

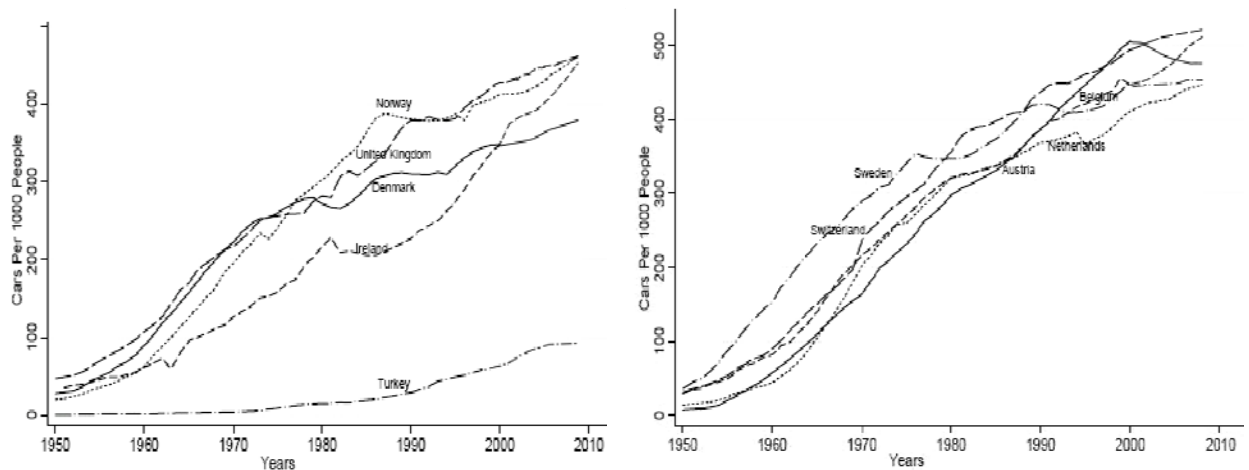


Figure 2.2. *Rates of car ownership in European Countries, 1950-2008*

Source: Chamon *et al.*, 2008: Figure 3.

Following the trend, there has been significant growth in car ownership in middle-income countries due to the rapid growth in the post-war economy and the declining price of automobiles. According to Table 2.1, the largest growth of motor vehicle ownership (including motorcycles)

was found in developing countries such as China, Poland, Turkey, the Dominican Republic and India. Regardless of the differences between these countries, there is a common tendency for all social levels towards more individual motorisation (Vasconcellos, 2001). The historical trends indicate that automobiles have been gradually regarded as a common tool rather than as a luxury for daily travels in both developed and developing countries.

Table 2.1. *Historical Data on Vehicle Ownership of selected countries, 1960 & 2002*

	country	Vehicles per 1000 population		
		1960	2002	Average annual growth rate (%)
North America	Canada	292	581	1.6
	United States	411	812	1.6
	Mexico	22	165	4.9
Europe	Belgium	102	520	4
	Germany	73	586	5.1
	France	158	576	3.1
	Great Britain	137	515	3.2
	Luxembourg	135	716	4
	Poland	8	370	9.5
	Sweden	175	500	2.5
	Turkey	4	96	7.7
Asia	Japan	19	599	8.6
	India	1	17	6.8
	China	0.38	16	9.8
	Malaysia	25	240	6.7
	Pakistan	1.7	12	4.7
South America	Argentina	55	186	3.1
	Brazil	20	121	4.6
	Dominican Rep.	7	118	7.3
	Ecuador	9	50	5.2
Middle East & Africa	Israel	25	303	6.2
	Syria	6	35	4.1
	South Africa	66	152	6.1

Source: United Nations, *Statistical Yearbook*, 1960 & 2002.

Many modelling studies suggest that car ownership commonly follows an S-shaped growth curve which ends with a saturation level (Tanner, 1962; Mogridge, 1967, Bates *et al.*, 1978; Department for Transport, 1997). However, such a pattern in ownership is not apparently identified in the long-term data for each case above. Besides, some declines could be noticed in

the growth patterns of car ownership in the United States and some European countries. For example, a number of recent studies and reports show a halt to the growth in vehicle ownership, use and overall travel demand in the UK (Millard-Ball & Schipper, 2010; Le Vine & Jones, 2012; Goodwin & Van Dender, 2013). Historical trends seem to be different from the forecasting model depending on individual income. The deviation suggests that the factors for the purchase and use of automobiles might be more complex than purely the influence of the economy.

2.1.2 Historical factors for the growth pattern in car ownership

Some previous studies focused on the relationship between car purchase and the level of an individual household's disposable income with the aim of establishing a model for car ownership forecasts (Tanner, 1962; Mogridge, 1967). As long as the increasing data have been collected, many other factors have been recognised as influencing the trend of car ownership, such as household types, local geographic features, fluctuating petrol prices, quality of alternative travel modes and social preference (DfT, 1997; Newman & Kenworthy, 1989; 1999; Whelan, 2000; Vasconcellos, 2001; Deka, 2002). Recent studies and new survey approaches suggest that the drivers for the growth pattern in car ownership can be more complex than previously estimated. These factors, including individual income, can be used to explain the most recent trends in car ownership.

Income growth

It is suggested that once the living standards have been improved, the demand for car purchase and use will rise (Newman & Kenworthy, 1999). It is the primary concept that an average person of a given income level spends a given quantity of money on the purchase of cars, in other words, the relationship between wealth and car ownership seems positive (Mogridge, 1967). According

to Chamon *et al* (2008), the pattern of the relationship is presented as a smooth ‘S-shaped’ curve (Figure 2.3 & Figure 2.4).

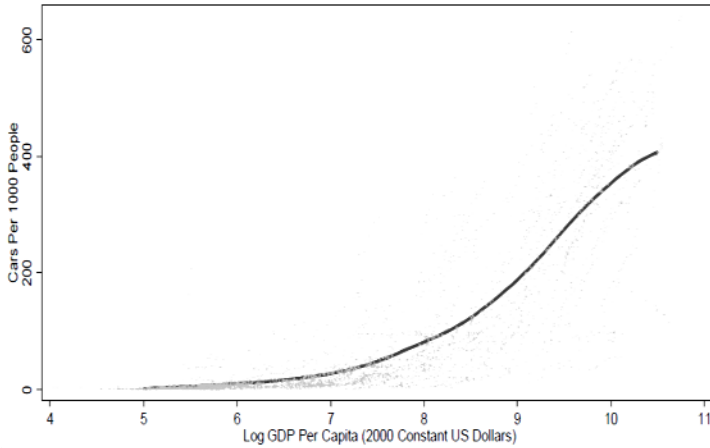


Figure 2.3. *Historical Relationship of Car Ownership and Real per-capita Income in a Panel of Countries, 1970 – 2003* (the data refer to 122 countries over 1963 – 2003 with 3255 actual observations).

Source: IRF, *World Road Statistics*; World Bank, *World Development Indicators*; cited by Chamon *et al.*, 2008.

(Cars per 1,000 people on the y-axis; size of bubble represents population)

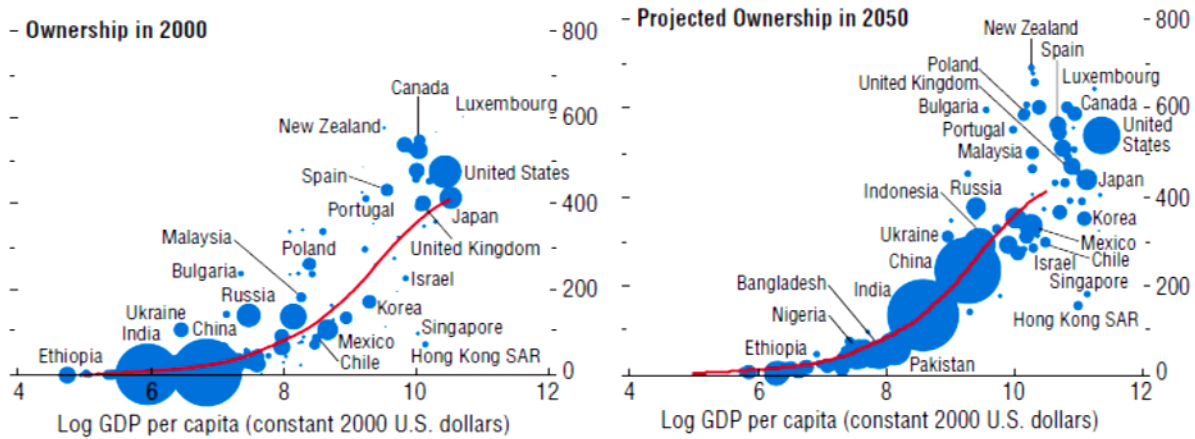


Figure 2.4. *The cross-country comparison of the relationship between Log GDP per capita and car ownership in 2000 and projected in 2050*

Source: *ibid.*

According to the prediction model of Mogridge (1967), based on the predictable income growth, the forecast trend of car ownership resembles the above cross-country pattern. Nevertheless, the saturation level of 0.66 per head has been raised to 0.90 in his 1989 estimation (Figure 2.5). In the view of Dargay *et al.* (2007), the long-run projection can be estimated by employing the Gompertz function which is empirically based on the historical trend. The relationship between the growth of vehicle ownership and income is shown in Figure 2.6 and which is highly non-linear: the vehicle ownership rate grows slowly at the low-income levels, then rapidly at middle-income levels, and eventually, gradually reaching saturation at the highest levels of income.

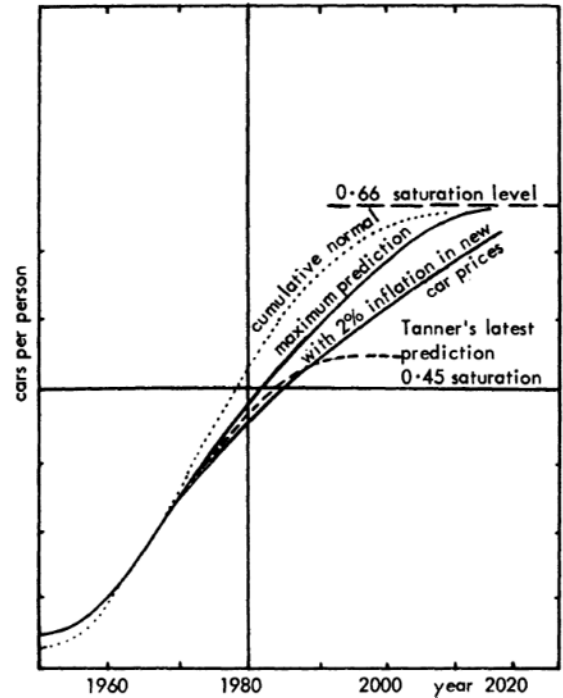


Figure 2.5. (Right) *Car ownership predictions, 1950-2020.*
Source: Mogridge, 1967, Figure 24.

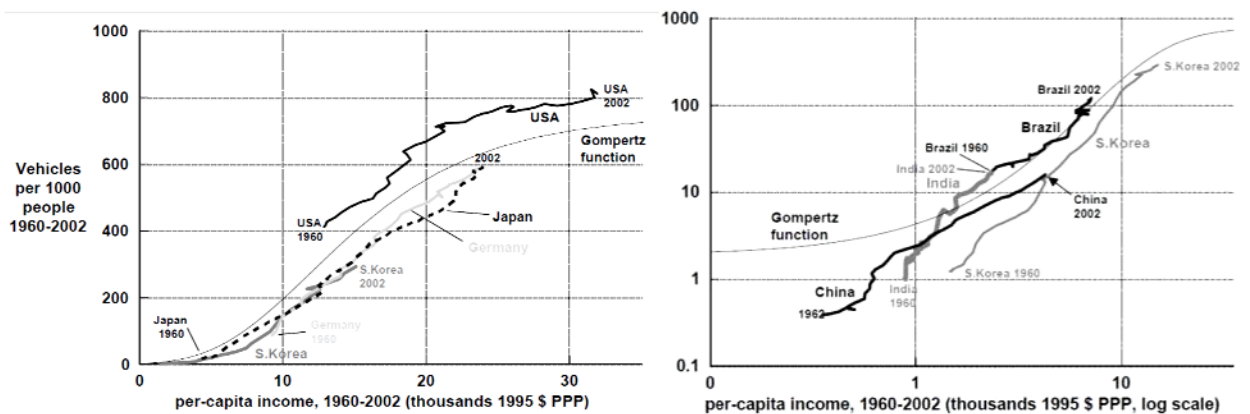


Figure 2.6. *The non-linear growing of car ownership rates - Vehicle Ownership and per-capita Income for Selected Countries, with an Illustrative Gompertz Function, 1960-2002*
Source: United Nations Statistical Yearbook, cited by Dargay *et al.*, 2007.

Similarly, Chamon *et al.* (2008) suggest that the pattern of the relationship will be slightly different according to the level of inequality in a certain country. As shown in Figure 2.7, three hypothetical countries with different levels of inequality are involved to illustrate the variation of

the evolution of car ownership rates as a function of income *per capita*. The pattern shows that there is a higher car ownership rate in the countries with low income levels and high levels of inequality. But, as incomes rise, the country with the lower level of inequality will obtain a higher rate of car ownership and reach a saturation level faster.

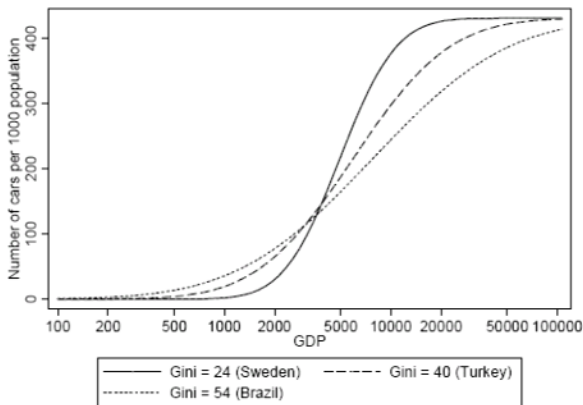


Figure 2.7. *Impact of Income Growth on Car Ownership at Different Levels of Inequality in three Selected Countries* (Income measured on a logarithmic scale, at per-capita income levels well beyond those observed so far)

Source: Chamon *et al.*, 2008.

The cross-country comparisons, historical data and forecasts all indicate that the growth in car ownership is strongly related to *per capita* income. The trends are expressed in different patterns in different countries. All the studies suggest that there should be a predictable saturation level for car ownership. Nevertheless, the saturation level ranges widely between 0.45 and 0.90 per head, since the employed function or methodology for each of the estimations is not consistent (Chamon *et al.*, 2008; Dargay *et al.*, 2007; Mogridge, 1989). The income factor is not the only influence on the growth in car ownership. For example, historical statistics indicate that the elastic coefficient of ‘car ownership growth / income growth’ is supposed to be addressed between 1 and 1.5 in western countries from the 1970s to 1980s, nevertheless, this coefficient had been steadily floating between 4 and 10 for decades (1988~2007) in Beijing (Chen & Wang, 2008). The trend suggests that private motorisation may also be motivated by other factors, since the costs of travel and maintenance have already become an economic burden to the car consumers.

Underperforming public transport

Inadequacy of public transport may not be the most significant factor in relation to the growth of car ownership. It has been proved by a number of studies that significantly improved public transport brings limited effects to reduce car ownership levels (Deka, 2002). In contrast, insufficient public transport services, as well as their poor condition, are convincingly responsible for the increase of vehicle ownership in both developed and developing countries.

In both developed and developing countries, the remarkable split of transport modes could be clearly observed (Figure 2.8). The private motorisation, especially in North America and Australia, could be the consequence of the deficiency in public transport systems. For example, a radially-oriented public transport network is unlikely to meet the travel needs in suburbanised non-centrally-oriented countries. In contrast, non-radial journeys can be easily made using the ever-expanding road network. According to Deka (2002), the relationship between automobile ownership and public transport in Los Angeles suggests that there is an inverse relationship between the household car ownership rate and public transport availability in census tracts of residence. Newman and Kenworthy (1989) agree that there is a significant negative correlation between them (Table 2.2).

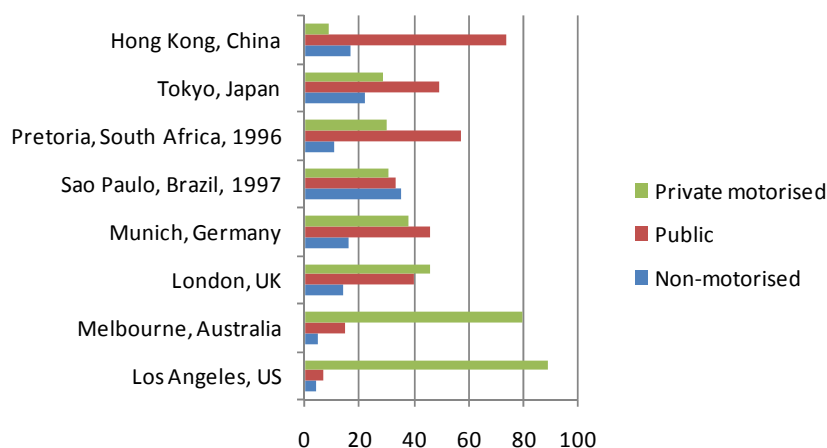


Figure 2.8. Daily motorised trips by non-motorised, public and private transport (%) in 1994 (indicated if in the any other years), selected cities in global.

Source: World Bank, 1994; Vasconcellos, 2001: 17.

Table 2.2. *Correlations between the transport variables (part A)*

	Car ownership	Private car (pass. kms per capita)
Public trans. (pass. kms per capita)	-0.7450 s=0.000	-0.7633 s=0.000
Public trans. (vehicle kms per person)	-0.8082 s=0.000	-0.7981 s=0.000
Public trans. (pass. trips per person)	-0.8712 s=0.000	-0.9234 s=0.000

Source: extracted from Newman & Kenworthy, 1989: 46.

Insufficient public transport can cause a high rate of individual motor-mobility to become a feature of the urban travel model. Regarding the conditions in developing countries, the tendency is particularly significant in congested cities where motorcycles are advantaged over public transport (Vasconcellos, 2001). Overall, compared with bus transit, the car did have a higher speed and less journey time in most cities (Plowden, 1972; Newman & Kenworthy, 1989; Vasconcellos, 2001). Table 2.3 shows that in the 1969 morning peak of Central London, for example, although journey times by both car and bus increased along with the proportion of car journeys in total, the average journey time by car was consistently less than by bus. Today, there is little advantage in using a car in central London, however, as a historical trend, the car's advantages in travel efficiency, flexibility and accessibility generally outweighed those of any mode of public transport, which made them a less attractive travel choice (Transport for London, 2012).

Table 2.3. *Commuter journey time to Central London by car and bus*

<i>% of journeys made by car</i>	<i>minutes taken to travel by</i>	
	Car	Bus
0		50.4
10	34.5	53.7
20	36.9	55.7
30	40.5	59.8
40	45.8	66.2
50	55.6	77.4
60	83.5	108.2

Source: Goodwin, 1969, Table IV.

Social preference

The car is so deeply immersed in our culture as an ideological 'being' that it replaces human beings in people's minds. It is like a powerful fetishism (Vasconcellos, 2001: 157).

Many studies contribute to the cultural underpinnings for private automobile use, which represent a convincing factor for the rapid growth in car ownership. Although the institutional structures of different countries can be significantly varied and cultural styles are not easily defined, the overwhelming flood of evidence proves that the charm of the automobile has become an international phenomenon (Davison, 2004).

The dominant car culture, across different genders, classes and ages, sustains a major discourse about the nature of the 'good life' and the necessity for an appropriate mode of mobility for a given social class and presents compelling literary and symbolic images of auto-mobility. "Indeed the car culture is that, although it is a means of mobility, it is not simply a means of mobility" (Urry, 1999: 14). It has been suggested by Forster (1931) that a 'sense of flux' was generated within the flood of automobiles. Ballard (1995: 6) also believes that the automobile and its use are symbolized "as a total metaphor for man's life in modern society". For Whitelegg (1981: 155), the 'car shapes the whole lifestyle' and 'it is impossible to reject car ownership', 'the car is the centre of a complex web of lifestyle organization which sets it apart from many other consumer durables'.

Automobile dependence first arose in the United States where people were fascinated by the suburban culture. The low-density developments pervasively deployed in the majority of American cities made the use of a car become a necessity rather than a luxury. Because of its powerful influence on both the economy and cultural values and priorities at a global scale, the American car culture has inevitably been appreciated by the rising middle classes in a number of developing countries since the last quarter of the twentieth century, despite the national physical variations.

Vasconcellos (2001) indicates that wealthy cities in developing countries had recently motorised as an expression of the new lifestyle which is favoured by the middle-classes along with the demands for 'efficient transportation'. He argues that the socially and economically constrained demand for cars is transformed into something natural and that automobiles are increasingly seen as efficient social reproduction. Consequently, a symbiosis is then formed between the middle classes and the automobile.

2.1.3 Main threats from the flood of cars

The pervasive use of cars does not only provide motorists with higher mobility and comfort, but also brings anger and grief to the people who live and travel in the car-dominated traffic environment. Road congestion and casualties have increasingly become the most significant problems in the motor age. As soon as the first automobile ran on a street, it was seen as the new 'efficient' mode of travel. However, the realistic situation of traffic congestion and road casualties goes beyond the motorists' expectation.

Road congestion

Through historical data collected by traffic surveys, the congestion should be mainly the natural result of the growing population and car ownership (Brown, 2006). As a conventional belief, the inevitable conflict between the ever-growing traffic demand and limited land resources for improving road capacity can be the main factor causing congestion (Goodwin, 2004).

As the use of automobiles increased, many large cities were confronted with the plague of vehicle-based traffic congestion (including private cars, buses, trucks and motorcycles). Cities in America in the 1920s suffered from 'a chaotic environment of congestion and social unrest'

(Southworth & Ben-Joseph, 2003: 66). In Chicago, “automobiles slow to snail’s pace on the expressways and main thoroughfares of the great urban centre of Illinois. Automobile traffic often moves no faster in our central cities than did horsedrawn carriages of 100 years ago” (Illinois & Ogilvie, 1971). “In New York and, more surprising because of its wide streets and smaller central business district, Washington, D.C., pedestrians could travel faster than cars downtown during rush hour” (McShane, 1999: 381). Similar situations widely existed in European cities from the 1960s to 1970s, such as Athens, Copenhagen and Paris (Thomson, 1977). Ironically, the automobiles invented with the aim of accelerating the speed of travel had become a factor in traffic stagnation.

Other than the increased vehicle numbers on roads, motorists travelling by automobile occupied more street space than non-motorists or passengers by public transport (Table 2.4) and they made more trips than their non-motoring compatriots (Bottles, 1987). On the other hand, the automobile’s potential for high speed created an expectation of rapid movement (Foster, 1981), which suggests that the speed of cars should be maximised on a design speed road.

Table 2.4. *Space required for a peak-hour 10km two-way working trip (9 hours)*

Mode	Space (km×m ²)		
	Parking	Traffic	Total
Bus, 50 people	< 0.5	3	3
Two-wheeler	12	8	21
Car, 1.25 people	72	18	90

Source: Vivier, 1999.

Road casualties

The safety-related problem was becoming severe at the beginning of the twentieth century in the United States. In the 1920s, more than 200,000 people were killed in motor vehicle accidents in the United States, with more than 70% of the victims being pedestrians (Norton, 2008: 21-23). After the Second World War, the problem spread to most European countries and became the third most common cause of death in Europe, just after cancer and cardiovascular disease (Vasconcellos, 2001). Today, the road traffic fatality remains a grave threat in all the

car-dominated cities with over 1.2 million people dying each year because of road accidents and between 20 and 50 million suffering traffic injuries (WHO, 2009). Moreover, nearly half of these victims are vulnerable road users (i.e. pedestrians, cyclists, motorcyclists and their passengers).

Figure 2.9 and Figure 2.10 give the correlations between the car/vehicle ownership and road casualties. Not surprisingly, the highest rate of death occurs in those cities with the highest level of car ownership. The incidence of road accidents also follows the pattern of vehicle ownership in different countries worldwide. As noted by King (1968), the relationship is logical since the multiplication and increasing use of motor vehicles has led to a great number of casualties. In eastern Germany, for example, the rate of car ownership nearly doubled between 1988 and 1992 from 225 to 415 per thousand people. During almost the same period, traffic fatalities and injuries increased by 111% and 104% respectively. This means that the doubled level of car ownership should be related to the more than doubled fatalities and injuries to people (Pucher & Lefevre, 1996). Through international studies in disability-adjusted life years, the WHO (2004) indicated that road injuries will be the third largest cause of death by 2020.

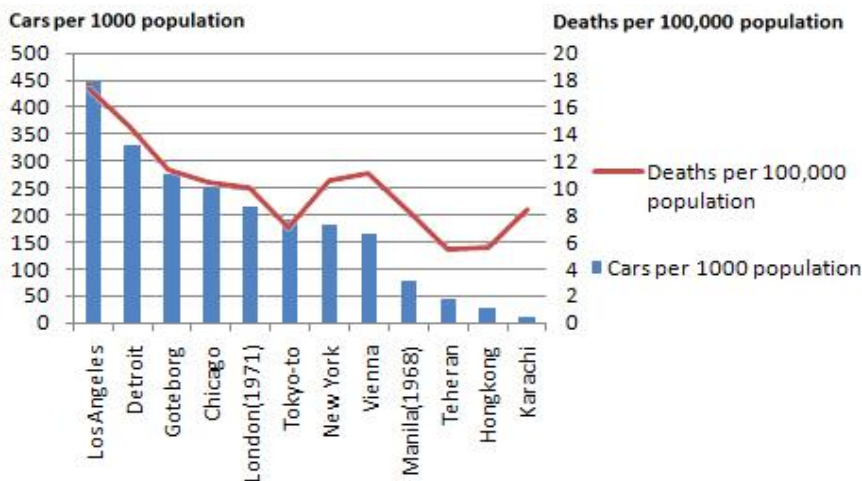


Figure 2.9. *The correlation between the car ownership rate and traffic deaths, 1970*

Source: adapted from Thomas, 1977, Table 3.

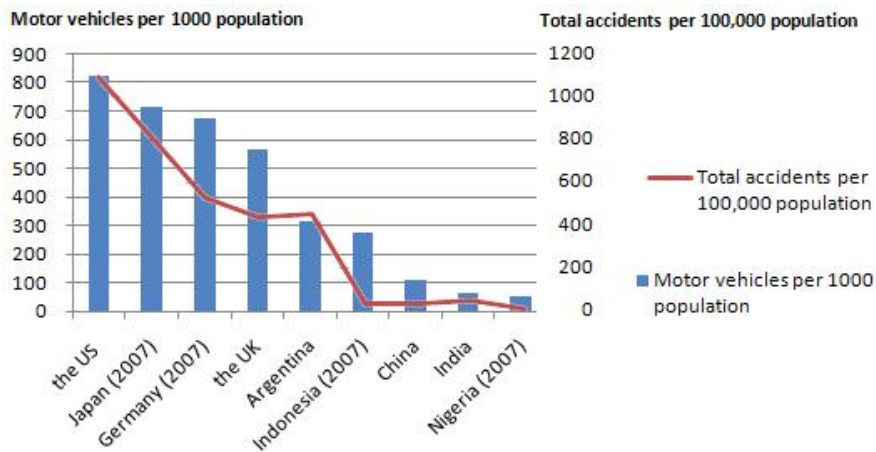


Figure 2.10. *The correlation between motor vehicle ownership and accident rate, 2006 & 2007*

Source: adapted from WHO, 2009.

Threatened by these two main problems, traffic flow and road safety were mainly targeted and pursued. As the efficiency of movement has been transferred to the equivalence of economic cost, the cost-benefit evaluations of road provision can be achieved. At the beginning of the 20th century, the pioneer in movement efficiency, Frederick Taylor, argued in his publication *The Principles of Scientific Management* (1947) that the goal of human labour and thought is efficiency. Technical calculation is in all respects superior to human judgement. He suggested that the affairs of citizens should be best guided and conducted by experts (Postman, 1992: 51). Based on this concept, every road project attempts to be economically justified to ‘get the most roads and road use for our money’ (Wells, 1976: 6).

2.2 APPROACHING TRAFFIC FLOW AND SAFETY:

TRAFFIC-ENGINEERING-BASED STANDARDS

Little blame was attached to street design for the traffic problems in the first two decades of the twentieth century, while ‘everyone blames the automobile’, as the architect Harvey Corbett observed (Norton, 2008: 48). The automobiles were tagged as ‘dangerous weapons’ which were

responsible for the increasing road fatalities and injuries which are the most shocking effect of the new motor traffic in cities (Le Brun, 1922; Norton, 2008). However, people realised that it was impossible to reject car use or even reduce its speed of growth, because the car had already become an indispensable part of modern life (Southworth & Ben-Joseph, 2003).

Thus, attention had turned to the streets and networks. As noted by Alvan Macauley, the president of Packard Motor Car Company, in 1925: “when the cities and their traffic commissions begin to find that traffic problem cannot be solved by putting drivers in jail, they will turn their attention to the streets”. In 1923, the National Automobile Chamber of Commerce organised a Safety Committee to seek ‘ways and means of making it easier for vehicles to operate on city streets and to make the streets safer for pedestrians’ (Norton, 2008: 208). When downtown business interests turned to traffic engineers to solve traffic problems in the 1920s, city streets were classified as public utilities instead of public space, which had never been questioned by engineers at the beginning of the century. Streets were public utilities to be regulated for efficiency’s sake and to a lesser extent, for the consideration of safety (*ibid.*).

Road and street classification may be one of the most significant changes in the design of street layout in twentieth century; it was seen as the most ‘scientific’ means to respond to the demands of efficiency and safety. *It has provided a robust basis for managing the risk of a motorised society* (Hebbert, 2005: 40). The concept of separating pedestrians from motor vehicles was formed even before the large number of automobiles flooded onto the streets. Historically, the thought might be derived from the plan of New York’s Central Park, which was superintended by Frederick Law Olmsted in the second half of the nineteenth century. In order to maintain the safety and comfort for pedestrians and efficiency for automobiles, the pathway was separated from the circulation system to make a split in the movements of vehicles and pedestrians. By now, the concept has been rigidly standardised and physically formulated to be the hierarchical street system (i.e. classifying urban streets into several categories with different widths and facilities according to their function and designed speed) and its by-products including freeways, flyovers,

ring roads, roundabouts, *culs-de-sac* and pedestrian bridges or underpasses, which are commonly seen today.

2.2.1 1920s – 1940s: the emerging profession of traffic engineering

In 1921, the Federal Highway Act was passed to provide for federal aid to construct integrated highway systems in America. Its emphasis created the basis for the hierarchical street system and the first official classification of roads and streets (Ben-Joseph, 2005). With the endorsement of highway engineers, the construction of existing street layouts was to be reshaped. Highway engineers, with a preference of efficient traffic movement, became powerful shapers of city form and have continued to dominate decision-making regarding streets since the 1920s (Francis, 1987: 23). In 1930, highway engineers who were trained in civil engineering were well represented in the new Institute of Traffic Engineers (Norton, 2008). Traffic engineering was defined as:

That part of engineering which deals with traffic planning and design of roads, of frontage development and of parking facilities and with the control of traffic to provide safe, convenient and economic movement of vehicles and pedestrians (Wells, 1976: 1).

The definition explicitly emphasises the safety- and movement-focused responsibility of traffic engineering in traffic planning and road design. Vehicle speed, as a key response to traffic movement and safety, was applied to road space control for vehicles accelerating, turning and braking thereby transforming street design into a field of dynamics (Hebbert, 2005). The engineering principle embraces an inverse correlation of access and movement, advocating that highways, as channels of movement, should be segregated from static spaces to respect non-motorists' safety and classified by designed speed and function to optimise the efficiency of movement (*ibid.*). Based on this concept, the artery and the freeway are applied as the form of maximised free flow of motor traffic, while the *cul-de-sac* is proposed as another extreme.

Meanwhile, European Modernists, such as Le Corbusier and Ludwig Hilberseimer, were very keen on the model of the traffic-protected superblock which was considered as the foundation for the ‘machine-age revolution’. They conceived the city on *a new scale that emphasized speed, movement and efficiency, with a clear separation between pedestrians and automobiles* (Southworth & Ben-Joseph, 2003: 79) (Figure 2.11). Along with the impact of increasing automobiles, a hierarchical street system was also in tune with engineering approaches. Thus, the flood of automobiles, the engineering preference and the advocacy of modernists become a triple force in revising the existing transportation network policy in America. Therefore, changes in the configuration and planning of networks and streets were bound to happen (Ben-Joseph, 2005).



Figure 2.11. *Le Corbusier's futuristic vision of the city and superhighways, 1922*

Source: Marshall, 2005, Figure 3.1.

According to Olmsted (1928), the plan of Central Park was designed as a completely independent network for each traffic mode, including both a major through road and wide parkways which were supposed to be a part of the metropolitan traffic system. This idea had inspired American architects, Clarence Stein and Henry Wright, to plan the garden city of Radburn in 1928 when the impact of motorisation brought the urgent demand of road safety and fluidity to American cities and suburbs (Figure 2.12). In this plan, the superblocks were surrounded by 18.3-metre-wide feeder streets, which were separated from the pedestrian ways. The *cul-de-sac* was also used as another rational escape from the regulation of the checkerboard layout where the streets are all through streets. Although the plan did not become the model for the coming decades, the road hierarchy system had been unchangeably established for the first time. It provided a basis for residential planning layout and then exemplified along with the growth of automobile

dependency (Southworth & Ben-Joseph, 2003).



Figure 2.12. *The Radburn Plan*, by Stein & Wright, 1928

Source: Southworth & Ben-Joseph, 2003: 71.

The hierarchical system had been considered as the ideal response to the demand for traffic flow and safety. Raymond Unwin, who was regarded as an expert on neighbourhood planning, argued as early as 1922 that localities should protect neighbourhood living through planning measures: main streets should be located on viaducts bridging over cross-street traffic; and private automobile traffic should be relegated to specific routes away from transportation facilities (Boyer, 1983: 184). This concept was embraced by Clarence Perry who was a member of both the Community Centre Movement and the Regional Planning Association. He proposed a set of principles that included statistics-based dimensions for a successful neighbourhood development with the aim of finding a fractional urban unit that would be self-sufficient and self-protected yet capable of contributing to the whole (New York Regional Plan Association, 1929). Unlike the Radburn plan which had difficulties in being executed at larger-scales, or Unwin's theory which was only favoured in suburban developments, Perry's concept could fit any planning scheme and provide reasonable solutions to remedy the traffic ills in the city itself (Southworth & Ben-Joseph, 2003) (Figure 2.13).



Figure 2.13. *Woodside Acres, Redwood City, California, 1944*, using Perry's Neighbourhood Unit concept
Source: Southworth & Ben-Joseph, 2003: 93.

A new profession in road and traffic engineering was urgently necessary as the result of the rapidly changing requirements in transportation policies and systematic models (Ben-Joseph, 2005). In 1930, through the national Institute of Transportation Engineers (ITE), the new profession was formally impelled to achieve a more fluid flow and fewer traffic accidents. Its procedures were based on scientific and engineering disciplines with methods including regulation and controls, planning and geometric design (Matson & Smith, 1955).

In the 1940s, the hierarchical street system was recommended by traffic engineers to prevent through traffic passing through residential blocks and steer it towards the main arterial streets (Southworth & Ben-Joseph, 2003). Then, as the functional ideal, ITE promulgated engineering standards which promoted the curvilinear and hierarchical pattern which were the characteristics of post-war suburban development (Peterson, 2003; Scott, 1995). Later, professional street design guidelines and standards, such as the *Traffic Engineering Handbook* in 1942 (and *Recommended Practices for Subdivision Streets* in 1965), were articulated and published by ITE. The ITE standards were assumed to be accurate and considered as professional regulations which had been sourced from scientific and empirical research. Thus, the standards became widely used by local agencies and public departments.

2.2.2 1940s – 1960s: the ‘USA model’ in European cities

Yet, during the mid-twentieth century, the traffic engineers in European countries paid attention to road safety and traffic flow. In fact, the concept of traffic segregation can be reflected in the German *autobahn* system attempts as early as in the 1920s. As an important precedent in European countries, *autobahn* constructions were carried out from the 1930s onwards. Then the concept was extended from the intercity freeways to the urban road transport system. Because the expansive free economic market was extended to road transport, and because traffic engineers became professionally active in the post-war period, efficient motor traffic was seen as the key factor for the economic health of the city. Most believed that traffic separation was the optimal means to improve traffic flow and safety (Hass-Klau, 1990).

The hierarchical approach, along with the model of arterial and ring roads, had been deployed in Kassel, Germany. However, Germany has always had a strong sense of its urban heritage; thus, there were hardly any major towns which adopted the totally new approach in their centres. In 1950, the land-use plan of Kassel was passed. In this plan, ‘the medieval city centre street layout had almost disappeared and been replaced by a functional traffic and land-use division’. Traffic was separated into pedestrian areas, access streets and a major ring road for through traffic (*ibid.* p 179). Other cities, such as Hanover, Hamburg, Frankfurt and a number of the Ruhr cities, were also experiencing such a new reconstruction. Furthermore, in order to achieve higher efficiency and economic health, for example, there should be no building allowed along major and fast roads, and pedestrian streets in the urban area should not be longer than 300 metres (*ibid.*).

The model of road hierarchy was also set and advanced in Britain. The question of how to improve road safety in built-up areas became particularly important in relation to the increasing car ownership after World War II. However, the inadequacies of the existing urban road network were increasingly unable to cope with the existing traffic demands (Hass-Klau, 1990). Guidelines on the *design and layout of roads in built-up areas* were published by the Ministry of War Transport (MWT) under growing pressure in 1946. The guidelines included recommendations for

the segregation of transport modes first made by Alker Tripp who was the Assistant Commissioner of the Metropolitan Police (MWT, 1946: 26-30).

The guidelines were frequently referenced by a number of new land-use plans in many cities and towns. Besides the regulation of street classification, designs of ring roads and widening of arterial roads were advocated by these new plans emphasising the efficient access by car to the city centre (Hass-Klau, 1990). The ring road was positively recommended because it involved fewer intersections than alternative designs and would keep through traffic out of the central area (Plowden, 1972). The design of arterial roads which turned their buildings 'back to front', or even eliminated them, deployed wide green margins instead was given the character of 'parkways'. These wide roads were justified as the ideal model that greatly 'reduced both the quantity of accidents and the level of traffic congestion', which 'in turn bring economic gains' (Plowden, 1972: 146; Marshall, 2005). The system of arterial and ring roads had been planned in London by Patrick Abercrombie as the most well-known example. He suggested five ring roads for Greater London which he numbered from A to E by the distance to the centre. They were all arterial or sub-arterial roads except the D-ring planned as a motorway. The system would allow the inner areas called precincts to be 'free from the disturbance – noise, dust, danger etc. of the main route traffic' (Abercrombie & Forshaw, 1943: 51).

It was only after WWII, that the United States' models for road design became feasible in some British cities which had been badly damaged during the war. And these ideas and designs were not only valid for road planning, but also for urban renewal, which began to change most major British cities (*ibid.*). MacKay and Cox (1979) reveal that the concept that roads should be built to accommodate motor traffic was firmly established during that period. Tripp (1942) argued that two types of road should be built: the first type was roads which acted as traffic channels for long distance movement through the country, and the frequency of access should be reduced to a minimum; and the second type was roads meeting the needs of the local communities where pedestrian safety should be pursued as the priority. The idea of street classification was believed

to be the most important step in achieving traffic segregation by most planners who were highway engineers. In the 1950s, Tripp added heavy stress to the classification of roads by their functions and volumes. He argued that the roads should be designed into three categories:

Arterial roads for motor traffic only;

Sub-arterial roads for all types of traffic but dominated by motor traffic;

Minor roads for access to buildings, where pedestrians have the priority (Tripp, 1950).

He thought that road casualties or traffic intrusions could be reduced rapidly if sufficient roads were correctly designed and provided. He promoted the idea of turning existing arterial streets into segregated channels for motor vehicles and public access banned: 'Roads' ends need not be closed up with bricks and mortar; a row of posts will suffice for the present' (Marshall, 2005). Moreover, Tripp's hierarchical street system was in turn required by the accessibility consideration of motorist's needs, in particular, the micro-accessibility which refers to the possibility and ease of vehicles' direct access to buildings (Vasconcellos, 2001).

Buchanan redeveloped Tripp's principles in his report *Traffic in Towns* in 1963. The report paid more awareness to the long-term development of roads and traffic and their influence on the urban environment. It was implicit in the concept of building traffic-protected environmental areas with which boundaries would be defined by district distributors - the equivalent of Tripp's sub-arterial roads - were determined in hierarchy and connected with each other as the branches and twigs of a tree (Plowden, 1972). As well as the horizontal segregation of traffic flows, vertical segregation in some proper districts was also positively suggested in this report.

As mentioned before, the simple standards and design codes remarkably shaped the cities and suburban neighbourhoods. The hierarchical street model had already established a professional framework and a reference basis which seemed to be absolute and indisputable. The dominance of the traffic engineering profession continues today as the requirements of flow and safety are the aspiration entrenched in street design and planning (Southworth & Ben-Joseph, 2003). It is a logical response to exclusively focus on needs as a result of the technological revolution and

social competition inherent in the background of motorisation during the twentieth century.

2.2.3 1970s – today: the universal acceptance of the street design standards worldwide

Little literature referred entirely to the logic of the universal acceptance of the standardised model for street design, since the motives and physical conditions would vary from country to country. However, in reality, most of the world's modern cities, their streets and layouts, appear to be dramatically uniform with a combination of automobile-oriented traffic channels and traffic-protected blocks of buildings. The urban street seems to be exclusively designed for serving automobiles, speed and economic efficiency. The standardised model has not only shifted the construction of transport facilities, but also reshaped the physical environment in which millions of people live. In Los Angeles, for example, two thirds of the land in the city has been devoted to roads, parking lots and other vehicular infrastructure, half of which is consumed by streets and highways alone. This trend also extended to cities in developing countries (Table 2.5).

Table 2.5. *Road supply as a percentage of urbanised area in cities of developing countries, 1997-2001*

<i>City</i>	<i>Road space (%)</i>
Kolkata (India)	6.4
Shanghai (China)	7.4
Bangkok (Thailand)	11.4
Seoul (South Korea)	20.0
Delhi (India)	21.0
Sao Paulo (Brazil)	21.0

Source: Vasconcellos, 2001, Table 2.1.

Between 1940 and the late 1970s the scientifically-developed street standards were considered as the effective means to remedy the ills of modern cities and started to be deployed extensively and uniformly around the world (Banerjee & Baer, 1984; Southworth & Ben-Joseph, 2003). As mentioned above, the modern street design principles, such as a street classification system, were established rapidly through scientific research and systematic analysis. According to Miller McClintock (1926), the procedure usually included three steps: 1) observing current travel

behaviour and collecting traffic data to achieve a better understanding of the relationship between the street layout system and movement; 2) identifying the primary causes of the traffic problem by using the data, and then advancing a hypothesis and 3) the hypothesis can be tested and utilised to develop planning and engineering treatments.

These scientific processes were finally developed in the US in the 1950s under the heading 'urban transportation planning system' (UTPS), which was organised to forecast future transport demand and define the best ways of coping with such demand, and has been widely exported to developing countries for most major transport studies since the 1970s (Gakenheimer, 1993; Vasconcellos, 2001). Besides the steps described above, UTPS also assumes that it is possible to predict a balanced distribution of urban space at some future time by modelling and evaluating the selection of alternatives (Vasconcellos, 2001). Today, the UTPS may be seen as a 'scientific' method which prevails in developing countries. People cannot stop using this planning system before another survey or method has been proved to be more 'scientific' (*ibid.*).

In 1994 the International Code Council (ICC) was established as a single set of national and international model construction codes. By now, a set of codes, including the International Residential Code, the International Building Code and the International Zoning Code, was published by the ICC. Because the ICC is a non-profit organisation, its standards and model codes are embraced by communities worldwide, particularly the districts in developing countries lacking the financial resources to develop their own codes. Meanwhile, the International Organisation for Standardisation (ISO) also pays a great deal of attention to safer road standardisation.

These modern street design standards largely embedded in the main requirements of movement efficiency, road safety and economic feasibility are produced through scientific and empirical research based on modern techniques and traffic engineering requirements. These requirements generate speed-based standards and codes for *lane width*, *kerb height*, *visibility*, *junction geometry* and *segregation forms* (i.e. types of road segment), while the designed vehicle speed

largely depends on the certain hierarchical type and function of the road. Moreover, the other street components, such as frontages, height-width ratios, pavement materials and aesthetics-related issues are rarely mentioned since they seem to be less relevant to the demand for traffic ‘efficiency’. In order to achieve a critical understanding of the paradigm, the bias of traffic engineering in designing urban streets should be investigated and explained. Those efficiency-related design variables and the non-traffic considerations are therefore the key objects to be studied and discussed in the later chapters.

The engineered hierarchical system provides a standardised approach and paradigm for urban street design, allowing very few alternatives or exceptions, regardless of the various conditions of different cities. The reason why the standards have been universally accepted without variations should be considered as sound standards which are valued as the positive result of *scientific research and authoritative profession*, and thus can be safely copied and reproduced without any modifications (Ben-Joseph, 2005). The key reasons are:

First, during the last four decades, it has been a universal trend that, along with the worldwide steady growth and tremendous economic and technological success, the world’s cities are experiencing a dramatic growth of motor vehicle population. Based on forecasts of future urban traffic demand and the predicted trends of motorisation and encouraged by transport industries and local economic interests, growing sums need to be invested on new transport infrastructure and the reconstruction of the ‘out-dated’ urban traffic facilities. Under the threat of increasing traffic congestion and accidents, the international street design profession’s aim of improving traffic flow and safety is becoming one of the most important factors of modern cities worldwide (Vasconcellos, 2001; Plowden, 1972). The hierarchical model was, for example, initiated with the motivation of protecting pedestrians from motorised through-traffic. It was soon established as the indisputable standard in the vision of the ‘efficient city’ by traffic-engineering-based professions and today has been universally accepted by both developed and developing countries. It shows how the automobile-adapted space has turned out to be a model to be pursued

(Vasconcellos, 2001: 213). It enables networks and streets to keep the city and its suburbs free to provide more convenient traffic routes for motorists (Thomson, 1977).

Second, the desire to travel efficiently requires rigid and absolute standards that are based on the outcome of scientific engineering surveys rather than any other demands (Southworth & Ben-Joseph, 2003). The principle of scientific management captured the minds of business, industry and developers because it seems to apply calculated conduct and ensured economic profits (Ben-Joseph, 2005). On the other hand, practitioners of new professions, like urban planning and transportation planning, embrace science as a means of enhancing their professional status and claim to authority (Schultz, 1989; Scott, 1969). By embracing the possibilities offered by scientific techniques, highway engineers, as well as transportation planners, can develop their own sophisticated analytical techniques and use them to stake an early claim to apolitical expert status and develop a body of respected, scientific knowledge about the development of local and national transportation planning and policy (Kemp, 1986; Levin & Abend, 1971). They may then establish their profession as the acknowledged source of expertise on urban transportation (Brown, 2006).

Last but not least, there are some other aspects not directly related to engineering requirements that should also be addressed. In respect of profession, by virtue of being reproducible, a standard becomes widely adopted. Southworth and Ben-Joseph (2003: 139) summarise the process of street design standardisation by saying:

What began as visionary design with valid motivation has often evolved into a rigid, over-engineered approach. Once they are established, it is too easy to apply standards automatically.

Because of its 'nature of complexity' (Hass-Klau, 1990: 159), personal liability can be avoided safely by following the routine, even if accidental consequences occur (Ben-Joseph, 2005). As explained by Vasconcellos (2001: 214), much time can pass waiting to evaluate the planned or

forecasted practice and there is always a possibility of explaining any deviations from the expectation by a set of unexpected social and economic changes. Therefore, in a number of developing countries, it seems to be efficient and reasonable to import modelled procedures and technologies from foreign developed countries as standards for their domestic traffic planning and management without making proper adjustments for their own conditions. However, in certain countries, such as Morocco and Tunisia, European colonial power still has a strong effect on their spatial structure which includes the construction of street layouts and networks. In other cases, such as Egypt and Jordan, the funds for development are mainly supported by international subsidies and remittances from people working abroad. Their urban traffic forms are inevitably influenced by foreign-developed techniques and models (Vasconcellos, 2001: 211).

In terms of technology dependency, the basic techniques building our cities and streets have been universally improved, acquired and deployed through the modernism movement. The modern materials, equipment, requirements of urban infrastructures and methodologies for measurements and indicators, are all technology-dependent. The trend strongly related to the commitment to the automotive development model with a bias in favour of motorists occurring because the technology which supports walking and other non-motorised transport does not exist or is poorly developed (Vasconcellos, 2001). Traffic technologies which are internationally acknowledged and coupled with the regulated use of uniformly-designed automobiles, have been propelled as the modern street standards and models to universal acceptance. Furthermore, Newman and Kenworthy (1999: 286) point out that these mechanisms of urban transport systems and infrastructures have become established as professional praxis and manuals to be applied in every city as universal solutions.

2.3 CONCLUSION

Urban planning and design can be seen as a response to the forecast and prediction of future changes, with the aim of providing quality and healthy development in urban transportation. The standards are the set models for conducting and regulating the planning and design, because these models are considered as the outcome of empirical and scientific research and logical induction. Modern standards, embedded in the engineering profession are, however, rigid and indisputable, as they are regulated by precise statistical and geometric requirements. Therefore, new standards suitable to the new situations find it difficult to survive under the pressure of the old absolutist professions.

Against the background of global economic growth and urban motorisation, these street standards have to respond to the increasingly complex demands of travelling conditions. However, the procedure of standardisation has been strongly dominated by the train of thoughts of traffic engineering technology. Therefore, the rigid design standards were set to aim at efficiency and safety needs which arose from the emerging traffic problems of road casualties and growing demand for traffic growth, while the other 'less important' needs such as environmental qualities, local characteristics and sense of place - in short, the complexity and diversity - were neglected. These standards have been adopted worldwide and used to shape our cities, towns and suburbs. Numerous towns and suburbs have been unified with the 'modern' appearance. However, considerable debates on the street standards have been widely held in the second half of the twentieth century. A number of alternative standards and models have been tried, tested and implemented with more consideration on balancing such diverse needs as efficiency, liveability and sustainability

CHAPTER 3 NEW THINKING: AN ALTERNATIVE APPROACH TO URBAN STREET DESIGN

While standards can of course help prevent the worst conditions, they can also stifle creativity and inhibit adaptation to local situations. What began as visionary design with valid motivations has often evolved into a rigid, over-engineered approach. Once they are established, it is too easy to apply standards automatically (Southworth & Ben-Joseph, 2003: 139).

Since World War II, traffic engineers have taken the responsibility for reregulating urban streets and layouts to satisfy traffic demands. On the large scale, the predicted growth in car ownership and personal mobility will result in excessive land use for road provision. The present land use, in turn, stimulates the demand for private transportation. From a micro-perspective, the present urban streets and layouts are designed in a hierarchical structure which intends to facilitate the increasing vehicle journeys and separate the ‘slow’ travel modes (i.e. walking and cycling) from the ‘fast’ ones (i.e. automobiles). The engineering-based model has overly focused on individual issues of traffic flow and safety, but neglected the overall picture. It regards urban streets as nothing more than traffic channels - ‘a means of getting vehicles from one point to another’ (Ben-Joseph, 2005: 43).

Since the 1960s, there has been increasing criticism of conventional methods of urban street design. As a consequence, alternative practices have been gradually evolved and implemented. The urban streets, especially in residential areas, have been increasingly considered as multi-functional public places that serve diverse public needs. This classic traditional perspective on streets has been rediscovered as the new approach to remedy the automobile-oriented circulation environment and engineering-dominated design regulations of modern cities. This chapter identifies the obstacles and possibilities in shifting the conventional approach towards the new thinking about the ‘best practice’ in urban street design.

3.1 RETHINKING THE ENGINEERING CONVENTION

During the first half of the 20th century when the conventional paradigm was gradually formed and spread, the rigid and mono-focused street design standards have ultimately changed the circulation environment in many cities and suburbs. A majority of streets have been designed and implemented under the requirements of traffic flow and safety. Little consideration has been actually given to the diverse needs of other street users (CABE, 2008). The streets are no longer a place for social activities, but are channels for vehicle movement, barriers for pedestrians and threats to local residents. On the other hand, the automobile-dominated transport infrastructures in turn attract more motor traffic flows, which eventually result in more critical social inequity and environmental nuisance.

3.1.1 Traffic induction loop

The relationship between road transport and land use is referred to as a rather complex cycle (Stover & Koepke, 1988). Physical circumstances have enormous impacts on the mode and cost of travel behaviour. The type of local transportation facilities, in turn, greatly influences urban form (Kelly, 1994). Owen (1956) also believes that the form of the city and its land-use closely relates to the provision of transportation.

It had been recognised in the 1960s that building more roads was not ultimately helping the congestion situation (Hall & Hass-Klau, 1985). Known as the ‘law of congestion’, Downs (1962) illustrates that peak-hour traffic congestion on urban commuter expressways is induced to rise to meet maximum road capacity by a complex set of forces. As reported by the Tokyo Road Bureau (1969), for example, after extensive expressway construction in 1960s, “the arterial highways and roads encounter chronic traffic jams which will continue for a few years, which may cause the bottle-necking of economic growth and at the same time pressurise various aspects of people’s ways of living”. A similar situation was also found in Istanbul: “the renewal and improvement on

modern avenues only increases the volume of traffic on main thoroughfares and the spillover into streets not designed to handle modern vehicles and traffic volumes” (De Leuw Cather International Inc., 1968).

A model has been given by Barra (1989) to demonstrate the interactive nature of transportation system and land use. Examples of land-use and transportation planning decisions in Brazil are given in his book to support the model with feedback loops demonstrating the interaction between them. Mogridge (1990) formulates the proposition that *traffic expands to meet the available road space*. He also indicates that sometimes traffic congestion can be relieved by provision of new roads, but resumed within several weeks or months.

In the long term, the traffic induction loop can be one of the factors for extensive urban sprawling. Since the 1920s, the level of suburbanisation has been steadily rising and reinforced by the increasing car ownership and road supply during the second half of the twentieth century (Frumkin, 2002). The process is concisely introduced by Plowden (1972: 18) as below:

New roads will encourage people to live further from their work or from other place of activity, which means their journeys become longer and are less easily catered for by public transport. This kind of dispersal ... is very much encouraged by the tendency of development to take place either along the lines of new roads or at least in places convenient to them. As a result of all these tendencies, the attraction of owning a car, or the deprivation of being without one, is increased, so that car ownership is stimulated. Finally, increased car ownership itself leads to increased travel.

The transportation priority, according to Newman and Kenworthy (1999), is one of the dominant factors that have shaped cities. In their early studies, the manifest positive correlations among car ownership, rate of private trips and land-use, e.g. road and parking supply, had been demonstrated (Table 3.1). It shows that the automobile priority in a city can strongly influence the choice of travel mode and the changes in road layouts and conditions. Consequently, once

new infrastructure was sufficiently deployed and road capacity was improved, more motor traffic would be attracted even before the congestion and accidents could be eliminated from the cycle (Hass-Klau, 1990). Figure 3.1 summarises the effect of traffic induction cycles on people's travelling and living behaviour in the short, medium and long terms. The cycle indicates that the road demand-supply chain can eventually reorganise the existing land-use allocation.

Table 3.1. *Correlations between the transport variables (part B)*

	Car ownership	Private car (pass. kms per capita)
Road supply	+0.7026 s=0.000	+0.7854 s=0.000
Central city parking	+0.5271 s=0.001	+0.5574 s=0.001

Source: extracted from Newman & Kenworthy, 1989: 46.

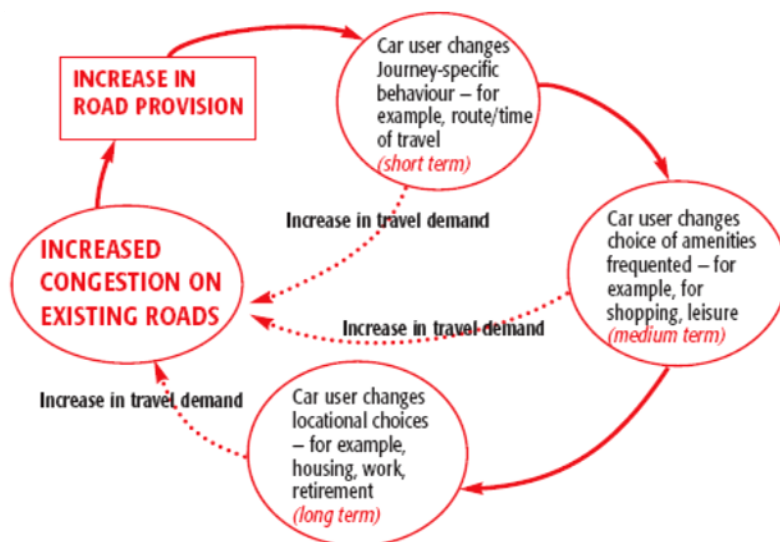


Figure 3.1. *The basic traffic induction loop*

Source: European Commission, 2004: 19.

3.1.2 Identified issues

Vasconcellos (2001) suggests that there are six objectives to be pursued in urban circulation: *fluidity, safety, accessibility, public transport, cost and environmental quality*. People play a variety of roles in daily travelling with changing needs in time and space and the diversity can be multiplied by the increasing number of activities and roles. Therefore, traffic rules and

management should have to be provided to manage the conflicts, as well as the planning and construction of the streets and roads (*ibid.*). However, it is apparent that the conventional approach mainly responds to the demand for greater capacity and safety other than for diversity.

The gap in understanding road accident rates

Recently, in a majority of developed countries, a decline in road fatalities has been observed (Figure 3.2). However, it is difficult to claim a correlation between road casualties and the increased road supply and capacity. With the improved first-aid techniques, medical-care, safety education, strict traffic control and the significant decrease in non-motorised traffic, it is easy to come to a false conclusion that the risk of traffic accidents has been reduced (Vasconcellos, 2001). CABA (2008) argues that it is not reasonable to use the accident rate as the only indicator for road safety, because it is possible to make roads appear to be safer by discouraging vulnerable users. In the UK, for example, despite the lower road casualty rate, the levels of walking and cycling are also lower than elsewhere.

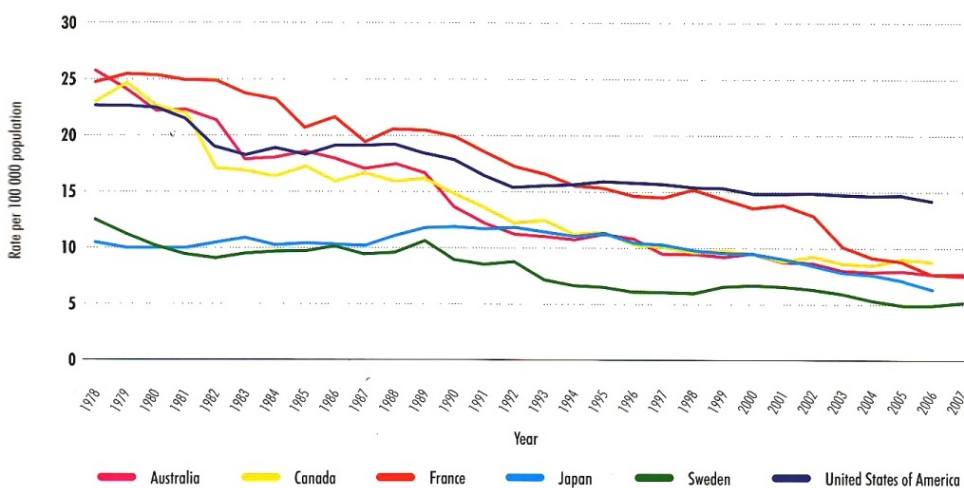


Figure 3.2. Trends in road traffic fatality rates in selected high-income countries

Source: WHO, 2009, Figure 4.

First of all, the travellers in automobiles have been given priority because they are much better shielded and protected than pedestrians and cyclists (Plowden, 1972). According to the World

Health Organization (WHO) (2009), pedestrians, cyclists and travellers using motorised two- or three-wheelers are vulnerable road users who account for almost half of global road traffic deaths. This group of road users has to be more at risk than those in protective vehicles. It seems that only the safety of motorists had been addressed directly. For example, a survey on independent mobility of English junior school children by Mayer Hillman in 1993 illustrated a significant decrease in children with independent mobility in a number of English cities between 1971 and 1991. This was the time when the standardised streets were pervasively implemented, whilst the rate of car ownership had increased by less than 10%. This implies that urban roads and streets had not become safer for children and their needs in traffic had been radically ignored. Moreover, vulnerable road users may have to take additional risk as their needs are not considered during the land-use planning or road design (WHO, 2009). This is particularly true for vulnerable road users in developing countries. The auto-oriented travelling environment is *unsafe in any place*. The built environment is hence *pedestrian-hostile* (Vasconcellos, 2001: 206).

Spatial inequity

The conventional street systems often require large and dispersed space to facilitate higher-level traffic volumes and provide adequate parking lots, which not only results in auto-oriented special distribution, but also adds inconvenience to the mobility and accessibility of non-motorised travellers. In terms of special arrangements of streets, increased road space is dominated by automobiles by compromising the space for other functions, which raises a major concern over spatial equity issues (Appleyard, 1981; Hillman, 1988).

Vasconcellos (2001) believes that the use of space is a key component for examining the equity of urban transport. The consumption of space can be measured by the unit of ‘space × time’ (i.e. ‘m² × hour’). The private car is considered as the most demanding transport mode in terms of space. Research indicates that a journey to home by car demands 90 times more space than the

same journey taken by bus, tram, or walking (European Commission, 2004) (Figure 3.3). Spatial inequity by transport modes is also reflected in the difference in family incomes. The case of Sao Paulo in Brazil shows the ratio between the lowest and highest income levels to be almost 1:9 (Figure 3.4).

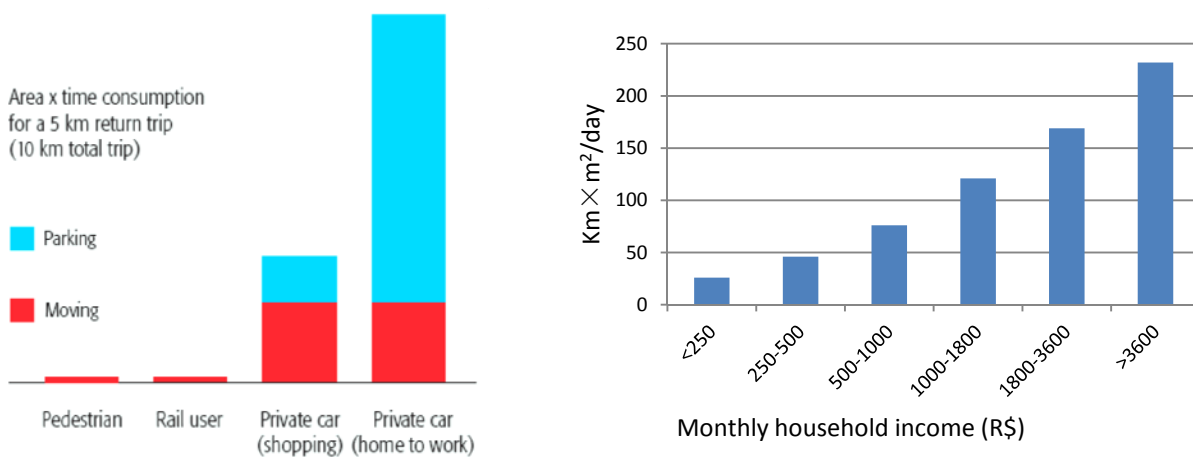


Figure 3.3. (Left) *Consumption of urban space by different transport modes*

Source: European Commission, 2004: 15.

Figure 3.4. (Right) *Daily dynamic family space consumption and income, Sao Paulo, 1997*

Source: CMSP, 1998; Vasconcellos, 2001, Table 14.5.

The auto-oriented large and dispersed road arrangements can often result in excessive space for carriageways which become barriers to non-motorists. For example, a widened carriageway is often applied at the expense of sidewalks and cycling lanes, which squeezes pedestrians into a narrower space and increases the distance for crossing. Khayesi (1997) argues that because of the absence of adequate pedestrian facilities and little regard for the vulnerable road users' right of way, which forces pedestrians to undertake risky activities to cross streets. In the cases of pedestrian bridges and underpasses, they are safe enough to separate the pedestrians who are crossing the roads from motor vehicle fleets, but they add considerable inconvenience to the cyclists and the disabled, since few of them served the vulnerable users well. In addition, the micro-circulation environment oriented by automobiles increases the burden of responsibility on other street users, particularly parents who have to take their children off the street to reduce their exposure to accident risk (Hillman, 1988; Whitelegg, 1993).

City ‘erosion’

Streets play an important role in shaping local character and sense of place. The local streetscape, as a result of good street design practices, should respect a district’s historic context and encourage visual enjoyment for walking and cycling, however this has been rarely achieved (DfT, 2007). Southworth *et al.* (2003), Jones *et al.* (2008) and CABE (2008) argue that a street design should not only focus on road capacity, but also on the other street activities which create a good-quality urban environment, such as socialisation, communication, pedestrian amenity and visual aesthetics. Those activities are not often encouraged by the conventional circulation environment. Concerning the safety issues, the mixed traffic seems to be inherently dangerous to pedestrians. Therefore, it seems to be better to keep pedestrians completely separated from motor traffic flows (Buchanan, 1963). It is frequently said that cities are disturbed by motor vehicles and the consequences of *arterial ways, parking lots, gas stations* and *drive-ins*, are powerful and insistent instruments that lead to city destruction (Jacobs, 1961: 338).

The automobile-oriented street system is eroding the city amenity little by little. For a specific example, visibility splay is required in designing a junction to ensure there is adequate inter-visibility between vehicles on the major and minor arms (Department for Transport, 2007: 92). Visibility should not be obstructed within the shaded area of the plan (Figure 3.5). The distance for X and Y mostly depends on the speed of vehicles on both arms. The higher the speed allowed, the larger the shaded area required. In this geometric regulation, the shaded area must not be occupied by any objects considered as visual obstructions. Figure 3.6 shows a comparison of the intersections in Market Street in San Francisco between 1937 and 1992 - the corners of building frontages were replaced by ‘non-obstruction’ as the result of the visibility requirement. As described by Allan Jacobs (1993), for the experience of a pedestrian, this street has been transferred from the great parade of shops to the prosaic desert. Social interactions are difficult to generate in these unattractive corner sites.

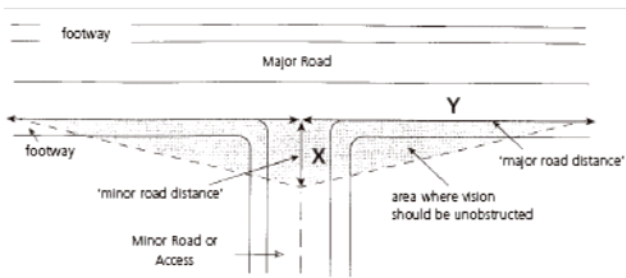


Figure 3.5. *X and Y dimensions on a highway junction*

Source: ODPM, 1998: 58.

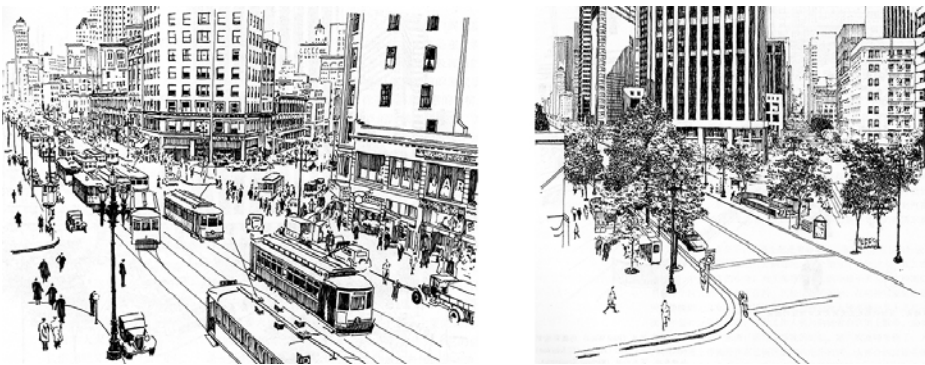


Figure 3.6. *The decline of the corner buildings in the auto-oriented street patterns - Market Street in 1937 (left) and 1992 (right), San Francisco*

Source: Jacobs, 1993: 83-84.

The required instruments and infrastructure for fluid motor traffic flows also result in abundant clutter and the decline of visual aesthetics. While the vehicle right of way is elaborately facilitated at a high standard, the sidewalks are not actively managed (Hebbert, 2005). The recent English Heritage survey of several London streets shows that, for instance, over 70% of the clutter of traffic signage, bins, bollards, guard rails and street furniture was found to be *unnecessary, duplicated or redundant* (English Heritage, 2000: vi). In addition, these instruments lead to the uniformity of clutter in auto-oriented cities. *Lined with barriers and retrofitted with the giant standardized signage of arterial routes, the urban streetscape viewed through the car windscreen begins to resemble any other part of the intercity road hierarchy* (Hebbert, 2005: 45-46).

These facts of 'city erosion' have been described by Jane Jacobs (1961: 353) who argues that

these consequences of over-dependence on vehicular traffic, such as erosion, *subtract reasons for using an eroded district and at the same time make it less lively, less convenient, less compact, less safe, for those who continue to have reasons to use it. The more concentrated and genuinely urban an area, the greater the contrast between the smallness of what is delivered and the significance of what is lost by the process of erosion.*

The neglected groups

For the last 60 years, most streets have been designed with the needs of drivers and motor traffic put first. According to this way of thinking, a ‘good’ street is one that helps make driving easier and vehicle journey times shorter. The needs of people who want to use streets in other ways – for instance for walking, shopping, cycling, pushing prams, using wheelchairs, playing, or sitting and watching the world go by – have been given relatively little consideration (CABE, 2008: 2).

As mentioned before, the needs of pedestrians and cyclists are neglected by the conventional design concept and standards. The conventional travelling environment is built to optimise the level of motor vehicular flow for higher speeds, the pedestrian and cycling movement is therefore restricted due to the lack of consideration. The restrictions on pedestrians and cyclists, who should have an equal priority to travellers by motor vehicle, can be attributed to the lack of ensured road safety and convenience.

The fact is that the most vulnerable road users, such as children, the elderly and the disabled, were forced out of roads by the more powerful groups, like automobile users, and the ‘pedestrian-free’ circulation environment that catered for the increasing flow of motorised traffic (Vasconcellos, 2001). The existing loop of land-use and car ownership implies that automobile-oriented traffic facilities would encourage the consumption and use of the car, which has resulted in the deprivation of other road users, especially the most vulnerable ones. Plowden

(1972: 26) explains the tendency to focus attention on the most prominent parts of any complex problem:

Traffic jams are headline news, but the decline [in] cycling is not. The eye is more naturally drawn to a long line of stationary vehicles than to a group of people waiting patiently at a bus stop or trying to cross the road. People who do not travel are the least conspicuous of all. There may be many people ... who would like to travel but are deterred by the decline in services or by the physical difficulties involved, but no attention has been paid to their problems.

3.1.3 Criticisms of the conventional approach

The conventional street design standards were based on the concept of traffic segregation by different types of traffic flows with the objectives of promoting traffic flow and safety. Ben-Joseph (2005) makes great criticisms of the conventional street design standards (the ITE standards, for example) and principles which have over-focused on creating fluid and safe vehicular movement. This international phenomenon can be attributed to the traffic engineers' strong belief in modernity and robust design solutions. This narrow focus on the scientific facts of traffic sustains professional rigidity and ignorance of the negative effects of the resulting transport system on non-motorists and public transport passengers (Brown, 2006).

Above all, the effectiveness of the conventional approach in dealing with the issue of traffic flow and safety has been re-examined. Albeit the conventional hierarchical system has been seen as the scientific means to cope with the increasing congestion and accidents, the system has inherent deficiencies. There are numerous examples of hierarchical structures in both nature, like a tree, and man-made instruments, such as a drainage system. However, Alexander (1965) demonstrates in *A City is not a Tree* that both have the structure in which no one part is ever connected to another. They are one-to-many and many-to-one flow structures, while traffic is a many-to-many

flow. Therefore, the same idea of hierarchy is not necessarily logical in organising urban circulations.

First, the hierarchical system often requires a sparse pattern of streets, which limits the range of choice of traffic routes. Jiang (2009) indicates that 20% of the streets that are well connected in the hierarchical system often accommodate 80% of the traffic flow and only 1% of the streets that are extremely well connected account for more than 20% of traffic flow. In the sparse network, a single-destination journey by a car can often have only one available route to choose. Within the one-way control or left-turn / right-turn restriction, the choice would be extremely limited.

Second, the intersections are inevitably the obstacle to the efficiency of the hierarchical system, as its advocates expected. Intersections that are shared by two surface streets cut their capacity in half immediately. Thus, increasing the scale of arterial roads does not imply a higher capacity to accommodate traffic flows, rather they become less efficient with the increase in size because of the further share of left- or right-turns which need extra intersection signal waiting time (Kulash, 1990). Unfortunately, when congestion occurs at the intersection, drivers have no choice other than being patient because of the first reason. Compared with the dense and flexible traditional street patterns, the 'scientific' patterns do not often have the claimed advantage of 'efficiency'.

As indicated by Marshall (2005), the gap in the conventional hierarchy is that it imposes an artificial relationship between 'mobility' and 'access' which appear to be two dimensions, but are bound together in a single, inverse relationship. This means that any street that does not fit this 'idealised' relationship would not be encouraged by this convention (Figure 3.7). It results in a deficiency in the classification of streets which cannot therefore represent the actual street types of today's aspirations.

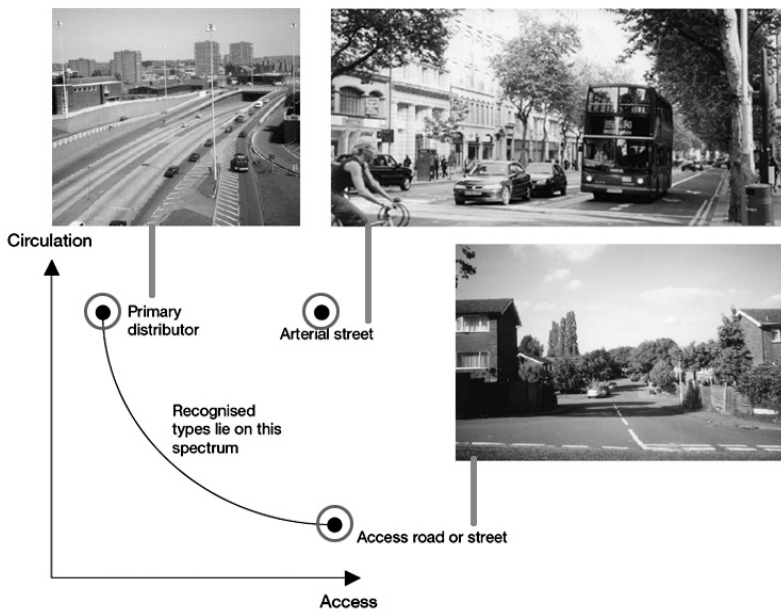


Figure 3.7. *The conventional classification spectrum* - the traditional arterial street does not lie on the spectrum from primary distributor to local access road.

Source: Marshall, 2005, Figures 3.5 & 3.6.

The conventional engineering approach with its inherent deficiencies can be criticised for its failure in dealing with the whole mixture of urban life. This might stem from the inverse relationship between movement and place imposed by modernism. Although some standards may have claimed the importance of environmental and social issues in street design, they inevitably give prior consideration to traffic fluidity and safety in most intentions. For example, Buchanan (see Section 2.3.2) emphasised the urban environmental quality as the starting point in *Traffic in Towns*, with traffic in a subservient role. But despite this good intention, it often appears to be motor-traffic-dominated outcomes that are presented as a vision in *Traffic in Towns* (Figure 3.8) (Marshall, 2005).

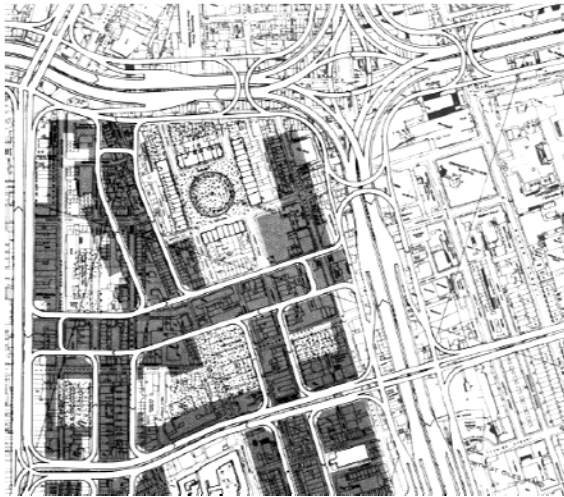


Figure 3.8. *Inner London transformed*. In this illustration from Buchanan's *Traffic in Towns*, 1963, the north-south commercial street - Tottenham Court Road - is replaced by a multi-lane motorway, severing the Fitzrovia district (west) from Bloomsbury (east).

Source: Marshall, 2005, Figure 1.1.

The absolute rigidity of engineering conventions might be one of the technical barriers to the integrative thinking approach to street design. For example, one of ITE's publications – *Recommended Practice for Subdivision Streets* - stated “Although it is extremely important that sound standards be followed in the layout and design of neighbourhoods and of neighbourhood street systems, it is equally important that there be room for variety, experimentation and improvements in residential design” (ITE, 1967: 6). The document used figures and measurements to explicate detailed requirements as rigid as:

Right-of-way: minimum 18.3 m;

Pavement width: 9.8 – 10.4 m;

Sidewalks: at both sides, minimum width 1.5 m;

Planting strip: 1.8 -2.1 m, sloping toward street;

Cul-de-sac: maximum length 305 m, with 15.25 m radius at end;

Parking lane: 2.4 m;

Driveway: minimum width of 3 m for one car, with 6 m wide curb cut and 1.5 m flare at each side.

These rigid standards and geometrical configurations remained unchanged from 1965 to 1984. Only a slight revision was made in the 1990's version of *Guidelines for Subdivision Streets*.

Another example is the UK's document *Design Bulletin 32* (DB32) which was originally published in 1977, revised in 1992 and superseded by *Manual for Streets* (MfS) in 2007. The lack of flexibility also resists the diverse demands of daily travelling. Whilst DB32 contains some principles relevant to new thinking, many of them nonetheless place a strong emphasis on the needs of motor vehicles and traffic flows. Although one of the later companion documents, the technical requirements of *Places Streets and Movement* (ODPM, 1998), has sought to revise this rigidity and encourage a more flexible interpretation of DB32, the prescriptive nature of much of its content makes the task difficult (Department for Communities and Local Government, 2006). However, its successor, MfS, remains the principal source of numerical standards and measurable criteria. Thus, the dominant mode in practice is still inspired by DB32. It also focuses more on residential streets with minor traffic thereby allowing the gap in detailed guidance for the design of streets with heavier traffic to remain (Jones, 2008).

3.2 ALTERNATIVE DESIGN PRACTICE OF URBAN STREETS

A number of factors mentioned in Chapter 2 can be regarded as the drivers for automobile dependency and the universal adoption of the conventional standards. Those factors place obstacles in the way of developing an alternative practice in urban street design. Although the conventional approach has been widely debated and criticised since the 1960s, its impact on the urban circulation environment can hardly be overlooked on either large or small scales.

As well as the inherent defects of engineering convention, the importance of social equity and environmental quality has been increasingly recognised since the 1960s. The advance of new technology and rising public awareness have provided opportunities for new thinking and alternative practices in urban street design (Monheim, 1994). Increasing concerns have been voiced to reduce the dependence on automobiles and encouraging 'greener' transport modes,

which necessitate new paradigms that can cope with the whole picture of the urban circulation environment.

3.2.1 Challenges of implementing alternatives

The irresistible use of automobiles or ‘automobile-dependency’ might be the main support to the conventional approach in design practice for urban streets. For example, by replacing the automobile trips by bus or other travel means, the middle-class family who highly relies on automobiles will not be able to make its time schedule feasible, which is not acceptable (Vasconcellos, 2001). Vasconcellos (2001: 156) stresses the power of ‘class decision’ in automobile preference in developing countries. The decision to buy a car is believed necessary by the middle class to maintain their status and social mobility that clearly separates them from the working class. Moreover, the automobile is used as the class symbol that has been reinforced by the lack of alternative travelling choices in urban areas. Considering the existing sparse spatial patterns and poor supply of public transport, private motorisation is the only means that can efficiently cope with the busy middle class lifestyle. Due to the auto-oriented circulation environment, the reduction in social interaction and in the right to use streets as a public space has significantly impacted on children and youngsters. From an early age, they are informed that street space does not belong to them or the public but to motor vehicles. It will impose a behavioural pattern that will last for their lifetime. This fact would reinforce the culture of embracing the auto-oriented environment and society (*ibid.*: 184).

Many early research studies show a significant association between urban structure and travel behaviour. This is proven and clarified by the latest research at a range of scales (Newman & Kenworthy, 1989; Ewing, 1995; CfIT, 2009). Many decision makers, such as traffic engineers, transport planners and government officials, are strongly attached to the ideology and lifestyle of the dominant class. The built environment is, therefore, produced by a combination of the

dominant interest and professional support (Ball, 1986). Due to the long-term effect of the traffic induction loop, auto-dependency can be underpinned by the revised urban spatial organisation. Newman (1989) shows the significantly negative correlation between car ownership level and density level in urban areas. The lessons of suburbanisation in the US also send out a warning against the reinforced relationship between auto-dependency and urban sprawl. Once the auto-dominated urban spatial organisation has been physically established, dependency on cars can hardly be released.

Another major concern of new practices is whether they would incur a liability in the occasion of damage or injury when considering a design that is inconsistent with established standards (DfT & CLG, 2007). Since the requirement of fluidity and safety is still pursued as a priority, the planning and design standards adopted by traffic engineering professionals can hardly be easily replaced by any new approaches. According to Vasconcellos (2001: 66), *conventional traffic engineering has already developed sophisticated methodologies to deal with road capacity problems in which analysis refers to vehicle rather than people*. With these street standards sanctioned by the professionals, new standards (or even modifications) have been restricted and very slow to develop (Ben-Joseph, 2005).

According to a recent nationwide survey in the United States, the main obstacles consist of liability concerns and legal issues. Engineering and public agencies often hesitate to adopt new practice schemes due to the fear of lawsuits by drivers, passengers or pedestrians. The survey believes that these two issues can be seen as the most important drawback to new alternative practice and traffic-calming management (Southworth & Ben-Joseph, 2003). Planners and developers were obliged to follow local highway requirements; otherwise the designed roads would fail to be adopted by the local authority. The standards imposed by local authorities which allow little flexibility have been profoundly embedded in engineering conventions, as well as in the legal and financial structures, resulting in a visible similarity of developments that are unresponsive to their users, landscape and historical contexts (*ibid.*).

On the other hand, the established profession with the rigid and absolute standards and terminology provided by traffic engineers allows little room for new thinking or practice. Since there is a lack of compelling reasons from advocates in national governments; local governments or public agencies are reluctant to initiate changes (Ben-Joseph, 2005). Risk and liability concerns can lead to an over-cautious approach, where designers have to strictly comply with the standards in spite of their suitability and innovation. They discourage the creation of distinctive places that sustain thriving communities (DfT, 2007).

Nevertheless, according to a survey by the UK Roads Board in 2005, most liability claims against a highway authority were for maintenance deficiencies, while claims for specific design defects were rare. In fact, innovative and context-specific design that does not comply with conventional standards can achieve high levels of safety (DfT, 2007). However, it is still difficult to claim that design is an important factor for liability concerns in terms of road safety, since all of the new streets were supposed to be highly standardised.

3.2.2 Aspirations for new visions

As mentioned before, there are increasing criticisms of automobile-dependent cities and pressure on the over-motorised traffic flows and limited choices of travel modes. Newman *et al.* (1999) systematically summarised the most common comments on the shortcomings of these cities. Increasingly countries have shown their interest in the idea of sustainable development with the objectives of reducing car use and improving the urban living environment.

Since the traffic problems can hardly be solved by the conventional demand-supply approach which has failed in thinking the overall picture, an alternative approach should be practised and tested (Figure 3.9). The loop of automobile dependency and land use needs to be broken by shifting the reason for existence of streets from automobiles to people. “The basic value of

vehicles is the people and goods within them; and all the benefits of vehicle flow are the ability of those people and goods to access their required destinations” (Marshall, 2005: 195).

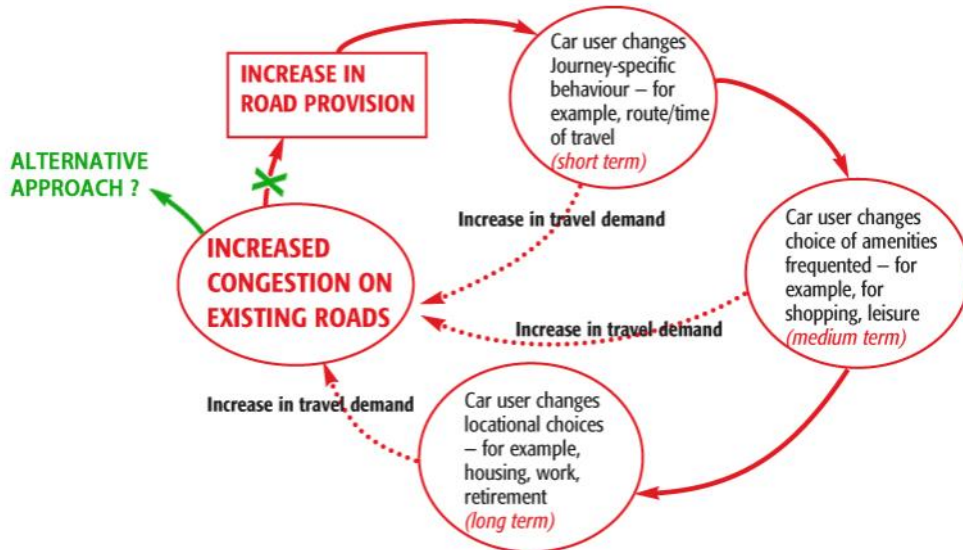


Figure 3.9. Interrupting the traffic induction loop by employing alternative approaches

The vocabulary for the new vision of urban streets has gradually arisen as a protest to the use of engineering terminology. The vision for ‘new’ streets, including the expressions *democratic*, *liveable*, *civilised*, *green*, *quality*, shows a very positive attitude to the changing role of urban streets (Francis, 1987; Hass-Klau, 1992; CABE, 2002; Southworth & Ben-Joseph, 2003; DfT & CLG, 2007). An underlying shift in the way that streets are thought about and designed is underway. Many policymakers have recognised that this traffic-centred and auto-oriented conception of streets can result in the creation of ‘dysfunctional places’. The social, environmental and economic value of the pre-twentieth century role of streets, as places for social activities, playgrounds for children, as well as conduits for traffic, is being rediscovered. The positive relationship between link/movement and place/access functions is recognised. Urban streets can be alternatively classified by a two-dimensional matrix so that all kinds of urban streets can find their place in the new method of classification. By emphasising this, a street plan can be more inclusive in its consideration of the form, layout and surroundings than the conventional street network or land-use plan (Jones *et al.*, 2008).

According to Ben-Joseph (2005), the contents of a standard can be either text- or numerical/graphic-based, on the one hand, and guideline- or specified-regulation-based, on the other. The conventional street design standards typically consist of specified regulations in which a certain type of street has been articulated by the given physical feature and a range of rigid dimensional requirements. Southworth and Ben-Joseph (2003; 2005) suggest the introduction of ‘performance standards’ which are mostly text-based guidelines to street design. Ben-Joseph (2005: 98) adds that the development of such performance standards, together with “innovative accountability approaches”, would provide the tools for local authorities or public agencies that are willing to develop alternative circulation systems.

In the UK, MfS emphasises the principle of inclusive design of streets and great flexibility in practice, and encourages a better balance between the functions of place and movement in local streets. Inclusive designs of urban streets which provide for all people regardless of age or ability is highly valued (DfT & CLG, 2007: 63; CABE, 2006). In 2010, a companion guide to MfS, *Manual for Streets 2*, was published by the Chartered Institution of Highways and Transportation (CIHT) to provide wider applications of the principles beyond residential streets, so that the inclusive street design can provide pedestrians, cyclists and public transport users with their needs for safety and good quality walking and cycling environments in both urban and rural situations. It is equally important in the discouragement of car use and reduction in street crimes, which requires developers to ‘design out’ crime and ‘design in’ community safety at the earliest stages. CABE (2006) defines that the aim of inclusive design should be addressed in removing barriers and enabling everyone to *participate equally, confidently and independently* in everyday activities.

New local street design guidance is emerging globally in many cities, towns and villages, such as the *Street Design Manual* for New York City, *Street Design Guide* in Leeds, *Street Design Guidelines for Landcom Projects* and the Kent Downs’s design handbook for *Rural Streets and Lanes* (New York City Department of Transportation, 2009; Leeds City Council, 2009; Landcom,

2006; Kent Downs AONB Unit, 2009). These design guides strongly adapt to local distinctiveness and features and, in practice, incorporate local details within inclusive design principles. They can be regarded as good examples that succeed in determining the balance between the principles and flexibility given by new guidance and standards at the national level.

3.2.3 New practices

During the last five decades, a number of alternative approaches had been initiated and practised, contributing to the increasing needs for sustainable redevelopment, particularly with the consideration of reducing car use, encouraging green transport modes and improving local character and the quality of the urban environment. The new approaches ranged from street design to traffic management and, in some cases, were incorporated in local transportation policies as integrative solutions to traffic problems. The approaches involving modal shifts in design, regulation and management of parking control and road pricing, etc. have an impact on the vehicle-movement-oriented conventional paradigm.

The travel-mode-focused solutions, such as pedestrian-oriented development (POD), transit-oriented development (TOD) and cycling policies, are often applied as approaches redressing the problems derived from the high dependence on automobiles in modern cities. They require a mixture of land-use policies and physical-design principles, including mixing land uses, improving the quality of walking and cycling environments and encouraging street life (Ewing, 1999; Federal Transit Administration, 2002; New Hampshire, 2008; Golbuff and Aldred, 2011). Those solutions have been widely applied in American and European cities and fully recognise the needs of non-vehicular movement in urban circulation and non-traffic activities in urban streets.

Early 'new' practices

In terms of urban street design, particularly in residential areas, early 'new' practices such as traffic calming management and the new urbanism design movement have been implemented and tested (Hass-Klau, 1990; Newman & Kenworthy, 1999; Southworth & Ben-Joseph, 2003). Although those practices have partially succeeded in reducing traffic accident rates and traffic demand, they are heavily contested for some limitation.

Traffic calming refers to a combination of road design approaches to reduce the negative effects of motor vehicle use, such as restricting the motor traffic speed and volume and improving the conditions for non-motorised street users (Lockwood, 1997). Hass-Klau (1992) and Litman (1999) summarise a set of common traffic calming strategies and devices with illustrated implementations in both arterials and local streets. Figure 3.10 shows some typical examples of traffic calming solutions by physical revisions in street forms.

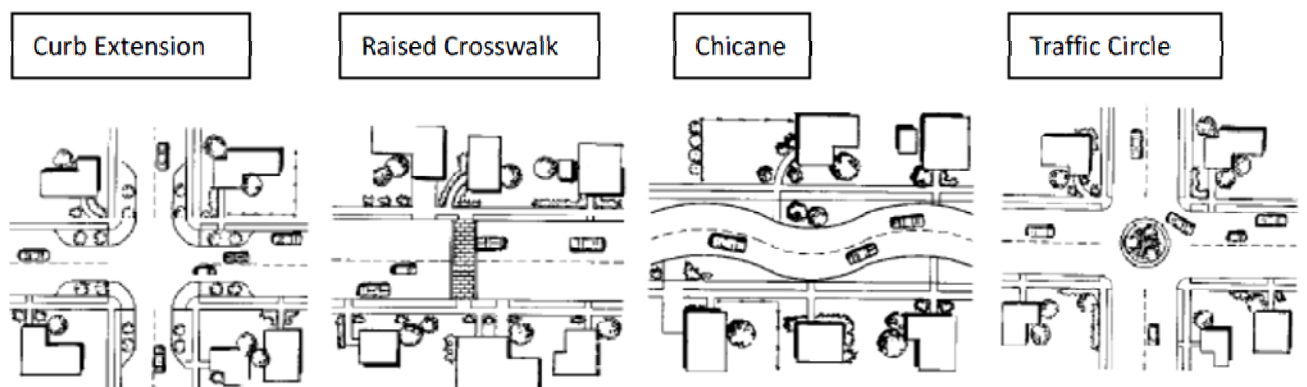


Figure 3.10. *Four typical solutions for traffic calming in neighbourhoods*

Source: Pay Noyes and Associates, 1998.

Empirical studies indicate that traffic-calming projects have significantly reduced traffic accident rates and severity (Clarke, 1994). Reduced motor vehicle speeds and volumes enable a safer and more relaxed community for walking and cycling. The traffic-calming-related street design features have been highly valued by non-motorists (Litman, 1999; Carlson, 1995). However, traffic calming has a number of limitations and fails to solve the real problem: reducing the traffic

volume. Traffic calming on one road can result in a shift or ‘spillover’ of vehicle flows to other roads, which would revert to the problem experienced in the conventional traffic model (Atkins & Coleman, 1997; Pay Noyes and Associates, 1998; Litman, 1999). Furthermore, the implementation of traffic calming measures can be expensive (e.g. Chicane, Raised Intersection, Traffic Circle), often following the further costs of education and enforcement in changing the behaviour of drivers.

While traffic calming in European cities was practised as the remedy for their urban ailments, the parallel pastiche of neo-traditional non-orthodox highway designs was evolved in a number of American cities (Hebbert, 2005). New urbanism design schemes are in favour of the street network characterised by high density, mixed-use, accommodation of non-motorists and a more interconnected pattern of streets, which is more-or-less learnt from the traditional patterns of ‘walk-able’ neighbourhoods and cities and alternatively tagged as neo-traditional design (Southworth & Ben-Joseph, 2003). To some extent, new urbanism schemes in urban street design are a composition of traffic calming strategies, but more focused on the overall network than specific devices or managements. Marshall (2005: 36) suggests that new urbanism intends to represent its vision as a kind of ‘integrated grid network’ that differs greatly from the conventional ‘hierarchical network’. With the intended interconnection of streets, new urbanism practice provides much more route choice for trips than the conventional model.

Aside from the United States, new urbanism approaches in neighbourhood design have brought innovative efforts to create interconnected street patterns and achieved great success in revising the standardised street design regulations in many developed countries (Southworth & Ben-Joseph, 2003; Marshall, 2005). A study by Khattak and Rodriguez (2005) shows that the new urbanism neighbourhood tends to have a significantly lower automobile trip rate (by 1.6 trips per day) than the conventional one, as well as a lower daily vehicular travel distance (by 14.7 miles fewer on average). It also demonstrates a great possibility of increasing independent mobility of children in neo-traditional neighbourhoods. However, Marshall (2005) points out that

new urbanism development does not strictly follow the structure of traditional street patterns. Southworth (1997) illustrates that some designs still resemble conventional automobile-oriented suburbs with large proportions of crossroads and *culs-de-sac* (Figure 3.11). On the other hand, one of the new urbanists' propositions is a "permeable" street network - the route options offered by the grid traffic in favour of "dispersing vehicular flows rather than forcing all traffic onto increasingly crowded arterial streets" (Morris & Kaufman, 1998: 210). Brindle (1995: 9.8) and Marshall (2005: 38) indicate that this "permeability" has oversimplified the dynamics of traffic networks and "it has generated mischievous theories about the ideal structure of networks".

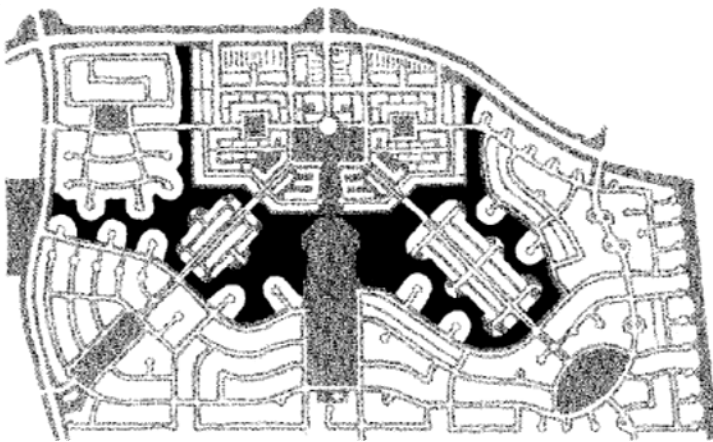


Figure 3.11. *Laguna West*, a neo-traditional project begun in 1990 - the layout of streets in this plan shows abundant *culs-de-sac* and crossroads.

Source: Southworth, 1997, Fig. 17.

Current design practices

Alternative design practices, such as 'shared streets/space' and 'context-sensitive design', are gradually evolving in developed countries (Hass-Klau, 1992; Southworth & Ben-Joseph, 2003; European Commission, 2004; Hickman & Cason, 2006; Transportation Research Board, 2006; CABI, 2008). The fundamental concept is one of integration where pedestrians, cyclists, children at play, parked cars and moving automobiles all share the same street at the same time, emphasising the equality of all users rather than separating them into different traffic flows. The

design approach also shows great respect for local urban contexts and natural features. It regards urban streets as essential places reflecting local characteristics, history and landscape, emphasising a strong relationship between streets and surrounding buildings and land use. The following paragraphs introduce some specific recent schemes for urban streets in the UK as examples of good design practice in a range of scales.

The new scheme for Kensington High Street (London) can be a good example of inclusive design on a small scale. It was originally designed under the conventional traffic-centred principles. The street was streamered to separate motor traffic into lanes, which generated two islands in the street which resulted in three separate crossings for pedestrians. Safety railings were placed on the edges of islands to keep pedestrians in their place. In the new design scheme, the triangular island was removed to enable pedestrians to cross the street in one single operation without any frustrating diversions, while the traffic flows were kept the same. The guard railings were therefore removed to make the streetscape more legible and less cluttered for both drivers and pedestrians (Figure 3.12). As a result, the new scheme has proved to be safer without compromising the road capacity (Davis, 2008).

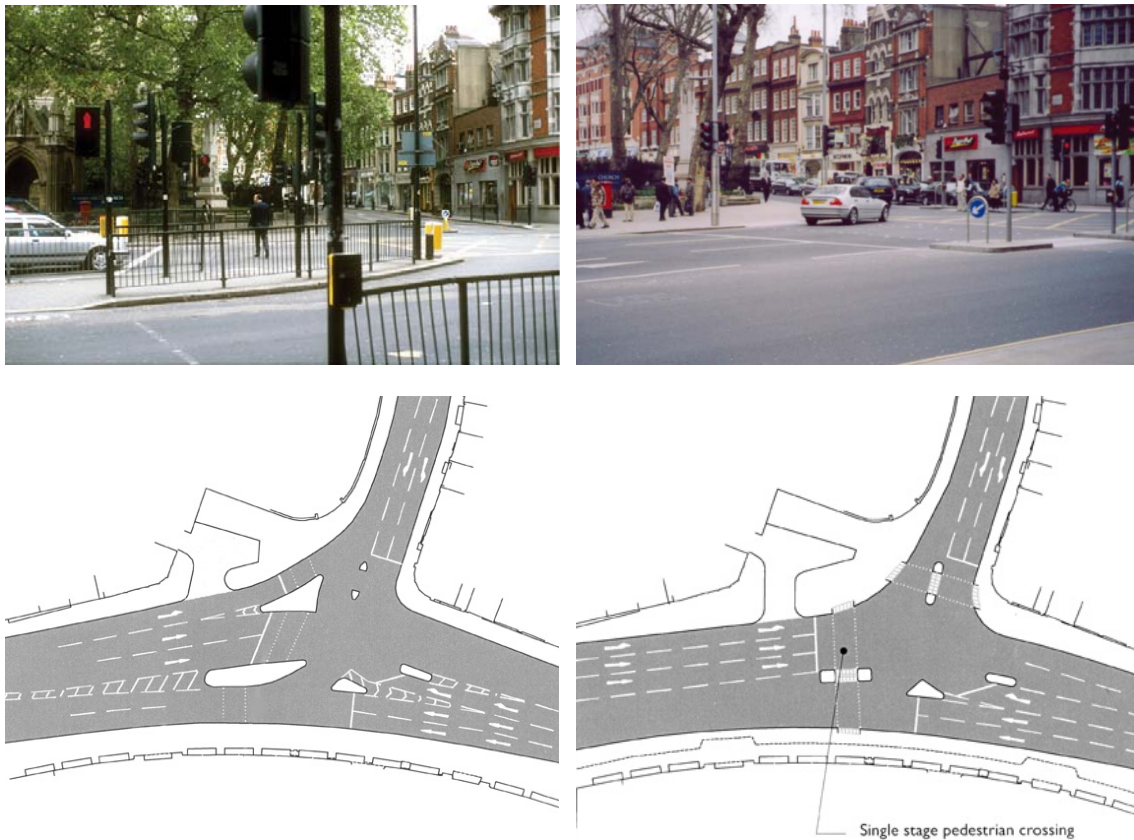


Figure 3.12. A sample crossing at Kensington Street, London, before (left) and after (right) the revision
Source: Davis, 2008: 73.

The winner of the 2008 Landscape Institute Awards Design under 1ha, New Road redesign project in central Brighton achieved a remarkable success in transforming a deserted link to an attractive public space and tourist destination. The street was built in the early 19th century and performed as a cultural connection linking the key cultural institutions of the city. However, it was increasingly dominated by vehicles with narrow footways over the last century. In 2005, the New Road project was commenced by the team of Landscape Projects and Gehl Architects with the aim of integrating the street with its surrounding theatres, restaurants and Brighton Royal Pavilion to promote the use of ‘shared space’. The scheme was people-focused and pedestrian-dominated: encouraging walking, cycling and civic activities. The project was completed in 2007, providing Brighton City Centre with a sustainable public realm, an important cultural quarter and a popular civic place (Figure 3.13). In the new shared space, vehicle speeds and trips were significantly reduced, while the cycling, pedestrian traffic and staying activity

increased by 22%, 62% and 600% respectively (Gehl Architects, 2007). It was an exemplar of good, new, design practice in a city centre which created a shared space where the needs of all different user groups were inclusively considered.



Figure 3.13. *The streetscape of New Road before (left) and after (right) the project*

Source: Gehl Architects, 2007, <http://www.gehlarchitects.com>, accessed in June 2013.

Another winner of top UK planning awards, The Ashford Ring Road Project, was a large-scale plan of shared space and integrated streetscapes applied to a former ring road in Ashford, Kent. The scheme followed the town's 'mend before extend' policy to reconfigure a one-way ring road built in the 1970s to approach a better balance between the needs of pedestrians and motorists. As a 'concrete collar' coiling around south-western side of central Ashford, the ring road had little connection with the surroundings and restricted pedestrians' movement to and from the town centre. The vision of the transformational scheme was clear and challenging: turning the traffic channels into multi-functional quality streets where people could meet, live and shop while accommodating up to 10,000 vehicles per day. To a wider extent, the revised ring road was expected to stimulate the regeneration of the whole town centre. The project embraced the concept of an Integrated Design Team with the cooperation of traffic engineers, transport planners, urban designers, landscape architects and artists to produce an integrated design rather than several individual designs. The cooperation also included the communication with stakeholders covering Council members, the public, safety auditors, the media and particular interest groups (Stubbings, 2009).

As the largest shared space scheme to be implemented in the UK, in 2008, the ring road has finally been changed to a two-way traffic flow and shared space opened in Elwick Road and West Street (Figure 3.14). It removed unnecessary street furniture, such as safety railings, traffic signals and road markings, from the street and limited the vehicle speed to 20 mph within the shared space area. Proven as a better result than conventional plans, the new scheme of shared space did not only bring street life back to the town centre, but also reduced congestion and the number road casualties – no road accidents in the first 12 months - compared to 5 in the previous year (Watson, 2010).



Figure 3.14. *The streetscape of Elwick Road before (left) and after (right) the Ashford Ring Road Project*
Source: Hamilton-Baillie Associates, 2010, <http://www.hamilton-baillie.co.uk>, accessed in June, 2013.

Although it seems that there are numerous conflicts among these different uses in shared space, the physical design is such that drivers are placed in a lower position, while vulnerable users are given the priority on using the street. Southworth *et al.* (2003) suggest that the conditions are actually much safer for pedestrians in a shared street than in a conventional one, since the drivers would be more alert and slow down their speed when they are driving in such conditions (i.e. Uncertainty Principle). Moreover, the shared streets do not only provide users with great safety and equity, but also better environmental qualities. These include a reduction of noise and visual clutter, involving more social activities, strengthening liveability and local character and, most importantly, that green transport modes are greatly encouraged while private cars are fading out

(Southworth & Ben-Joseph, 2003; Marshall, 2005). In contrast with the previously assumed limitations in such practices, the cases show the great potential of the philosophy of shared space in both small- and large-scale reconfiguration projects in urban central areas.

3.3 CONCLUSION

All these concepts discussed above are tagged as ‘street design with sustainability’. The importance of sustainability has become increasingly recognised as a force in determining further development. The big picture includes increased pressure on the natural ecosystem, climate changes, the ever-increasing demand for raw materials, water shortages, rapid industrialization, urban sprawl and city erosion as examples of crisis being caused for the planet (Bevan *et al.*, 2007). In order to promote the remedies, in the medium scale, opportunities should be provided within the transport planning process to improve green transport modes for the majority of journeys rather than the private motorised mode (DfT, 2008). The detailed vision considered as the ‘inclusive design of urban streets’ should shape the solutions to reduce car usage, provide equality of street use for all people and improve local environmental quality.

The street, particularly the urban street, is either a physical or social part of the living environment and is used simultaneously for movement, social interactions and civic activities, as has long been argued by many authors, including Kevin Lynch, Donald Appleyard, Jane Jacobs and Christopher Alexander. The paradigm shift of street design will usually be a complex process, involving a balance of different priorities among street users, business interests, the natural environment and inherent sub-conflicts between these elements themselves. However, where opportunities and challenges co-exist, city planners and urban designers should play an equally important role in the changing climate of urban circulation systems.

Over the years, street patterns and transport systems in most of the world’s modern cities are still oriented by vehicular movement. The factors for this trend are complex and the resulting built

environment continues to attract more motor vehicular flows. The traffic induction loop has yet been enhanced by the traffic-engineering-based street standards that are too rigid and absolute to be modified. The standards have been considered as professional methods that developed from scientific surveys and analyses, and therefore any development of new standards is restricted. However, concerning the increasingly deprived vulnerable road users, social interactions and environmental qualities, deficiencies on the highway engineering convention and the consequent impact have been increasingly recognised. A considerable amount of research has contributed to this new thinking on urban circulation and street designs. In the early years, the shift of approaches with the concepts such as sustainable and inclusive design has been practised and tested, but it is often built on an *ad hoc* basis. Recently, the concept has been increasingly appreciated since numerous social benefits and much public satisfaction have been achieved in a number of exercises.

Sustainability and inclusiveness, involving principles, ideas and methods, should be considered integrally to improve quality of life and to provide for a positive and long-term vision. Providing the equal opportunity of urban street use and ownership for the public, introducing social equity and environmental quality to the city itself, shifting rigid standards into flexible ones and using improving communication techniques, are key opportunities for making a remarkable improvement in achieving urban sustainability through the introduction of new approaches to inclusive street design practice.

CHAPTER 4 URBAN STREET DEVELOPMENT IN CHINA

Chinese cities used to be known as the leaders in non-motorised transport such as walking and cycling. Their urban forms were also conducive to low levels of automobile dependence. However, urbanisation levels in China are increasing rapidly, so is the rate of private motorisation such as cars and motorcycles. There are a number of factors that are driving their transport and land use towards a greater reliance on motor vehicles. Traffic engineering conventions require urban streets to have forms and functions primarily to respond to vehicular movement. The other traffic or non-traffic needs are rarely considered in street planning and the design process. This results in a deteriorated pedestrian environment and public transport service which intensifies automobile dependency in the urban circulation system. The particular traffic induction loop, therefore, occurs in many Chinese cities along with market-oriented land-use and rapidly increasing private motorisation. In order to achieve a comprehensive understanding of the factors and solutions to traffic and urban problems, this section indicates and explains the current conditions and different concepts of urban transport planning and street design by reviewing Chinese literature and research studies.

4.1 PROBLEMS: URBAN ROAD TRANSPORT IN CHINA

It is predicted that one in two people in China will live in an urban area by 2020. In other words, the cities and towns in China would have to accommodate approximately 712 million people by then. The cities in China are growing rapidly, both in quantity and size. According to the official statistics, at the end of 2007, there were 655 cities in China, 119 of which had a population of more than one million (Table 4.1). The number of cities has increased by 151% during the last

two decades, while the total urban built-up area has doubled. Along with rapid urbanisation, traffic demand in urban areas is increasing at a remarkable pace. Most urbanised cities suffer serious problems of traffic congestion, road fatalities and air pollution. Compared with the strongly growing private motorisation, the proportions of non-motorised transport modes are decreasing in response to the longer travel distance and decreased quality of travel conditions. These issues together have become a main constraint on urban sustainability and further improvements in living quality (Liu, 2005).

Table 4.1. *The number of cities in China, 1978 to 2007*

	<i>The number of cities</i>		
	1978	1988	2007
Total number	192	434	655
>1 million	13	28	119
0.5 – 1 million	27	30	118
0.2 - 0.5 million	60	110	151
<0.2 million	92	266	267

Source: National Bureau of Statistics of China, 2008; China City Statistical Yearbook, 1989 & 2008; Gu, 1992, Table 7-9.

4.1.1 Car ownership and road supply

In 1990, there were only 816,200 private automobiles in China, however, after 17 years, the number had reached around 28,762,200 (Figure 4.1). From 1990 to 2007, the growth rate of car ownership was 23% *per annum* (National Bureau of Statistics of China, 2008). During the same period, the total length of paved roads in China increased by approximately 250% (Figure 4.2). The pattern of vehicle ownership by different household income levels is also identified (Figure 4.3).

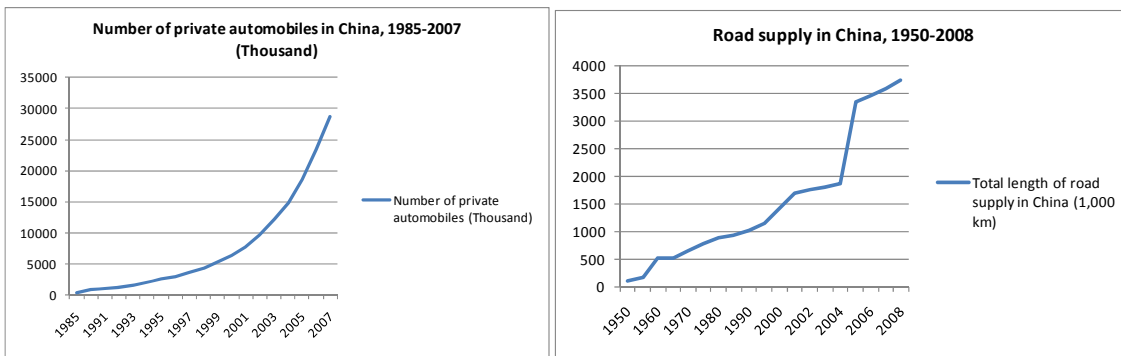


Figure 4.1. (Left) Growth of car ownership in China from 1985 to 2007

Source: National Bureau of Statistics of China, 2008

Figure 4.2. (Right) Growth of paved roads in China from 1950 to 2008

Source: *ibid.*

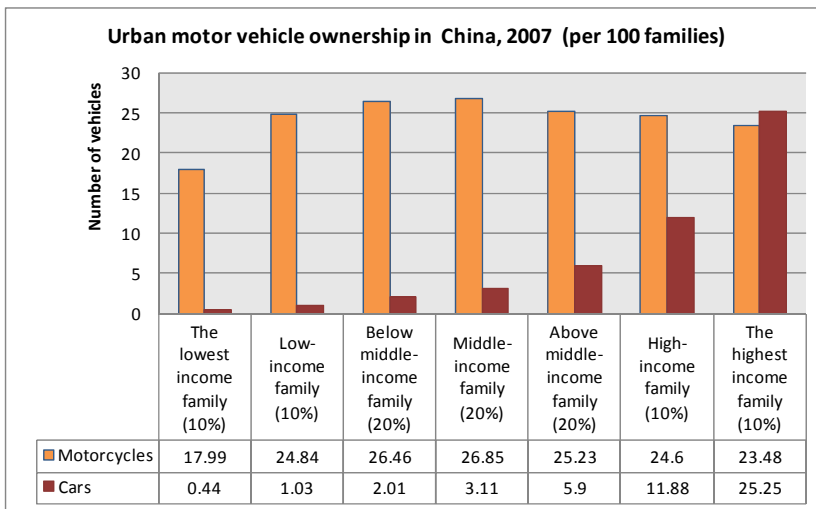


Figure 4.3. Motor vehicle ownership by different levels of family income, 2007

Source: *ibid.*

It is projected that a coming wave of major growth in private car ownership will occur in the next 40 years following the rapid growth in the economy and real incomes during the last two decades (Figure 4.4) (Chamon *et al.*, 2008; Li, 2005). According to the *Strategy of National Land-use Plan, 2005-2020*, the demand of land for road transport is more than 2 million hectares which occupies two thirds of the total land-use plan. It is also predicted that 84,800 kilometres of motorway will be built by 2035 when China will become the country with the largest area of motorways and the largest amount of energy consumed by traffic (Qiu, B., 2006; *The Strategy of National Land-use Plan, 2005-2020*: 3).

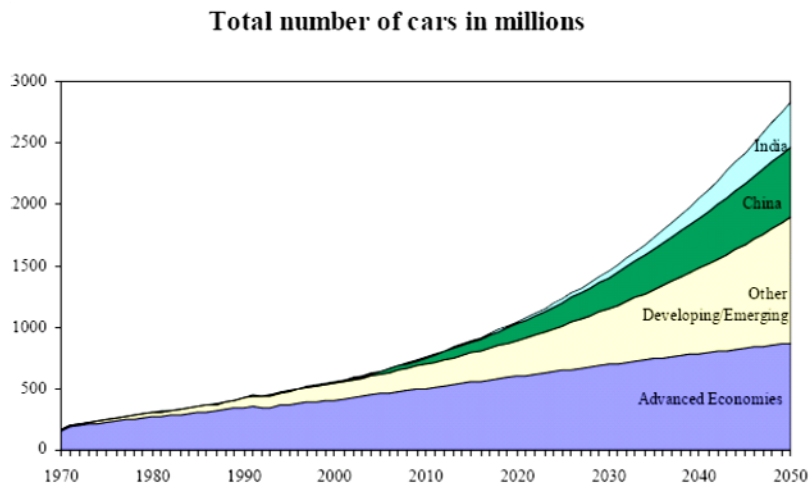


Figure 4.4. *The projected car ownership*

Source: Chamon *et al.*, 2008, Figure 11.

Private motorisation in China is also promoted by the booming car industry. Automobile manufacturing is expected to become an important pillar industry in China in the coming decades. By the end of 2009, China had produced almost 14 million automobiles, increased by 214% since 2003 and become the world's leading automobile producer (Liu, 2005; Ministry of Commerce of China, 2010). Automobile industries achieved great economic success in the east of China with the increasing support and endorsement of the national *Automobile Industry Policy* of the former Ministry of Machinery Industry. Jun Liu, Director of the Department of Motor Vehicle Industry in the Ministry of Machinery Industry advocated that automobile industry development is an inevitable result of economic growth, which has been proven from the experience of a number of other countries. She also quoted the case of Japan to advocate that a 'large population and lack of land' is not an obstacle to developing private motorisation. Liu's opinion expresses the perceived economic and political realities behind the policy (Kenworthy & Hu, 2002: 13).

These macro-statistics indicate that China has experienced a revolution in urban road transportation following the great economic success in the last two decades. The trend of urbanisation at the moment seems to be towards an automobile-oriented built environment and society. In terms of urban street design, one of the most remarkable changes is road width. In order to accommodate the ever-growing traffic demand in urban areas, providing them with wider

roads and streets is naturally considered as an ordinary measure. Statistics indicate that in 1990 the average road width was only 9.37 metres, but reached 17.23 metres in 2007, i.e. road width had almost doubled during these years. The *per capita* area of paved roads has also increased from 3.1 m² in 1990 to 11.4 m² in 2007 (National Bureau of Statistics of China (NBSC), 2008).

Although the length and width of urban streets have significantly increased, street density, especially the density of minor streets, has been restrained at a very low level (Table 4.2). The international comparison shows that the street densities in Beijing, Shanghai and Guangzhou are significantly lower than the cities in the other countries (Table 4.3). The statistics indicate that inadequate consideration was paid to the development of street networks. Although noted by a number of scholars, the factors responsible for this situation have rarely been identified (Shi & Wang, 2007).

Table 4.2. *Street density in some cities in China*

City	Year	Street density by different types (km/km ²)				Grading proportion
		Arterial road	Secondary road	Branch road	Mean Road density (km/km ²)	
Nanjing	1997	0.48	0.34	0.2	1.38	1: 0.71: 0.42
Hefei	1993	0.92	0.59	0.24	1.76	1: 0.64: 0.26
Anshan	1993	0.67	0.68	1.73	3.08	1: 1.01: 2.58
Bangbu	2001	1.64	0.97	0.29	2.9	1: 0.59: 0.18
Huzhou	2002	2.87	1.34	3.19	7.4	1: 0.47: 1.11
Suzhou	1999	1.18	0.56	0.51	2.25	1: 0.47: 0.43

Source: Shi & Wang, 2007, Table 2.

Table 4.3. *Comparison of urban street indicators in different cities*

City	Year	Urban area (km ²)	Total road length (km)	Total road area (km ²)	Road density (km/km ²)	Mean road width (m)
London	1991	1579	14693	210.11	9.31	14.30
New York	1992	780	10200	198.12	13.08	19.42
Tokyo	1992	618	11546	92.26	18.68	7.99
Osaka	1992	220	3899	37.81	17.72	9.70
Beijing	1998	650	1104	33.83	1.70	30.64
Shanghai	2003	610	2840	42.44	4.66	14.94
Guangzhou	2005	3836	5107	86.14	1.33	16.87

Source: Sun, 2009, Table 4.5.

4.1.2 Negative consequences

The rapidly increased private motorisation and road construction has not only shaped the urban physical environment to be automobile-oriented, but has also made a huge impact on the future development in the social, economic and ecological environment. The direct negative consequences are summarised below.

Energy Security and air pollution

Liya Liu (2005) indicates that the motor vehicles account for 90% of the total petrol consumption and 45% of diesel consumption in China. According to a survey by Tsinghua University, road transport will make up more than 20% of the total oil demand by 2020 and nearly 90% by 2030. It is also predicted that, by 2020, 70% of the total oil consumption in China will be highly dependent on imports. China is, therefore, facing serious challenges in energy security and the consequent problem of air pollution.

Experts estimated that motor vehicles in large cities are responsible for 60% of carbon monoxide, 50% of nitrogen oxides and 30% hydrocarbon emissions (Liu, 2005). In Beijing, for example, 77% of carbon monoxide and 40% of nitrogen oxides air pollution were attributed to the motor vehicles in 1995, comparing with 10-54% carbon monoxide and 29-32% nitrogen oxides of global emissions and only 16% and 14% as the average in Asian Cities in 1993. Even though the level of motorisation in China in 1995 was much lower than today. The current air pollution indicators in China's large cities are ten to twenty times higher than those in Western countries (*ibid.*; Hao *et al.*, 2001; Faiz, 1993; Vasconcellos, 2001).

Furthermore, because of the traditional layouts and existing spatial organisations, many citizens are likely to live beside the main trunk roads. They have increasingly become the victims of air and noise pollution since the increase in the number of motor vehicles. Diseases of the respiratory

system caused by air pollutants such as carbon monoxide, nitrogen oxides and volatile particulates are the third largest cause of death in Chinese cities - claimed to be 330,000 deaths each year (Liu, 2005). Though it is still not clear if these deaths are directly related to the increase in motor vehicles, these machines are responsible for a considerable proportion of air pollution in urban areas.

Traffic congestion and downgraded public transport service

The traffic congestion on urban roads and streets is becoming more and more severe in recent years. In a majority of great cities, Lu *et al.* (2006) point out that average speed on main roads is usually below 20 km/hr. at peak times. Liu (2005) indicates that in some central areas average operating speeds have even been reduced to 8-10 km/hr. and sometimes below 5 km/hr. She shows the evidence from bus services in Beijing that the 'on-time' reliability rate of buses has fallen from 70% in 1990 to 8.4% in 1996. The traffic congestion also results in extra fuel expenditure and air pollution. It is estimated that due to the congestion, the annual increase in automobile fuel consumption exceeds 300,000 tonnes and a 15% annual increase in automobile pollution emissions, which results in RMB 15 billion *yuan* worth of economic damage each year. Statistics indicate that the total economic loss due to the traffic congestion is about RMB 170 billion *yuan* annually in China (Liu, 2005; Gao, 2004).

While private motor vehicles are increasing at a rapid pace, the quality of bus services is relatively downgraded due to the low speeds, lacks of road space and the ever-increasing traffic congestion (Li, 2005). The average travel time to work is 42 minutes for a city resident in China. It is even worse in large cities, such as Beijing. For example, usually an employee would have to spend more than an hour on a bus or underground (including the walking and waiting time, the author suggests) to reach their work place (Liu, 2005; Gao, 2004). The poor service results in fewer people choosing public transport modes. A study from 2001 indicates that public transport

accounts for only 19% of total daily travel in Chinese cities, which is significantly lower than the 31% in other Asian cities (Kenworthy, *et al.*, 2001). The trend is especially significant since it shows that the attraction of public transport is decreasing in large cities. For example, the public transport in Beijing accounted for 29% of the daily trips in 2001, but it used to accommodate about 70% of the total trips at the beginning of the 1980s (Gao, 2004).

Furthermore, along with the rapid increase in the number of private automobiles in recent years, the reduction in public transport is even more severe. The current urban transport infrastructure has primarily responded to the travel demand of high-income families with automobiles, while the needs of low-income families, such as investment on improving public transport services, are usually ignored or delayed. This inequity raises traffic costs of low- and middle-income families, which leads to a remarkable decrease in their life quality (Zhang, 2008). The massive government investment on roads, particularly in some suburban areas, is therefore actually a hidden subsidy to private car users (Chen, 2008).

Road casualties

While the increasing numbers of automobiles are facilitated by the growing investment in urban road construction, vulnerable road users, such as pedestrians and cyclists, have to take increased risks of becoming road casualties. Figure 4.5 indicates that during 2002 and 2006, road casualties were responsible for one third of the total deaths from accidents in China (Figure 4.5). According to the year report of 2007, 81,649 people died in traffic accidents with 380,442 people injured (National Bureau of Statistics of China, 2008). Approximately 60% of the deaths are vulnerable road users and 20% are motorcycle riders (Disease Prevention and Control Bureau of Ministry of Public Health, 2007). Figure 4.6 indicates that people aged between 15 and 35 are at a relatively high risk of being a road fatality, i.e. accidental deaths on roads, as they seem to have the highest level of exposure to the daily traffic. Thus, traffic deaths also constituted the largest proportion of

Potentially Productive Years of Life Lost (PPYLL) of the total fatalities (Wang *et al.*, 2008).

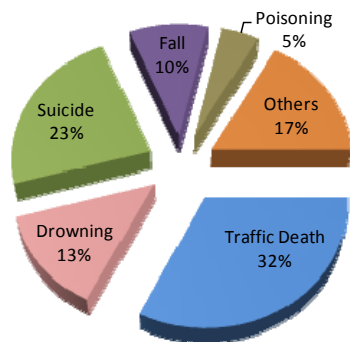


Figure 4.5. *Distribution of fatalities by accidents in China, 2002 to 2006* - the traffic death contributes to 32% of the total fatalities.

Source: Wang *et al.*, 2008, Figure 5.

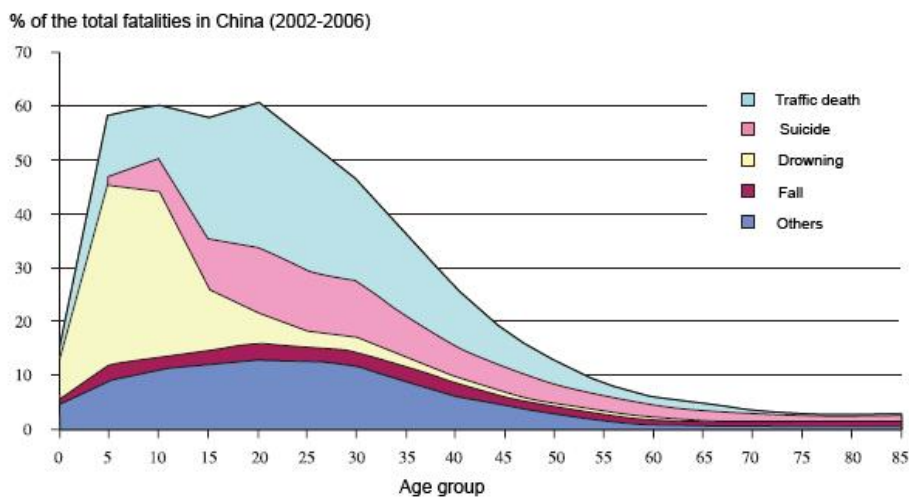


Figure 4.6. *The percentages of accidental fatalities by age groups*

Source: *ibid.*, Figure 3.

According to the 2009 Report of the World Health Organisation (WHO), there was a slight decrease in the number of traffic fatalities in China since the year 2003. As discussed in Chapter 3, the level of correlation between road casualties and the urban transport systems is difficult to state, because of the improved levels of first-aid, medical-care, safety education or self-protection of road users. The decrease in non-motorised traffic (i.e. walking and cycling) can also lead to a false conclusion that accidents have been reduced (Vasconcellos, 2001). Thus, the traffic fatality data may not be a proper indicator for road safety.

Deteriorating urban liveability

There is a trend of urban decentralisation due to the increased car ownership with the increased road space and car park lots occupying more urban land than before (Qiu, B., 2006; Lu & Li, 2007). Kenworthy and Hu (2002) suggest that the rapid process of motorisation would have a large negative impact on the compact Chinese cities with their vibrant urban life and traditional cultural and architectural heritage. Currently, there is no law that provides specific definitions, controls and frameworks to guide transport planning and urban design, therefore new developments of urban streets and frontages tend to be speculative. In Hangzhou, for example, the road widening projects around the West Lake district have had a huge impact on the environmental quality and pedestrian amenity in the surrounding areas (Zhou, 2000). The phenomenon of ‘city erosion’ is becoming prevalent and severe in China. The historical context appears to be torn up and the cities are given a uniform ‘modern’ appearance by the hierarchical street systems ‘scientifically’ developed to meet the requirements of traffic efficiency and safety (Li & Yang, 2000). Along with the increased traffic chaos, visual clutter such as traffic signs, signals, barriers, pedestrian bridges and viaducts are mushrooming everywhere (Zhou, 1993; Han, 2003).

Sloman (2006) points out that the increased private motor mobility has favoured large supermarkets and out-of-town ‘shopping cities’ at the expense of small independent shops in central areas. Shen *et al.* (2006) argue that the traditional commercial centres in Beijing have faced competition from the suburban commercial districts recently as there has been a shift in the shopping culture with shoppers preferring to use private automobiles. A study on retail in Shanghai by Ning *et al.* (2005) shows that, during the last two decades, the newly-developed shopping centres have tended to be in suburban locations (Figure 4.7). Ning *et al.* believe that suburban districts have a stronger attraction to new commercial development than the centre, which is partly due to the expansion of the urban transport network. Qian (2008) suggests that although commercial suburbanisation has not actually become the obstacle to the central

commercial development due to the increased consumption capacity, the competition will become more severe and significant with the future increases in private car ownership. Along with the loss of thousands of small shops, the city has not only lost variety and local distinctiveness, but also local liveability (*ibid.*).

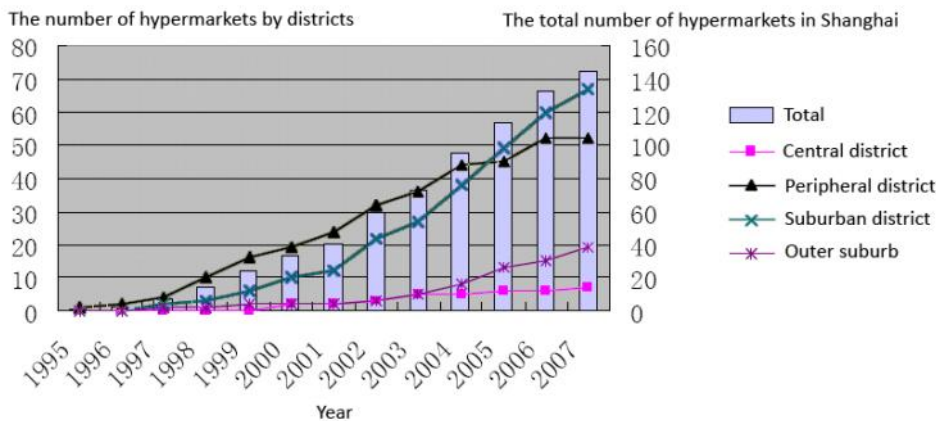


Figure 4.7. *The number of hypermarkets in Shanghai, 1995-2007*

Source: Qian, 2008, Figure 1.

4.1.3 Urban transport inequity

The lessons are not just for developed, car-dependent countries. They are also important for countries where car ownership has not yet reached critical levels. In China and India, civil engineers and technical experts from the World Bank and the multinational consulting firms rule the roost. Billions of dollars are spent on elevated highways and expressways, whereas low-tech, sustainable, efficient means of transport are ignored and despised. These countries are making the same mistakes that the developed countries made in the 1970s, with even more far-reaching consequences for their societies and for the global environment (Sloman, 2006: 16).

Vasconcellos (2001) examined a wide array of urban transport conditions in developing countries in recent decades and concludes that urban transport is in crisis in different ways. He argues that the current urban transport conditions in developing countries are the result of their economic,

political, technical and social development. China, as a developing country with the largest population, has achieved remarkable economic success and experienced significant shifts in social, political and technical aspects, but it is not an exception that can circumvent the crisis in urban transport. The ever-increasing numbers of motor vehicles and traffic channels have not only reshaped cities and towns, but also reshaped people's lifestyles, elegantly named as 'living modernisation'. In China, inequities in land use and public health may be the most important crisis resulting from rapid transport modernisation.

Land-use inequity

Illich (1974) argues that motorised transport increases the consumption of urban space and the demand for facilities, and hence creates a form of inequity for non-motorists. The urban spatial structures and patterns are highly biased towards those with access to private transport, and give them a means of exercising power over space. Vasconcellos (2001) indicates that the different transport modes have highly distinctive spatial consumption rates and structures. In China, most of the road users are pedestrians and cyclists who do not only consume low quantities of space, but also suffer from the unacceptable spatial forms which are automobile-dominated. Pedestrians, the majority of road users, are usually squeezed into the uncomfortable, narrow and discontinuous sidewalks, leaving a large road space for motorists. By contrast, automobiles often invade the space of sidewalks or cycle lanes for temporary parking (Zhou, 1993).

Statistics indicate the *per capita* road area has increased by 8.3 m² from 1990 to 2007 (NBSC, 2008). However, this increased road space is almost all consumed by motorists rather than the other road users. The average motor vehicle ownership rate in 2007 was approximately 110 vehicles per 1,000 person (including motorcycles), which implies that only a small proportion of people can benefit from the increased road areas, whilst the crossing time for pedestrians and cyclists is twice that in 1990 due to the nearly doubled street width. The automobile-oriented

urban spatial organisation also increases the travel distance, time and cost. Non-motorists and public transport users are more likely to be affected by the increased distance than motorists.

Furthermore, the physical environment of Chinese cities has been highly degraded in recent decades. Considerable urban heritage - public property – has been destroyed or isolated from its surroundings due to extensive road and transport infrastructure construction. In many large cities, the traditional communities and historic contexts are relentlessly divided into pieces by the ‘concrete canyons’ of trunk roads, viaducts and loop streets (Han, 2003). Along with the disappearing pedestrian amenity and shrinking public space for social interaction, the modernised transport system built for only 11% of the people leads to pervasive erosion of traditional street-oriented social activities. Vasconcellos (2001: 218) suggests that the ‘barrier effect’ represents a persistent impact on residential and living spaces, because of motor traffic.

Health inequity

Public health inequity can be seen from the large number of traffic fatalities in China. The enlarged street width and travel distance increases risk exposure for road users, especially the most vulnerable ones who are most affected by the traffic safety problems. The WHO indicates that half of the world’s traffic deaths are accounted for by the vulnerable users (including motor cyclists). Furthermore, the proportion reaches almost 80% in China (Wang *et al.*, 2008). Car travellers can always have priority on road movement rather than pedestrians and cyclists, since the former are much better shielded and protected (Plowden, 1972). It is a common scene in China that pedestrians have to be patient when waiting for the motor traffic flows to ensure their own safety. Besides the increased risks, the lack of security can be considered as another hidden burden on vulnerable users. This is particularly true at intersections where the traffic becomes even more chaotic and most pedestrians usually have to run across the roads.

For vulnerable street users, the automobile-dependent circulation environment is not only putting

stress on their movement, but also causing health risks. The environmental inequity implies that ‘a few people produce most of the pollution, which will impact on all’ (Vasconcellos, 2001: 217). As mentioned before, China has more severe air pollution problems than other developing countries due to the large number of motor vehicles. Furthermore, vulnerable street users who have the highest exposure to vehicular emissions, pollutants and noise are also the most direct victims as they are not as well protected as the motorists in cars (Han, 2003).

4.2 FACTORS: THE CAR DOMINATED CIRCULATION ENVIRONMENT

The current modernised transport system in China is not only the result of the tremendous economic achievement, but also a political product of the thirty years of “reforms and opening-up”. The loose control and inadequate management of land use has bred unwarranted urban transport planning and street design. Many transport investments are speculative and short-term, emphasising a political performance rather than pragmatism. The forms of urban streets and networks are also strongly influenced by the cultural preference for automobiles and the technical bias of the traffic engineering professions. This strong tendency has enhanced the process of ‘transport modernisation’, i.e. the automobile-oriented transport system.

4.2.1 Chasing efficient traffic flow

Transport modernisation was first initiated in 1954 as one of the most important strategies of ‘modernisation’, and then replaced by ‘technology modernisation’ in 1964. However, the strategy has been used frequently at regional and local levels since the 1950s. Thus, the meaning of ‘transport modernisation’ is vague and varied without a clear definition. In the China Road Transport Development Forum 2002, Jiexi Hu (2002), the assistant minister at the Ministry of

Communications in China, suggested that China would achieve transport modernisation by the 2050s when the total road length would reach 4 million kilometres. He defined the modernised road transport as a high-quality and intelligent road transport network which can sufficiently meet the demands of future traffic by emphasising the requirement for safety, convenience, flow and efficiency. The road transport modernisation project seems to focus on ‘meeting the future traffic demands’, aiming at the construction of efficient traffic channel networks. Under this definition, the criterion in judging a ‘good’ road is nothing more than ‘efficiency’ or ‘capacity’ for motor vehicle movement. At the end, according to Hu (2002), the whole strategy would like to pin its hope on “intelligence” and “new environmental-friendly automobiles” - those two imaginary objects - to circumvent the negative impacts from over-motorisation.

Zhou (2000) criticises the ‘performance projects’ in road transport developments which are more or less steered by government officials with their personal political goals. He argues that many cities and local authorities are relentlessly pursuing wide roads, viaducts and so-called ‘landscape boulevards’ to emphasise their *Zheng-ji* i.e. political achievement that strongly influences a government official’s political career. Nevertheless, those municipal projects have not only failed in dealing with the problematic traffic, but also generated potential traffic risks.

Vasconcellos (2001) explains why only two objectives - fluidity and safety - are pursued in urban transport planning and traffic management. He suggests that the functional approach to urban management has kept urban planning, transport planning and management isolated from each other. The isolation also occurs at different administrative levels in China (Zhou, 2006). Urban planners, transport planners, traffic managers, police, civil engineers, architects and developers are all working within a very complex institutional structure. There are still gaps and misunderstandings amongst these stakeholders in their co-operative working process (*ibid.*).

Only after the 1970s, did people in China begin to realise the differences between highway planning and transport planning. Before the 1980s, the forecast of future traffic flows had been considered as the core of urban transport planning for a long time. In most people’s opinion, the

highway or transport planning was to forecast traffic flow, determine the forms of networks, road widths and construction phases, regardless of the diversity in the local economy, community and ecology. Thus, highway or transport planning was considered as a set of technical processes, lacking awareness of social and economic aspects (Zhou, 2006). However, the standards and process of highway engineering in transport planning and street design are too entrenched to be questioned or modified. The indisputable and absolute engineering standards had dominated road design and planning for decades in western countries until considerable debates and opposition occurred in the 1970s. However, today, the standards are still continuing their dominance in Chinese urban highway planning and design (Qiu, S., 2006).

4.2.2 Reorganised urban space

[For] most Chinese cities whose historic centres had much earlier been laid out according to pre-modern administrative planning principles, the 20th century offered relatively little opportunity to experiment on a large scale with new models of redevelopment. When the opportunities did finally come at the end of the century, they did so at a time when postmodern aesthetics, modernist social goals, market-inspired economic policy and party-state political machinery all coexisted and coexisted too with the persistence of pre-modern urban environments (Abramson, 2008: 233-34).

Based on recent studies in China, increasing car ownership may not be the dominant factor for existing changes in land use, but there are considerable expectations that it is increasingly becoming an important factor for urban sprawl. Liu (2009) argues that urban sprawl in China differs from that in western countries, which is an outcome of the late stage of urbanisation. It is characterised as a ramification which occurs in the process of rapid urbanisation in China. In the last two decades, a number of large cities in China have been sprawling at a rapid pace which far exceeds those in New York, London and Tokyo during their historic period of industrialisation.

The correlation between car ownership and urban sprawl has become stronger and positively significant in the large cities since the end of the 20th century. The built-up area in Shanghai, for example, has grown almost seven times since 1949, but the most significant growth happened during the last decade (from 549.6 km² in 2000 to 885.7 km² in 2007) (NBSC, 1998 & 2008; Yao & Guan, 2007: cited in Zhang, 2008). Along with the expanding urban space and increasing travel distance and demand, more investment is encouraged in transport infrastructure, such as expressways and flyovers.

The current urban spatial organisation has been formed since 1978 after the ‘reforms and opening-up’ policy when the free market was open and began to facilitate economic and technical development. National and local authorities believed that the process of urbanisation, especially in the metropolitan regions, could effectively lead to the efficient use of capital, the labour force and energy. Since 1990, mass capital investment has been collected and injected into the urbanisation movement. During the last two decades, China has succeeded in achieving rapid urbanisation and transport modernisation at the expense of large amounts of arable land and green belts in suburbs. Differing from the automobile-oriented urban sprawl in North America, the trend of urban sprawl in China inclines to be land-use-oriented in character. Chen (2009) shows that the urban spatial expansion of Chinese cities is usually characterised by a mono-centric outspreading which is directed by the land-use zoning under the guidance of government. Speculative planning and development has resulted in the pervasive urban sprawl and land wastage around the country and generated great amounts of extra cost in transport and energy consumption (Qiu, B., 2006).

Planning with mono-function zoning, i.e. superbloc development, is one of the most significant phenomena focused on by a majority of the literature. Chen (2009) believes that the mono-function zoning development is one of the most important drivers for the recent urban sprawl, which includes the large-scale redevelopment for residential or industrial use in suburban areas. Lu and Li (2007) argue that rapid urban sprawl is enhanced by the storm of large-scale land

business in suburban real estate. Because of the strong central state-socialist control of land, financial benefits from land transactions can be easily collected by the government. The rapid speed of real estate development in recent years, by the use of mono-function zoning, means that the value of land can be maximised. During 2003 and 2005, for example, the amount of suburban land transactions in Shanghai was very substantial (Table 4.4). Lu and Li (2007) indicate that land transactions in the outer suburbs for residential use were approximately 112 km² which accounted for 47% of the total residential area in Shanghai.

Table 4.4. *Percentage areas of land transaction in Shanghai, 2003-2005*

	<i>% of area of land transaction by districts, 2003-2005</i>
Pu-xi (west) central area	5.9%
Pu-dong (east) new district	8.8%
Suburban districts	26.6%
Outer suburb	55.0%

Source: adapted from Lu & Li, 2007: 1.

Walled residential quarters (i.e. gated communities) are the representative form of superblock development in residential areas. According to Miao (2003: 48), a standard Chinese gated community usually covers 12-20-plus hectares of land and accommodates 2,000-3,000 families (assuming 3.2-3.5 persons each family). As indicated in *Standards for Urban Residential Community Design* [GB 50180-93], a standard walled residential quarter with multi-storey housing can cover 13.4-44.8 hectares of land, which is believed to fit with the optimal economic efficiency of supporting facilities (Miao, 2003; MoHURD, 2002a & 2002b). Those superblocks, mainly in the form of walled housing and administration developments, are generated from ‘the sense of fear in massive urbanisation’ and reinforced by ‘political-economic restructuring and increased mobility’ (Xu & Yang, 2008: 214). Pre-existing minor streets within the blocks are often reallocated or transferred to inner routes as private places and are closed to public use, which generates a significant negative impact on permeability. As a typical ‘inward-oriented’ development pattern, the trend is found from new districts and urban peripheries to central areas (Abramson, 2008). Miao (2003: 52 & 53) criticises the trend as “making a suburban development in the central area, preventing local nutrients (the residents) from being fed into the urban vessels

and causing long detours to the visitors”. However, evidence shows that, even with strict control at entries, the gated communities only provide the image of a safe environment but generate more crimes on deserted streets, which works against the purpose of gating (Miao, 2003; Wang *et al.*, 2001). On the contrary, opening the boundaries to public streets can create the more efficient security measures of ‘natural surveillance’ (Newman, 1973: 78-101).

Another point argues that urban expansion in China is, to some extent, driven by the changes in location choice of low-income households who have lost their domiciles in the urban area when large-scale urban regeneration was carried out in the early 1980s (Liu, H., 2003). In many Chinese cities, the land for residential use is priced by its accessibility to the city centre. While low-income families intend to pursue affordable housing beyond urban areas, land speculators and developers are continuing to seek cheaper agricultural lands on the city periphery for lower costs (Chen, 2008).

All of the above changes in urban land-use, directed by increased car-use, traffic demands, or other factors, have resulted in a car-dependent circulation environment. Without sufficient public transport services, the car dominated spatial organisation is increasingly enhanced by the growing private motorisation. It is a long-term outcome of the traffic induction loop that was mentioned in the previous chapter.

4.2.3 The traffic induction loop in China

Downs Law has been increasingly recognised under conditions such as those in China (Chen, J., 2008; Qiu, B., 2006). Like the traffic induction loop mentioned in Chapter 3, it suggests that without proper governmental management, the more new roads built, the more new traffic lured; and the need for travel always exceeds the supply (Downs, 2002). Besides the traditional induction loop of Downs Law, traffic problems in China are enhanced by the relatively loose control in land-use and decrease in public transport services (Zhou, 2000; Liu, 2003; Lu & Li,

2007; Chen, 2008).

As mentioned above, the rapid increase in built-up area is not only driven by growing car ownership, but also by market-oriented land use. Urban sprawl in China is characterised by superblock and mono-functional developments from urban peripheries to suburban areas. This kind of development is often accompanied by new giant road and infrastructure frameworks with very few considerations of existing transport structures or potential costs to public transport (Chen, 2008). Development of public transport systems appears to be failing to keep pace with the emphasis given to private transport (Kenworthy & Hu, 2002).

Without sufficient public transport services, increased travel demand promotes the growth in private motorisation and leads to increasingly serious congestion in central urban areas. This phenomenon often results in a misconceived shortage of urban road resources. It is well acknowledged that increase in road provision is not a proper or even physically feasible solution to road congestion given the high population densities and limited land resources in most Chinese cities (Zhou, 2000; Lu & Li, 2007). To summarise, the conventional solution to urban traffic problems in China has been an enhanced traffic induction loop (Figure 4.8). The loop can be seen as a basic factor for the emerging auto-dominated urban-circulation environment.

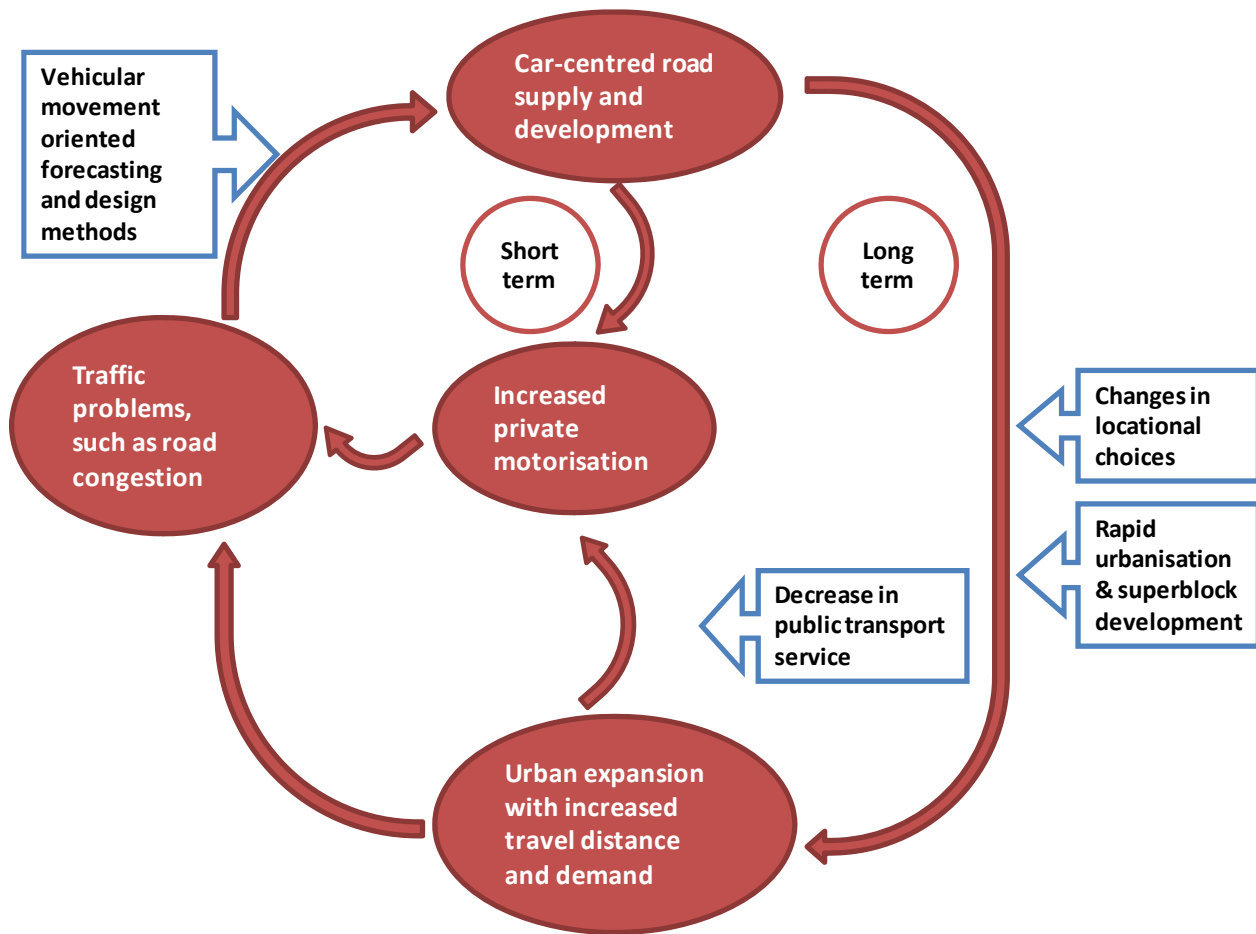


Figure 4.8. *Macro traffic induction loop in China*

Source: developed from Mogridge, 1989; Downs, 1992; European Commission, 2004; Zhou, 2000; Chen, 2008.

4.3 SOLUTIONS: SUSTAINABILITY IN URBAN ROAD TRANSPORT

There may be a consensus in Chinese academia on the factors that cause traffic problems. However, the ideological split often emerges with different solutions to the problems. It is not difficult to understand why experts in China have adversarial opinions on urban transport planning and street design. The traffic engineers and managerial departments mainly focus on solving individual traffic problems, such as improving road capacity and fluidity, because their duty is only to be responsible for enabling faster movement with fewer accidents (Shi & Wang, 2007; Guo *et al.*, 2011). The urban roads and networks are, therefore, designed with the exclusive

aim of facilitating fluid motor traffic, regardless of other traffic or non-traffic needs. In contrast, emerging urbanists in China are more or less keen on the overall picture of streets, networks and the city itself as an ensemble (Sun, 2009; Yin, 2010; Pan, 2011). They suggest that the problems should be considered along with the diverse needs of urban traffic. However, many of them are just advocates of “green transport” and “proper traffic structure”, without a clear or specific contribution to implement their visions (Guo *et al.*, 2011; Zhou & Yi, 2011).

4.3.1 Principles and standards

For a long time, urban transport planning has been considered as exclusively technical, which leads to a lack of studies on social, economic, institutional and political perspectives. It is worth noting that development policy for urban transport is extremely vague. There is a major mismatch between central government and local authorities and among different departments, which places significant barriers to developing integrated administration (Xu, 1995; Zhou, 2006).

In 1982, many scholars issued a joint proposed for ‘inclusive planning and integrative administration of transport in large cities’, which indicated that urban traffic problems and transport planning had been valued in China for the first time. In April 1985, The State Council of China placed great stress on developing public transport services and indicated that the integrated administration of urban traffic was the mandatory solution to road congestion problems (Zhou, 2006).

Since the 1980s, most cities in China have policies embracing sustainability as a key strategy in urban transport, focusing on the integrative development of economy, ecology and community. In order to restrain massive urban sprawl and excessive use of land for transport infrastructure, the *Land Management Law of China* was enacted in December 1988. It requires that the urban population density in China is not allowed to be lower than 100 persons per hectare in general. According to Newman and Kenworthy (1999), 100 person/ha or more is typically associated with

“walking cities” and is insignificant in automobile-dependency. The concept of a “compact city” could be a rational principle for the sustainable development of urban transport in China. It encourages high densities, small blocks and mixed land-use with shorter travel distances and fewer demands (Liu *et al.*, 1998).

However, currently, this idea has not generally been favoured by the particular governance ideology in China. Due to the large urban population with its unbalanced spatial organisation, the density standard for a ‘compact city’ is not suitable for large cities in China which already have very high population densities. Hence, the applicability of a more compact solution to urban sprawl in China remains questionable (Chen *et al.*, 2008). Qiu (2006) suggests that the inapplicability is also entrenched from the imbalanced spatial organisation formed during the last two decades: the over-dense city centre and the over-extensive peripheral land use. It is agreed by Chen (2008) that mono-centric urban sprawl intensifies traffic demands in the central area, while the loose controls over land use makes a city less compact at its periphery.

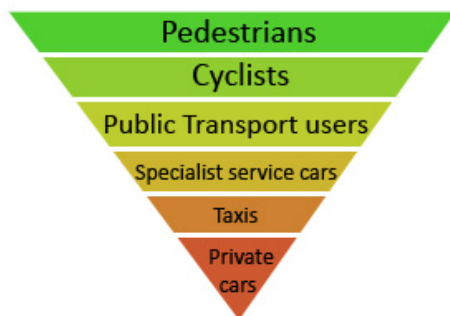
In 1993, The State Council stressed the importance of developing optimal street networks and a complete municipal infrastructure. The gradual establishment of urban rail transport systems and expressways was encouraged in metropolises. Since 2001, urban transport has become an interdisciplinary subject to be widely studied and discussed. However, so far, those efforts have rarely been articulated in the current transport planning policies and street design standards (Zhou, 2006).

There is a lack of literature on how Chinese national design standards were established and assessed. Through a historical literature study on urban planning and design, Zhou (2011) believes that the current design standards and codes in China are developed from relevant empirical studies during the 1970s and 1980s. These empirical studies mainly focused on traffic engineering databases, such as surveys on traffic volume distribution, vehicle-speed-oriented street geometry, traffic forecasting and economic evaluation models. The standards were largely based on foreign experience and representative models (Zhou, 2006).

4.3.2 Sustaining a mix of travel modes

Although the level of private motorisation is still low, it is well acknowledged that automobile dependency is not a sustainable outcome of urban circulation development in China. The phrase ‘green transport’, encouraging a mix of energy-saving and environment-friendly travel modes, is frequently seen in a variety of publications and reports. Most literature shows positive attitudes to the modes of green transport in Chinese cities. According to recent literature, proposed approaches to green transport seem to be more or less coherent: encouraging walking and cycling and improving public transport. However, green transport is currently more like a slogan than a pragmatic solution to traffic problems, because it can hardly be applied to the physical circulation environment which is increasingly dominated by motorists’ needs.

Hierarchical priority of road users on transport planning is suggested by Li *et al.* (2008) with the pedestrian at the top and private automobiles at the bottom (Figure 4.9). In small-scale developments, pedestrian priority can be achieved by providing them with narrow and dense streets and with easy access to public transport services. Zhou (1993) emphasises that pedestrian transport in urban planning should be systematically considered. She suggests that community districts should be carefully planned by taking pedestrians' needs into consideration and that local services and bus stops should be arranged within a walking area. In large-scale developments,



urban transport should be fast and efficient public transport, which requires great financial support from local government and developers (Li *et al.* 2008).

Figure 4.9. Road user hierarchy

Source: adapted from Li *et al.*, 2008, Figure 6.

Zhao and Gao (2007) claim that cycling is the most efficient travel mode in terms of energy (Table 4.5), and suitable for use in relatively compact city centres. They also indicate that the *per capita* road space consumption for cycling is only a half that of driving. It is estimated that bicycles occupy 40% of the total area of road surface but can make up 70% of the total traffic in a

typical Chinese city (Zhao & Gao, 2007). Two modes for urban cycling transport development are suggested. The first mode is applied to small- and middle-size cities with large cycling populations. It requires an integrated cycling network, adequate parking areas and service points. The other mode for large cities, a bicycle-bus transfer system, needs to be facilitated (Cao, 1996). However, the latter mode was questioned by using Beijing as a specific case (Zhang, 1995). The study indicates that the bicycle-bus mode places limitations on its users, because most vulnerable people, such as the elderly, children and the disabled, cannot use bicycles. They suggest that bicycle-bus mode is more suitable for the people who live on the urban periphery rather than in the central area, since the walking distance to bus stops is much longer.

Table 4.5. *Energy consumption in different transport modes*

	<i>Transport mode</i>					
	Cycling	Walking	Bus	Underground	Motorcycle	Car
Energy consumption kJ/(person×km)	63.84	328.86	714.00	322.40	1495.00	1795.10

Source: Zhao & Gao, 2007, Table 1.

4.3.3 Debates on sustainable development of urban streets

Although both traffic engineers and urbanists are working for the goal of sustainable development as a principle for transport planning and street design, they have different ways of interpreting the sustainability strategy. From an engineering perspective, sustainability can be interpreted as ‘efficiency’, which means increasing traffic demand can be eventually satisfied in the future at the least expense of energy and financial resources. In contrast, a majority of urban planners and architects consider urban streets, especially minor streets, as public space that does not merely serve traffic but also diverse social activities. They also consider a city itself as an indivisible part of the whole natural ecological environment and the street as the key ingredient in the urban-social-ecology system.

Like Hu’s (2002) optimistic expectation, a number of experts believe that the traffic problems in China can be ultimately solved by an optimal street network system and improved traffic

management technology. Moreover, some of them have focused on inventing ideal mathematical models for the optimal street geometry and network for universal applications. It is suggested by Wu and Shen (2003) that the street and network planning and design should aim at achieving fully functionalised streets and efficient and feasible road transport. “The certainty is that a blurred or mixed traffic system is significantly harmful to road transportation and even the whole circulation and redevelopment of the city. The modern urban street should be clearly classified in order to approach the most efficient use of each road category” (Wu & Shen, 2003: 4).

Owing to the lack of inclusive or mature considerations, many suggestions have little evidential support. For example, Yang (1997), a traffic engineer of the Institute of Municipal Engineering Design in Xiamen City, emphasises that the urban street should be designed in a more generous manner in order to meet the future traffic demands. The building setback to the arterial road is suggested to be as wide as 5-10 metres providing extra space for future widening. The extra area can be used for greenery at present, which can provide infrastructural preconditions for a “garden city” development. He also suggests that, along with the increased private car ownership, the provision of special lanes for cars in developed cities is financially feasible.

Jing (2000) also advocates the excessive/advanced design for urban streets and regional road transport networks: the priority in solving the urban traffic problems is to increase the transport infrastructure which is inadequate to facilitate the future growth of private cars. In the sustainable development project *Planning for Improvement of Regional Urban Transport in Guangzhou*, he suggests building expressways in the Tianhe District and reorganising the existing car parking space to allow for the sustainable rapid growth of motorisation within the context of the shortage of urban land space. However, conflict emerges between the ‘facilitating motorised traffic’ and the ‘people foremost’ principles in sustainable street designs. For example, Li and Zhou (1999) advocate that urban street design should be people-oriented with the aim at facilitating the efficiency in transporting greater volumes of people rather than automobiles. Nevertheless, they suggest that the design of the street cross-section should largely refer to the speed, type and size

of automobiles and set excessive standards to cope with the increasing numbers of automobiles.

In contrast, Chen and Guan (2006) advocate the elimination of the separation of pedestrians and automobiles to achieve a mixed use of streets in and out of urban residential districts. They believe that the speed of automobiles could be reduced to a 'safe level' in the shared street and that pedestrian amenity could be rediscovered by introducing greenery and active building fronts to the walking space. Social interactions and commercial developments along the street can be revived in the shared space. They also encourage the development of shared streets with casual green open spaces rather than expensive 'landscape boulevards' because the former are more popular with residents.

Li (2000) indicates that the present development of urban streets has neglected the function of place or social activity. Many historic cities and towns are almost flooded with automobiles. Alternative standards or guidelines should thus be used to guide the street design in cities with heritage and historic contexts to shape city identities. Land developments along the street should also give full consideration to historical and cultural sustainability by emphasising the continuity of the historical context and visual aesthetics (Li, 2000). Zhou and Zhu (2007) argue that urban street facilities, as well as the street itself, should also be pedestrian-oriented, considering the physical and psychological needs of street users, especially the most vulnerable users such as the elderly, children and the disabled, with the objective of creating an environment of social equity and equality. In order to facilitate social activities and reduce motor vehicle speeds, greenery and proper street furniture should be provided according to the local environment and climate along with casual small-scale open spaces (Zhou & Zhu, 2007).

It is clear that the experts hold different opinions on the sustainable design of urban streets. Although urban streets are increasingly acknowledged as public places which serve multiple functions and demand more inclusive considerations, they are still designed with great respect to vehicular movement and tagged with engineering professionalism.

4.4 CONCLUSION

Urban transport planning and management in China has been challenged by the flood of automobiles since the 1990s. Increased air pollution, traffic congestion, road accidents, city erosion and the consequent spatial and health inequity are more or less the negative impact of the rapid growth in automobile numbers. To simply increase the supply of road space may not be a good solution to deal with the urban traffic problems; since the new roads have not only attracted more private motor vehicles, but also relatively decreased the quality of public transport services and enlarged the area of urban sprawl which leads to a new wave of huge traffic demands. The automobile-oriented traffic induction loop has played a leading role in urban sprawl at present and would continue to reinforce the trend in future without proper control.

Street design in Chinese cities has been generally oriented for the use of automobiles. However, with the increasing recognition of sustainability requirements, a number of urban planners and architects have advocated alternative ways to improve urban street designs that encourage green transport and the reduction of private motorisation, rather than adopting the rigid design standards based on engineering instructions for vehicle movements. However, considering the paradigm of the traffic engineering profession and the growing bias towards automobiles in both economic and social lives, there is a reluctance to implement new approaches in Chinese cities. New design approaches have been exercised in western countries for 50 years, but rarely found in China. Theoretically, Chinese cities should have embraced the transportation policies that discourage private motorisation because of their high population densities and limited land resources.

It is very important to question the inconsistencies between sustainability strategy and car-centred street development in China and to identify the factors for the policy bias which has not fully been found in the literature. Therefore, it needs an examination of real-world planning and design practices of urban streets in Chinese cities to provide a substantial description of the current development trends. In subdivisions, problems in land-use control and transport planning, neglected needs in street design, political bias towards arteries and technical obstacles to

alternative design applications, etc. are all intended to be investigated and analysed to narrow the knowledge gap between the new thinking and actual practices of urban street design in China.

CHAPTER 5 RESEARCH METHODOLOGY

The methodology is shaped by the research objectives and the empirical studies of urban street design and practice. Although urban street design is well developed in theoretical knowledge terms since the last century, there is a lack of practical investigation into the particular conditions of Chinese cities. This means first-hand empirical investigation is very important as there is an aspiration in China to develop and justify methods to establish data foundations and facilitate the analysis of design trends of urban streets.

Through examining perceptible inconsistencies and discrepancies in regulation-based policies, design practices and outcomes, the present conditions of urban street design in China were investigated in this research. To establish a comprehensive understanding of the design trends, a multi-case study was employed with supporting field observations and interviews. The study eventually developed evidence-based recommendations to Chinese decision makers on the future practice of urban street design.

5.1 RESEARCH CONCEPTUALISATION

This section outlines a logical structure of key concepts as an overall framework for the research design. Yin (2009) believes that the choice of the right methodology is highly dependent on the research questions and the nature of the research subject. Burns (2000) indicates that all research methodologies have inherent flaws, thus a mixed use of multiple methods for data collection can enhance the strength of corroborating evidence. This study, aims to examine how the design trends of urban streets are generated and intensified in modern China, with the premise of a comprehensive understanding of current practical transport planning and the street design process. It does not only require an adequate theoretical literature review and archival surveys, but also a real-world investigation which offers more robust data and analysis.

5.1.1 Research aim, objectives and questions

The research aims to examine the contemporary trends and development approaches of urban streets in China, with a specific focus on real-world design processes through examining different standards, practices and outcomes. Under the overall aim, four research objectives are proposed and addressed by a number of research questions. These objectives are framed using a chronological logic which begins by recognising the historical and current trends, identifying the knowledge gaps, problems and reasons for the trends and providing solutions for future development.

Objective 1: to develop a critical understanding of conventional design standards and new global design trends for urban streets.

To provide the research with a wide and comprehensive context of the historical trends of urban street design and practices in developed countries, as well as the development and universal acceptance of traffic-engineering-based design codes and standards, the first objective therefore requires a broad review of the literature and empirical studies on both conventional and new approaches to urban street design. It focuses on responding to the following questions:

- How have engineering conventions in urban street design been developed and universally accepted?
- What are the problems and global criticisms of the conventional design approaches?
- How has the new thinking on urban street design been developed and practised since the post-war period?

Objective 2: to investigate current street design trends in China by exploring and identifying inconsistencies and discrepancies in design standards, practices and outcomes.

In order to investigate the real-world conditions of urban street design in China, the second objective was achieved by compiling and analysing data on contemporary design trends for different types of urban streets in Chinese cities. It provides the following discussions and

arguments with evidence-based findings and outcomes. The research issues are addressed through the following questions:

- What are the current trends and problems of urban transport and street design developments in China?
- To what extent have the national standards guided the actual design practice of urban streets?
- Where are the gaps among sustainability requirements, the national standards and actual practice?

Objective 3: to identify factors affecting current design trends and barriers to alternative design practices under Chinese political and technical conditions.

Based on the findings from the real-world investigation, the third objective reveals the challenges and opportunities of new design practice within the Chinese context. In order to determine the factors which have not been fully acknowledged by the previous studies, both exploratory and explanatory methods were employed to answer the following questions:

- How have the current design trends been formed and come to dominate China's urban street developments?
- What are the challenges and opportunities for applying new approaches to street design in Chinese cities?

Objective 4: to make recommendations for decision makers to develop better practices in street design to deliver sustainability policies.

The fourth objective intends to develop a set of evidence-based recommendations in both short- and long-term policy making and delivery, which requires a synthesis of the research findings from the above stages. The research questions focus on new approaches to better future street design practices in China.

- What are the key elements for successful sustainability policies in urban street developments?
- Based on what principles can sustainability in urban street design be approached in China?

5.1.2 Conceptual framework

The new global design trend uses the word ‘street’ to describe an area for public use, but not exclusively devoted to circulation. Streets play a crucial role in economic and social well-being and are at the heart of what people look for in their local environment (CABE, 2002). By focusing on the ways of accommodating vehicular traffic, the forms of urban streets have been exclusively dominated by traffic engineering conventions and functions for many years. The consequent built environment in turn stimulated the demand for private motorisation and contributed to the deterioration of the physical conditions for non-motorised travel modes.

With a whole set of negative consequences of automobile dependency, there was a need to change the current automobile-oriented design trends for urban streets in China. It requires a new policy framework with a full respect for sustainability in street planning and design processes. Besides the theoretical need to redefine a ‘good’ street, a comprehensive understanding of the current design trends in modern China becomes the priority of the new framework. The required changes could therefore be addressed by explanatory investigations into the current problems and by exploratory research into the practical challenges and opportunities.

According to the literature review in the previous chapters, the current design trends in China could be investigated through design standards, practices and outcomes. Other than descriptive investigations, the facts about how the standards, practices and outcomes are linked in the real world need to be determined and articulated. First, the relationship between the current design standards and traffic engineering conventions, as well as the reasons for the domination of these engineering conventions, could be analysed by reviewing existing studies and standards themselves. Second, the effectiveness of the design standards could be determined by examining and explaining the discrepancies between the regulatory requirements and actual practices. Third, as practical results, the design outcomes could change the practices in forms and functions for actual use with different purposes and result in positive or negative impacts on different street users. Factors for the changes and consequences could be discussed by analysing the physical

forms and human behaviours in streets.

Based on the previous empirical studies, a conceptual framework was developed to outline the key courses to promote understanding of the conceptual changes, actual design trends and processes, knowledge gaps and barriers to sustainability for urban streets in China. The review of the literature and empirical studies enhanced a comprehensive understanding of the paradigm shifts in urban street design in developed countries, as well as the current traffic problems and urban circulation environment in China's context. Then it identified the knowledge gap between sustainability policies and their delivery in urban street development in China. Through investigating the actual design trends and processes in Chinese cities, the research bridged the gap and provided a new policy framework for sustainable development of urban streets in China. The conceptual framework is illustrated as the following diagram (Figure 5.1). Although there could have been other approaches, e.g. social theory, given the practice-oriented nature of this research, the choice of concepts respected urban design theory e.g. Ben-Joseph's approach in the real-world investigation (Ben-Joseph, 2005).

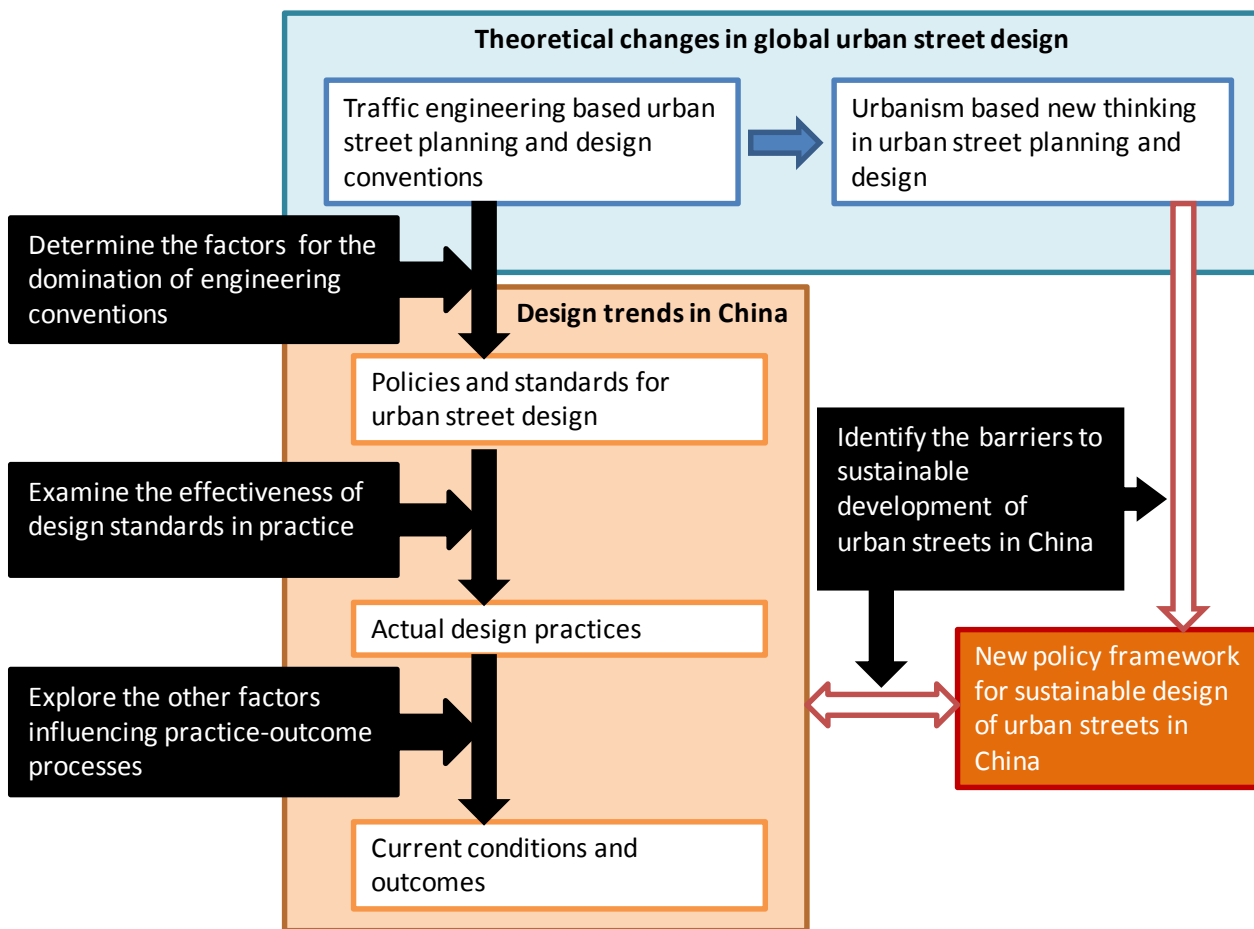


Figure 5.1. *Research conceptual framework*

5.1.3 Linking research objectives with methods

To bridge the research objectives and methods, it was important to consider the urban streets as an integrated system that accommodated varied activities and diverse needs rather than individual parts for the designed functions. To link research questions with methods, the schedule (Table 5.1) shows the methods corresponding to the research objectives and specific research questions.

Table 5.1. *Linking research objectives with methods*

Overall research aim: to examine the contemporary trends and development approaches in urban streets in China, with a specific focus on real-world design processes through examining different standards, practices and outcomes.				
<i>Objectives</i>	<i>Methods</i>	<i>Data requirement</i>	<i>Phases</i>	
Objective 1: to develop a critical understanding of conventional design standards and new design trends for global urban streets.	Literature review	·previous studies on the logic of universal acceptance of the conventional street design approaches, ·debates on the conventional paradigm, ·studies on the new thinking of sustainable street design, · new “good” practice in theory.	Identifying problem and opportunity	
		Literature, policy and standard review		·existing studies on the current trends of urban road transport development in China, ·current design standards and policies in China.
Objective 2: to investigate current street design trends in China by exploring and identifying inconsistencies and discrepancies in design standards, practices and outcomes.	Multi-case study	Archival and documentary examination	Data collection and analysis	
		Field observation and survey		·local urban transport and street design policies. ·historical maps, photographs, figures and reports of local street development.
		Mapping and illustrating		·physical changes in actual use of streets, ·street users’ behaviours, ·street elements.
Objective 3: to identify factors affecting current design trends and barriers to alternative design practices within the Chinese political and technical conditions.	Interview	·elite interviews: factors, motivations, values.	Discussion, evaluation and recommendation	
	Analysis and Discussion	·data collected from literature review and archival research, ·data collected from fieldwork, · findings of the multi-case study.		
Objective 4: to make recommendations for decision makers to develop better practices in street design to deliver sustainability policies.	Induction and further research	·all findings above, ·gaps and limitations of the research, ·considerations for further research.		

The necessary information for Objectives 1 and 2 was achieved by an academic review of previous research and empirical studies. There is a rich academic literature focused on both the theoretical and practical dimensions of urban road transport and street development since the 1990s. The review reflected the achievements and failures in the current practice of transport planning and street design, as well as the resulting impacts in social and environmental terms. It also provided the research with a critical understanding of relevant planning and design policies in China. By analysing the data obtained from the literature, a theoretical and methodological basis for the whole research was established.

A multi-case study was used as the primary method for the real-world investigation. The

'how/why' questions in Objectives 2 and 3 favoured the use of case studies to describe and explain the particular situation of urban street design trends in Chinese cities. Compared with a single-case study, the evidence and findings demonstrated from multiple cases were more convincing for research that intended to capture the wholeness and significance of the spatial, social and environmental aspects of existing phenomena.

The data for the case studies was collected in two ways. To have a substantial description of the current trends and problems of street design for each case, the first-hand data, such as the conditions of street components, road space allocation, street layouts and frontages, were obtained through fieldwork including site visits, field surveys and observations, etc. To achieve the background information for each sampled case, local transport policies, historical maps, development reports and photographs were collected through archival research and documentary examination.

In order to demonstrate the effectiveness of the national standards in guiding design practices, mapping and illustrating was used as the main method to analyse the data collected from the fieldwork and documents. The case studies used a large number of figures and tables to illustrate comparisons and analyses, since they were a strong and concise way of expressing the particular findings.

The use of elite interviews was another major method to obtain first-hand information in this research. These personal interviews were used to explore individual views and evaluations of current design trends for urban streets in China. They helped to identify the dominant factors for the trends that had not been fully recognised in the existing literature and research studies. As an exploratory method, conversations with interviewees were also constructive in determining the challenges and opportunities for a modal shift in urban street design in China.

Finally, through analyses and discussions on the key findings derived from above methods, key elements and principles were identified to achieve successful delivery of sustainability policies.

Recommendations on the new policy framework were developed to guide better practices of street design in China.

5.2 RESEARCH METHODS

Various approaches were considered, for example, Marshall's methodology of pattern analysis and Gehl's methodology of people-focused empirical survey and activity mapping (Marshall, 2005; Gehl, 1987). However, given the conceptual framework, the method had to examine the relation between design rules and outcomes. It therefore focused on the sociological and morphological investigation of a complex set of interrelated factors for urban street design in China. Multiple methods, such as a literature review, archival survey, multi-case study and systematic analysis were employed to explore and explain how the current street layouts were designed and implemented in the context of the universal standards and peculiar conditions in Chinese cities. The research methods were applied in two stages - data collection and analysis.

5.2.1 Multi-case study

Jacobs (1993) argues that subjectivity always exists in investigations of a street. They, therefore, require long-term surveys, multi-perspective examinations and multiple methods of data collection to reduce subjectivity as much as possible. Nevertheless, he suggests that researchers should tolerate some degree of subjectivity since it cannot be completely eliminated in research processes (*ibid.*).

In this research, nine sample streets in three cities were selected for the multi-case study by a set of criteria, in order to examine “what is actually happening in the real world when urban streets are designed, revised, implemented and valued” and “the effectiveness of the national standards

and sustainability strategy in directing these particular practices". The data for the case study were collected by a total of six months of fieldwork, which consisted of multiple methods in the real-world data collection, such as documentary examination, site surveys and field observation.

Deciding case study areas

Yin (2009) emphasises that any use of multi-case designs should follow a replication rather than a sampling logic, and each case must be chosen carefully. The selection of multiple cases therefore started by examining their characteristics which are required to be individually integrative and replicable, and representative of the most common conditions of cities in China. It is important to note that the main factors for the planning and design of urban streets in *Code for Transport Planning on Urban Roads* [GB 50220-95] are population-based (MoHURD, 1995a). Although it has particular disadvantages as a basis for highway standards, this is the typical approach in many aspects of Chinese public administration. It clearly states that the physical dimensions for each category of road largely depend on the city size (i.e. urban population) (Table 5.2).

Table 5.2. *Indicators for street and network planning in different sizes of cities*

	<i>City size*</i>	<i>Expressway</i>	<i>Main road</i>	<i>Secondary road</i>	<i>Minor road</i>
Designed Speed (km ² /hr.)	Large	60~80	40~60	40	30
	Medium	-	40	40	30
	Small	-	40	-	20
Street density (km/km ²)	Large	0.3~0.4	0.8~1.2	1.2~1.4	3~4
	Medium	-	1.0~1.2	1.2~1.4	3~4
	Small	-	3~6	-	3~8
Number of carriageways	Large	4~8	4~8	4~6	3~4
	Medium	-	4	2~4	2
	Small	-	2~4	-	2
Width (m)	Large	35~45	40~55	40~50	15~30
	Medium	-	35~45	30~40	15~20
	Small	-	25~35	-	12~15

*A large city refers to a city with a population larger than 500,000. A medium city refers to a city with a population between 200,000 and 500,000. A small city refers to a city with the population smaller than 200,000. Source: MoHURD, 1995a, Table 7.1.6.

Due to limited time and budget, the research selected three cities for case study with a set of justifiable criteria presented as below: First, all the selected cities should not have the same size of population and urban area. The transport problem changed with the size of city and comparisons between cities of very different sizes were therefore important (Thomson, 1977). It was acknowledged that travel distance and traffic demand increased along with city sizes. In addition, in order to achieve a comprehensive understanding of design trends in different circumstances, it had to reduce administrative and geographical gaps for data analysis and comparisons. Thus, for the case study areas, the research selected two large cities and one small city with two cities located in the same province.

Second, each chosen city should have significance in both local history and economic growth, because the research fieldwork aimed at investigating the modern (conventional) design practices of urban streets, as well as traditional street layout for a better understanding of their transformation. The selected city should have a relatively high population density, rich inhabitation history, and a remarkable growth rate for motor vehicle ownership and road supply. In order to circumvent extreme conditions in traffic demand and travel distance, cities with medium-sized populations and built-up area were preferred in this research. Last but not least, since cities in China are widely and unevenly distributed, those chosen should be easily-accessible to the investigator alone within the limited fieldwork period to avoid long distance travelling.

According to the criteria, two groups of cities were selected by their different sizes: two large cities (Hangzhou and Harbin) and one small city (Pinghu) (Figure 5.2; Table 5.3; the detailed selection process can be found in Appendix 1). This assumed that cities with very different sizes should have very different traffic problems and responses. Applying this theory to the multi-case study, traffic problems and street design trends might significantly vary between the big cities (i.e. Hangzhou and Harbin) and the small city (i.e. Pinghu).



Figure 5.2. Geographical locations of the selected cities

Table 5.3. Summary of the selected cities

City	Size	Population in central built-up area (in thousands)	Location	Built-up area (km ²) (2008)	Population density (person / km ²)	Number of private motor vehicles (in thousands)	Private motor vehicle ownership (per 1000 persons)
Hangzhou	Large	4,140	Zhejiang province	314.5	13,163	789	191
Harbin	Large	4,642	Heilongjiang province	302	15,371	322 (2007)	69
Pinghu	Small	180	Zhejiang province	49	3,673	108 (2007)	52 (2007)

Source: National and Local Statistic Yearbook of Hangzhou and Harbin, 2008-2009; Local Statistic Yearbook of Pinghu, 2008-2009.

Hangzhou, the capital of Zhejiang Province, was one of the most outstanding cities in this area with significant economic and urban development, as well as serious transport problems. Harbin, the capital of Heilongjiang Province, is one of the largest cities in northeast China, in which the

urban context and traditional streets are greatly characterised by both Chinese and colonial styles. In contrast with Hangzhou, street design in Harbin had to respond to different climate conditions. Moreover, these two cities are similar in population density, size of population and built-up area. In terms of small city selection, Pinghu was selected as a small city located near Hangzhou in North Zhejiang Province. Compared with the other small cities in Zhejiang Province, Pinghu had a medium-sized population and built-up area. Along with the rapid growth in its economy, motor vehicle ownership and road supply have increased significantly in this small city.

Selecting sample streets

In terms of sample street selection, although the conventional hierarchical system of urban streets has been debated, it was still important to employ the classification system for investigating the current design trends in China. Besides the optional expressway, Chinese national standards classify urban streets into three types: arterial road, secondary road and branch road. The sample streets in each city should cover the full spectrum of this hierarchy.

The selection of the samples from a large number of streets in the case study cities should be inclusive in physical forms and uses for all travel modes, as well as representative of the surrounding land-use. For availability and accessibility in data collection, it was important to select the samples that are significant in local road transport development history and with relatively comprehensive development records and reports. The selection, therefore, came up with nine streets in the three cities that are generally representative of the common conditions of street design in China (Table 5.4). It was worth noting that Wenjin Road in Pinghu was the only sample street not located in a central area, since it is suggested for a case of street design in a peripheral residential area. For a specific investigation, an inclusive data sheet for each case of street was used (Appendix 2). The data sheet covers the core information that was regarded as necessary for the analysis of the case study.

Table 5.4. *The selected sample streets*

City	Road type	Types of selected Streets	Surrounding land-use
Hangzhou	Arterial	Qingchun Road	Business and residence
	Secondary	Zhongshan Road	Residence, retail and education
	Branch	Haier <i>Xiang</i> (Ally)	Residence and retail
Harbin	Arterial	Dazhi Street	Administrative business and retail
	Secondary	Guogeli Street	Highly mixed
	Branch	Manzhouli Street	Residence and education
Pinghu	Arterial	Chennan Road	Residence and business
	Secondary	Renmin Road	Residence and retail
	Branch	Wenjin Road	Residence and education

It is important to point out that the current standards established in the 1990s have little control over the earlier development history of the sample streets. Only the recent revision practices are expected to be responsible for the regulated requirements. The study has to take into account that discrepancies between the standards and practices are significantly influenced by actual conditions which can hardly be compromised. The difficulty in the examination is, nevertheless, inevitable since most urban streets were built earlier than the current standards. It is, therefore, important to employ a number of newly built suburban roads as reference for the examination.

Documentary examination

The desk-based research into documents and archival records involved an examination of contemporary and historical data. It focused on previous and existing conditions of urban street design practices in the case study areas. The examination aimed at providing each case with the necessary background information, including local policies, reports, records, maps and photographs for street development over time.

Local policies for street design were often determined in local or regional master plans, or specific plans for urban road transport. Some streets with historical significance, such as Zhongshan Road in Hangzhou, had a specific design strategy for their development. By examining those policies, planning and design strategies, some factors for current design trends of the sample streets could be interpreted. Those policies could easily be accessed by visiting

government or local planning websites.

Supplementary data for the development of a certain sample street could be described by reviewing relevant local reports, such as traffic problems accidents, congestion and illegal activities in the sample streets. This was useful for establishing a more critical understanding of design practices and consequences.

Historical records, maps and photographs were essential for highlighting the transformations of the sample streets. They were important methods describing physical changes of a street over time. Those data were often interspersed in various kinds of documents, archives and even personal collections and required considerable efforts to collect. It was worth noting that the data were not evenly available for each sample street. The development histories of arterial roads and the roads with significant historic values were, therefore, more likely to be identified by this method.

Field observations

A combination of participant and structured observations was used in the multi-case study. Field observation is widely used in design studies on open spaces which require practical data for analysing the real-world conditions (Jacobs, 1993; Gehl, 2010). According to Gillham (2000), participant observation can be used at first for the getting-to-know phase of the research. Participant observation which involved the investigator's own experiences, feelings, fears and anxieties could more or less capture the actual conditions of a certain place (Gray, 2004). In this research, participant observation of each sample street allowed the physical features, psychological issues and incidental events to be identified and obtained.

Structured observation that might be more quantitative usually comes later when the research issues have become well in focus (Gillham, 2000). In this research, it involved counting

movement and activity for each travel mode in the sample streets under different weather and climatic conditions. It aimed to determine and compare the positive and negative conditions of each street by using a quantitative analysis of human behaviours. Observations were recorded immediately by written notes and developed by visual media in the form of tables, illustrations, sketches and photographs to provide a robust database for each case.

It was impossible for the researcher to observe every activity taking place in a situation. It was therefore important to focus on key areas and time periods (Gray, 2004). Human behaviours in each sample street were observed at several points, which were usually intersections, during both peak and off-peak thirty-minute periods. The observations for each street were made on weekdays under different weather conditions. If permitted by time and budget, some streets were revisited to test the reliability of the observation results.

5.2.2 Semi-structured interviews

Due to the limitation of the literature concerning the Chinese context, the use of interviews can be considered as an important approach to improving the understanding of the current phenomenon. Kvale (1996) and Robson (2002) believe that interview is a widely preferred method when the research wants to get an in-depth and grounded understanding of a specific topic. Semi-structured interviews are semi-standardised and often used in qualitative analysis, allowing the investigator to cover both predetermined questions and potential issues that had not been previously considered but were raised during the conversation process (Robson, 2002; Gray, 2004).

Face-to-face interviews were employed in this research, to ascertain the actual experience, perceptions and perspectives which had never been examined in previous studies. It was preferred for the elite interviews for the purpose of eliciting more sophisticated information from experts (Gillham, 2000). The researcher interviewed 23 experts including academics, urban planners and designers, highway engineers, architects, landscape architects, government officials and local

public transport operators who were mainly from the selected cities. The interviewees were more or less familiar with street design processes or had experience in urban street design. They were chosen on the basis of convenience (i.e. accessibility and availability) and by snowballing (i.e. one interviewee could be introduced by another). However, concerning their accessibility and responsibility, the interviews were not evenly distributed in each city. Some of the interviewees were from the cities of Shanghai and Nanjing which supported stronger academic resources. The final composition of the interviewees is listed below (Table 5.5):

Table 5.5. *Distribution of interviewees by cities and disciplines*

City	Stakeholder disciplines							Total	Total (expected)
	Academic	Urban planner	Highway engineer	Architect	Landscape architect	Government official	Local bus operator		
Hangzhou	1	1	1	0	2	0	0	5	10
Harbin	1	1	1	1	0	1	1	6	10
Pinghu	0	1	1	1	0	2	1	6	10
Shanghai	1	1	0	1	1	0	0	4	0
Nanjing	1	1	0	0	0	0	0	2	0
Total	4	5	3	3	3	3	2	23	
Total (expected)	5	5	5	5	4	4	2		30

Before the interviews, questions were concisely prepared according to the findings obtained from the previous research stages. Each interview included 6 to 8 predetermined questions depending on the interviewee's discipline. The questions covered three main topics: evaluations and explanations of the current design trends and recognised challenges to alternative design approaches. Details of the interview questions are given in Appendix 3. All the interview responses were precisely transcribed, and a majority of them were also electronically recorded with the interviewees' permission. The data collected from elite interviews were mainly personal qualitative perceptions and for special cases, some documentary data of local plans and statistics. They were analysed with the focus on two aspects: undiscovered factors for the current design trends of urban streets which had not been considered or mentioned by previous studies; and interviewees' authentic agreements or disagreements with the findings from the preceding stages. However, the number of interviews actually carried out was much less than planned, because

some of them were turned down or interrupted or provisionally declined by the predetermined time or place. Besides, some interviews were poorly organised and offered very limited information since the interviewees' ways of expression were too general to be probed. It was clear that if an interviewee was interested in a certain topic, more useful information could be obtained from the conversation. It also suggested that more specific questions could evoke more interest from the interviewee. In contrast, if a topic was too general or broad, the respondents would be reluctant to give their own opinions. For example, most interviewees could barely respond to the meaning of sustainability in the contemporary street design practices. Based on this phenomenon, the questions were gradually updated from one interview to the next.

It was worth noting that street users were intensively concerned in the research but not eventually involved in the interviews, because very limited information provided by them had been suggested as useful data for the research. First, a pilot research showed that the feelings of street users could be neutrally reflected by the means of observation and previous research. It suggested that the required data could be more easily and objectively obtained by the researcher's observations and literature review than through interviews. Second, it required a relatively large number of street users' opinions to represent objective findings of the daily street conditions. It exceeded the researcher's ability to collect such a large amount of data. In other words, the limited quantity of street-user interviews could hardly reflect common or representative ideas on the actual conditions of urban streets and their subjectivity was more likely to be questioned. Nevertheless, the research was not advocating that the street-user interviews were not as important as elite interviews. The former could be used in the further research when more resources of time, budget and manpower might be available.

5.2.3 Analysis and discussion

The collected data were analysed with the focus on the correlations among street design standards,

actual planning and design practices and outcomes. The results of the analysis were discussed to establish a critical understanding of the current trends and challenges to alternative design approaches, and develop recommendations for achieving “good practice” for future urban street designs in China.

The different types of data were analysed by a variety of approaches. Mapping and illustrating were extensively used in analysing the physical conditions of the sample streets. Street forms and layouts could be visualised and extracted by eliminating unimportant and unnecessary information. The process facilitated both qualitative and quantitative analysis on a model-like extract. And it provided both the researcher and readers with direct perceptions of the descriptive demonstrations (see Appendix 4).

Historical and contemporary photographs were widely used as supportive materials for analysis. Photographs could reliably tell what was happening at a certain time and place. It could also reflect changes over time by comparing the pictures from different time periods. Nevertheless, a single picture could be questioned as inadequate for robust evidence. In this research, photographs were often grouped to indicate or explain a situation.

New information could be obtained by classifying and comparing the data. The data from the sample streets were classified according to their types and forms, and then compared with the relevant standards. By identifying the inconsistency between practices and standards, the effectiveness of the current design standards could be examined. The data were also classified according to street functions for different users’ needs. Comparing the groups of different functional foci and human behaviour revealed how negotiations between different street users were made and reflected in the final outcomes. The data were therefore analysed to investigate the real-world design procedure from standards to actions and outcomes. In this process, unexpected findings could be obtained, such as new factors for the current design trends and unsuspected challenges to sustainable urban street development.

Content analysis was used in analysing the data collected from the interviews. Flick (1998) distinguished three steps in the content analysis process: summarising, explicating and structuring. Through summarising the conversation records, the common opinions on a certain topic were identified and paraphrased. In the explicating stage, characteristic features were revealed by breaking the paraphrases down into smaller units. Ambiguous or contradictory materials were distinguished and clarified. Then, the specific materials were restructured to interpret and explain a situation and new, previously unrecognised insights were also obtained. The interviewees' attitudes were compared and ranked to clarify the intensity of the opinions about a certain field.

All the findings were discussed and evaluated with the focus on physical changes in street forms and layouts. People's attitudes and comments on the present standards, practices and outcomes were also obtained. The findings might vary with the street type and location, local policy, climate and dominant travel mode. The different results from the analysis of each sample street were therefore clarified and articulated.

At first, the findings and results were restructured by different spatial scales from the national to the local level, with an in-depth examination of their similarities and differences. Then the findings were discussed by reintroducing the arguments from previous research. New factors, challenges and opportunities could be revealed and proved. At the induction stage, the discussion developed an indicative framework for sustainability in urban street design with alternative methods that could provide recommendations for decision makers. However, the framework did not focus on formulating new models for sustainable street design, but on determining the scope for justifiable alternative schemes of future good practices at both national and local levels. The final discussion arose from the evidence-based findings and results. The framework for decision makers should therefore be reliable and deliverable. Meanwhile, the research limitations were clarified through the investigation process, which raised detailed concerns for further empirical research.

5.3 CONCLUSION

This chapter demonstrates the design of the research methodology including the conceptual framework and mixture of methods. The use of this methodology in this research is determined by the research aims, objectives and questions which focus on the assessment of current design trends and the proposals for a new policy framework for the sustainable development of urban streets in China. The focus of the methodology is to engage in real-world investigations involving elite interviews and a multi-case study using multiple methods for both data collection and analysis.

CHAPTER 6 POLICIES AND REGULATIONS OF URBAN STREET DEVELOPMENT IN CHINA

Policies and regulations are legislated guidance with a compulsory obligation to have a decision-making procedure for urban street planning and design. The relevant policies often consist of design codes and standards, land-use regulations and urban transport development policies. This chapter examines the policies and their delivery and identifies the factors that influence the decision making concerning urban street planning and design procedures. The chapter first introduces relevant policies, laws and standards for urban street development to contextualise the research within the policy background. It then examines the current practices for urban road transport development and land-use-related planning under national policy guidance and standards. This helps to identify the problems and inconsistencies between national policies and actual practices.

6.1 POLICY FRAMEWORK FOR URBAN STREET DEVELOPMENT

A contextual understanding of the policy framework provides the research and case studies with the background of key elements to be fully met in any street planning and design processes. Codes and standards are the most direct requirements to be followed in deciding all the physical dimensions of a street. Land-use-related policies can influence urban spatial organisation which strongly affect the actual development trends of urban road transport. Policies for public transport development and private motorisation control ask for diverse travel modes to be sustained through decision-making procedures for street planning and design. The policy framework for urban street development can be considered as both rules and requests for actual practices of planning and design.

6.1.1 Street design legislation in the urban planning system

In order to involve rural areas in the whole planning system, the 2008 *Urban and Rural Planning Act* replaced the former *Urban Planning Act*. However, this significant change did not radically influence urban street development in Chinese cities and towns. The new planning system for urban and town plans has not been significantly changed. Figure 6.1 shows the urban planning system at the local level. Following the planning principles at national and provincial levels, local master and detailed plans are normally oriented by local planning policies. The policies are proposed by the Committee of Urban & Rural Development of the local People's Congress, and then individually or cooperatively reported by the responsible departments. After being formally demonstrated and adopted through conferences held by local government, the policies are then published, interpreted and delivered by the relevant local government offices e.g. the Urban Planning Bureau.

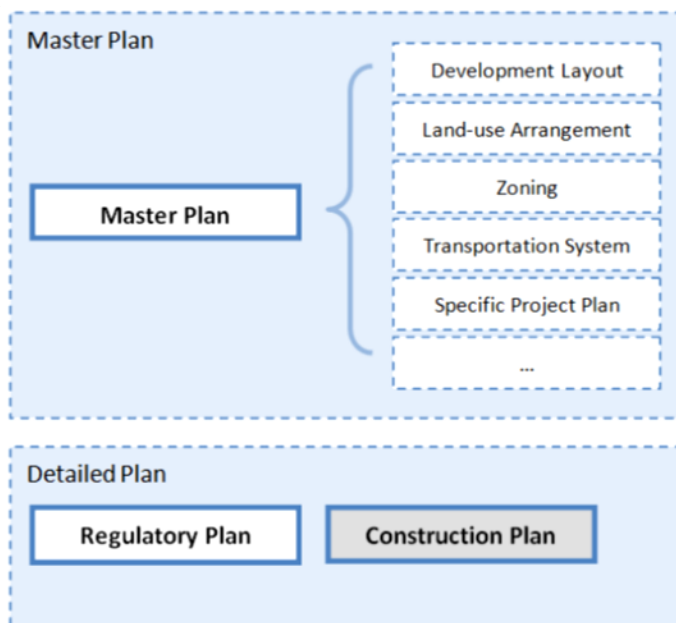


Figure 6.1. *Planning system for urban/town plans in China* (shaded plan is optional).

Source: adapted from NPCSC, 2008.

A master plan involves a set of blueprints and text-based schemes and explanations which define land-use boundaries and layouts and guide site developments. A detailed plan schedule includes

regulatory plans and, optionally, construction plans. A regulatory plan is combined with planning and management that stipulates specific land-use, space, architecture, environment and transport developments, while a construction plan focuses on architectural constructions in a particular parcel of land. For urban street design, the illustrated system covers all the legislated design processes for urban streets. For the development in old and new areas, there is no difference in the planning procedure, but in planning policies and principles. For example, the plan of street networks often remains unaltered in old areas since the existing context is an important reference for new adjacent developments.

According to the planning system, urban road transport structures which consist of expressways, arterial and secondary roads are determined at the very beginning of the master plan as preliminary frameworks. The design of urban arterial and secondary roads, including the geometric forms and segments, is indicated in the master plan, and then completed in the regulatory plan, while the design of branch roads is mainly processed in the regulatory plan. In other words, all the physical dimensions for an urban street can be determined and legislated in the master and regulatory plans. Figure 6.2 shows some examples of maps for the master plan, regulatory plan and urban design of Hangzhou. The plans have legal validity while urban design is just a suggestive approach to site development. It has to clarify that urban design does not cover all the streets which need to be designed. In this example, due to the historical significance, Zhongshan Road can be involved in the urban design. Since the layouts and forms of urban streets are completely determined in the regulatory plan, most street designs seem to be irrelevant with surrounding buildings or constructions which are not specified at this stage.

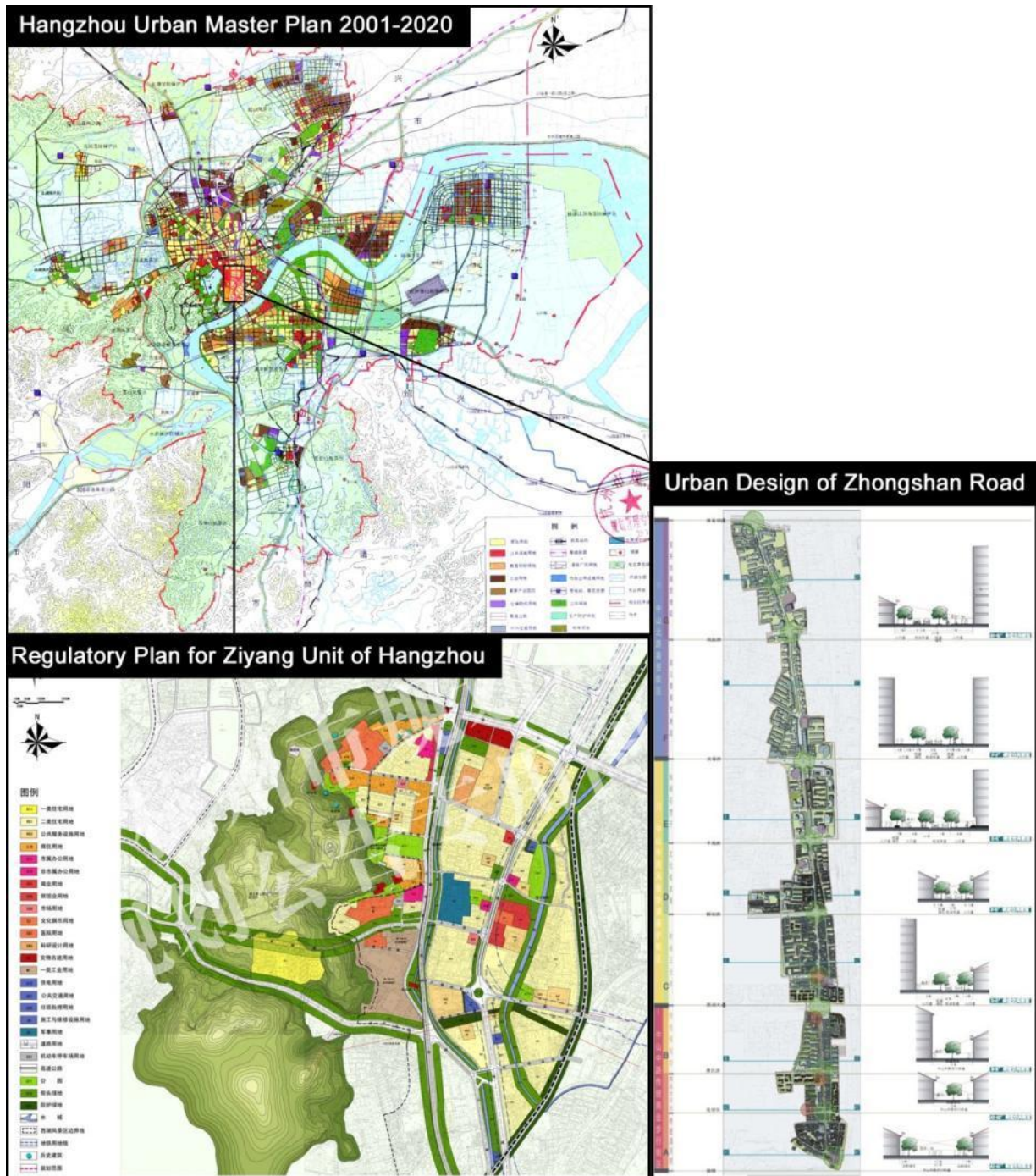


Figure 6.2. Examples of the master plan (top left), regulatory plan (bottom left) and urban design (right) in Hangzhou

Source: adapted from Hangzhou Urban Planning Bureau, 2001; 2006; 2007.

A design process is supposed to comply with relevant legislation and strictly follow national standards and guidelines to ensure the legality of the result. Figure 6.3 shows the main legislation and standards that have to be fully respected in any urban street design process. According to the

content of those regulations, the *Code for Transport Planning on Urban Roads* [GB 50220-95] and the *Standards for Urban Street Design* [CJJ 37-90] are the key documents for urban street design. ‘GB’ means ‘national standard’ while ‘CJJ’ stands for ‘regulation for specific urban construction or development’. The figures are serial numbers and end with the established year. For example, GB 50220-95 indicates that it is a national standard number 50220, and the latest year of the regulation approved or updated is 1995. In addition, CJJs are also the standards at the national level but more specific in their disciplines.

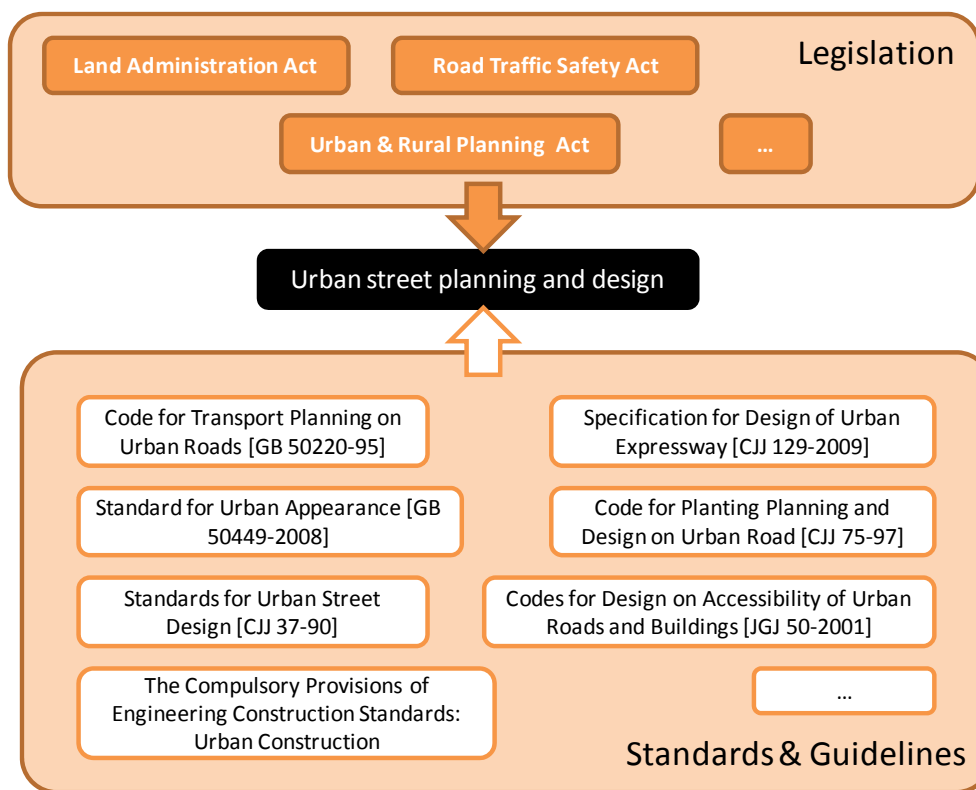


Figure 6.3. Legislated acts, standards and guidelines for urban street planning and design

Traffic engineering domination of design codes and standards can be identified by content analysis of relevant documents. *The Compulsory Provisions of Engineering Construction Standards* (CPECS) are a set of documents that summarise all the compulsory clauses from relevant codes and standards, e.g. GB 50220-95 and CJJ 37-90. The documents explicitly indicate that the compulsory regulations are mainly based on engineering requirements (NPCSC, 2000). As stated in the Explanatory Memorandum for GB 50220-95 (MoHURD, 1995b), planning of an

urban street and traffic network should be mainly based on traffic engineering techniques and feasibility assessment. Through systematic surveys of urban topography, economic development and level of local techniques, planning should seek the optimal scheme for economic efficiency and feasibility. The suggested flow chart for urban road transport planning is shown in Figure 6.4.

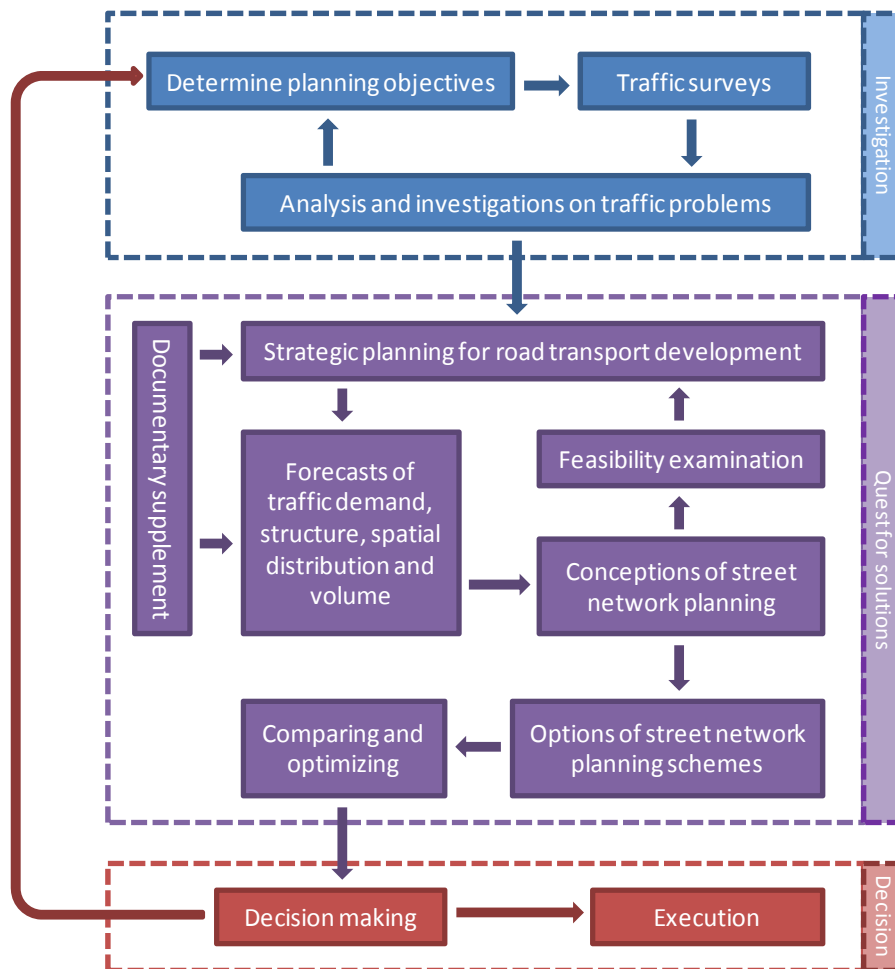


Figure 6.4. *Urban Road Transport Planning Process*

Source: adapted and translated from MoHURD, 1995a, Figure 1.

6.1.2 Street design codes and standards

The *Urban and Rural Planning Act* places a great emphasis on the importance of the technical standards and codes for planning and design. In Clause 62, it claims that the responsible

department who fails to meet the relevant standards or codes in planning procedures should be punished by local authorities. The technical standards are not only the legal basis for urban and rural planning, but also the important reference for regulating, monitoring and examining the process and implementation of planning. However, compiling progress of the standards for urban and rural planning is slow and even reluctant. Only one third of the standards have been established so far, which has intensively influenced the rationality and effectiveness in establishing and administrating urban and rural planning (Huang, 2008). The standardisation system which is indisputable and rigid becomes increasingly important along with the implementation of the new planning law.

The use of a hierarchical system and traffic segregation in urban streets are strongly emphasised in GB 50220-95. As stated in Clauses 7.1.2 and 7.1.3, urban street planning should meet the requirements of segregation between people and vehicles, non-motorised vehicles and automobiles; and urban streets should be classified into four categories: expressways, arterial roads, secondary roads and branch roads (MoHURD, 1995a: 7.1.2-3).

According to CJJ 37-90, street design standards and codes are rigidly based on the size and speed of automobiles, as well as traffic volumes estimated by urban population because the urban roads are conventionally considered as industrial products that accommodate vehicular flows. For example, the widths of vehicle lanes are defined by designed speeds and vehicle types (Table 6.1), while the width measurements for cycle lanes and pavements are determined by traffic volumes.

Table 6.1. *Width for motor vehicle lanes*

<i>Type of automobiles</i>	<i>Designed speed (km/hr.)</i>	<i>Width per traffic lanes (m)</i>
Heavy vehicle / mixed heavy and small vehicle	> or =40	3.75
	<40	3.5
Small vehicle lane		3.5
Slip lane at bus stop		3

Source: MoHURD, 1990a, Table 4.3.1.

In the light of both domestic and foreign experience in urban street development, the interpretation shows the deficiency and inaccuracy in forecasting traffic demand since the

increase of local traffic demand is inevitably faster than the growth in urban population and land use. Transportation development is also strongly affected by varieties of local policies. Regarding the rapid process of urbanisation in China, the population-based standards often propose great advancement and flexibility in coding urban street planning and layouts (GB50220-95, 1995: 45-46). Based on these limited and problematic benchmarks, urban streets are more inclined to be designed to have a higher design speed, a greater number of vehicle lanes and larger street width. Such changes go beyond the patterns of the new good practices in developed countries.

Once a road type has been determined, regarding the currently employed industrial standards, i.e. CJJ 37-90, local traffic volumes and features can become the determinants of designing street cross-sections and intersections. According to Clause 1.0.3 in CJJ 37-90, urban street design should consistently follow a certain type, boundary and total width, cross-section form, controlled elevation and underground infrastructure determined in the local master plan, as well as traffic volume, traffic features and the technical requirements of surrounding constructions. As indicated in Clause 4.1.1, in order to ensure traffic flow and safety, the form of the cross-section and proportion of every component of the design scheme should be arranged in accordance with street type, design speed, service length, traffic organization, volumes and features of travel modes, traffic facilities, underground infrastructure, greenery and terrain.

In summary, Table 6.2 shows the essential design principles determined by a variety of key indicators as required by the national standards. These principles can determine the basic forms of urban streets in the development programmes.

Table 6.2. *Key indicators of urban street design.*

<i>Key indicator</i>	<i>Main determinants</i>					<i>Main targets</i>
	Road type	Urban population	Local traffic volume and features*	Local street network layout	Design speed	
Total width	√	√				
Design speed	√	√				
Number of vehicle lanes	√	√				
Cross section form**	√		√		√	Traffic flow and safety
Intersection form			√	√	√	
Land-width					√	

* Traffic feature suggests travel model split.

** Cross section form includes determining proportions of pavement, cycle lane and carriageway and provision of separators.

Source: MoHURD, 1990a; 1995a; 1995b.

The cross-section design of urban streets is regulated in CJJ 37-90. Based on the number and position of separators, four types (A to D) of cross-section are suggested in the standard (Figure 6.5). Deciding cross-section types for a street design should respect traffic volumes and speeds of different travel modes. For example, Types C or D would be preferred if cycling traffic flow is heavy on this road.

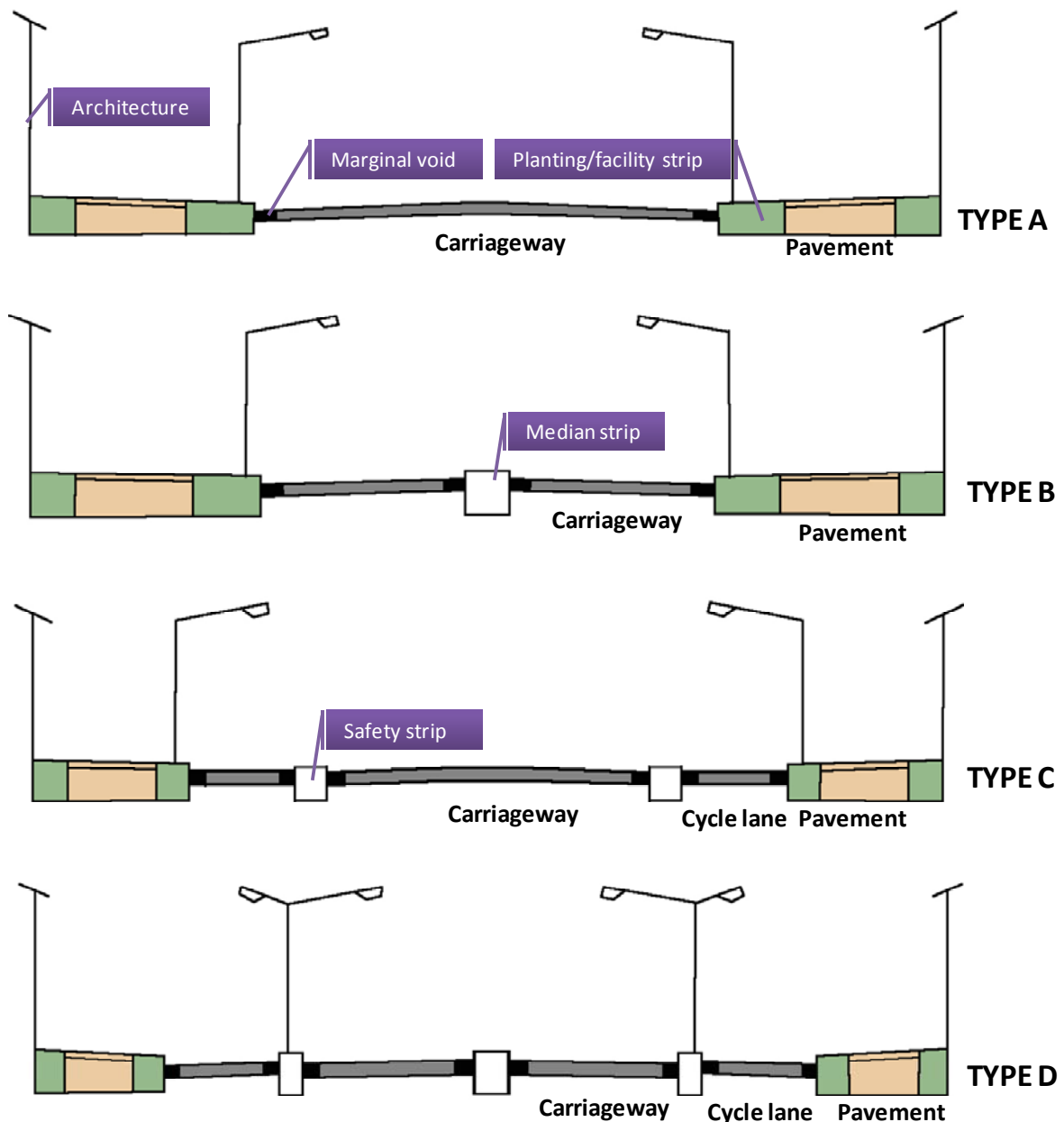


Figure 6.5. Four types of street cross-sections

Source: translated and adapted from MoHURD, 1990a, Figure 4.2.1.

In terms of intersection design, additional vehicle lanes are expected to be provided at the intersections where traffic volumes are heavy (MoHURD, 1990a; 1995a). As stated in the explication for GB 50220-95, *the road capacity should be increased by enlarging road space to compensate for the waiting time for traffic lights* (MoHURD, 1995b: 7.4.3 & 7.4.4). Vertical intersections i.e. flyovers and underpasses can be applied to the intersection of two arterial roads

which have more than four vehicle lanes and where traffic volumes exceed 4,000 cars per hour (MoHURD, 1990a: 6.1.8). The standard suggests that vertical intersections should be least considered only if traffic flows could not be effectively organised at normal intersections (*ibid.*). Nevertheless, this premise can be easily compromised by the ‘projected’ traffic volume if the application of a vertical intersection is permitted by physical and financial conditions, since other considerations e.g. impact on the environment and aesthetics are not indicated in the standards.

Design principles for an intersection mainly include cross angles, kerb radius, stopping sight distance (SSD), lane control, additional vehicle lanes and specific parameters for roundabouts. Normally, the standards favour an intersection designed in the shape of a cross with the angle above 45°. As an alternative intersection, staggered junctions are not encouraged. Kerb radius for a carriageway mostly depends on the designed turning speed of both crossing roads. The designed turning speed is briefly a half of the designed speed and determines the minimum kerb radius (Table 6.3). SSD requires a sight clearance within the splay formed by the estimated SSDs in both intersecting roads. It is worth noting that the SSDs in CJJ 37-90 are much larger than in the MfS (Table 6.4). This difference might be addressed in their different perception-reaction times - 2.5 seconds in CJJ 37-90 and 1.5 seconds in the MfS.

Table 6.3. *Minimum right turning radius of an intersection*

Designed speed for right turning (km/hr.)	30	25	20	15
Required minimum turning radius (m)	33-38	20-25	10-15	5-10

Source: MoHURD, 1990a, Table 6.2.4

Table 6.4. *SSDs for urban streets in CJJ 37-90 and the MfS*

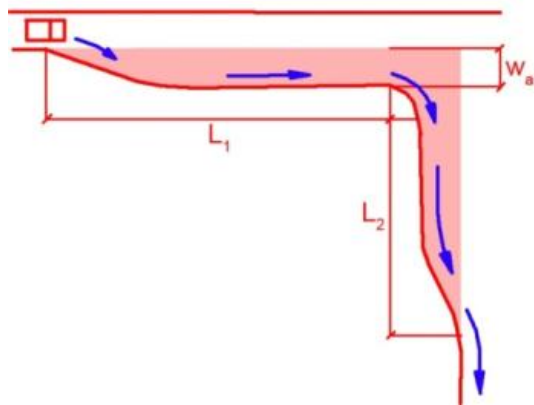
Speed (km/hr.)	80	60	50	45	40	35	30	25	20	15	10
SSD in CJJ 37-90 (metres)	110	70	60	45	40	35	30	25	20	15	10
SSD in the MfS* (metres)		59	45	39	33	-	23	18	14	-	-

*SSD should be adjusted for bonnet length.

Source: MoHURD, 1990a, Table 5.1.11-1; DfT & CLG, 2007, Table 7.1.

Lane control is generally required in designing an intersection which serves heavy volumes of motor traffic. It requires motor vehicles to use different lanes at intersections for different driving directions. Additional vehicle lanes need to be created to conduct turning vehicle flows in an

intersection where a flow becomes more than 3 or 4 cars per traffic signal period. Once an extra right-turn lane is created in a carriageway, another additional lane is required in its crossed carriageway for vehicle acceleration (Figure 6.6). In Figure 6.6, L_1 and L_2 stand for the lengths of added vehicle lanes for right turning channelization and post-turning acceleration, which mainly responds to the design turning speed. W_a stands for the width of the added lane, which should be allocated at between 3 and 3.5 metres. Due to the rapidly growing vehicle volume and the



increasing length of traffic signal interval in urban arterial roads, lane control and additional lanes have increasingly become a necessity rather than an option.

Figure 6.6. *Right-turn design of an additional lane*

Source: MoHURD, 1990a, Figure 6.2.7.

The general layout and form for a street can be defined by the above dimensions. To summarise, the main dimensions for designing a street largely depend on the traffic volumes estimated by street position and local population. In addition, the more specific geometrical requirements of street design codes and standards would be introduced and articulated in the multi-case study in Chapter 8.

6.1.3 Land-use-related policies

The *Land Administration Act of the People's Republic of China*, part of the national fundamental legislative framework, enacted in 1986 and slightly amended in 1988 and 2004, is formulated with the objectives to “enhance the rationality in land-use management, safeguard socialist public ownership of land resources, and promote social and economic sustainability” (NPCSC, 2004: 1.1). The *Act* strongly stresses the limitations of land resources in China, as stated in Chapter 1, Clause 3, as one of the fundamental strategies of the country where “every level of government

should protect and use land resources and restrain illegal occupancy of land by adopting measurements of integrative planning and strict administration". The 2008 *Urban and Rural Planning Act* explicitly emphasises equity in the use of spatial resources and the importance of intensive development as fundamental principles for planning. This is due to the persistent lack of resources and the increasing pressure on the environment in China (Huang, 2008).

All levels of local authorities are responsible for organising and managing local land-use planning according to the requirements of social and economic development plans, national land renovation, environmental and resource conservation, site capacity and the superior land-use plans. The master plan of land-use - another planning system differing from the one defined in the *Urban and Rural Planning Act* - indicated that urban and rural master plans should be formulated in accordance with land-use plans. It implies the precedence of the *Land Administration Act* and land-use plans. Kenworthy and Hu (2002) believe that the *Land Administration Act* is designed to prevent cities from experiencing extensive urban sprawl and to restrain the use of massive amounts of land for urban transport infrastructure. *China has clear and strict national laws and regulations to secure the control of urban development*, which might be one of the significant differences between China and some other Asian countries (*ibid.* 11).

The area and proportion of different categories of land-use for construction is explicitly defined in *Standard for Urban Land-Use Classification and Planning Land-Use* [GBJ 137-90], a national development standard established in 1990 by the Ministry of Construction. Table 6.5 indicates the area requirements for *per capita* land-use for construction by different grades of development intensity. These required standards express the central government's expectations on restricting the consumption of construction land. Meanwhile, Table 6.6 shows the proposed contribution of land to ensure the basic demands in urban land-use for residential, industrial, streets and squares and green space development.

Table 6.5. *Standard of per capita land-use for construction* in China*

Present per capita land-use for construction (m²/person)	Planned per capita Land-use for construction (m²/person)		
	<i>Intensity grade</i>	<i>i.e.</i>	<i>Per capita Land-use (m²/person)</i>
≤ 60.0	I	Old and dense central areas	60.1~75.0
60.1~75.0	I	Old and dense central areas	60.1~75.0
	II	Restricted new development	75.1~90.0
75.1~90.0	II	Restricted new development	75.1~90.0
	III	New development areas	90.1~105.0
90.1~105.0	II	Restricted new development	75.1~90.0
	III	New development areas	90.1~105.0
	IV	Special economic zones	105.1~120.0
105.1~120.0	III	New development areas	90.1~105.0
	IV	Special economic zones	105.1~120.0
>120.0	III	New development areas	90.1~105.0
	IV	Special economic zones	105.1~120.0

*Land-use for construction includes the land used for housing, retailing and business, infrastructure, industry and manufacture, warehouses, transportation, streets, squares, municipal utilities, green space and some special uses.

Source: adapted from MoHURD, 1990b, Tables 4.1.1 & 4.1.3.

Table 6.6. *Permitted ranges of per capita area and the percentages of urban land allocated for different uses*

Category of urban land-use	m²/person	Proportion (%)
Residential use	18.0~28.0	20~32
Industrial use	10.0~25.0	15~25
Streets and Squares	7.0~15.0	8~15
Green space	≥9.0	8~15

Source: adapted from *ibid.* Tables 4.2.1 & 4.3.1.

6.1.4 Urban transport development policies

In many cities, urban transport development policies show more or less positive concerns for sustainability, though the outcomes are not as positive as expected (see Section 4.1). Along with the rapid growth of urban population and built-up areas in Chinese cities, increasing traffic demands with limited road resources have become an intractable problem. Although the *per capita* street length and area, as well as street density are low in many Chinese cities, especially in the large cities such as Beijing, Shanghai and Guangzhou, massive constructions of urban roads and expressways are not explicitly encouraged by local policies. Owing to the constraint on land-use in urban areas, particularly in traditional centres, road construction and widening

projects seem to find difficulties in being approved. Statements like ‘integrating street network’, ‘maintaining traffic flow’ and ‘developing intelligent transportation’ have become alternative expressions for road supply solutions and are to be found in many cities’ master plans.

Public transport development is literally given priority in a majority of cities and their transport policies, including the solutions of increasing the number of bus routes, establishing special lanes for bus transit and Bus Rapid Transit (BRT) systems (Huang, 2008). In order to deliver these policies effectively, many master plans soundly state that “urban public transport should be primarily invested and developed and supported by various modes of transit”. Numerical descriptions are commonly seen in the text of master plans, such as:

680 kilometres of 70 new bus routes are planned to be in operation with [an increase of] 360,000 square metres of land for bus transit facilities in [the] main built-up area in Harbin by 2020. 3,000 new buses and 2,200 vehicles for public transit will be provided and updated. It is expected in 2020 that the number of buses will increase to 6,615 (Harbin Master Plan 2004-2020, 2003).

The control policy for private automobiles is also applied as a compulsory means of reducing traffic volumes in some cities. However, the attitudes towards the control of private automobiles differ widely among cities. For example, Shanghai adopted the policy of auctioning car licences (registration) in 1994, while Beijing adopted the ‘lottery system’ in car registration at the end of 2010 (Liu, 2008; Beijing Traffic Management Bureau, 2011). On the contrary, Guangzhou had no solutions to control the number of private cars by 2011, whereas Hangzhou even cancelled the registration fee of private automobiles in 2002 with the aim of encouraging local automobile consumption. In terms of restricting private car use, the policy of weekday driving restriction is widely adopted in many large cities where the congestion is increasingly serious at peak times. In general, the control policies of administrative solutions and regulations have been commonly implemented, while street-design-related approaches that are heavily adopted in European countries have rarely been used or suggested in China.

Although the main policies in China intend to encourage public transport in urban areas, a variety of conflicting policies always exist (Kenworthy and Hu, 2002). The national *Automobile Industry Development Policy* persistently encourages the consumption of private automobiles to promote the development of the automobile industry which is expected to be one of the national ‘pillar’ industries before 2010.

The policy propounds a set of requirements in private automobile consumption, involving nursing the automobile market which is dominated by private consumption, adapting the urban environment to the use of automobiles and safeguarding the rights of car consumers. Besides, it asks local authorities to provide appropriate supporting facilities and parking for the convenience of car users in order to promote local automobile consumption. It also requires government to provide subsidies and establish standards for car parking provision in residential and public areas (Freund & Martin, 1993). In dealing with the increasing negative impacts on the environment, the policy suggests car consumers should “purchase the new energy powered automobiles which are low in energy consumption, pollution and emissions” (National Development and Reform Commission, 2004: Clauses 61, 69, & 70).

6.2 PROBLEMS IN POLICY DELIVERY

Although the relevant policies show positive sustainability considerations for urban street development, they have to confront the problems of delivery and their inherent deficiencies. The effectiveness of policy delivery can be significantly influenced by the real-world conditions, which indicate whether a policy is inclusively considered or feasibly established in its coverage. By the means of content analysis, archival research and documentary examination, problems of policy delivery and interpretation are determined and explained to provide the research with a grounded understanding of the difficulties of implementing sustainability policies.

6.2.1 Intrinsic inconsistency in design standards

There is an expectation that traffic engineers should be able to accelerate the running speed of automobiles in urban streets. It is not difficult to understand the fear of road congestion in the cities where so much public attention and stress have been placed. Rapid and advanced development of the street network has become one of the key determinants in the process of urbanisation, regardless of the practical conditions and any needs other than those of traffic. The fetishism of ‘modernised faster, wider, cleaner and greener super highways’ in many cities can be easily shown with abundant advertising publicity (Figure 6.7). Many planners and economists show great concerns about the unnecessary investment in these excessive transport projects, which are considered as a huge waste of land resources and social wealth (Sun *et al.*, 2009; Lang, 2009; Wu, 2000; Li, 2008; Qiu, 2006). The policy bias to these excessive projects needs to be explained to identify the knowledge gap between sustainability requirements and advertising publicity.



Figure 6.7. A huge poster in Shanghai Qibao District - showing an image of the political objective of the modern transport system.

Source: Zhu, 2008, Figure 5.

Through the review of relevant documents, sustaining diverse travel modes has been more or less indicated in planning policies and standards. Urban transport development should provide citizens with options of different travel modes to optimise their traffic efficiency in time, convenience and expense (MoHURD, 1995b). Meanwhile, the urban street system should be multifunctional whilst respecting the local character, history, traditional customs and culture

(MoHURD, 1995a: 7.1.1). It is obvious that GB 50220-95 and its explanatory memorandum have made significant efforts on preventing cities from becoming automobile-dependent or universally alike.

However, they also strongly emphasise the efficiency of motor vehicles on urban streets under the absolute hierarchical system and segregations. As explicitly stated in GB 50220-95, *the planning of urban street networks should adapt to the extension of land-use and be developed in favour of motorisation and rapid transportation* (MoHURD, 1995a: 7.2.1). Concerning the liability and legality in planning and design, and the possible risks in new practices, urban planners, architects and local governments have got used to thinking ‘scientifically’ under the technical profession of design standards and codes, which are engineering dominated.

However, even in the most ‘scientific’ system of street hierarchy, inconsistency is often found in regulations and implementations. According to the codes and standards, a perfect street network with an explicit hierarchy system is considered as a universal solution for urban road transport problems. However, the criteria for the classification is confusing, as indicated by Li and Zhou (1999), the urban arterial road, for example, can be defined by either the designed speed (40-60 km/hr.) or the width and the number of traffic lanes (usually above 20-24 m with 6 lanes). According to the table provided by CJJ 37-90, the traffic speeds on each type of road are divided into three classes (Table 6.7). Usually, the large city should adopt the first class of designed speed; the middle city should adopt the second one, etc. This population-based standard implies that the motor traffic speed on a branch road in a large city can exceed the speed on an arterial road in a minor city.

It is worth noting that there are a few inconsistencies in these primary standards. As shown in Table 6.7, the required range of design speed of urban streets in different-sized cities is inconsistent, comparing GB 50220-95 to CJJ 37-90.

Table 6.7. *Sub-stratified design speed on each type of road*

Road Type	Arterial Road			Secondary Road			Branch Road			
	<i>City size</i>	<i>Large</i>	<i>Medium</i>	<i>Small</i>	<i>Large</i>	<i>Medium</i>	<i>Small</i>	<i>Large</i>	<i>Medium</i>	<i>Small</i>
Design Speed (km/h) in GB 50220-95	40~60	40	40	40	40	-	30	30	20	
Design Speed (km/h) in CJJ 37-90	50, 60	40, 50	30, 40	40, 50	30, 40	20, 30	40, 30	20, 30	20	

Source: MoHURD, 1995a, Table 7.1.6-1&2, MoHURD, 1990a, Table 2.2.1.

A rational hierarchical system for urban streets is extensively advocated in the content of a considerable number of master plans of many cities, such as the Beijing Master Plan 2004-2020, the Beijing Transportation Development Compendium 2004-2020, the Hangzhou Master Plan 2001-2020 and the Harbin Master Plan 2004-2020. It is difficult to provide further details about the policy solution, whereas the ‘perfect’ street network has been virtually proposed in each master plan in terms of maps and graphs, and commonly described as ‘rational’ organisations. For example, the street network plan in Hangzhou is justified on the grounds that:

On the basis of expressways as the framework combined with main and secondary roads, the road transport in Hangzhou is expected to be mainly accommodated by the network which is based on the grids of streets and supported by ring roads and radial highways, with a great respect for a rational hierarchical system and explicit sorting of functions (Hangzhou Urban Planning Bureau, 2001).

The system has been faithfully implemented in most cities in China. It is not difficult to detect objectives such as ‘integrating the hierarchy of urban streets’ in a majority of master plans. However, the suggested proportion for each category of road has not been consistently implemented in a variety of cities. Development of expressways and arterial roads is highly valued, while branch road development is rarely encouraged, since only the former have been considered as the solution to the persistent lack of road resources. For example, the proportion in terms of the density of expressways, arterial roads, secondary roads and branch roads is almost 1:1:1:1 in Beijing and 0.75:1:0.71:0.42 in Nanjing (Shi & Wang, 2007; Sun *et al.*, 2009). The proportion seems to be ‘irrationally’ integrated in organisation (see Table 4.2).

Providing a higher density of minor roads in the central area is suggested in the national standards, but there are some problems worthy of note. The Explanatory Memorandum for GB 50220-95 indicates that, for the same land consumption for roads, a high density with minor streets can serve more traffic and have fewer accidents than sparse networks with wide main roads (MoHURD, 1995b: 7.1.6). Nevertheless, according to Table 5.2, the suggested street density in large and medium cities is much lower than in small cities. The memorandum explains that the street density is an average which should include streets in the urban periphery and industrial areas (MoHURD, 1995b). However, neither the suitable density for urban areas in large or medium cities nor for the urban periphery and industrial areas in small cities are articulated, which leads to serious problems in actual planning. For example, street planning in the master plan for the Shangcheng District of Hangzhou adopts the street density suggested in Table 6.8 as the indicators for future development. However, Shangcheng District is located in central Hangzhou without any industrial land use and the relatively low street density should not be applied.

Table 6.8. *Statistics for street planning in Shangcheng District of Hangzhou*

<i>Street type</i>	<i>Expressway</i>	<i>Arterial road</i>	<i>Secondary road</i>	<i>Branch road</i>	<i>Total</i>
Total street length (km)	7.18	27.19	33.052	55.981	123.40
Present street density (km/km²)	0.39	1.48	1.79	3.04	6.70
Suggested street density (km/km²)	0.4-0.5	0.8-1.2	1.2-1.4	3-4	/

Source: Institute of Urban Planning and Design of Hangzhou, 2005: Table 4-2.

To improve road safety and flow, street segregation is another requirement in the codes and standards. As mentioned before, the form of segregation also determines the type of street cross-section. In most cities, metal barriers and planting strips are the most common facilities used to divide traffic flows by different travel modes or speeds, and to prevent irregular or unpredictable behaviour of pedestrians by limiting the number of openings for crossing. Although the facilities bring considerable inconvenience to pedestrians and cyclists, they are often considered as a consequence of the legislative requirements of a street.

The rights of vulnerable street users including children, the elderly and disabled are nominally

valued in the decision-making process. National standards such as JGJ 50-2001 provide a set of requirements and parameters for the barrier-free design of public streets, but they neglect their needs in the overall urban circulation environment. Policies and measurements focusing on motor traffic flow remarkably increase the health risks and inconvenience of vulnerable people. Detours, discontinuous footways, flyovers, pedestrian bridges and underpasses are all significant barriers to vulnerable street users.

Forecasts of traffic demand and volumes are also required in urban road transport planning procedures. However, the memorandum for GB 50220-95 argues that it is difficult to achieve an accurate forecast due to technological limitations. Urban planning should, therefore, ‘provide flexibility and room for urban transport development’ (MoHURD, 1995b: 1.0.4). Since the methods for traffic forecasting are somewhat unreliable, ‘thinking ahead’ for urban street development is often interpreted as excessive land use for greater road width and capacity, which is articulated in the case studies in Chapter 9.

When taking the specific indicators and geometrical regulations for street planning and design into account, urban streets are more inclined to be universally designed and implemented, which conflicts with the requirements such as ‘respecting local character’ and ‘sustaining diversity in choosing appropriated travel modes’ (MoHURD, 1995a; 1995b). The latter requirements are often compromised when road capacity and traffic efficiency have been the prime targets, which can occur for the following reasons.

First, it supposes that the requirements of ‘sustainability’, ‘liveability’, or ‘local identity’ are much less quantifiable, while the requirements such as street hierarchy, segregation, designed speed and road width, can be technically examined by different sets of measurements. As the standards are defined by the ‘inspector’ of practices, concerning the liability and legality in planning and design, the efficiency-related indicators have been preliminarily and even exclusively adopted.

Second, the supply-demand solution may have been entrenched in planning procedures and methods. The predicted traffic demand is assumed to be one of the most important planning considerations in both large and small cities. In many medium and small cities, it may not be hard to understand why the large arterial roads and sparse networks have been provided in advance before the number of cars actually increases.

Third, 'new efficient' street networks and 'intelligent' transportation management often attract public and media attention, while social activities, casual businesses and small retailers and pedlars on urban streets can be seen as the 'obstacles' to traffic flows and as 'eyesores' in modern urban life. These factors may have directed public opinions about urban streets towards the automobile-oriented mind-set. In judging the level of transport development in a city, the indicators are usually the level of local car ownership, *per capita* road area, travel mode split, mean time for travelling to work and the conditions of traffic flow. So far, street design may still be a technical topic chasing the optimal forms for accommodating increased motor traffic.

6.2.2 Land-use and automobile dependency

There is evidence showing the efforts made on regulating and controlling the urbanisation process by the government. With the fear of the maladies of large cities and the crisis of food shortage, the 2008 *Urban Planning Act* used to put great emphasis on constraining the growth of large cities while encouraging the rational development of medium and small cities (NPCSC, 1990: 1.4). However, through content analysis, the relevant expression 'constraining large cities' can hardly be found in the 2008 new planning act. It implies that development of large cities is free from constraints by the present policy. The 1997-2010 land-use plan of Hangzhou, for example, shows that the growth of built-up areas was cautiously restricted according to that allowed by the land-use standard. It aimed to optimise the arrangement of different land usage to promote intensive use of land resources and to achieve sustainability in land-use (Hangzhou

Government, 1997). However, the present built-up area in Hangzhou has dramatically exceeded the planned regulations in 1997. Table 6.9 indicates the large gaps between the planned urbanisation and reality.

Table 6.9. *Comparisons of urbanisation indicators in Hangzhou* (including Xiaoshan and Yuhang Districts) between the 1997 Plan and the reality

<i>Year</i>	<i>2000 (planned)</i>	<i>2000 (actual)</i>	<i>2010 (planned)</i>	<i>2009 (actual)</i>
Built-up area (km²)	166.9	177.2	201.7	392.7
Population (1,000 person)	1936	1846	2202	2978
Land-use per capita (m²)	85.53~86.21	95.99	91.60~92.10	131.87

Source: adapted from Hangzhou Government, 1997, Tables 7 & 12; Hangzhou Statistics Bureau, 2001; 2010.

Although control of land transfer has been provided by the land-use law, the principles such as arable land requisition compensation seem to be 'bureaucratic' but 'tolerant'. The compensation for arable land which is expropriated by local government is remarkably cheaper than its price on the open market. The price gap has been considered as an important factor for the massive land-use and urban expansion in many cities (Liu, 2009). Second, along with the extraordinary growth in real estate since 2003, land transfer has become the most effective means of propelling the growth of local GDP and government revenue. Without feasible policies for restraining the irregular urban spatial organisations, the development of real estate has invaded and occupied large amounts of land in the urban periphery and suburbs, which remarkably increased the urban built-up area in irregular ways (Chen, 2009).

On the other hand, although the law requires that any construction projects should be rigidly subject to the land-use master plan once it has been approved by the State Council or superior government, it provides permission for some exceptions. As stated in Chapter 3, Clause 26, the land-use master plan can be modified if there is a necessity for any approved use of land for infrastructure development. Despite the bureaucratic process for modification, it implicitly provides considerable opportunities for changing the use of land when infrastructure constructions, such as urban roads, are required. The increase of built-up area in Hangzhou, for example, had been intensified following the significant growth of the local economy when the investment in capital assets had increased from 26.8 billion *yuan* to 168.4 billion *yuan* between

1998 and 2007. This involved 40.5 billion *yuan* in infrastructure constructions (Liu, 2008).

Weimin Yang, the Secretary-General of the National Development and Reform Commission, showed great hesitation about the current urbanisation trend in the Top Forum of the 2011-2015 Urbanisation Development Strategy in March 2011 (Yang, 2011). He indicated that the built-up area in China had increased by 50%, while the urban population had only grown by 26% since 2000. The speed of urbanisation was twice faster than the level of population growth. He criticised the inconsistency between the growth of built-up area and urban population, and indicated a food and energy provision crisis may occur because of the trend of decentralisation in land use. It is obvious that the land-use regulations developed in the 1990s are losing their power to control the present urban expansion. Without effective constraints on land-use, massive new economic zones are mushrooming in urban peripheries and suburbs causing the serious wave of urban sprawl in a majority of Chinese cities.

Despite the fact that current land-use policies are not in favour of massive road construction development in urban areas, the growth of urban street length and width is still significant. For example, between 2001 and 2006, the per capita road surface area in Hangzhou doubled from 5.11 m² to 10.17 m². In addition, statistics show that most of the increased road space in those five years is devoted to peripheral and suburban areas (Hangzhou Statistics Bureau, 2002; 2007). Figure 6.8 indicates the remarkable increase in the area and length of streets in the built-up area of Hangzhou, for example, which also implies an increase of average street width from 11.3m in 2000 to 21.2m in 2009. Another remarkable growth occurred in Guangzhou where, for example, the municipal total road length and area had increased by 77% and 120% respectively in the first five years of the twenty-first century (Sun *et al.*, 2009).

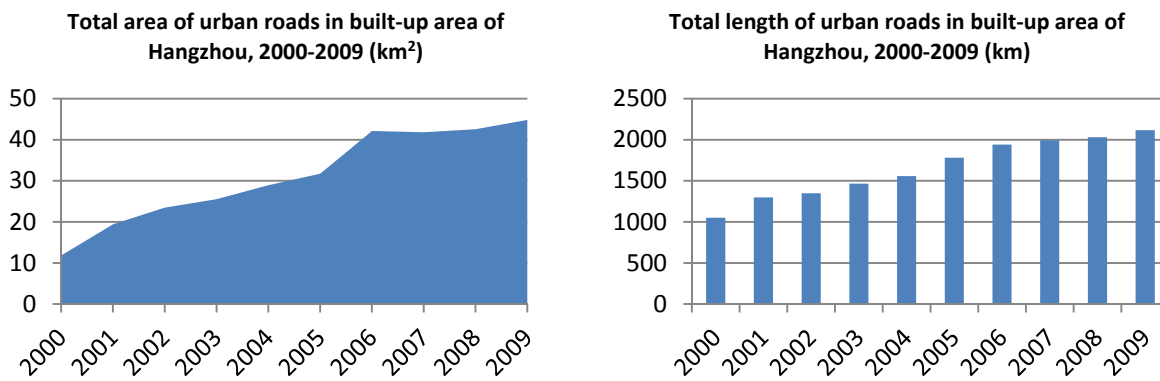


Figure 6.8. *Development of urban road construction in the built-up area in Hangzhou*

Source: Hangzhou Statistics Bureau, 2001- 2010

In general, the patterns of the growth rate of urban road supply vary in different cities (Figure 6.9). It is unusual that the growth rate of road area in Shanghai is much less than its road length, which implies that the focus of the road supply strategy in Shanghai is shifting from new construction of roads and widening existing streets to the integration of street networks (Sun, 2009). However, this trend has hardly been observed in other Chinese cities. It supposes that the limitation of land resources can propel a city to find alternative solutions to its traffic problems. Nevertheless, road provision may still be the main solution in the city permitted by the condition of urban land resources.

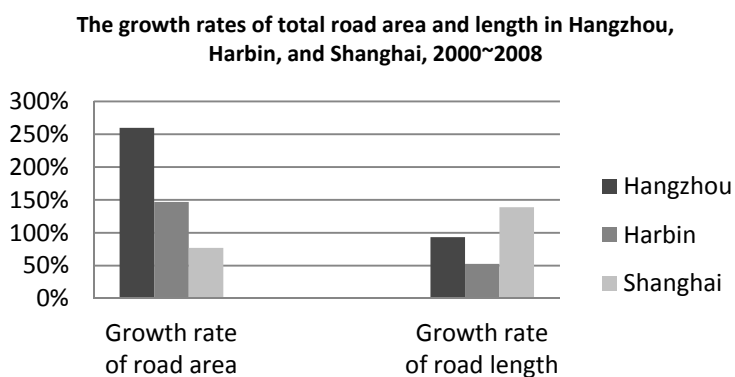


Figure 6.9. *Growth rates of urban road area and length in Hangzhou, Harbin and Shanghai*

Source: Hangzhou Statistics Bureau, 2001 & 2009; Harbin Statistics Bureau, 2001 & 2009; Shanghai Statistics Bureau, 2001 & 2009.

It may not be appropriate to use road area or per capita road area as an indicator for the

development level of urban road transport. Firstly, using road area as the only indicator can result in imbalanced investments and developments of road transport between downtown and peripheral areas. Secondly, road area cannot specify the distribution of road resources to different travel modes. Pedestrians and cyclists may not actually benefit from the increased area of road surface. Last but not least, to be a solution to the increased traffic demands, road provision is not supported by the fact of the traffic induction loop. In China, road area can be a misleading indicator which forces local authorities to expropriate excessive amounts of land for road provision and reinforces the traffic induction loop in both short- and long-term effects.

6.2.3 Implementation of transport policies

Rather than increasing road provision, improving public transport services and controlling private motorisation are the fundamental principles in China's urban transport policies. However, the policies are not effectively implemented, since they have encountered barriers such as the lack of financial support and resistance from the car industry. The policy priority of public transport can hardly be maintained because of the increasing congestion on urban roads caused by the ever-increasing numbers of private automobiles. It is impossible to effectively restrict private motorisation due to both growing traffic demands and declining public transit services. Road provision is, therefore, the dominant solution for resolving urban traffic problems.

Although the development of public transport has been widely adopted as the primary transport policy in a majority of cities, the condition of public transport has never been actually improved. The research by the Ministry of Construction in 2006 shows that almost 70% residents were not satisfied with the local public transport service. According to Sun (2009), a number of large cities in China have experienced declining public transport services since the 1990s. The research on travel modes in Shanghai indicates that the percentage of daily trips by public transport has dropped from 24.1% in 1986 to 18.5% in 2004. In the central area of Shanghai, the proportion of

public transport trips was 36%, but much lower than the level in Tokyo (87%) and Hong Kong (90%) (Cheng, 2005).

Statistics show that the policy adopted to control the growth of private car ownership seems to be effective. For example, from 1999 to 2010, the annual growth of motor vehicles was 99,000 in Shanghai, where the policy of a registration auction has been strictly implemented, while the number was 282,000 in Beijing before any control policies were adopted (Shanghai Statistics Bureau, 2000-2011; Beijing Statistics Bureau, 2000-2011). The latest data also indicates that, comparing with the corresponding period last year, the growth rate of motor vehicles in Beijing has declined by 59.1% in 2011 after the ‘lottery system’ was adopted (Li, 2011). However, both cities still have phenomenal rates of traffic growth. In Shanghai, the total energy consumption for transport increased by 236% from 2000 to 2011. In Beijing, the annual *per capita* petrol consumption also increased by 231% from 2002 to 2011 (Shanghai Statistics Bureau, 2012; Beijing Statistics Bureau, 2012).

Unlike Beijing and Shanghai, proposed policies such as “raising the registration fee of private automobile to reduce the use of private cars and encourage the development of public transport” have confronted opposition from the Municipal Traffic Police Office in Hangzhou. The reasons are suggested as the “negative impacts of 1) inequity between those who have already purchased cars and those who are going to; 2) lead to a leap in the number of cars before the policy has been adopted; 3) a diversion of car consumption to external adjacent regions and 4) [it is] inconsistent with the national economic policies of encouraging car consumption” (Hangzhou Municipal Traffic Police Office, 2010). It is believed that “urban transport problems cannot be resolved by controlling the number of private cars solely, but by improving public transport services and encouraging the use of public transport” (*ibid.*).

The demand for fast transport and car consumption can be the main factor for the mania of modernisation of urban road development in a majority of Chinese cities. This is especially true in the medium and small cities when considering the competition of their urban circulation

environment with their peers, advanced street networks in plans usually serve as a significant indicator of the local transportation level and the advertising publicity for attracting external investment.

Most large cities in China have realised that it is a crucial principle to place emphasis on the development of public transport such as adopting a set of policies to improve the bus, underground and metro services in the central area. However, there is no significant growth in the use of public transport in large cities (Li *et al.*, 2008). The development outcome for public transport is not as effective as expected, which can be shown in Figure 6.10. The declining ratio of volume/capacity (i.e. transport volume of public transit/offered capacity of public transit service) indicates that the increased investment in the development of public transit infrastructure and facilities has not resulted in a corresponding growth in the volume of public transit (*ibid.*). The factors for the current deficiencies in public transport can be rooted in three aspects.

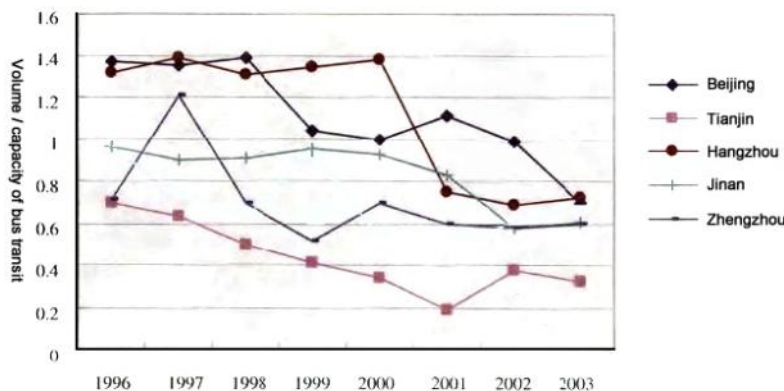


Figure 6.10. The declining ratio of the volume/capacity of public transit in selected cities in China from 1996 to 2003

Source: Li *et al.*, 2008: Figure 4.

First, public transport tends to be considered by local governments as a regular competitive business open to the market, which causes a persistent lack of financial support to public transport development and guarantees about the level of service (Sun *et al.*, 2009). According to the experience of cities in developed countries, annual investments in the development of public transport infrastructure should be maintained at around 3-5% of GDP, whereas the development of public transport in China was only 19 billion yuan in 2001, which was even less than 1% of

total GDP (Li, 2007). In some small cities, considering the relatively lower traffic demands, public transport has never been adequately respected.

Second, the limited street surface and parking space in central areas has increasingly been occupied by the increased number of private automobiles, which significantly reduces the speed and quality of public transport services such as bus transit, and results in the persistent shortage of road capacity, which becomes an obstacle to the development of special lanes for rapid bus transport (Sun, 2009). Furthermore, the development of special bus lanes has met with financial difficulties and complex and conflicting interests (Li, 2007).

Last but not least, the development of public transport has not been adequately supported by rational spatial management. The low density street network and mono-function land-use development are considered as barriers to improving the urban circulation system which is oriented towards public transit (Wang, 2007).

It is noticeable that official attitudes to private motorisation in China are still not consistent, even among the departments in central government (Kenworthy and Hu, 2002). Sun (2009: 35) believes that the policy should pay more attention to controlling the use of private cars rather than on car ownership. He indicates that the latter “has no direct responsibility for road congestion” and would “generate more or less negative impacts on the development of the automobile industry”.

Obviously, the current conditions of urban transportation development, such as massive urban road provision, inadequate public transit service and increased use of automobiles, imply the ineffectiveness of the present urban transport policies in China. Transport infrastructure and road development may be intensively steered by the market, which tends to favour the implementation of the most profitable projects that attract both public and private investment, while the non- or less-profitable developments receive the least consideration. Reinforced by the traffic-centred standards, the market-oriented road and automobile industries continue to dominate the current

trends of street design and practice in Chinese cities through showing little interest in improving the non-motorised travelling environment, street liveability, aesthetics and even local sustainability.

6.3 CONCLUSION

Neither the transport policies nor the current planning system in terms of the codes and standards show any favour towards encouraging the massive use of automobiles in China, but urban streets are increasingly developed to facilitate private mobility. Although the land-use has been strictly controlled by law and regulations, ample evidence demonstrates the serious conditions of urban sprawl and suburbanisation in many cities. Cities in China are becoming increasingly automobile dependent and going far from the sustainability strategy. Urban space and land-use-related policies are losing their power to manage the huge wave of urbanisation.

This chapter proposes a set of possible deficiencies in the delivery of sustainability policies in the development of urban streets in China. The planning and implementation of urban streets may be driven by the present level of urbanisation, the market and traffic engineering at the respective areas of urban spatial organisation, urban transportation and design practice. Barriers and gaps to sustainability in urban street design need to be determined and articulated as the issues generated from the inherent deficiencies of policies and regulations, as well as the contradictions between different motivations represented by the varied interests of local officials, traffic managers, the automobile industry, motorists and developers.

Although different cities exhibit different levels of conditions of urban transport and land-use, generally speaking, sustainability policies have not been comprehensively implemented in the planning and design of urban streets. This general trend calls for further exploration of the actual design practice of urban streets to provide a detailed picture of development trends. It is clear that the gap between the sustainability strategy and the traffic-oriented national standards needs to be

bridged, but how effective the standards are in guiding actual practice is also questionable. If there are significant discrepancies between the standards and outcomes, what the other factors can be and how they drive the current design trends need to be determined. Those factors may be complex and varied in different cities and different types of roads, and they may also have some common ground in some particular aspects.

CHAPTER 7 PROFILE OF THE SAMPLED CITIES AND STREETS

This chapter aims to provide an overview and the macro-analysis of the selected case study cities and the sampled streets (Table 5.3). It helps to give a more informed understanding of the street development, distinctive backgrounds and conditions of each city. Figure 7.1 shows the location of the selected cities and the sample streets, most of which are located in the central urban area, surrounded by residential, retail, business and mixed developments. Through site mapping and historical documentary analysis, this chapter reveals common characteristics and distinctiveness in the development of urban streets in different cities. Analysing and comparing the collected data with previous research and empirical studies reflects how the current design factors have influenced actual practices and outcomes.

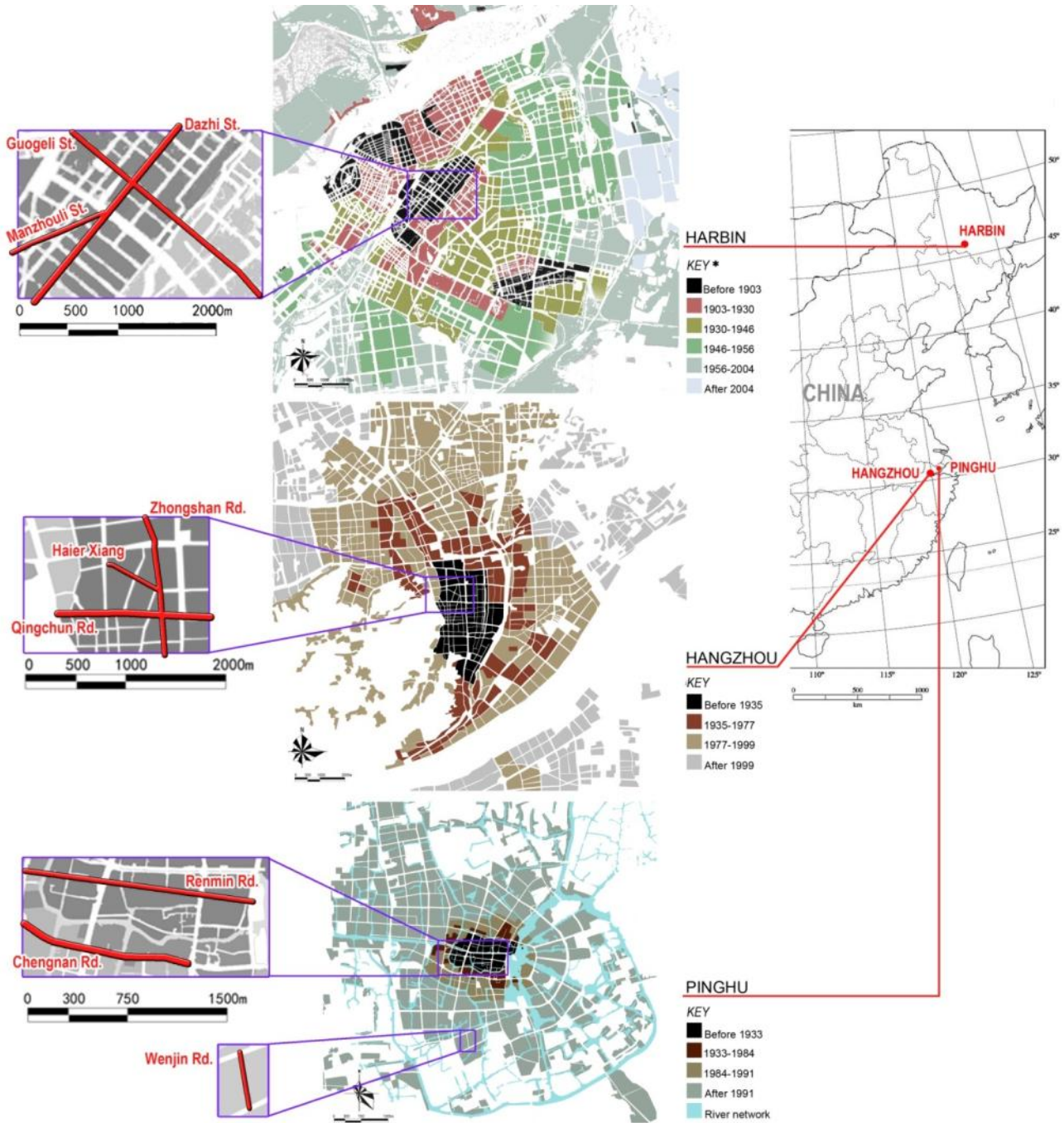


Figure 7.1. Selected urban streets in Harbin, Hangzhou and Pinghu

*Due to the different sources of map information, the individual keys are provided.

Source: Harbin Urban and Rural Planning Office, 1903; 1930; 1946; 1956; 2004; Hangzhou Urban Planning Bureau, 1935; 1977; 1999; Pinghu Urban and Rural Planning Office, 1933; 1984; 1991.

7.1 HANGZHOU

Hangzhou is the capital of Zhejiang Province in east China. It accommodates more than 4 million citizens in the central built-up area which covers 314.5 km². It used to be the national capital during the Southern Song Dynasty (1127-1179). At that time, the inner city had already been intensively developed and surrounded with defending walls. The West Lake and its surroundings had become one of the most famous tourism spots in China. After China's 'Reform and Opening-up' period (1976-1989), Hangzhou has kept on expanding. To the south, it shifted the land use along the Qianjiang River from industrial to business and residential use. To the east, the city went across the moat to expropriate new land for housing. At the beginning of this century, new developments are extending along the south bank of Qianjiang River (Figure 7.2).



Figure 7.2. Street network and development map of Hangzhou

Source: Hangzhou Urban Planning Bureau, 1935; 1977; 1999.

7.1.1 Urban street development in Hangzhou

The development of urban streets in Hangzhou is rapid and significant in the macro-statistics of total road length and area (Table 7.1). The statistics for *per capita* road area seem to be appropriate (according to the suggested 7-15 m² national standard) but deceptive. The figures may fail to indicate the actual condition of urban streets, since the population, travel demand and road area are not evenly distributed at any time. In other words, the macro-statistics may be too optimistic in reflecting the real-world conditions and more or less misleading for future decisions.

Table 7.1. *Statistics of road development in urban districts of Hangzhou*

<i>Year</i>	<i>2000</i>	<i>2005</i>	<i>2010</i>
Total road length (km)	1050	1782	2194
Total road area (1000 m²)	11,830	31,750	47,540
Per capita road area (m²)	6.6	7.8	10.9

Source: Hangzhou Statistics Bureau, 2011.

In fact, reduction of street density can be perceived by mapping the street network of Hangzhou. Street density means the total street length in an area of 1 km², which can more or less reflect street permeability in a certain area. Within 1 km² of the case study area in central Hangzhou, for example, street density has declined by 22% since 1977 (Figure 7.3). Apparently, it is not the area where the most significant reduction has occurred, which was in some residential areas during 1977 to 2011, while the density was more likely to be retained in the areas for business or mixed uses (Figure 7.4). It implies that the decreased streets might not be physically eliminated since their property is transferred to private developments of gated communities and thereby no longer being open to through traffic. The formerly permeable street network has been transformed into a series of impermeable superblocks defined by the dominant typology of the gated community.

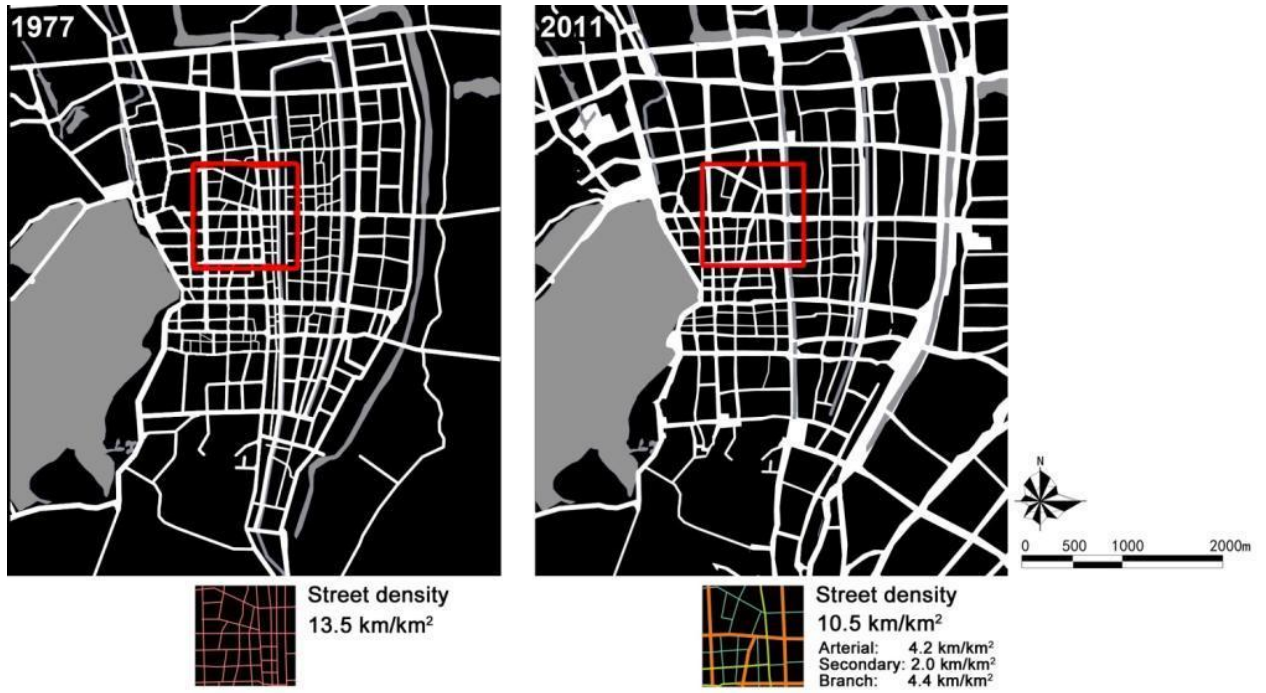


Figure 7.3. *The changes of street density in downtown Hangzhou, 1977-2011*

Source: adapted from Hangzhou Urban Planning Bureau, 1977; 2011.



Figure 7.4. *Land-use and street network in downtown Hangzhou, 2011*

Source: *ibid.*

However, superblock development has not yet dominated the central urban area which remains a blend of small traditional developments. The constitution of the street structure therefore appears to be incoherent and unintelligible. Street permeability is often weak and uncertain since access is highly constrained by the entrance gate of individual residential communities (Figure 7.5). It implies that the actual street permeability can occasionally be weaker than the pattern perceived as street density. Apart from the significant difference of traffic demand between urban and peripheral areas, the access restriction adds another important implication that the average street density can be a problematic indicator in directing street planning and design since the superblock became the dominant development pattern in many modern Chinese cities.

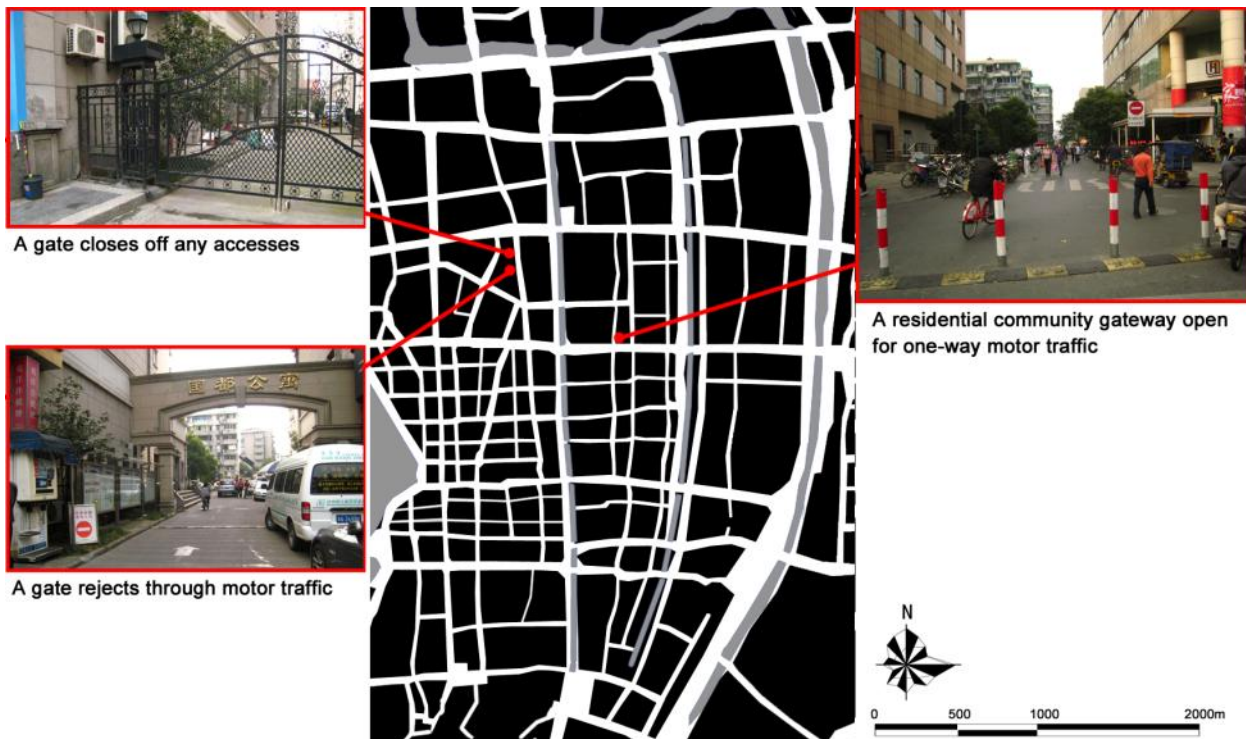


Figure 7.5. *Different extents of access restrictions to residential communities*

7.1.2 Sample streets in Hangzhou

The selected sample streets in Hangzhou are all located in the central area and cover the hierarchy of urban streets from arterial to branch. All the streets are significant in historic terms and have

experienced several revisions to adapt to motorised traffic. The revision practices and outcomes can indicate changes in their functions and negotiations with different street users.

Qingchun Road

Located at the heart of central Hangzhou, Qingchun Road is an arterial road that accommodates prosperous developments of the banking business on both sides (Figure 7.6). Its predecessor was a combination of four streets (i.e. Great Qiantang Gate Street, Qianyang Street, Court Road and Great Qingchun Gate Street). After 1964, the four streets were given the joint name of Qingchun Road. According to local records, it was the first road that served motor vehicles in Hangzhou. Since automobiles were introduced to this road around 1990, traffic congestion has never been entirely absent (Figure 7.7).



Figure 7.6. (Left) *The streetscape of Qingchun Road in 2011*

Figure 7.7. (Right) *Photograph of traffic congestion in Qingchun Road in 1989*

Source: photograph collection in Zhejiang Library.

To improve its traffic capacity, two significant transformations to Qingchun Road took place in 1992 and 2005 respectively. The 1992 reconstruction was one of the greatest urban construction projects in Hangzhou's history (Figure 7.8). It removed all the adjacent buildings to enlarge the road surface by four times, with two vehicle lanes in each direction and increased the total road width from 10 m to 40 m. This tremendous project was finished in 1994 and advocated as a

'30-year advanced artery'. Nevertheless, after only five years, the road became seriously congested.



Figure 7.8. *The reconstruction of Qingchun Road in 1992*

Source: photograph collection in Zhejiang Library.

In order to release the jammed traffic, the Hangzhou government decided to add two extra vehicle lanes to Qingchun Road in 2005. Figure 7.9 illustrates the process of the 2005 widening project in which the cycle lanes on both sides were moved inwards at the expense of the pavement area to give space for the carriageway. This leaves the street trees on their original spots where the pavement borderlines used to be. Figure 7.10 shows the changes in road space at the same place on Qingchun Road before and after the two revision projects. Most of the road surface is now devoted to moving motor vehicles instead of cyclists and pedestrians. It can be seen as an episode of transformation in road spatial organisation typical of many arterial roads.

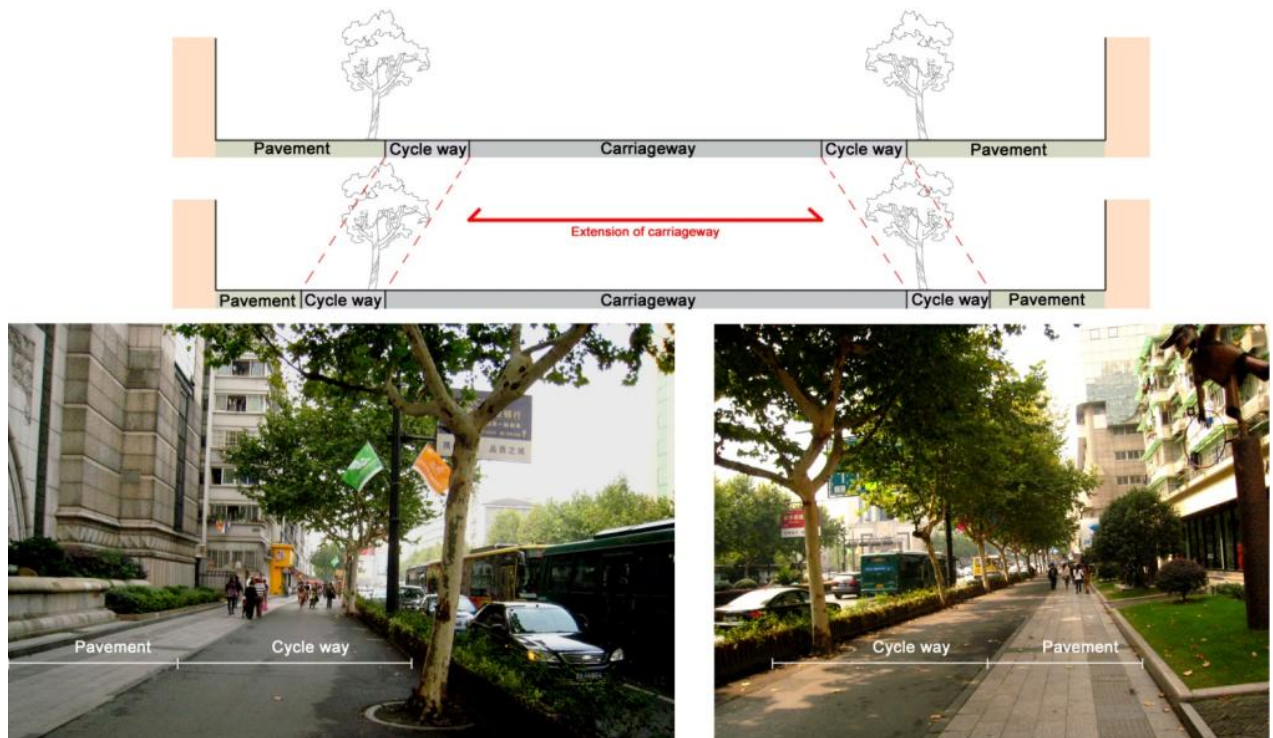


Figure 7.9. Reallocation of road space in Qingchun Road since the widening project in 2005



Figure 7.10. The streetscape of Qingchun Road before 1992 and after 2005

Source: photograph collection in Zhejiang Library.

Today, as a busy traffic artery, the 40-metre wide road still suffers serious congestion during peak time when vehicle speed is persistently restricted to less than 20 km/hr. The design speed of Qingchun Road is 40 km/hr., much less than the required 60 km/hr. for arterials in a large city. The correction of this exception was carried out in 2002 by the official document *Reply to Preliminary Design Scheme of East Qingchun Road* to control the increasing number of casualties on this road (Construction Committee of Hangzhou, 2002). Although its traffic

capacity seemed to be improved since the widening project in 2005, its design speed has constantly been limited to 40 km/hr. at present.

Zhongshan Road

Zhongshan Road is a secondary road in central Hangzhou. It is 4,300m long and 34m wide on average. Zhongshan Road was built in 1138 as the 'Imperial Street', one of the most successful commercial streets in Hangzhou's history, it was 6,000 m long and 63.34 m wide and paved with 35,300 flagstones. The cross-section of the street is divided into three parts by two canals. The path in the middle was for the exclusive use of the emperor. The street was fringed with willow and peach trees, while the canals were flowered by lotus. Trade at both sides was encouraged and flourished at all hours day and night. However, the prosperous scenes declined as soon as the empire perished. People filled in the canals and narrowed the street for building more housing. Although the streetscape could not be recovered, it still reserved a significant position for business and trade.

The business and trading position of Zhongshan Road had never been replaced until 1966 when a new parallel commercial road was upgraded. However, its historical and cultural value cannot be superseded. After the e-paving and widening in the 1920s, the road's appearance was preserved but becoming dilapidated until an entire renovation was carried out in 2008. The renovation programme was carried out under the policy of heritage conservation and retrofit. It attempted to conserve the historic and cultural value while improvement work on the quality of living, shopping and traffic environment of this street made progress in gradual phases. After the renovation project, the physical appearance of Zhongshan Road changed remarkably (Figure 7.11). The road was widened and separators of planting strips were applied between the carriageway and cycle ways. According to Jacobs (1993), the sense of enclosure can be generated by proper planting and maintenance of street trees which play an equivalent architectural role in

defining street boundaries. In Zhongshan Road, the aged street trees bring a feeling of narrowness and safety to street users.



Figure 7.11. *The changing streetscape of Zhongshan Road, 1990s – 2010s*

Source: photograph collection in Zhejiang Library.

Haier Xiang

Haier Xiang (Alley) was built in the same time period as Zhongshan Road. It is a 600 metre long and 15 metre wide branch road in the residential area. As a minor street, the revision history of Haier Xiang was rarely recorded. According to local newspaper records, the latest revision was carried out in 2009, including pavement updating and street tree planting. Owing to its great location, commercial activity in Haier Xiang is thriving. In the middle of the street, a historical building stands for an episode of the street's history (Figure 7.12). Before the 2000s, Haier Xiang was narrower than 5 metres and just allowed one car to pass through. After several widening projects, the street has been able to accommodate the increasing car use of local residents. On-street parking is allowed on both sides of Haier Xiang, leaving a narrow but sufficient carriageway space for vehicle and bicycle flows (Figure 7.13).



Figure 7.12. *The historical building in Haier Xiang before and after 2004*

Source: photograph collection in Zhejiang Library.



Figure 7.13. *The streetscape of Haier Xiang, 2011*

Summary

Documentary examination, mapping and field observation are the main data collection methods for each sample street. Key parameters for street size, scale, cross-section and design speed are recorded and illustrated in tables and diagrams. Table 7.2 summarises the general conditions and parameters of the three sample streets in Hangzhou.

Table 7.2. *Summary of the sample streets in Hangzhou*

Street name	Qingchun Road	Zhongshan Road	Haier Xiang
Location	Downtown Hangzhou	Downtown Hangzhou	Downtown Hangzhou
Year of the latest revision	2006	2008	2009
Surrounding land use	Business and residence	Residence, retail and education	Residence and retail
Design speed	40 km/hr.	40 km/hr.	30 km/hr.
Total length	3400 m	3600 m	600 m

Mean width (Max., Min.)		40 m (50 m, 35 m)	34 m (38 m, 22 m)	15 m (19 m, 12 m)
Carriageway	Number of vehicle lanes	6, with additional lanes at intersections	2-4	2
	Width of individual vehicle lane	3.5-3.75 m	3.5-3.9 m	Shared surface with cycles
Cycle track	Number of cycle tracks	2	2	0
	Track width	2.0-4.2 m	2.7-3 m	N/A
Pavement	Number of footways	2	2	2
	Footway width	4-6 m	3-4 m	3-5 m
	Kerb height	0-90 mm	150 mm	90 mm
	Paving Material	Granite block	Granite block and greystone brick	Coloured concrete tile, grey brick
Median strip		2-metre wide vegetated strip	No	No
Safety strip		Vegetated strips or fences	Vegetated strips	N/A
Street tree and planting		Platanus, large deciduous trees, flowers and bedding plants form the separators	Platanus (on separators) and white osmanthus (on pavement)	Gingko tree and a variety of trees and shrubs are planted at building corners.
Street lighting and furniture		Street lighting and litter bins are uniform and regularly placed. Casual seating is provided.	Street lighting and litter bins are uniform and regularly placed. Seating is provided in the south section.	Street lighting is regularly placed on the south side of the street. Instead of fixed litter bins, a few types of moveable bin are irregularly provided for residents.
Street frontage		Generally defined by 2- or 3-storey annexes for retail and business use.	Residential buildings and their annexes for restaurant and retail use. A variety of steps are used to define building boundaries, which is commonly seen throughout the street.	The street is defined by low-storey residential buildings with opened ground floors for retail use. Retail stores are varied in colours with various steps defining their boundaries throughout the street.

7.2 HARBIN

Harbin is the capital of Heilongjiang Province, the political, economic, transportation, technological and cultural centre of Northeast China. Harbin has a population of 4,642,000 in its central built-up area which covers 302 km² of plain land. Comparing with Hangzhou, Harbin is relatively young in China's urbanisation history. It was developed as a hub of the Chinese Eastern Railway. Its development process can be divided into four periods: early development

before 1898, the era of Russian domination from 1898 to 1932, the period of Japanese colonisation during 1932 and 1945, and the post-war period. The city has changed from a consumption-oriented city to an industrial base (Figure 7.14). However, after a steady capital accumulation for several decades, Harbin has been gradually shifted from a heavy industrial base to a modern metropolis which accommodates multiple functions.

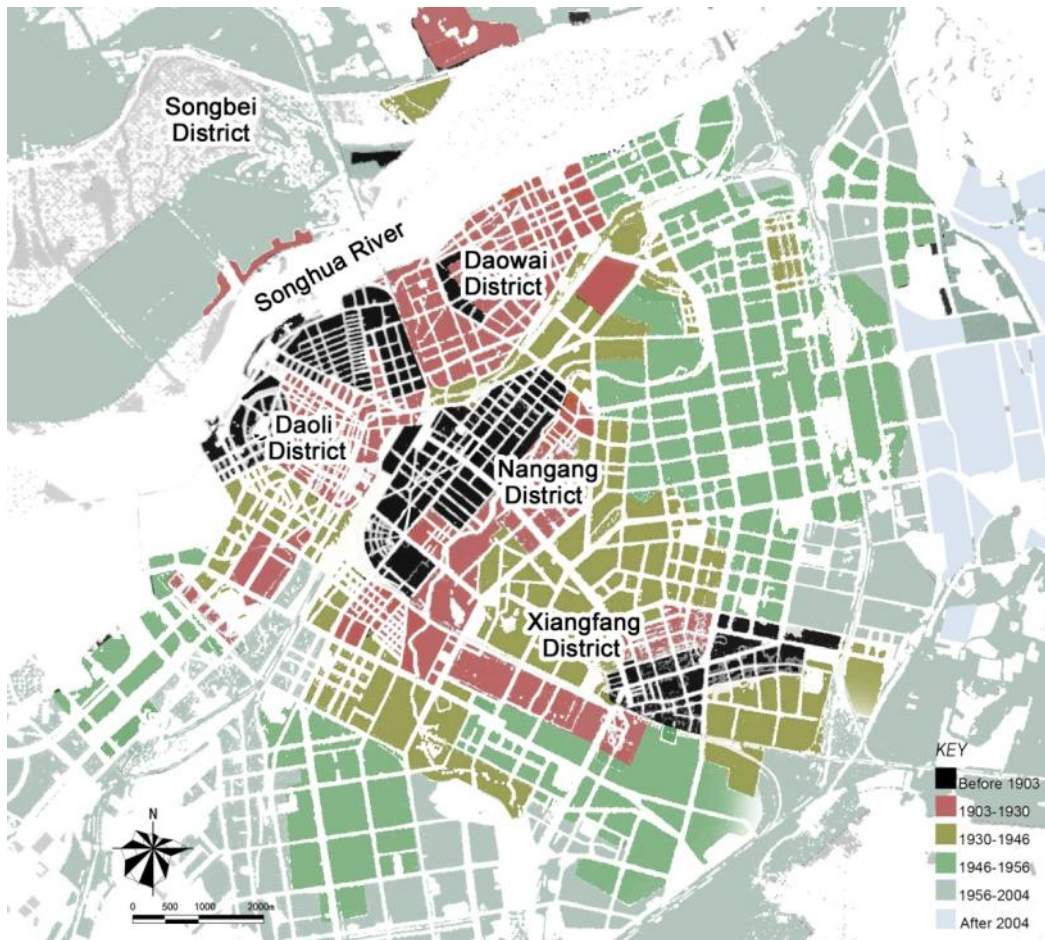


Figure 7.14. *Street network and development map of Harbin*

Source: Harbin Urban and Rural Planning Office, 1903; 1930; 1946; 1956; 2004.

Downtown Harbin involves three historical districts: Daoli, Nangang and Daowai. The majority of colonial historic buildings are located in Daoli and Nangang Districts, together with the Chinese Baroque style of architecture in the Daowai District, they represent Harbin's urban character. It is often considered as an exemplar of successful architectural integration of Chinese and western traditions.

7.2.1 Urban street development in Harbin

The street network of Harbin is generally presented as regular orthogonal square patterns. The patterns are oriented by the direction of the railway and the Songhua River. A number of streets appear in radial ways for historical reasons. The whole street network in downtown Harbin has not been significantly changed since it was built in the 1920s. Figure 7.15 demonstrates that the present spatial organisation in central Harbin has largely retained its original conditions as in 1920. Nevertheless, the analysis shows a decline of street density within the case study area. A number of minor streets have been taken over for the private development of residential communities and no longer serve public traffic.

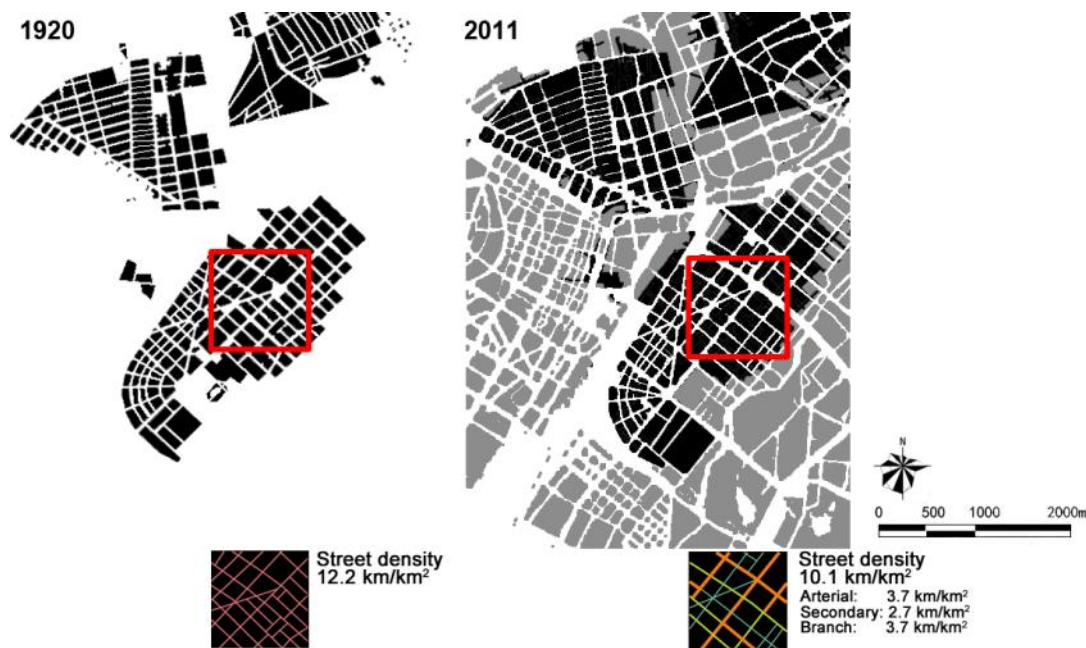


Figure 7.15. *The changes of street density in downtown Harbin, 1920-2011*

Source: Harbin Urban and Rural Planning Office, 1920; 2011.

Compared with the historical map, there is little evidence to show that the traditional spatial frameworks in the Daoli and Nangang Districts have been impacted by the prevalent use of automobiles. Nevertheless, the increased demand of motorisation can be reflected by the changes in the street spatial allocation. As one of the most remarkable changes in the spatial arrangement of streets in Harbin, most of the cycle lanes in Harbin were eliminated to improve road capacity

for motor vehicles. Cyclists were obliged to use footways for their journeys.

7.2.2 Sample streets in Harbin

Dazhi Street, Guogeli Street and Manzhouli Street are the three selected sample streets in Harbin. They are all located in the Nangang District in downtown Harbin. Unlike the streets in Hangzhou, separators are not intensively applied to these streets, since cycle ways were removed from the road surface. The street frontages are more or less characterised by Russian styles of buildings and decorations. In the light of the surrounding architectural distinctiveness, streets in downtown Harbin can be easily distinguished. Regarding the cold weather in Harbin, willows, elm and poplar trees are the dominant species of conventional street trees. Sometimes they are not regularly aligned with the streets, particularly in Guogeli and Manzhouli Streets, where trees are planted and maintained in raised planting beds and casually spread on pavements.

Dazhi Street

Dazhi Street is an arterial road located in the Nangang District. It is 7,814 m long in total, with the width varying from 32 to 45 m. It was first built in 1899 by the Bureau of the Chinese Eastern Railway and then re-paved with stone, brick and asphalt in 1927 and 1963 respectively. The latest major revisions were carried out in 1970 and 1983, which more or less established the present form of Dazhi Street (Figure 7.16). Besides major revision projects, minor repairs to the street have been carried out each year, due to the extreme variation in temperature from winter to summer, the asphalt surface becomes fragile under heavy vehicle flows. To accommodate the increasing number of automobiles, most cycle lanes in Harbin, including the ones on Dazhi Street, were removed and the space left as carriageways in the early 2000s. The building set-back space in Dazhi Street is commonly large, which generates wide sidewalks for pedestrian use. However,

a large proportion of pavement was sacrificed to provide more car parking lots in order to meet the increasing demand.



Figure 7.16. *Photograph of Dazhi Street in the 1980s*

Source: photograph collection in Heilongjiang Library.

There is a noticeable roundabout which divides Dazhi Street into two parts – East Dazhi Street and West Dazhi Street (Figure 7.17). The centre of the roundabout was originally a cathedral which was destroyed in 1966 and replaced by a monument tower in 1968. After the tower was demolished in 1972, this place appeared nothing more than a spacious lawn until a pyramid-like glass roof of an underground market was built in 1996. The street pattern was first planned in 1899 by the Russian planners with the typical concept of a radial street system. While the central island has been transformed over time, the pattern plan remains. Reasons for changing could always be recorded, whereas the reasons for preservation could not be easily determined from existing archives. Through interviewing local planners and architects, the conservation could be related to the inherent respect for local history and identity. The phenomenon shows that the standards and design codes may not be the main motivation for street upgrading or revision in an area with a strong local identity.



Figure 7.17. *The satellite view (left) and the photograph (right) of the roundabout in Dazhi Street*

Source: Google Map, 2011, <http://ditu.google.cn/>, accessed in June 2013.

Guogeli Street

Guogeli Street, previously named Yizhou Street, was built in 1901 and developed by the Russian businessmen in colonial times. It is a 2,642 metre long secondary road running across East Dazhi Street. In 1927, it was the first street served by streetcars (Figure 7.18). In 1987, the pavement of stone blocks was replaced by asphalt, and streetcars and rails were removed to make way for automobiles. Like all the other streets in Harbin, the cycle ways on Guogeli Street were removed in the early 2000s and merged with the pavements on both sides. In order to evoke past memories,

the local government attempted to update the street into one that was characterised by cultural and historic significance in 2003.



Figure 7.18. *Streetcars in Guogeli Street in the 1930s*

Source: photograph collection in Heilongjiang Library.

Today the street is more or less characterised by integrated scenes of building frontages and unified street furniture, showing a significant visual identity (Figure 7.19). The surrounding

buildings are famous for European architectural styles: Baroque and Byzantine facades, little Russian bakeries, French fashion houses, American eateries and Japanese restaurants. Although Guogeli Street is defined as a secondary road, its traffic flows are as heavy as an arterial one. Due



to the increasing pressure of congestion, the busy street has recently been designated as a one-way street while allowing bus counterflow.

Figure 7.19. *The streetscape of Guogeli Street, 2011*

Manzhouli Street

Manzhouli Street was built around 1900 as a residential-focused branch road in the central Nangang District of Harbin. The street is 1,500 metres long and surrounded by a variety of 6-7 storey apartment buildings with small retail businesses on the ground floor. The street width is often varied because of irregular building frontages and raised planting beds. The street has been revised in accordance to the revision programmes of Dazhi Street. The street form significantly varies from one place to another and is characterised by junctions with irregular shapes, inconsistent surface widths and levels and, occasionally, planted old willow trees with various planting beds (Figure 7.20). The street allows on-street parking and pavement parking on some selected sections.



Figure 7.20. *The varied streetscape in Manzhouli Street*

Summary

Like many other streets in downtown Harbin, the sample streets are all varied in their widths and frontages for historical reasons. Cycle tracks or lanes were all removed from the road surface, and reallocated as pavements. However, designated cycle lanes on pavements are visually illegible. According to site observation, few cyclists used the pavement cycle lanes in the sample streets. All the cyclists observed preferred travelling on the sides of carriageways. By removing cycle lanes, the total surface area of carriageways in Harbin was enlarged without paying extra widening costs. It is believed to be an economical means to accommodate increased use of automobiles without changing historical contexts. The key parameters and conditions are summarised in Table 7.3.

Table 7.3. Summary of the sample streets in Harbin

Street name		Dazhi Street	Guogeli Street	Manzhouli Street
Location		Nangang District, downtown Harbin	Nangang District, downtown Harbin	Nangang District, downtown Harbin
Year of the latest revision		2001	2003	2001
Surrounding land use		Administrative business and retail	Highly mixed	Residence and education
Design speed		60 km/hr.	50 km/hr.	30 km/hr.
Total length		7,814 m	2,642 m	1,500 m
Mean width		40 m (45 m, 32 m)	25 m (30 m, 22 m)	22 m (28 m, 20 m)
Carriageway	Number of vehicle lanes	6, with additional lanes at intersections	4 (one-way street)	2, with additional lanes at intersections
	Width of individual vehicle lane	3.5-3.8 m	3.5-4 m	3.5-3.9 m
Footway	Number of footways	2	2	2
	Footway width	6-8 m	4-6 m	3-8 m
	Kerb height	150-180 mm	150-180 mm	210 mm
	Paving material	Concrete block, coloured tile	Marble brick	Coloured bricks
Median strip		Metal fences	No	No
Safety strip		N/A	N/A	N/A
Street trees and planting		Elms and willows, large deciduous trees, irregularly planted with different statuses.	Elms, willows and unusual minor trees are the dominant plant species in the street.	Large willows and young poplar trees.
Street lighting and furniture		Street lighting system is uniform and regularly placed. Litter bins are discontinuously provided. Entrances to underpasses are	Unique street lighting pillars are provided as a local symbol. The west part of the street is characterised by spanning frameworks for	Street lighting is regularly provided. There is no provision of litter bins.

	frequently seen at intersections, particularly in the east part.	advertisement. A very few seating facilities are provided occasionally.	
Street frontage	Defined by large blocks of buildings for administration and business use.	Continuous perimeter buildings for retail use and cafes. Frontages at ground level are varied and cluttered in forms and colours.	The street is defined by residential buildings with their ground floors casually open for retail use.

7.3 PINGHU

Pinghu is a small city located in Northeast Zhejiang Province. The central built-up area is 49 km² and accommodates 180,000 dwellers. The most significant growth of urban built-up area happened after 1991 when large amounts of land were devoted to the development of factories in the northwest urban periphery. Land in the south and east has been expropriated to meet increasing housing demands and new investments in the real estate industry since the 2000s.

The administration of Pinghu was established in 1430 as a town named Danghu. In June 1991, it was upgraded from a town to a city by the State Council. Like many cities located along the Yangtze River, the surface features of Pinghu are characterised by dense networks of rivers and canals (Figure 7.21). Those rivers and canals were important channels for both inter- and inner-city transport until they were completely replaced by road transport in the 1990s. Meanwhile, the strong relationship between people, rivers and river walks has gradually vanished. This is particularly so in the last decade, over 1 million m² of buildings were demolished and redeveloped under urban renovation programmes. The traditional appearance of Pinghu City has significantly changed but very limited river walks and waterfront housing have been preserved to exhibit the distinctive local heritage (Figure 7.22).

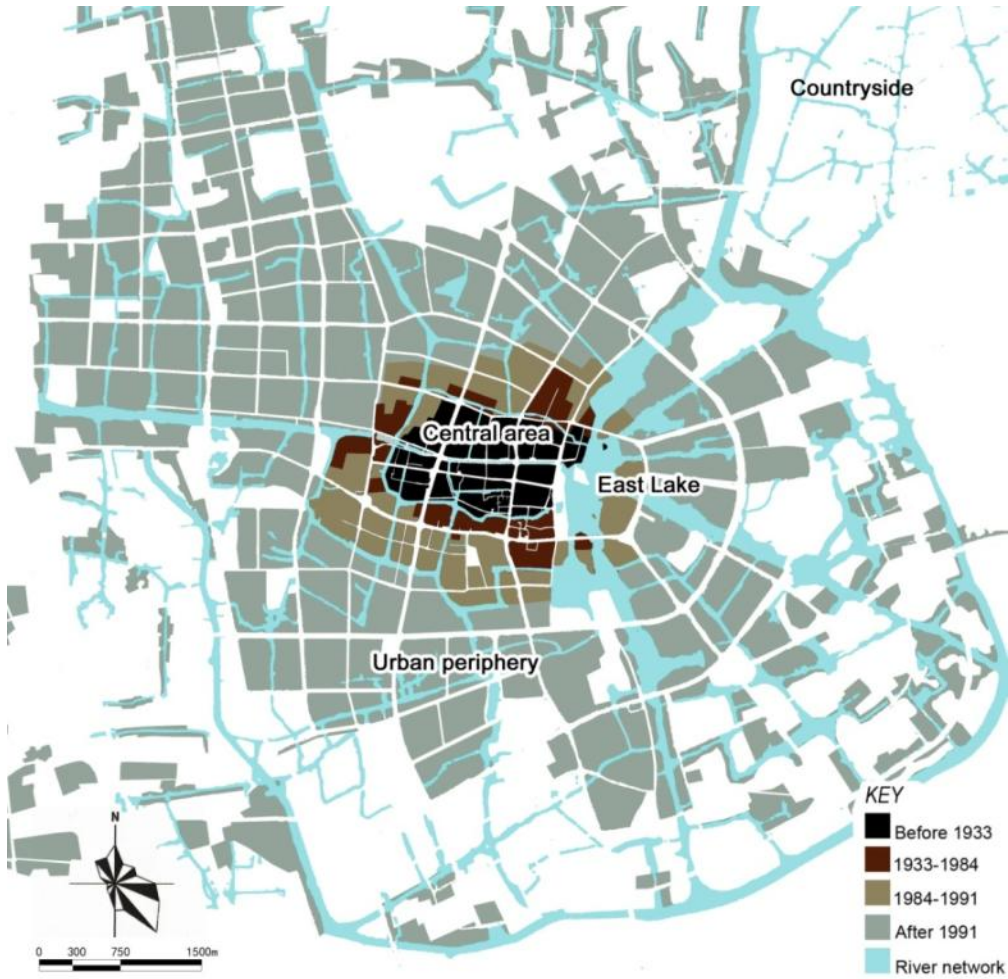


Figure 7.21. Street network and development map of Pinghu

Source: Pinghu Urban and Rural Planning Office, 1933; 1984; 1991.



Figure 7.22. Traditional river walks in Pinghu have a distinctive urban character

7.3.1 Urban street development in Pinghu

The street network in central Pinghu has been significantly revised to fit with automobile

movement in the last two decades, which was physically a proportional expansion of the street network. The total length and area of urban streets increased along with the sprawling built-up area, while the street density was significantly reduced due to the decline of minor streets, especially river walks (Figure 7.23). Unlike the rapid development of arterial roads and secondary roads, the development of minor streets was hesitant. During the last three decades, the development of urban branch roads in Pinghu gradually declined, giving them the lowest proportion of the total street length and area (Figure 7.24 & Figure 7.25).

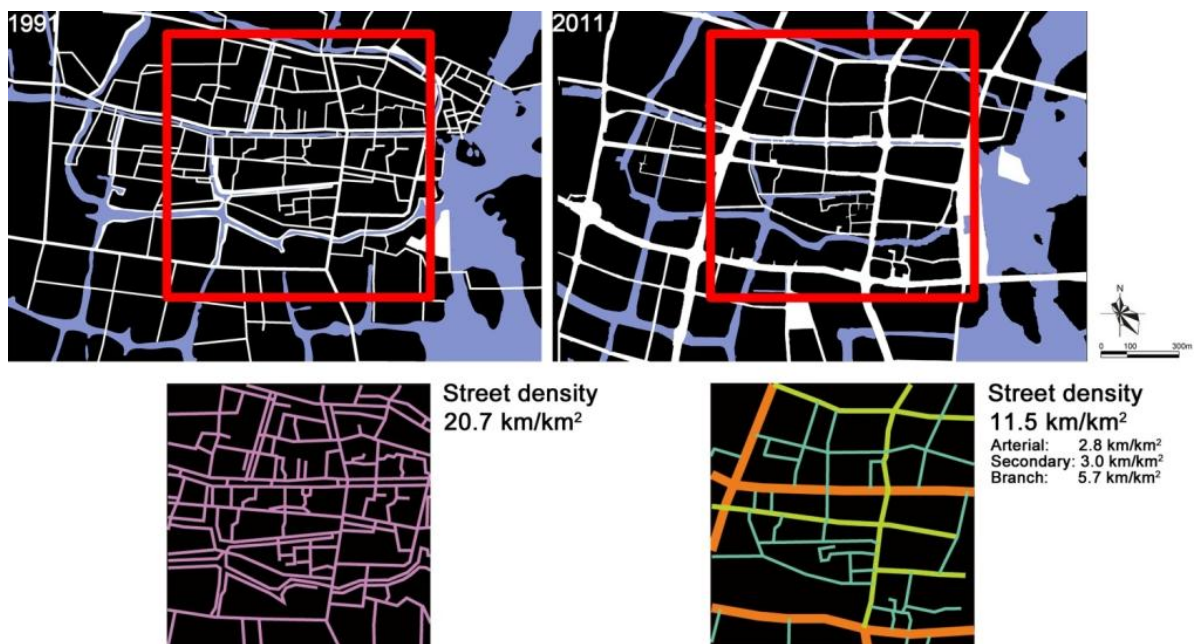


Figure 7.23. The changes of street density in central Pinghu, 1990-2011

Source: adapted from Pinghu Urban and Rural Planning Office, 1991; Pinghu Local Map, 2011.

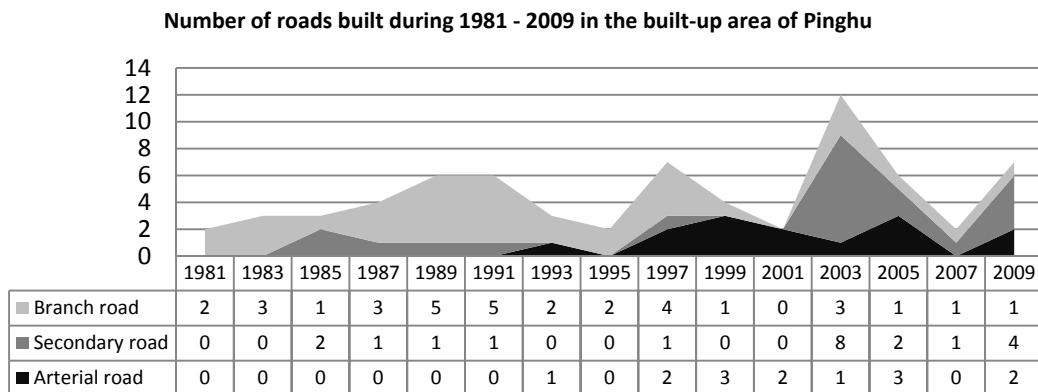
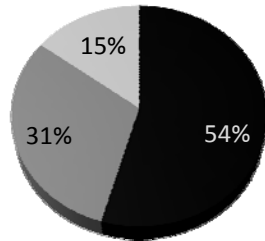


Figure 7.24. Number of urban streets built during 1981 and 2009 in central Pinghu

Source: Pinghu Urban and Rural Planning Office, 2009.

The proportion in total length of each type of roads built during 1981-2009

■ Arterial road ■ Secondary road ■ branch road



The proportion in total area of each type of roads built during 1981-2009

■ Arterial road ■ Secondary road ■ branch road

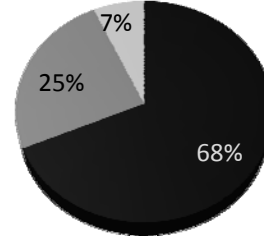


Figure 7.25. The proportion of total length and area of each type of urban road in Pinghu between 1981 and 2009

Source: *ibid.*

Through the rapid decline of street density in downtown Pinghu, the eventual street density is maintained as high as it is in downtown Hangzhou and Harbin. However, 10 kilometres of streets within 1 square kilometre can hardly be regarded as a high street density in downtown areas. In the earlier decades, the street density of many traditional city centres was laid out according to pre-modern planning principles, which could reach as high as 18-20 km/km² (MoHURD, 1995b). In the sample cities of Hangzhou, Harbin and Pinghu, the most significant decline of street density can be found in residential areas. Superblock-oriented redevelopment programmes of residential communities have in fact decreased the need for minor access roads. The development tendency is even more significant in peripheral or suburban areas.

7.3.2 Sample streets in Pinghu

Three streets in Pinghu were selected as the samples of urban streets in small cities. Some parameters of the design standards and revision practice of urban streets are different between small and large cities. The street configuration in small cities is expected to be narrower in width with lower design speed than it is in large cities. Due to their different types, positions and development histories, the sample streets have little in common. Unlike the streets in Harbin

which have local distinctiveness, the samples in Pinghu present few perceived characteristics which had almost been eliminated during the urban renovation programme a decade ago. It is a shame that the streets which could have been able to represent the local character of Pinghu, i.e. river walks, no longer exist in the modern city.

Chengnan Road

Chengnen Road is a 3,300 metre long and 34 metre wide urban arterial road in central Pinghu which was newly revised from an intercity highway in 2002. Figure 7.26 shows that the revision project was carried out in 2006. The name of ‘Chengnan Road’ stands for the ring road in the south of the city. It no longer serves as a ring road, but preserves the name. Unlike many other new arterials, it was not planned as a neat thoroughfare that serves traffic exclusively, but as a main commercial street which accommodates retail and business developments and provides street users with the vision of a “vibrant and thriving commercial atmosphere with strong local identity”. This prominent programme intended to reshape the traditional spatial organisation framework of urban commercial development in Pinghu. Nevertheless, the project confronted problems around 2007 due to a shortage of finance to pay local removal compensation as the cost had increased rapidly. Thus, the time period of this project has lasted much longer than expected, and a great amount of construction work on roadsides is still on-going.



Figure 7.26. *The retrofit construction of Chengnan Road in 2006*

Source: personal photograph collections.

Cycle lanes on Chengnan Road are simply defined by the white lines, which is not a common feature for an arterial road in Pinghu. The road surface appears unadorned without separation alliances except those in junctions (Figure 7.27). The separation-free design of Chengnan Road was adopted as required by the original intention of having a ‘thriving commercial road’. Since the time required for the surrounding constructions is not easily estimated, there is no sign of creating a prosperous commercial atmosphere yet.



Figure 7.27. *The streetscape of Chengnan Road with a few separators at junctions, 2011*

Renmin Road

Renmin Road used to be an arterial road in Pinghu since it was built in 1985. The 3,000 metre long road has retained the maximum width of 20 m since it was built. Its stratification has been downgraded into a secondary road since its suspension from a widening project in early 1990s. The project was opposed by a number of senior local residents. It was believed that funding should be invested in many other fields that could actually improve living quality. This resistance implied a negative attitude towards a widening project before automobiles were pervasively used in this small city.

Experienced several modifications, the streetscape of Renmin Road has been generally unchanged since it was first built. It can be regarded as a street that has not been revised for the

purpose of facilitating motor vehicle movement. Although the shop fronts along Renmin Road seem to be very varied in forms and colours, the sense of local character can be potentially stronger than Chengnan Road, because the road surface with no segregation provides the street users with an inviting atmosphere which integrates the surroundings and encourages participation. The mixed traffic also significantly reduces vehicle speed and has a traffic-calming effect. The low traffic speed and large plane trees provide pedestrians with a relatively safe and quiet space for walking and shopping (Figure 7.28).



Figure 7.28. *The streetscape of Renmin Road, 2011*

Wenjin Road

Wenjin Road is a new branch road on the urban periphery of Pinghu. It was built in 2008 to create a short link between the two main roads. The nearby middle school located in the west and the 6-storey apartment buildings in the east are kept away from this road by perimeter walls and metal fences. Although the branch road provides plenty of greenery for improving the quality of the pedestrian environment, it can act as nothing more than a mere traffic channel (Figure 7.29). Very few pedestrians and cyclists use the street since there is only one entry point to the buildings. Although it is classified officially as a branch road, it does not provide access more than a typical branch defined by the standard. Because of the perimeter wall, Wenjin Road has almost zero permeability with the man-made barrier isolating it from the buildings which should have access to it. Theoretically, it can be regarded as a branch road on which the access function has been

constrained unilaterally. The research takes Wenjin Road as an arguable case for the study of branch roads, because this form of road is typical with superblock developments in urban peripheries.



Figure 7.29. *The monotonous streetscape of Wenjin Road, 2011*

Summary

According to the standard, parameters for urban street design in small cities can be different from those in large cities. Regarding the relatively low traffic demand in small cities, the parameters are generally expressed as smaller road width and slower design speed. However, development of the sample streets in Pinghu does not reflect this rule. There are no significant differences in road width and design speed between the sample roads in Pinghu, Hangzhou and Harbin. Table 7.4 summarises basic information about the sample street in Pinghu.

Table 7.4. *Summary of the sample streets in Pinghu*

Street name	Chengnan Road	Renmin Road	Wenjin Road
Location	Downtown Pinghu	Downtown Pinghu	Urban periphery, Pinghu
Year of the latest revision	2011	2008-2009	2008 (built year)
Surrounding land use	Residence and business	Residence and retail	Residence and education
Design speed	50 km/hr.	40 km/hr.	40 km/hr.
Total length	3300 m.	3000 m.	370 m.
Mean width	40 m (45 m, 33 m.)	18 m (14 m, 20 m.)	25 m (25 m, 25 m.)
Carriageway	Number of vehicle lanes	4, with additional lanes at intersections	2
	Width of individual vehicle lane	3.9-4 m.	Shared surface with cycles

Cycle track	Number of cycle tracks/lanes	2 (cycle lanes)	Shared surface with motor vehicles	2 (cycle lanes)
	Track width	3.8-4 m.	N/A	2.75 m.
Footway	Number of footways	2	2	2
	Footway width	1.5-4 m.	2-6 m.	3.5 m.
	Kerb height	50 mm.	50 mm.	120 mm.
	Paving material	Granite block	Coloured concrete tile, grey brick, asphalt	Red and grey brick
Median strip	No	No	No	No
Safety strip	Metal fences at intersections	No	No	No
Street tree and planting	Ginkgo, small and delicate at present; planting beds are placed at intersections as traffic separators	Aged platanus trees which can give shade in summer. In winter the sun could reach the street through leafless branches.	Southern magnolia, evergreen tree, young and delicate; a line of sapindus trees and trimmed hollies are planted in the green belt.	
Street lighting and furniture	Street lighting and litter bins are uniform and regularly provided. Lighting boxes for advertisements are regularly placed along the roadside.	One-side street lighting is regularly placed in the middle and east parts which were newly revised. Moveable litter bins are also provided as fixed ones.	Street lights are alternately placed on both sides. No litter bins or seating are provided in the street.	
Street frontage	Continuously defined by 2- or 3-storey building annexed for retail use.	Low-storey residential buildings with the ground floors open for retail use. Alleyways appear frequently on both sides.	The street is defined by walls and fences as boundaries to a gated community and a school. Between the pavement and the fences, a 5- to 6-metre wide green belt establishes a distance between the street and the community.	

7.4 CONCLUSION

This chapter provides the case studies with the basic profiles and background context of the research objects. The development processes of the sample streets present different ways of dealing with the increased use of automobiles with limited road resources. Motor vehicle movement is always given a higher value than the other functions in an arterial road. Increasing the area of carriageways is often believed to be a solution to growing congestion. The revision projects of Qingchun Road can be representative of how road space in an arterial road has been gradually reallocated for improving the motor vehicle traffic capacity. The road surface for motor

vehicle movement was enlarged in Dazhi Street by removing cycle lanes. To compensate for motor vehicles' waiting time at intersections, additional lanes were enthusiastically applied to the key junctions in all the sample arterial roads.

The development of secondary roads is much less significant than arterial ones. They are usually adapted from the previous main streets, especially the traditional ones which were intensively surrounded by buildings and could not be effectively upgraded, such as Zhongshan Road in Hangzhou, Guogeli Street in Harbin and Renmin Road in Pinghu. Compared with the sample arterial roads, the secondary roads serve more assorted functions.

In terms of branch roads, their developments are not significant or valued. Most of the urban branch roads today are identified as the traditional streets characterised by their narrowness and minor traffic capacity, such as the sample streets of Haier *Xiang* in Hangzhou and Manzhouli Street in Harbin. Meanwhile, there is another type of branch that reflects the tendency of the design practice of branch roads in new developments, such as Wenjin Road located at the urban periphery of Pinghu and built with a fully modern appearance.

The definition and interpretation of a branch road in the hierarchical street system in China is fundamentally different from the western conventions. As defined in the national standards, a branch road is a minor street which is not only providing access to buildings, but also connected with other branch roads to constitute the reticular networks. Implicitly, the expression 'branch road' in the national standards can hardly reflect its actual position in the practical circumstances. In fact, there should be a fifth type of road in modern Chinese cities: the internal circulation lanes which provide direct access to the buildings in residential quarters. The semi-privatised inner circulation system connects individual buildings in a gated community and is not opened for public use. The reduced permeability can be one of the most significant results of recent superblock developments, as well as a setback in the development of street networks in Chinese cities.

CHAPTER 8 DESIGN STANDARDS AND PRACTICE: MULTI-CASE STUDIES

This chapter studies and compares the nine sampled streets, chosen on the basis of their different characteristics in the street hierarchical classification. Examining these streets' development implementations empirically with national standards and design codes reveals gaps and opportunities in applying new sustainable design practices to urban streets in China. The selected streets are located in urbanised areas surrounded by residential, commercial and educational use in general, which tend to be representative of local citizens' daily lives. Based on the three different categories of streets (Table 8.1), this chapter is divided into three main parts. Each category of sampled streets includes two sections of analysis: 1) systematic comparisons of sample streets with national design codes as quantitative benchmarks; and 2) negotiations between the diverse needs of different traffic roles.

Table 8.1. *Categories of urban streets covered in this chapter*

<i>Section</i>	<i>Street involved</i>	<i>Street location</i>
8.1: Arterial Roads	Qingchun Road	Hangzhou
	Dazhi Street	Harbin
	Chengnan Road	Pinghu
8.2: Secondary Roads	Zhongshan Road	Hangzhou
	Guogeli Street	Harbin
	Renmin Road	Pinghu
8.3: Branch Roads	Haier <i>Xiang</i> (Alleyway)	Hangzhou
	Manzhouli Street	Harbin
	Wenjin Road	Pinghu

Each sample road is analysed by the following two steps. First, design practices of the sample streets are expected to conform to the standards and codes. By examining discrepancies between the regulations and current conditions, the effectiveness of the current standards and codes can be perceived. Second, the extent of the inclusive design of urban streets is evaluated. The final results of street development can reflect which group of street users has mostly been considered and whose needs are primarily achieved. Examinations of street elements and users' behaviour

can reveal the trends and approaches adopted by decision makers.

8.1 ARTERIAL ROADS

The three arterial roads discussed here possess prominent positions in the downtown area of Hangzhou, Harbin and Pinghu respectively. Despite their varied physical appearance in terms of design speeds, number of traffic lanes, safety appliances, pavement materials and so on, these roads are all tagged as urban arterials according to their designed traffic function.

8.1.1 Conformity with the national standards

The examination of the conformity between national standards and actual practices of each sample street includes three stages. The first stage requires an overall inspection of the discrepancies between standard principles and actual types, forms and scales of the sample streets. The second stage compares the actual parameters of the sample streets with allocated design codes to reveal how far the applied design codes correspond to practice. The third stage examines the design practice of street intersections by comparing how actual interferences are managed between two streets under the standards.

Design principles

As explained in Chapter 6, urban street design under the national standard of GB 50220-95, including vehicle design speed, number of vehicle lanes, street width and forms, should primarily relate to the city's size (i.e. urban population) rather than local travel demand, volume, motorisation level or other traffic indicators. For example, large cities with an urban population larger than 2 million should adopt the first class standards for their urban street developments. As

shown in Table 6.2, key indicators are the dominant references for the design of a street based on their classification. By means of mapping and field investigation, some findings are summarised in Table 8.2 to show the consistency between the actual results of sample street development and the design principles required by the standards.

Table 8.2. *Key indicators of the sampled arterial roads: a comparison between actual practice and the national standards*

<i>Street</i>	<i>Key indicator</i>	<i>Current condition</i>	<i>Conformity</i>
Qingchun Road	Total width	40 m on average	Smaller than the required 45-55 m
	Design speed	40 km/hr	Below the required 60 km/hr
	Number of vehicle lanes	6, with additional lanes at intersections	Yes
	Cross-section form*	Type D	Yes
	Intersection form	Mixed by T intersection and Cross with pedestrian bridges provided at busy junctions	Yes, but T intersections are not encouraged
	Lane-width	3.5-3.75 m	Yes
Dazhi Street	Total width	32-45 m	Smaller than the required 45-55 m
	Design speed	60 km/hr	Yes
	Number of vehicle lanes	6, with additional lanes at intersections	Yes
	Cross-section form*	Type B	Yes
	Intersection form	Cross	Yes
	Lane-width	3.5-3.8 m	Slightly larger than the required 3.5-3.75 m
Chengnan Road	Total width	33-45 m	Larger than the required 25-35 m
	Design speed	50 km/hr	Exceeds the required 40 km/hr in a small city
	Number of vehicle lanes	4, with additional lanes at intersections	Yes
	Cross-section form*	Type A	Type A is not a proper form for an arterial road
	Intersection form	Cross and staggered	Yes
	Lane-width	3.9-4.0 m	Exceeds the required 3.5-3.75 m

*See Figure 6.5 (similarly hereinafter).

The data reveal that the specification of urban streets with built-up areas is not that strictly controlled in comparison with the standards of relevant design principles. For example, the widening programme of Qingchun Road was highly constrained by existing buildings, thus the road width is limited to around 40 metres, 5 metres short of the required criterion. In contrast, the

width of Chengnan Road reaches the maximum limits of the criterion by demolishing a large area of the surrounding buildings. Along with the improvement of road size, the design speed of Chengnan Road reaches 50 kilometres per hour which exceeds the required design speed standard. According to the development policies of Chengnan Road, the separator-free form of cross section aims to encourage interactions between street frontages and allow greater flexibility for traffic organization and the possibility for future development. As a consequence, the road space saved from separators has been used for the excessive width of vehicle lanes.

Comparing with the street development in new suburban areas, the development of Qingchun Road, Dazhi Street and Chengnan Road has to confront more constraints from existing urban conditions. The three samples of suburban arterial roads in these cities, however, demonstrate some reverse factors from the control of national standards (Table 8.3). Binjiang Road, Zhongyuan Road and Shengli Road are all newly built arterial roads which are commonly seen in new developing districts in suburban Hangzhou, Harbin and Pinghu respectively. Without being restricted by existing urban contexts, all of these three roads are intended to exceed the maximum limits of the total widths specified in the standards. And all of them are entirely equipped by separators of green strips as suggested in the standards for arterial roads.

Table 8.3. *Key indicators of suburban arterial roads: a comparison between actual practices and the national standards*

Street	Key indicator	Current condition	Conformity
Binjiang Road (in a newly developing district of Hangzhou)	Total width	57-59 m	Larger than the required 45-55 m
	Design speed	60 km/hr	Yes
	Number of vehicle lanes	6, with additional lanes at intersections	Yes
	Cross-section form	Type C	Yes
	Intersection form	Cross	Yes
	Lane-width	3.6-3.9 m	Slightly larger than the required 3.5-3.75 m
Zhongyuan Road (in a newly developing district of Harbin)	Total width	73-75 m	Much larger than the required 45-55 m
	Design speed	60 km/hr	Yes
	Number of vehicle lanes	10	Exceeds the required number of 6-8
	Cross-section form	Type D	Yes
	Intersection form	Cross	Yes
	Lane-width	3.5 m	Yes
Shengli Road (in suburban Pinghu)	Total width	50-51 m	Larger than the maximum width of 35 m
	Design speed	50 km/hr	Exceeds the required 40 km/hr

	Number of vehicle lanes	6, with additional lanes at intersections	Exceeds the required of 2-4
	Cross-section form	Type C	Yes
	Intersection form	Cross	Yes
	Lane-width	3.5 m	Yes

Design of street cross-sections and plans

In order to examine the design details of the sample streets, by contrasting the standards with actual practice, this study draws on a set of critical variables to cover most of the key dimensions of the entire street. As well as the design principles, these variables play an important role in deciding the eventual appearance and quality of an urban street (Figures 8.1-8.3; Tables 8.4-8.6).

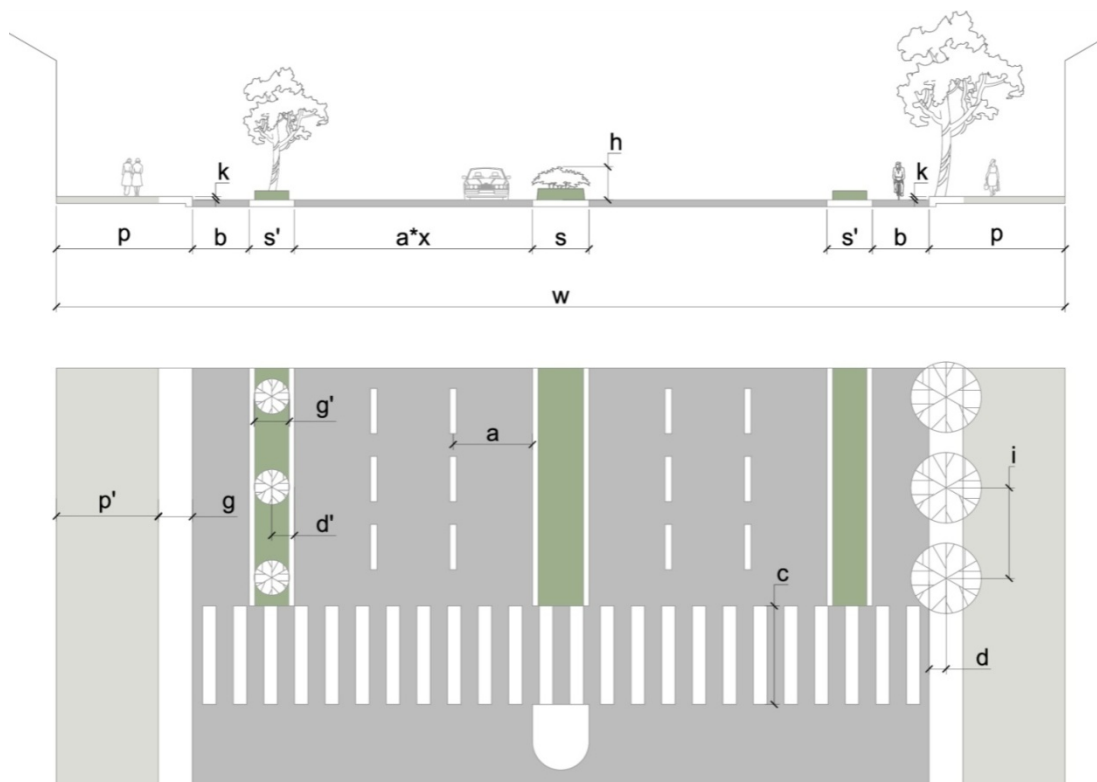


Figure 8.1. Cross-section and street plan of Qingchun Road

Table 8.4. Examination of design variables in Qingchun Road

Variable	Definition	Design code	Actual practice	Conformity
w	Total width	45-55 m	40 m on average	-
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	3.5-3.75 m	√
x	Number of one-way vehicle lanes	3-4	3-6	+
b	Total width of a cycle track	2.5-3.0 m*	2.0-4.2 m	X

p	Total width of a footway	4.5 m (min)	1.8-7.0 m	-
p'	Minimum valid pavement width	3 m (min)	1.8 m	-
c	Width of a pedestrian crossing	4-5 m**	4.0-4.5 m	√
s	Width of the median strip	2.5 m (min)	2.1-2.5 m	-
s'	Width of a safety strip	2 m (min)	0.8-1.3 m	-
g	Width of a planting strip	1.5 m (min)	1-1.2 m	-
k	Kerb height	10-20 cm	0-9 cm	-
h	Height of central planting	0.6-1.5 m	0.4-1.6 m	X
i	Interval of street trees	4-10 m	10 m at average	√
d	Distance between planting point and kerb edge	0.75 m (min)	0-0.75 m	-

*to determine the width of a cycle lane requires a figure for the estimated bicycle traffic volume on the certain street at peak time. Because of the difficulties in acquiring the previous figure recorded before the street was built, the figure was obtained from the researcher's observations during site investigations.

**to determine the width of a pedestrian crossing requires a figure for the estimated pedestrian flow on the certain street. Because of the difficulties in acquiring the previous figure recorded before the street was built, the figure was obtained from the researcher's observations during site investigations.

KEY

√: matches the required criterion

X: indicates out of the determined scope

+: exceeds the required dimension defined by standards

-: fails to reach the minimum measurement defined by standards

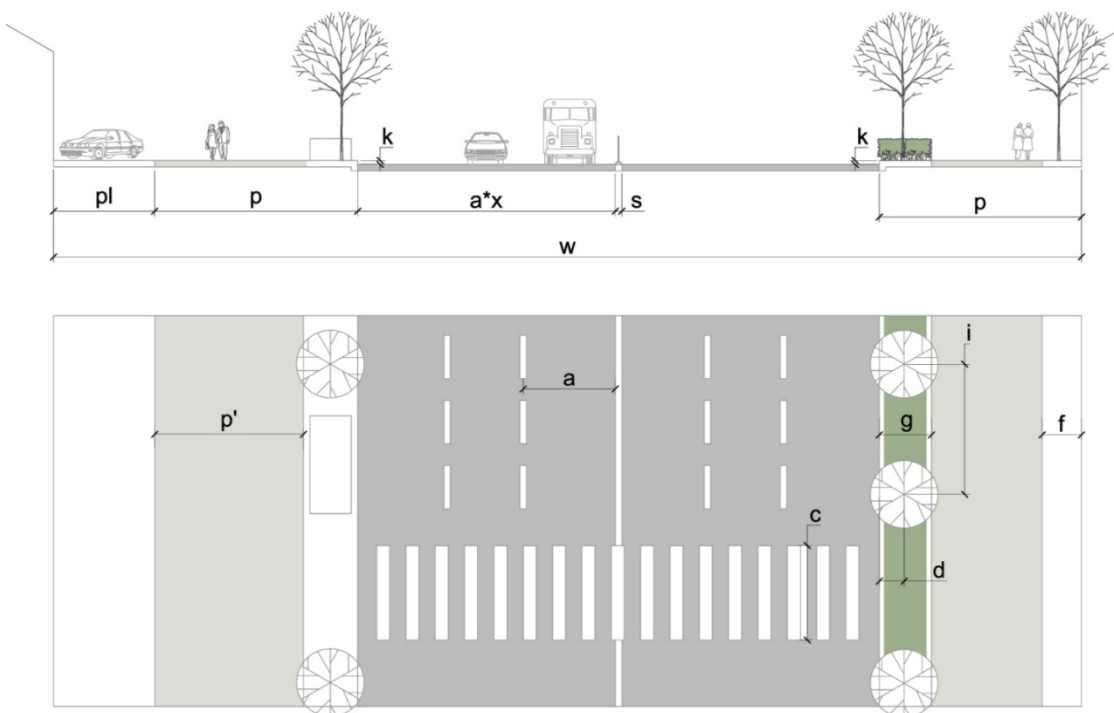


Figure 8.2. Cross-section and street plan of Dazhi Street

Table 8.5. Examination of design variables in Dazhi Street

Variable	Definition	Design code	Actual practice	Conformity
w	Total width	45-55 m	32-45 m	-
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	3.5-3.8 m	+
x	Number of one-way vehicle lanes	3-4	3-4	√
p	Total width of a footway	4.5 m (min)	4.5-8.0 m	√
p'	Minimum valid pavement width	3 m (min)	3.8 m	√
c	Width of a pedestrian crossing	4-5 m	4-5 m	√
s	Width of the median strip	2.5 m (min)	0.8-2.0 m	-
g	Width of a planting strip	1.5 m (min)	2.4 m	√
k	Kerb height	10-20 cm	15-18 cm	√
i	Interval of street trees	4-10 m	8-15 m	+
d	Distance between planting point and kerb edge	0.75 m (min)	1-2 m	√
f	Space for facility use	1.0-1.5 m	1.5-1.8 m	+

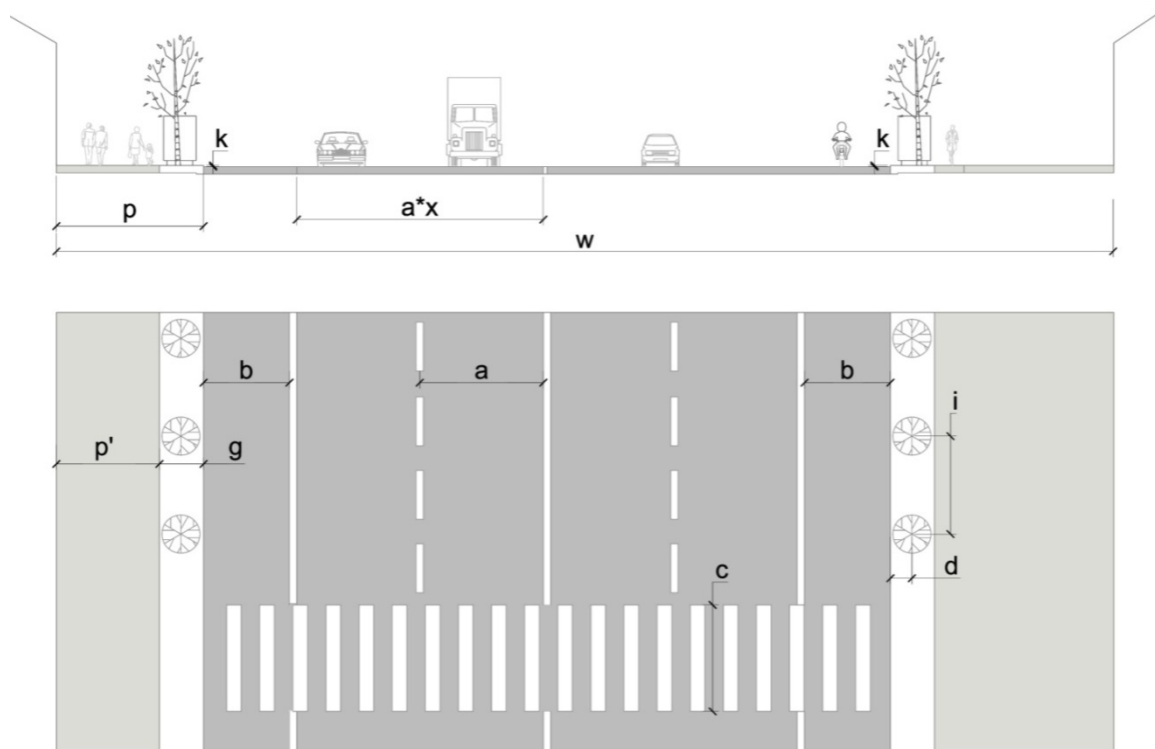


Figure 8.3. Cross-section and street plan of Chengnan Road

Table 8.6. Examination of design variables in Chengnan Road

Variable	Definition	Design code	Actual practice	Conformity
w	Total width	25-35 m	33-45 m	+
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	3.9-4.0 m	+
x	Number of one-way vehicle lanes	1-2	2	√
b	Width of a cycle lane	2 m	3.8-4.0 m	+
p	Width of a footway	4.5 m (min)	3.5-6.5 m	-
p'	Minimum valid pavement width	3 m (min)	1.2 m	-
c	Width of a pedestrian crossing	2-4 m**	4-5 m	+
g	Width of a planting strip	1.5 m (min)	1.8 m	√

k	Kerb height	10-20 cm	0-5 cm	-
i	Interval of street trees	4-10 m	8-15 m	+
d	Distance between planting point and kerb edge	0.75 m (min)	0.9 m	√

The comparative analysis shows that the cross-section design practised in Dazhi Street in Harbin was more likely to conform to the key design codes, while Chengnan Road and Qingchun Road were rarely restricted. In the light of their development histories, the latter two with remarkable recent revisions, should have more opportunities to adapt to the regulations. Rather than suggesting the failure of the codes in directing actual practice, it is more reasonable to argue that the codes have to be extensively compromised with the real-life conditions.

The transformation of Qingchun Road and Chengnan Road can be used as examples to illustrate how the conflicting needs of traffic mobility and the local economy have been considered. While both of the arterials were designed to accommodate social activities of trading and business, they have to confront the difficulties of accommodating the increasing motor traffic. To mitigate the conflict, the development of the two arterials had adopted different strategies.

Qingchun Road kept its original form of Type D (see Section 7.1.2) as required by the standard, but reduced the widths of median and safety strips, as well as the space for planting strips of street trees, in order to be kept within the constrained total width. The design of Chengnan Road followed the form of Type A to strengthen the relation between both sides of frontage, which is not associated with the suggested standard for an arterial road. In order to guarantee a sufficient number and an appropriate width of vehicle lanes, both arterials have reduced the width of footways to an unacceptable extent. Kerb heights were usually kept below the standard to allow cars to climb upon pavement, so that motorists can have access to the buildings along the road (Figure 8.4).



Figure 8.4. *Reduced kerb heights in Qingchun Road (left, middle) and Chengnan Road (right)*

Design of intersections

Traffic speed and capacity around intersections or junctions is sensitive to different time periods during the day, thus the standards for intersection design usually refer to the variables at peak times. Since intersections are the meeting points of two roads which might have different types, design speeds and cross-section forms, they are playing critical roles in dealing with the varied speeds, directions, volumes and features of traffic flows. As mentioned in Chapter 6, most of design parameters are defined in CJJ 37-90 with a large number of variables and criteria. The study selected a number of intersections in the sample streets to examine the conformity of actual practice to the related codes.

The analysis compares the key parameters of all the intersections of the sampled arterials with the design codes to determine how the actual practice matches the standards and codes. The essential criteria of intersections tagged with letters are examined and summarised in Tables 8.7-8.9. Some of the intersections, such as Intersections A, J and O, are selected as exemplars for interpretations (Figures 8.5-8.7). The tables and diagrams show that the nonconformity between actual practice and the standards is significant in all sample arterial roads.

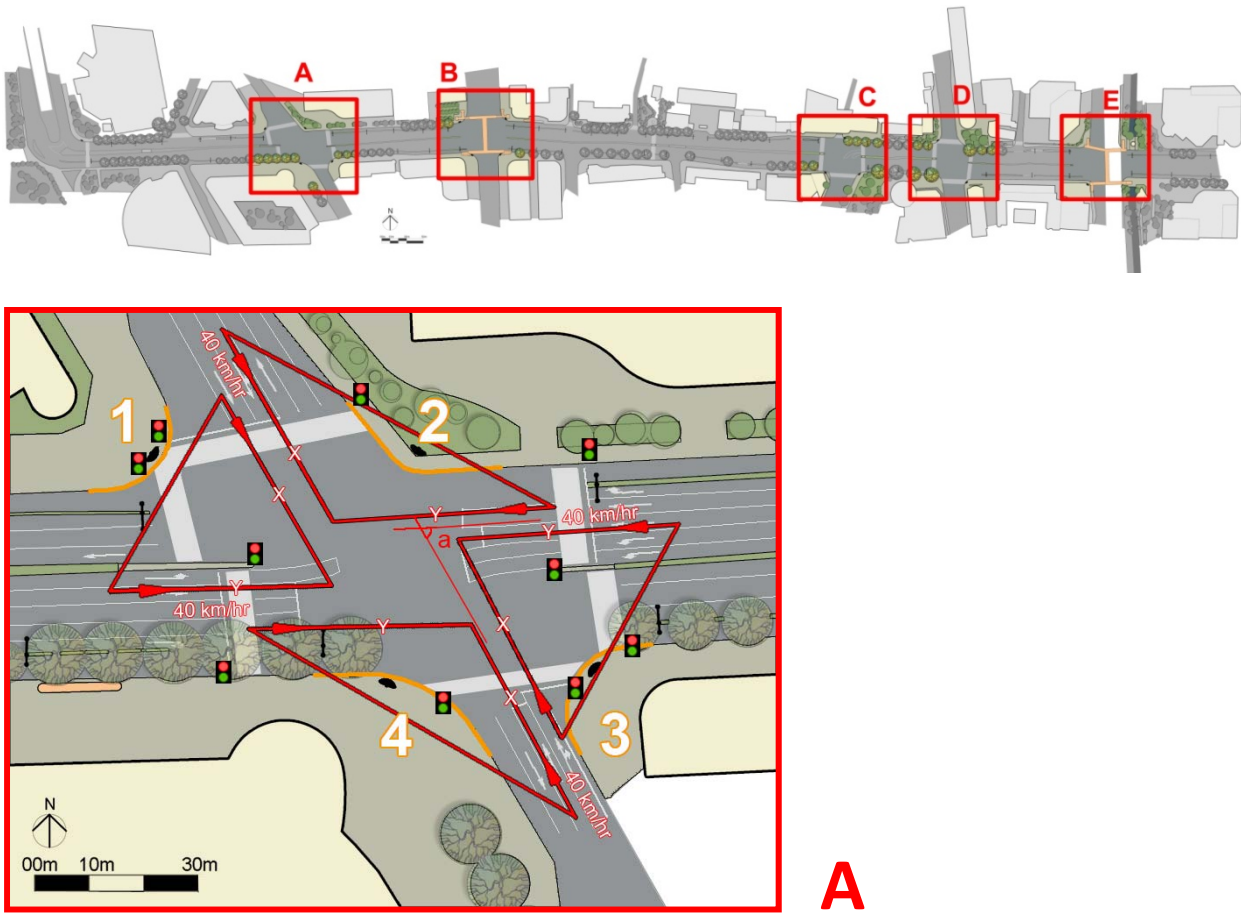


Figure 8.5. Map of Qingchun Road (top) and the example Intersection A (bottom)

Table 8.7. Analysis of the intersections in Qingchun Road

Inter-section	Type	Conformity with design codes				Remark
		Cross angle	Kerb Radius	Visual clearance within SSD	Additional lanes	
A	X	Yes	One of the turning radii exceeds by 60%	No, street trees as visual obstacles	Yes	
B	X	Yes	Yes	No, pedestrian bridge as visual obstacles	Yes	Pedestrian bridge
C	X *	Yes	One of the turning radii exceeds by 20%	No, street trees as visual obstacles	Yes	
D	X	Yes	Yes	No, street trees as visual obstacles	The crossed street does not provide additional lanes for right turning acceleration	
E	X	Yes	Yes	No, pedestrian bridge as visual obstacle	Yes	Pedestrian bridge

*the north branch goes through a spanning building

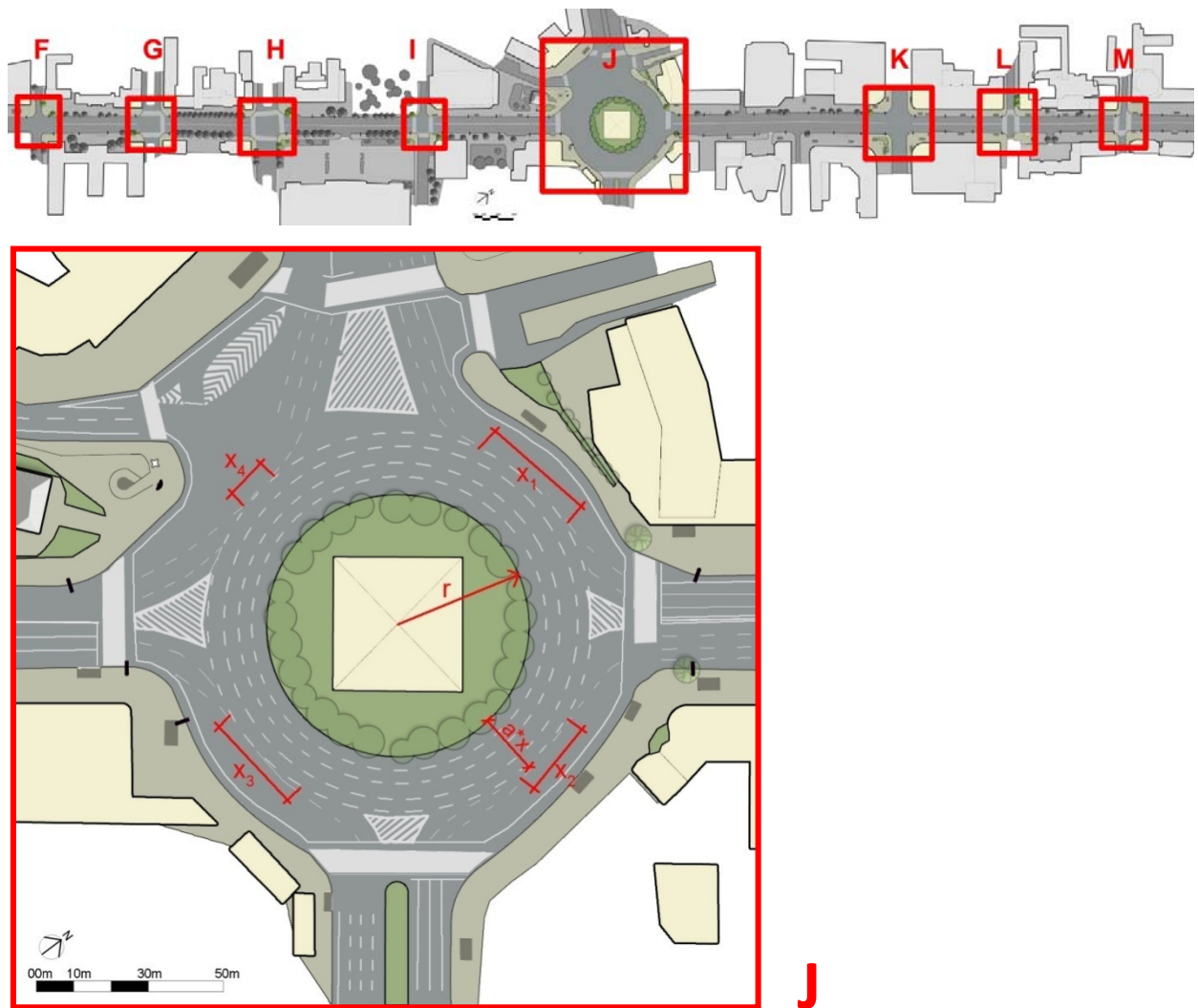


Figure 8.6. Map of Dazhi Street (top) and Intersection J (bottom)

Table 8.8. Analysis of the intersections in Dazhi Street

Inter-section	Type	Conformity with design codes				Remark
		Cross angle	Kerb Radius*	Visual clearance within SSD	Additional lanes	
F	X	Yes	Small radii	Yes	No	
G	X	Yes	Small radii	See remark	See remark	The junction is grade-separated
H	X	Yes	Small radii	See remark	See remark	The junction is grade-separated
I	X	Yes	Small radii	No	No	
J	R	N/A	N/A	Yes	Yes	Roundabout
K	X	Yes	Small radii	Yes, see remark	Yes, but not apparent	SSD had become right since the crossed street is modified to a one-way road
L	T	Yes	Small radii	Yes	No	
M	X	Yes	Small radii	Yes	No	

*turning radii in intersections of Dazhi Street are not fully adjusted to motor vehicle speed, since they were originally designed for cycles' turning speed.

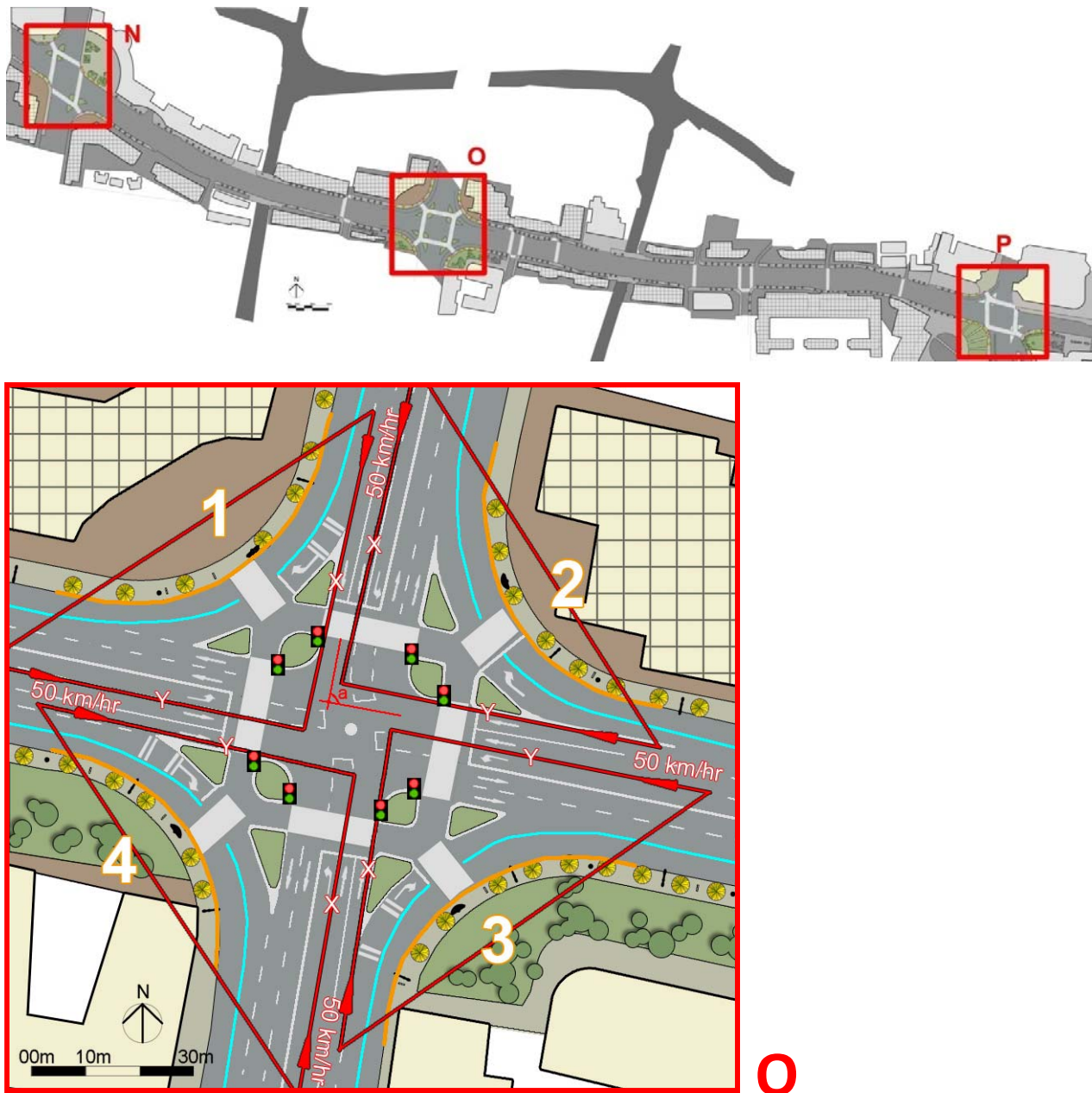


Figure 8.7. Map of Chengnan Road (top) with Intersection O (bottom)

Table 8.9. Analysis of the intersections in Chengnan Road

Inter-section	Type	Conformity with design codes			
		Cross angle	Kerb Radius	Visual clearance within SSD	Additional lanes
N	X	Yes	Too large, exceeded by 86% to 120%	No, street walls as obstacles	Yes
O	X	Yes	Exceeds by up to 50%	No, street walls as obstacles	Yes
P	X	Yes	The radii on the north side are exceeded by 160% to 300%	No, street walls as obstacles	Yes

By comparing the intersections of the sample arterials with the design codes as benchmarks, the discrepancies can be found. The practice that clearly departs from the design codes are the SSDs. Comparing with the MfS, CJJ 37-90 is more likely to embrace a longer distance for stopping sight at the intersection, which requires a longer distance between the opposite corners of buildings. However, the attempt is persistently conflicting with the restricted area of land available in the study cities. In order to prevent accidents from the fast design speed without demolishing corner buildings, for example, grade-separated vehicle lanes were employed in several junctions, i.e. G and H in Dazhi Street and at intersection K, for example, by changing the crossed street into a one-way street, the requirements of SSD on the north corners can be circumvented.

In Qingchun Road, although the design speed was reduced to 40 kilometres per hour, SSD requirements have not been fully achieved at most of the intersections. Street trees and pedestrian bridges (built in April 1993), which were never removed from their original spots during either the widening project in 1994 or the upgrade in 2005, became the main obstacles inside the SSD splay of clearance.

Another noticeable discrepancy exists in the reverse conditions of the turning radius in Dazhi Street and Chengnan Road. The right turning radii at the junctions of Dazhi Street do not meet the stipulated turning speed of motor vehicles. As long as the cycle lanes were given up to motor vehicles, the original kerbs at the intersections could not be adjusted to the higher turning speed of automobiles. In Chengnan Road, the kerb adjustment in design practice illustrates that a negotiation between pavement and carriageway had been made regarding the requirement of lane control and additional turning lanes (Figure 8.8). In practice, the flared junctions generate extra-large right turning radii, which allow automobiles to turn faster and also create a ‘vehicular barrier’ which makes it difficult for people who have to cross the road.

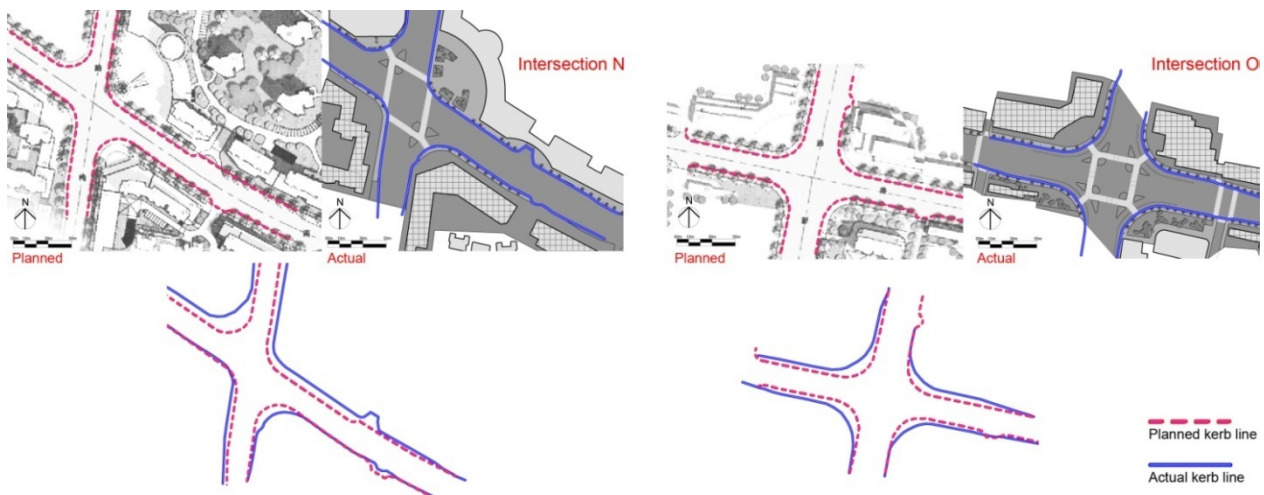


Figure 8.8. *Modification of kerb lines from planning to practice at Intersections N and O*

While most intersections in Qingchun Road and Chengnan Road are channelized to provide extra vehicle lanes, those in Dazhi Street rarely reflect the flare and channelization requirements. By introducing the three streets' transformation over time, it is not difficult to highlight the exception of Dazhi Street. Firstly, the latest major revision of Dazhi Street took place in 1983 when the street had not been fully motorised as there were few demands for distributing vehicle flows in varied directions. Secondly, like many traditional streets, Dazhi Street was defined sharply by building frontages, particularly at junctions, which allowed little space for additional lanes. The current condition may reflect the concern of the local authority over the importance of preserving the pavement and the corner buildings for pedestrians' convenience and that the local character outweighs the importance of providing flares at intersections for increased motor traffic. Thirdly, the entrance to underpasses and underground bazaars could be another concrete obstacle against intersection flaring, which makes any widening project in Dazhi Street more difficult.

The roundabout in the middle of Dazhi Street is probably another controversial outcome of its development history. According to the standard, the roundabout does not follow the 'right' type of junction where two arterial roads meet and the height of objects in the centre-island (i.e. the glass pyramid) should not be so tall as to form obstacles to a driver's line of sight. In order to claim the clearance of SSD splay, the carriageway of the roundabout is given extra width, but with a relatively short weaving distance as shown as x_4 in Figure 8.6. These facts suggest that the

roundabout is located entirely beyond the requirement of the design codes. However, the centre-island with the construction, demolished and rebuilt, has existed for over a century and no evidence shows that the roundabout has caused significant difficulties to the surrounding traffic.

In terms of pedestrian crossings, not many are related to the design codes or the standards. The requirements for determining the appropriate type or width of pedestrian crossings are usually concerned with the fluidity of vehicle traffic in the urban street. For example, CJJ 37-90 provides local authorities with great flexibility in applying pedestrian bridges or underpasses at street intersections. Clause 15.3.2 in CJJ 37-90 states that a pedestrian bridge or underpass can be applied in the intersection where the volume of pedestrians has significantly affected the traffic capacity of automobiles. Besides, underpasses should be considered as a type of pedestrian crossing if they can be integrated into the existing local underground facilities. As long as the obscurity in understanding the ‘significant effect’, bridges and underpasses can be proposed at any intersections of arterial roads in large cities since pedestrians can always have a ‘significant effect’ on vehicle traffic flow. As an ‘efficient’ solution (from the perspective of motorists) to separate pedestrians from vehicular flows, pedestrian bridges or underpasses are enthusiastically applied at the busy intersections of Qingchun Road and most of the junctions of Dazhi Street.

8.1.2 Inclusive design and street users’ needs

Vasconcellos’ (2001) study shows that comprehensive understanding of traffic management is important in dealing with dynamic travel needs of different traffic roles in developing countries, but only two managerial objectives - fluidity and safety - have been primarily pursued. Similar assumptions that these two objectives are preliminarily pursued in the design practice of urban streets in Chinese cities could be proposed in this study. The issue of how different needs are negotiated or compromised by the design of urban arterial roads is the focus of this section.

Street elements, such as pavements, cycle lanes, carriageways, street planting, lighting and

furniture, as well as separators or guard rails, are essential to the quality of an urban street. Although these elements are provided for different objectives and functions, in a modern street, they might help in defining the distribution of road space to improve traffic flow and safety. The arrangements of median strips, safety strips, pavements, aligned trees, traffic signs and the position of the lighting allocation, claim clear spatial boundaries for different traffic roles and designated functions.

Separators

Median and safety strips are considered as separators that facilitate the flow and safety by dividing traffic flows of different travel modes and directions. They are often in the forms of planting strips or metal fences. Median strips divide the carriageway in the centre to segregate two opposite directions of vehicle flows. Safety strips segregate bicycles from motor vehicles to define boundaries of cycle lanes or tracks. Pedestrian guard rails are usually applied to kerb edges to prevent pedestrians from crossing the road at undesigned points.

As assumed by the conventional paradigm, urban arterial roads should only be planned to serve traffic activities. The concept is clearly stated in GB 50220-95 that there should be a limited number of entrances to buildings open to urban arterial roads. Arterial roads are defined as main thoroughfares that connect separate inner-city districts with the primary function of accommodating traffic. The definition neglects the development of the city itself. First, to accommodate increased vehicular traffic, many minor streets in traditional built-up areas should have been widened and upgraded to arterials. Second, to provide good accessibility and business opportunities, new developments are very likely to be planned along the existing arterial roads. The dual nature of urban arterial roads is thus a common phenomenon in Chinese cities.

The provision of separators is in fact commonly found in urban arterials, with their absence often being regarded as atypical and crude. Even the reduction of the separator's height can be

criticised. For example, a report from Harbin argues that the reduced height of separators in Hongjun Street (an arterial road which intersects Dazhi Street at the roundabout) leads to illegal crossings. The replacement of the 0.5-metre high concrete separators for the former 2-metre high steel fences was noted as an improper change, which leads to “uncivilised” behaviours (Wu, 2011).

Due to the limited road space, separators in Qingchun Road are not as wide as required by the design codes. However, the function of segregating traffic flow is not compromised by their relatively narrower widths. In fact, the median strips succeed in separating one direction of traffic flow from the other to facilitate traffic flow, though at the expense of accessibility and aesthetics. The separators do not only isolate the traffic flow in movement, but also interrupt the interactive relationship between the two sides of the road. Whilst the traffic flow can be measured by the number of vehicle passing through per hour, the convenience or accessibility cannot be technically measured. By collecting robust statistics on road congestion, the economic loss caused by the blocked traffic fluidity can be assessed to raise official and public attention to find solutions to facilitate the movement. Most public attention has been paid to vehicular traffic conditions in Qingchun Road. The low speed allowance (40 km/hr.) in Qingchun Road has been pervasively questioned and complained about by motorists, albeit none of them could drive faster than 30 km/hr. on this busy arterial during peak time. In contrast, the provision of separators has rarely been queried, as many pedestrians and cyclists take the risk of crossing over the planting strips to cross the road (Figure 8.9).



Figure 8.9. ‘Uncivilised behaviour’ – ‘illegal’ crossing in Qingchun Road

The negative effect of median and safety strips is also apparent in terms of convenience and

accessibility of motorists. The design practices of Chengnan Road show the concern that separator facilities could be compromised to encourage active frontages. The ‘barrier-free’ design has provided great accessibility and convenience for the motorists so that they can park and access the buildings as often as they want.

As an urban arterial road in Harbin, Dazhi Street is equipped with median strips and pedestrian guard rails in the form of metal rails lying along the central line and kerb edges at intersections (Figure 8.10). As a historical street, all fences are kept at a relative low height in order to reduce the negative visual impact on the street. The insignificance of separators in Dazhi Street might be the result of the declining necessity for organising traffic flows since the cycle lanes were eliminated. The provision of separators only aims to regulate the vehicular flows in two opposite directions and to prevent unexpected interruptions by pedestrians at some intersections.



Figure 8.10. *Median strips and pedestrian guard rails in Dazhi Street*

Through the cases of Qingchun Road, Chengnan Road and Dazhi Street, the flexibility in road separation policy can be observed. Although separators might occasionally be rejected for some reasons, they have been consistently applied and believed as an effective facility to support efficient traffic flow on urban arterial roads in both large and small cities. Separators could have improved the safety of cyclists and/or pedestrians and the fluidity of vehicular traffic by reducing unexpected interruptions, by placing a gap for the street users, including the motorists, who want to cross the streets or intend to access the facilities on the roadside. The consistent use of street separators could be one of the most significant factors that reflect the decision-makers’ primary

responses to the traffic flow and safety at the expense of accessibility and convenience. On the other hand, equipped with median and safety strips, particularly in the forms of planting strips or metal fences, urban arterials are achieving a unified appearance because the main sense and character of a street generated by the combination of street frontages on both sides is disrupted by physical segregation.

Footways

Standards for footways are usually limited to the requirements of pavement materials, minimum width, kerb height and accessibility. Regulatory requirements for footways mainly focus on two aspects: 1) the effectiveness in organising pedestrian movement; and 2) the safety of pedestrian movement. The standard itself places an emphasis on walking fluidity and safety, integrity and continuity, i.e. the efficiency of walking traffic, which becomes the main indicators to examine the quality of pavements. A footway on urban streets can consist of four parts: the walking area, buffering area, planting area and the area for facility uses. The latter two can be combined together if the total road width is restricted.

In practice, a typical footway can be found in the western part of Qingchun Road. Figure 8.11 shows that the footway is evenly divided into three parts (with no buffering area) with clear boundaries. Footways in Chengnan Road also show an apparent spatial allocation for different functions. In particular, the areas for buffering, street trees and facilities are clearly defined with persistent positions and widths, whereas the walking areas are compromised (Figure 8.11). Some exceptions can be observed on the east of Dazhi Street where the integrity of footways is interrupted by trees, kiosks, stairways and infrastructure (Figure 8.11). The distinct conditions of footways are the reflection of the different sections of road development phases. Orderliness in footways might be more valued in relatively new developments, i.e. the revision of Chengnan Road, than in the historical ones.

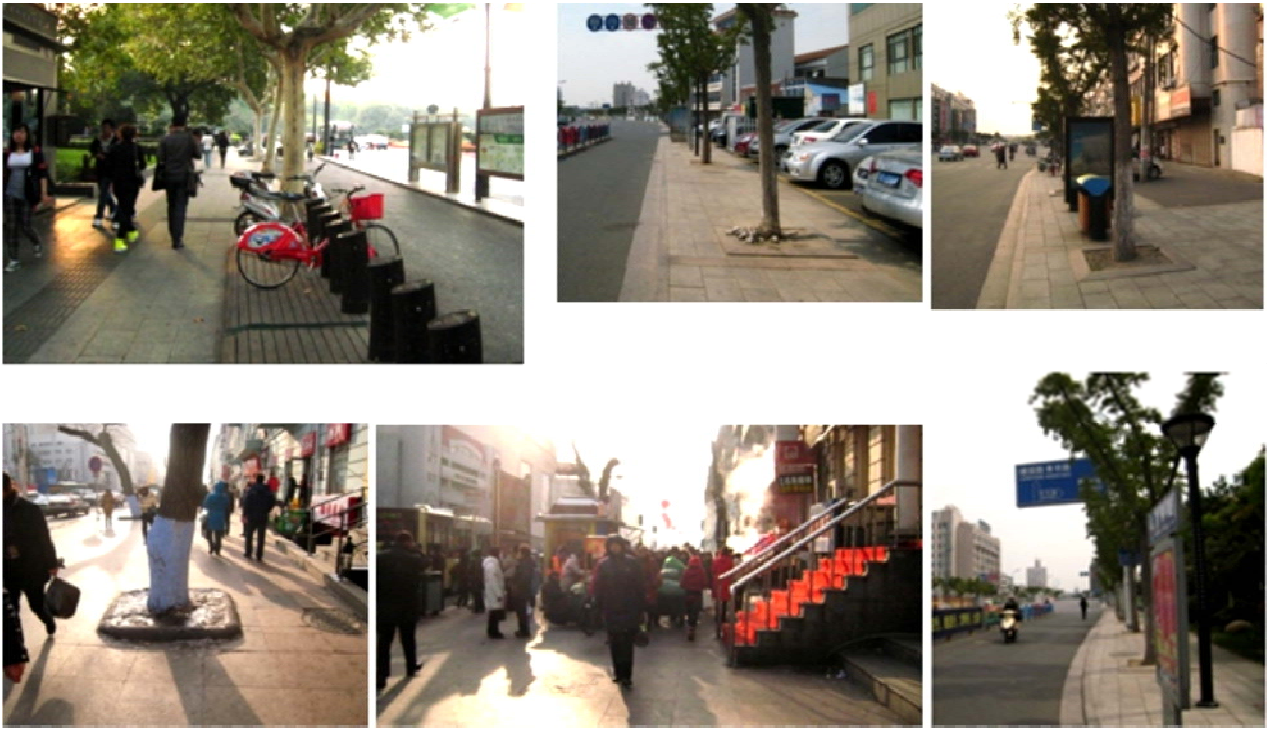


Figure 8.11. Samples of footways in Qingchun Road (top left), Dazhi Street (bottom left and middle) and Chengnan Road (top middle, right and bottom right)

By examining the footways in the three sample arterials, the standards of integrity and continuity have basically been achieved. However, the two indicators may fail to reflect the actual quality of footways in the sample streets. As shown in Figure 8.11, footways in Chengnan Road are in fact very difficult to use for a pedestrian, though they are claimed as being in good condition with both integrity and continuity. The constructions occupy large amounts of footway areas and have left a limited surface to walk on. This situation has lasted for seven years since 2004 and seems set to continue. According to the author's daytime observation during 5th and 6th October 2010, walking trips on the west of Chengnan Road only constituted 6% of the total trips (except bus passengers). Conversely, walking trips on the west of Renmin Road made up of 22% of the total trips within the same time period. The difference indicates that walking is not an attractive travel mode in Chengnan Road. The reason for the decline of walking trips could be reinforced by counting the number of pedestrians on each side of Chengnan Road, since the condition of the footway on the north side is better than on the south side regarding the valid width of pavement. The observation record shows that almost 70% pedestrians were counted from the north side.

Although the footways on both sides have fairly good conditions integrity and continuity, pedestrians prefer to walk on the footway with the larger pavement width regardless of their walking directions.

The limitation of road space is significant in traditional built-up areas. Reductions in either width or quality of footways might be the main solution to allow extra space for the carriageways. The revision projects of Qingchun Road can be a marked exemplar for such a phenomenon (see Figure 7.9, Section 7.1.2). The width of footways was cut in half, providing spare space for cycle lanes which had been sacrificed to the widened carriageways. This is the way that the negotiation between the needs of pedestrians and motorists has been made.

Due to the elimination of cycle lanes in Harbin, the footways in Dazhi Street can be preserved at their original width and conditions. Pavement parking can be seen anywhere in the east of Dazhi Street, which might be a compromise resulting from the shortage of public parking provision. A similar situation is also found in Chengnan Road, in which automobiles have occupied considerably large areas of footways, leaving little pavement space for pedestrians. Restricted by the current technique and materials, the pavement is not sturdy enough to serve as car parks and so is frequently being crushed (Figure 8.12 & Figure 8.13).



Figure 8.12. Cars invading the pavements in Dazhi Street (left) and in Chengnan Road (right)



Figure 8.13. Pavements damaged by heavy vehicles in Dazhi Street (left) and in Chengnan Road (right)

To drive automobiles onto footways, kerb heights have to be reduced below the standard. Kerb heights in Chengnan Road are usually less than 5 centimetres, which enables cars to climb upon the pavement and reach the buildings without any detours. In a few sections of Qingchun Road, there is even no difference in elevation between kerbs and carriageway (Figure 8.4). Though the kerbs in Dazhi Street are found as thick as 18 centimetres, the height has been widely reduced at every corner to invite cars to ride on the footways. Reduction in kerb height (known as ‘kerb ramp’) is one of the regulations for barrier-free designs for bicycles and wheelchairs (JGJ 50-2001, 2001). In Dazhi Street, kerb ramps are extended and enlarged to allow cars to drive on the footways (Figure 8.14). Nevertheless, the excessively large kerb ramp is permitted under JGJ 50-2001 since the code does not specify the maximum size for a ramp. The design practices in these streets imply that by following the objectives of traffic flow and safety has led to the sequential pursuit of car accessibility or parking spaces.

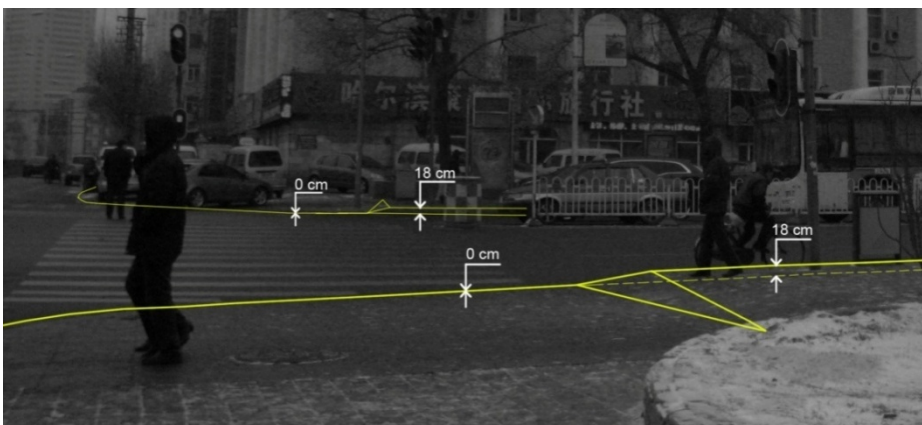


Figure 8.14. Extensively enlarged kerb ramps in Dazhi Street

To sum up, the cases of footways show the conflicts between parking and goods delivery and

freedom of pedestrian flow at the detailed level. The obstruction can be permanent by built infrastructure, or temporary by pavement parking. The latter is often tolerated as an alternative to public parking lots and enabled by the reduced kerb heights.

Pedestrian crossings

In an urban arterial road, any forms of pedestrian crossing should be placed every 250 to 300 metres (GB 50220-95). In fact, 300 metres is not a short distance for walking. However, pedestrian crossings are placed more often than required in urban arterial roads, since the intervals between the two junctions are usually less than 300 metres. The most common form of pedestrian crossing in China is the zebra crossing which could be frequently seen in the three sample arterial roads. Indeed, some of them are combined with safety islands where the carriageways have no less than four vehicle lanes which make it difficult for pedestrians to cross. Through the examination of relevant standards and design codes, parameters for pedestrian crossing design are only limited to the valid width which is determined by the expected pedestrian volume. No evidence shows that crossing times are fully considered as a key indicator. In Qingchun Road and Dazhi Street, pedestrian bridges and underpasses are provided occasionally as substitutes. The provision of pedestrian bridges or underpasses is flexibly suggested when ‘the vehicular traffic has been significantly affected by pedestrians’.

Most of the pedestrian crossings in Qingchun Road are provided with safety islands in the middle due to the heavy automobile volumes and the fairly wide width (Figure 8.15). The design suggests that the pedestrians have to stop half way to wait for another traffic signal before finishing the crossing. In Qingchun Road, the green-red interval at pedestrian crossings is approximately one seventh of the total signal cycle. Adding the consideration of the channelization at intersections, the time for crossing under the permission of two individual traffic signals is very difficult to determine. According to the author’s observation on 21st October 2011, the longest time for crossing the road (including the waiting time) at Intersection D

was about 125 seconds (60 seconds waiting for the first signal, 50 seconds waiting for the second



signal and 15 seconds for crossing). To divide one crossing into two parts can ensure sufficient time for people crossing and add green light time to right-turning vehicles at the expense of green light time at the pedestrian crossing.

Figure 8.15. *The design of the pedestrian crossing at Intersection D in Qingchun Road*

The pedestrian crossings at the intersection in Chengnan Road are divided into three parts and controlled by one traffic signal (Figure 8.7). The design of pedestrian crossings and intersections is adopted as a ‘good practice’ and can be found in many new arterial roads, such as Binjiang Road, Zhongyuan Road and Shengli Road (Figure 8.16). The design practice allows right-turning vehicles and cycles to bypass the control of the traffic signal and increase the green light time for the other direction of movement. For vehicular traffic, the new practice of channelization indeed improves the flow and reduces the waiting time at the intersection. For pedestrians, not only has the crossing distance been doubled, but their safety has been compromised (no longer protected by the traffic signals) and threatened by the control-free right-turn automobiles (Figure 8.17). In addition, as mentioned before, the turning corner radius is always excessively large, which enables motor vehicles to drive on at a fast turning speed. The author observed that the pedestrians had to concentrate to be aware of the fast turning cars at each corner, when they should have the absolute priority to cross the road under the permission of the traffic signal. In this design practice, pedestrian’s safety is subjected to the vehicular flow.

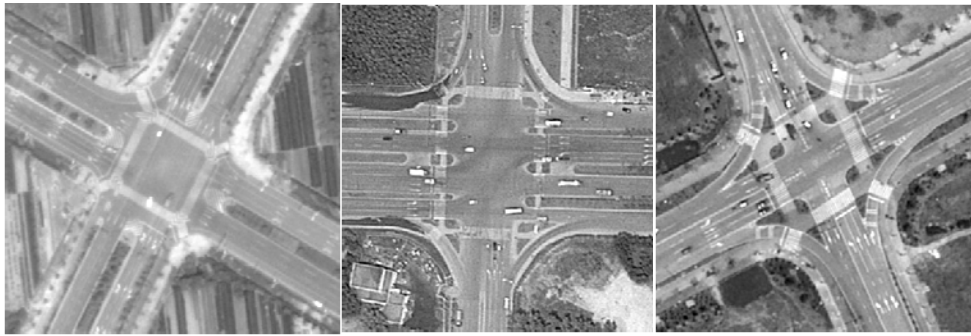


Figure 8.16. *The design of crossings in Binjiang Road, Hangzhou (left), Zhongyuan Road, Harbin (middle) and Shengli Road, Pinghu (right)*

Source: Google Map, 2011, <http://ditu.google.cn/>, accessed in June 2013.

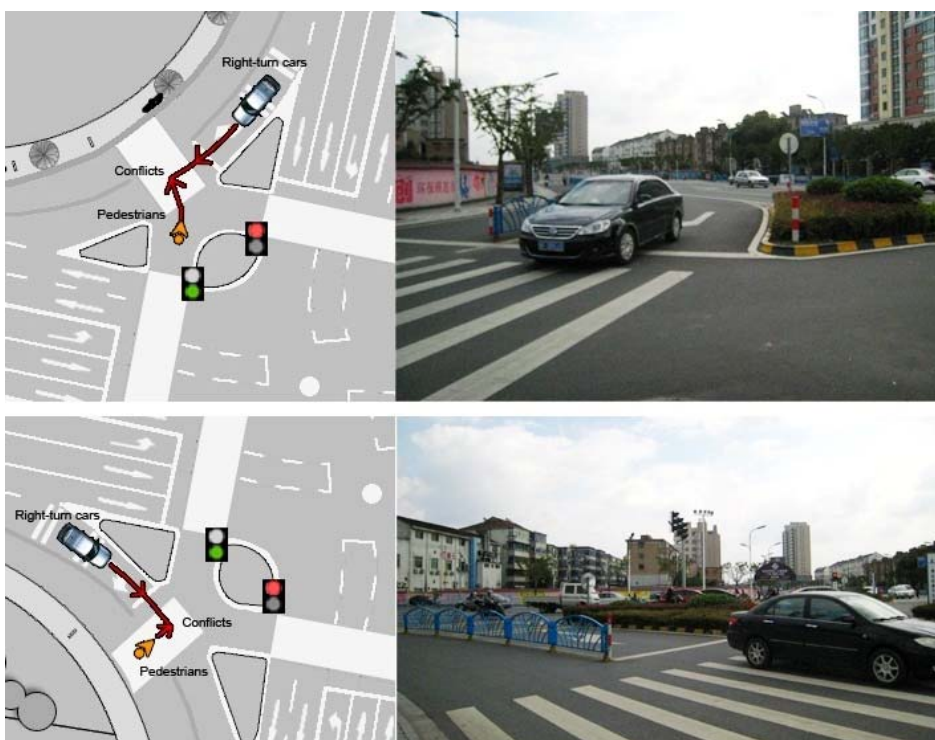


Figure 8.17. *A diagram of a crossing at Intersection O of Chengnan Road - right-turn cars pose threats to pedestrians twice at one crossing, in particular where they could have become free from the control of traffic signals.*

Pedestrian bridges or underpasses are widely used to ensure traffic flow and safety at the expense of pedestrians' convenience in Qingchun Road and Dazhi Street (Figure 8.18). The bridges and underpasses without lifts or escalators are major barriers to users of wheelchairs and carts. Besides, in order to save construction costs and reduce visual clutter, the design of the footbridge creates a detour by doubling the crossing distance of pedestrians. In order to steer the pedestrians to use the bridge, the metal fences are placed along the corner kerb line (Figure 8.19). Without

benefiting from the shade of street trees, together with the rising heat from the road surface, the temperature on the pedestrian bridge can approach 50° Celsius on summer afternoons. In terms of underpasses, according to the author's observation, very few people are willing to use those in Dazhi Street. In addition to the issue of inconvenience, the poor ventilation, unintelligible orientation and chaotic environment are the main problems of using the underpasses. It is particularly confusing when using the underpass at Intersection J in Dazhi Street where the direction cannot be identified because of the absence of orientation facilities (Figure 8.20). However, pedestrian crossings are provided at road surface level as well, which may be a compromise solution to offset the inconvenience of underpasses. The provision and design of pedestrian bridges and underpasses in the sample arterials implies that vehicular traffic flow has been primarily pursued by compromising the convenience of pedestrian traffic at intersections.



Figure 8.18. *The pedestrian bridge at Intersection B in Qingchun Road (left) and the underpass at Intersection J in Dazhi Street (right)*



Figure 8.19. (Left) *The design of pedestrian bridge at Intersection B in Qingchun Road*
 Figure 8.20. (Right) *Underpasses combined with shopping malls under Dazhi Street*

Bus stops

A bus stop can be considered as the connection point between pedestrians and buses, walking and riding, slow and fast speeds, dispersing and gathering, place and movement. The design of a bus stop should succeed in mediating these conflicts at the point where different needs meet. According to the standard, the design of bus stop should depend on the street section. 3-metre wide bus lay-bys can be applied beside kerbs and separators where conditions permit. Bus lay-bys are vehicle lanes added to accommodate the stopping buses without delaying the movement of other vehicles.

Bus stops in Qingchun Road are merged into the safety strips and served by bus lay-bys. The design is generally practised in Qingchun Road where the footways could be reduced in width (Figure 8.21). The diagram shows that the enlarged road space for bus lay-bys is compensated for by the reduced area of footways. The alternative design can be found in Chengnan Road. The bus stops are placed at the footways with the bus lay-bys in front of them (Figure 8.22). However, such a design of bus lay-by can hardly be found in Dazhi Street. For example, Figure 8.23 shows that no extra lane was created along the bus stop although the footway is large enough for a crescent to accommodate an extra vehicle lane. The design of bus lay-bys might not have been widely adopted in the 1980s when the latest revision project of Dazhi Street was carried out.

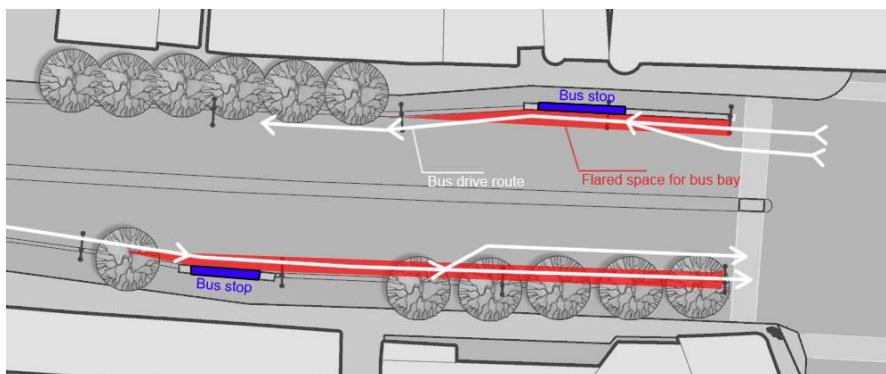


Figure 8.21 *The design of bus lay-by at Intersection C in Qingchun Road*

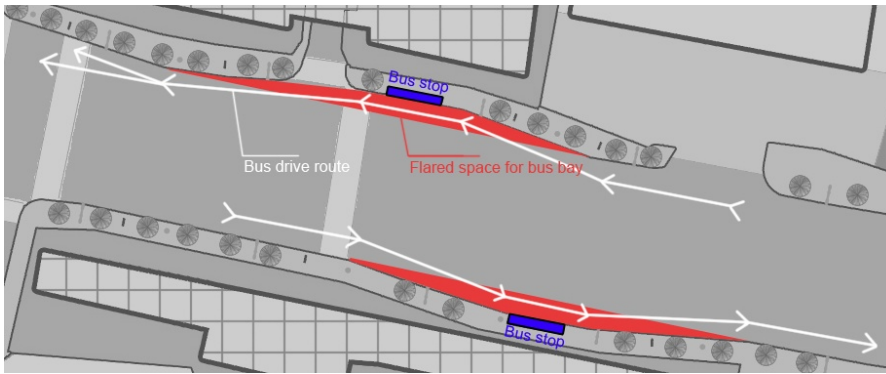


Figure 8.22. The design of bus lay-by at Intersection O in Chengnan Road



Figure 8.23. A bus stop in Dazhi Street

Generally, there are two basic forms of bus stop: simple stands and architectural frames. While the simple stands could only indicate the bus numbers and routes, the architectural frames can also provide passengers with shelter and seats. Limited by the road space, the bus stops are usually similar in design (Figure 8.24). Advertising panels can be seen as the signature of a bus stop, although they often appear as nothing more than a visual barrier. Sometimes it might be difficult for a visitor to distinguish them at a distance from some other facilities, such as a news board nearby, or a bicycle renting kiosk (Figure 8.25). The narrow space of the bus stops at the safety strips in Qingchun Road is a problem when the stop becomes crowded with passengers (Figure 8.26).



Figure 8.24. The designs of bus stop in Qingchun Road (left) and Chengnan Road (right)



Figure 8.25. A news board (left) and a bicycle renting kiosk (right) in Qingchun Road



Figure 8.26. Some bus stops in Qingchun Road - narrow standing areas can have safety risks.

The design of the bus lay-bys and bus stops on the sample streets has more or less neglected the needs of pedestrians and bus passengers. Besides, the large commercial boards mounted on the bus stops are not only visual barriers, but also add ‘visual clutter’ to the street. It implies that other needs, such as commercial advertising to yield income for the road investors, have also been involved in the negotiation process of urban street design.

8.2 SECONDARY ROADS

The selected secondary roads, Zhongshan Road, Guogeli Street and Renmin Road, are all located in downtown Hangzhou, Harbin and Pinghu. Due to the significant locations, these roads serve robust retail developments on their frontages. By repeating the examination steps used for arterial roads, the sample secondary roads are analysed to determine their design trends under the national standards and actual conditions.

8.2.1 Conformity with the national standards

Both the definition and description of secondary roads are rather ambiguous in the national standards. They simply state in CJJ 37-90 that “secondary roads should connect to the arterial roads to constitute the street network, collecting and distributing traffic as well as serving other public activities” (CJJ 37-90, 1991: 2.1.1). It does not indicate whether the secondary road can be applied to constitute the street network without the existing framework of arterial roads. According to GB50220-95, secondary roads are the optional type of roads in small cities. The function of secondary roads is mixed and associated with both traffic and social activities.

Design principles

Table 6.2 in Section 6.1.2 illustrates a set of design principles of urban streets. These principles are used to analyse the practical features of the sample secondary roads and summarised in Table 8.10 below. The comparisons indicate that some principles fail to match the requirement of the design codes. For example, similar to the condition of Qingchun Road and Dazhi Street, neither Zhongshan Road nor Guogeli Street reaches the minimum width of a secondary road, which may be the result of the restriction of the surrounding buildings. In contrast, Renmin Road in downtown Pinghu can approach the required width of a secondary road as specified in the design

codes for a small city.

Table 8.10. *Key indicators of the sample secondary roads: a comparison between actual practice and the national standards*

<i>Street</i>	<i>Key indicator</i>	<i>Current condition</i>	<i>Conformity</i>
Zhongshan Road	Total width	33-35 m on average	Smaller than the required 40-50 m
	Design speed	40 km/hr.	Yes
	Number of vehicle lanes	2-4	Fewer than the required 4-6
	Cross section form	Type C & B	Yes
	Intersection form	Mixed by regular crosses and irregular types of intersections	Irregular intersections are not recommended
	Lane-width	3.5-3.9 m	Slightly larger than the standard
Guogeli Street	Total width	22-30 m	Smaller than the required 40-50 m
	Design speed	50 km/hr.	Higher than the required 40 km/hr
	Number of vehicle lanes	4	Yes
	Cross section form	Type A	Yes
	Intersection form	Regular crosses in common	Yes
	Lane-width	3.5-4 m	Larger than the required 3.5-3.75 m
Renmin Road	Total width	14-20 m	Yes
	Design speed	40 km/hr.	Yes
	Number of vehicle lanes	2	Yes
	Cross section form	Type A	Yes
	Intersection form	Cross	Yes
	Lane-width	N/A	N/A

The issues that do not conform to the standards are less significant for the secondary roads located in suburban areas (Table 8.11). The newly built secondary roads had few constraints on design practices and corresponded to the key indicators well. Unlike their superior counterparts of suburban arterial roads, these secondary roads are more conservative in standardised land consumption. The cases of suburban secondary roads with little land-use restriction reflect that the standards have a stronger effect on the design practices.

Table 8.11. *Key indicators of suburban secondary roads: a comparison between actual practice and the national standards*

<i>Street</i>	<i>Key indicator</i>	<i>Current condition</i>	<i>Conformity</i>
Changhe Road (in a newly developing district of Hangzhou)	Total width	45 m	Yes
	Design speed	40 km/hr.	Yes
	Number of vehicle lanes	4, with additional lanes at intersections	Yes
	Cross section form	Type D	Type D is not encouraged for a secondary road
	Intersection form	Cross	Yes
	Lane-width	3.75 m	Yes
Xuehai Street	Total width	45-50 m	Yes

(in a newly developing district of Harbin)	Design speed	50 km/hr.	Exceeds the required 40 km/hr.
	Number of vehicle lanes	6	Yes
	Cross section form	Type B	Yes
	Intersection form	Cross	Yes
	Lane-width	3.5 m	Yes
Qiyuan Road (in suburban Pinghu)	Total width	30 m	Larger than the maximum width of 25 m
	Design speed	40 km/hr.	Exceeds the required 30 km/hr.
	Number of vehicle lanes	4	Yes
	Cross section form	Type B	Yes
	Intersection form	Cross	Yes
	Lane-width	3.5 m	Yes

According to the codes, there is a noticeable gap between the expected street widths in large and small cities. In other words, urban population significantly affects the decision on street width for each type of road. The codes assume that there can be a direct and remarkable correlation between urban population and traffic demand, as well as between street width and traffic volume. The assumption may be too simple to guide practice and allows little space for alternatives. The following analysis can reveal the limited effectiveness of the design codes in regulating the complex actual practice.

Design of street cross-sections and plans

By comparing the present conditions of the sampled secondary roads with the benchmarks of the design codes, the relevance of the design codes in practice can be determined and described. Figures 8.27-29 and Tables 8.12-14 illustrate how the street design variables of the sample streets in practice correspond to the related design codes. Other than the relatively short total widths, it is difficult to identify the similarities of practice for the sampled secondary roads in relation to the design codes. Nevertheless, pavement parking or on-street parking is frequently seen in these streets. However, neither parking form is identified or regulated by the current design standards and codes. All the sampled streets struggle to determine the ways to accommodate both movement and parking demands in response to the increased number of automobiles and the limited amount of urban space.

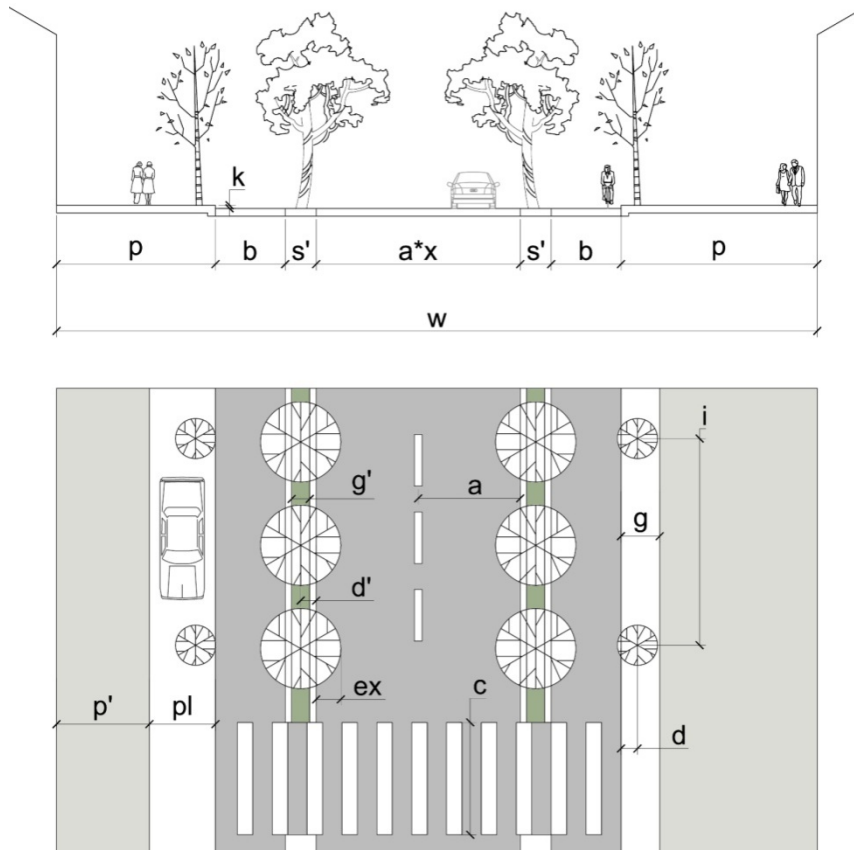


Figure 8.27. Cross-section and street plan of Zhongshan Road

Table 8.12. Examination of design variables in Zhongshan Road

Variable	Definition	Design code	Actual practice	Conformity
w	Total width	40-50 m	34 m on average	-
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	3.5-3.9 m	+
x	Number of one-way vehicle lanes	2-3	1-2	-
b	Total width of a cycle lane	2-2.5 m	2.7-3.0 m	+
p	Total width of a footway	4.5 m (min)	3-7 m	-
p'	Minimum valid pavement width	3 m (min)	0.8 m	-
c	Width of pedestrian crossing	4-5 m	4.3-4.5 m	√
s'	Width of a safety strip	2 m (min)	1.5-1.7 m	-
g	Width of a planting strip	1.5 m (min)	1.5 m	√
g'	Width of a planting bed	1.5 m (min)	1 m	-
k	Kerb height	10-20 cm	15 cm	√
pl	Space for pavement parking	No	2.1 m	X
i	Interval of street trees	4-10 m	8-10 m	√
d	Distance between planting point and kerb edge	0.75 m (min)	0.6 m	-

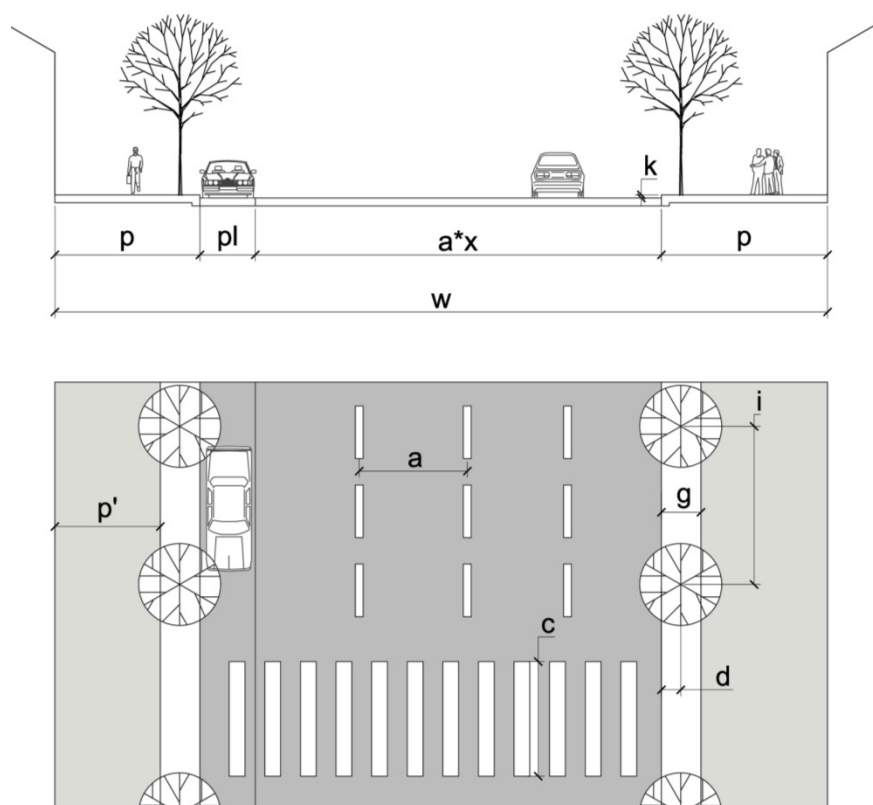


Figure 8.28. Cross-section and street plan of Guogeli Street

Table 8.13. Examination of design variables in Guogeli Street

Variable	Definition	Design code	Actual practice	Conformity
w	Total width	40-50 m	25 m on average	-
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	3.5-4 m	+
x	Number of one-way vehicle lanes	2-3	4	+
p	Total width of a footway	4.5 m (min)	4.5-8.5 m	√
p'	Minimum valid pavement width	3 m (min)	0.6 m	-
c	Width of a pedestrian crossing	4-5 m	4.0 m	√
g	Width of a planting strip	1.5 m (min)	1.8-2.2 m	√
k	Kerb height	10-20 cm	18-21 cm	+
pl	Space for on-street parking	No	2.1 m	X
i	Interval of street trees	4-10 m	10-20 m	+
d	Distance between planting point and kerb edge	0.75 m (min)	1-1.2 m	√

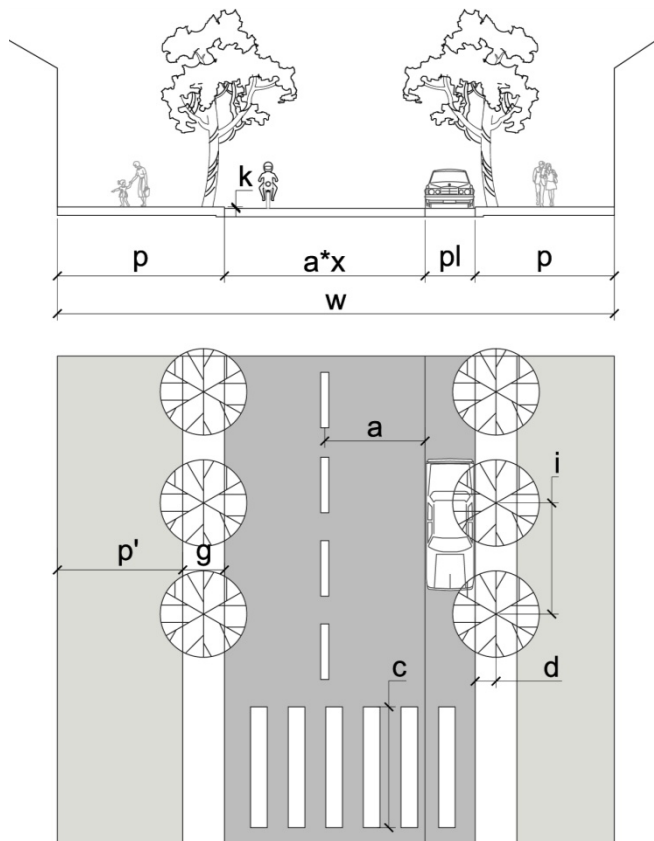


Figure 8.29. Cross-section and street plan of Renmin Road

Table 8.14. Examination of design variables in Renmin Road

Variable	Definition	Design code	Actual practice	Conformity
w	Total width	15-25 m	16 m on average	√
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	N/A	X
x	Number of one-way vehicle lanes	2-3	N/A	X
p	Total width of a footway	4.5 m (min)	3-6 m	-
p'	Minimum valid pavement width	3 m (min)	2 m	-
c	Width of a pedestrian crossing	3-4 m	4.0 m	√
g	Width of a planting strip	1.5 m (min)	1.2-1.5 m	-
k	Kerb height	10-20 cm	5-18 cm	-
pl	Space for on-street parking	No	2.1 m	X
i	Interval of street trees	4-10 m	8 m	√
d	Distance between planting points and kerb edge	0.75 m (min)	0.6-0.8 m	-

In terms of street tree planting, the position and interval are technically determined in the design codes. The series of large London Plane trees provide Zhongshan Road with the constant sense of enclosure and strong local identity. Like the history of Qingchun Road, the present situation of Zhongshan Road was the outcome of the several widening projects which increased the road widths while retaining the street trees in the original spots. The comparison of Zhongshan Road in different time periods demonstrates that the cycle lanes were added to the both sides of the

carriageway (as seen now), instead of sharing the road surface with motor vehicles in the 1980s (Figure 8.30).



Figure 8.30. *The development of Zhongshan Road from the 1980s to the present*

Comparing with the other two sample streets, Guogeli Street has relatively higher kerb heights and larger street tree intervals. High kerb height is a noticeable response to the snowy winters in



Harbin, though it is not mentioned in the design codes. The kerb in Guogeli Street is also characterised by the sloping edge which might be used to prevent the highly raised edge of the pavement from being damaged by vehicle axles (Figure 8.31).

Figure 8.31. *A unique design of the kerb in Guogeli Street*

In Hangzhou and Pinghu, the street trees are planted as continuous canopies as they are highly valued in southern Chinese cities. However, trees are irregularly planted at large intervals in Guogeli Street in Harbin (Figure 8.32). The situation could be traced back to the early history of street development. For example, Figure 7.18 (see Section 7.2.2) illustrates that the street trees were not arranged regularly in Guogeli Street in the 1930s. Although it is not recommended according to the design codes, the aged trees today have been kept in their original position rather than been moved into alignment.



Figure 8.32. *Irregularly planted street trees with raised planting beds in Guogeli Street*

The design of the street with the carriageway shared by automobiles and bicycles is not specified in the design codes. Therefore, the number and the width of vehicle lanes in Renmin Road do not correspond to the standards. In downtown areas, this street form is commonly observed with the types of secondary and branch roads which were developed from the traditional minor streets, but not designed under the standards, which also implies that a large amount of urban streets are not actually regulated by the present standards or design codes.

Design of intersections

The intersections of the sample secondary roads are analysed against the benchmarks derived from the design codes. As well as the sample arterials, some intersections of these streets are identified as examples for visual interpretation (Figures 8.33-35; Tables 8.15-17). Generally speaking, the design practice shows few attempts to meet the requirements of the design codes when it is restrained by the surrounding buildings.

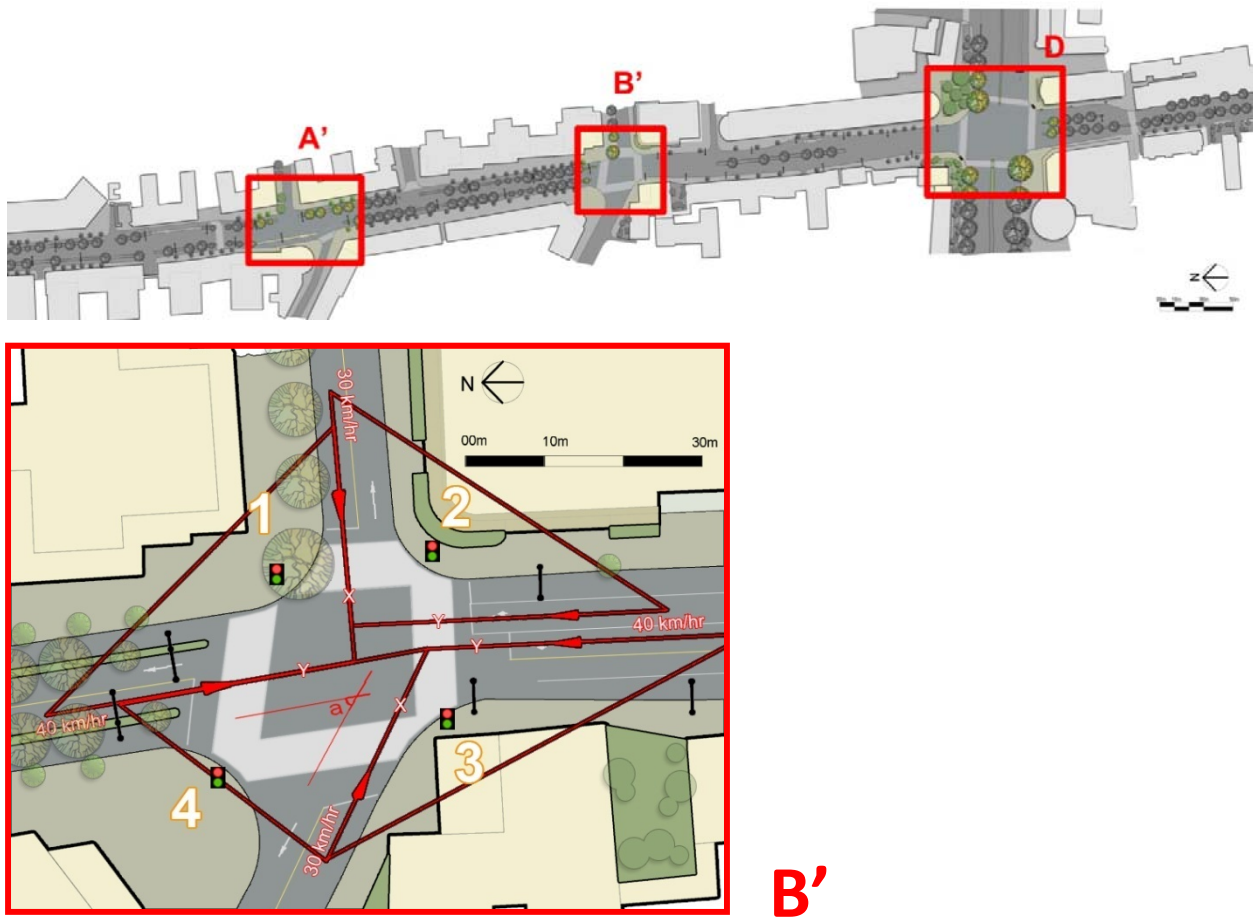


Figure 8.33. Map of Zhongshan Road (top) and the example of Intersection B' (bottom)

Table 8.15. Analysis of intersections in Zhongshan Road

Inter-section	Type	Conformity with design codes			
		Cross angle	Kerb Radius	Visual clearance within SSD	Additional lanes
A'	Irregular	Yes	Yes	No, street trees as visual obstacles	No
B'	X	Yes	Yes	No, street trees at corner 1 as visual obstacles	Partly
D	X	Yes	Yes	No, street trees as visual obstacles	The crossed street does not provide additional lanes for right turning acceleration

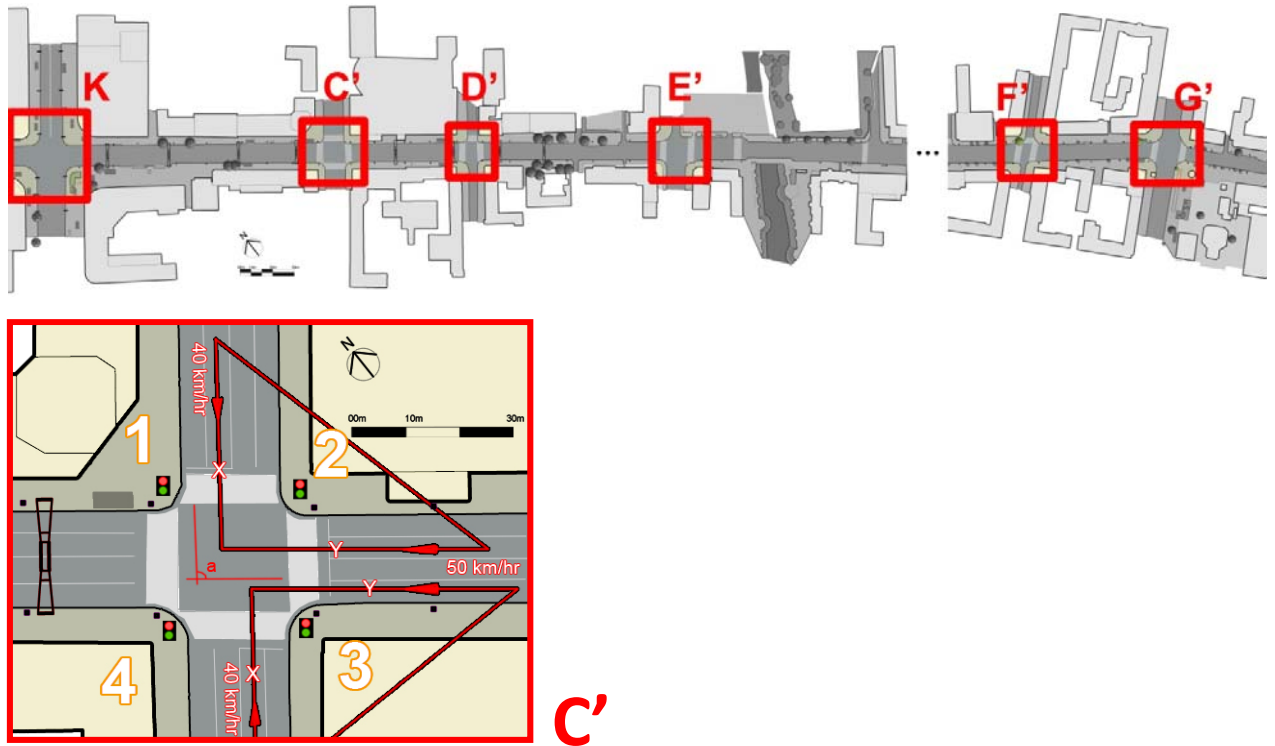


Figure 8.34. Map of Guogeli Street (top) and the example Intersection C' (bottom)

Table 8.16. Analysis of intersections in Guogeli Street

Intersection	Type	Conformity with design codes				Remark
		Cross angle	Kerb Radius	Visual clearance within SSD	Additional lanes	
K	X	Yes	Small radii	Yes	Not apparent	Underpass
C'	X	Yes	Small radii	No, corner buildings as visual obstacles	No	Underpass
D'	X	Yes	Small radii	Yes	No	Underpass
E'	X	Yes	Small radii	Yes	Yes	
F'	X	Yes	Small radii	Yes	Yes	
G'	X	Yes	Yes	Yes	Yes	Underpass

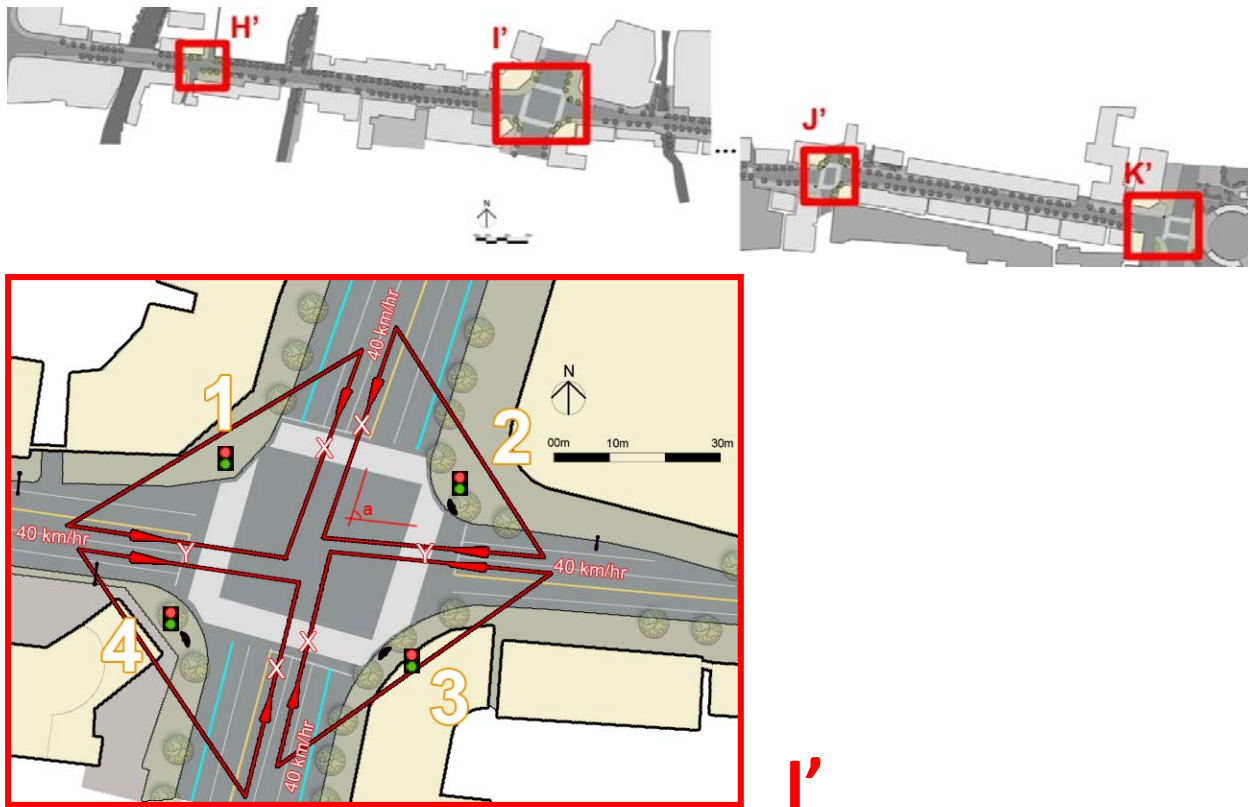


Figure 8.35. Map of Renmin Road (top) and the example Intersection I' (bottom)

Table 8.17. Analysis of intersections in Renmin Road

Inter-section	Type	Conformity with design codes				Remark
		Cross angle	Kerb Radius	Visual clearance within SSD	Additional lanes	
H'	Irregular	Yes	Yes, see remark	Yes	No	The crossed alleys are inaccessible to automobiles
I'	X	Yes	Excessive, Corner 1 and 3 is doubly enlarged	No, corner buildings and street trees as visual obstacles	Yes	
J'	X	Yes	Yes	No, corner buildings as visual obstacles	Yes	The north part of the crossed road is inaccessible to automobiles
K'	T, but irregular	Yes	Too large	Yes	Yes	The intersection is interrupted by a minor street which parallels with the crossed road.

In Zhongshan Road, street trees are very likely to appear as obstacles stopping sight. Clause 13.2.3 in CJJ 37-90 states that the height of the planting located inside the SSD splay must be kept under 1 metre from the ground level of the road centre line. For example, at Intersection B',

the street trees have significantly surpassed the highest limitation stipulated by the code (Figure 8.36). The sight is not actually blocked by the trees since the interval between the trunks is large enough to look through. Meanwhile, in order to have a clearer view between the trees, drivers can become very cautious at this corner, thereby reducing the car speed to avoid unexpected casualties.



Figure 8.36. *The view to Corner 1 at Intersection B' in Zhongshan Road*

The intersections of Guogeli Street are generally arranged with kerb corner curves with small radii like the ones in Dazhi Street. The design code is inclined to ask for a fairly fast turning speed (half of the design speed) of automobiles by providing them with a decently large kerb radius (Table 8.18). Therefore, the radius originally defined for bicycles could not be the proper size for the turning movement of automobiles. However, the sharp turning corner can help to reduce the turning speed of automobiles; thus, the result could be seen as the effective, though unintentional, practice of speed control.

Table 8.18. *The minimum kerb radius for right-turning vehicles*

Design speed of right turning (km/hr)	30	25	20	15
Minimum kerb radius (m)	33-38	20-25	10-15	5-10

Source: MoHURD, 1990a, Table 6.2.4.

Nevertheless, there might be no place for applying such a policy in Chinese cities because most of the road development policies are traffic-flow oriented and any designs that lead to a reduction in travel speed are unlikely to be favoured. Public complaints on the low speed allowance in Qingchun Road reflect this mindset. On the other hand, along with the growing vehicular flows, the provision of additional vehicle lanes seems to be increasingly important to improve traffic

flow. Additional lanes are widely applied to the intersections (Intersections E', F' and G') in the eastern part of Guogeli Street where there is sufficient road space or the absence of underpasses.

Obvious applications of additional lanes can be found in Renmin Road since the latest revision in 2009. The sudden increase of the carriageway width is commonly seen at the intersections. Because the carriageway is shared by bicycles and automobiles, the channelization process has confronted few difficulties in dealing with road separators. Not only has the carriageway been widened, some of the corner buildings have also been adapted to the increased total road width in order to maintain the integrity and continuity of footways (see the example of Intersection I'). However, the practice has created an excessively large turning radius which adds risks to traffic safety at the intersection. The similar tendency occurs in Chengnan Road where the channelization leads to an excessive size of turning radius too. Based on the analysis, it is difficult to determine the similar factors, because the two roads were designed and developed by different institutes.

8.2.2 Inclusive design and street users' needs

It is difficult to present the common ground of the negotiations among different needs in the sampled secondary roads because the streets are less regulated and appear in more varied forms than the arterial ones. Due to the relatively lower demand for traffic fluidity than in arterial roads, there is increasing spatial demand for car parking in the secondary roads. Other than pedestrians, motorists are considered as the main source of customers to local retailers and businesses. Car parking on the streets is significantly and widely arranged in the sampled secondary roads, particularly those along which there are storefronts. Spatial inequity appears in these streets due to the unfair allocations of urban spatial resources. Regarding the nature of automobiles, motorists can usually obtain priority in using urban road space by compromising the comfort and convenience of other street users like pedestrians and cyclists.

Pavement parking

While traffic flow and safety are primarily pursued throughout the design practice of the sampled arterial roads, creating space for car parking is another objective in the development process of the sample secondary roads. There are two main forms of car parking in the sample roads – on-street parking and pavement parking. On-street parking is one of the solutions to the shortage of urban space for public car parks. Compared with the parking serving the arterial roads, it is more frequently arranged and regularly placed in the secondary roads. On-street parking can be provided in the secondary roads where the cycle lanes are not physically separated from the carriageway. Pavement parking will be introduced to the roads where the flank separators are consistently placed.

Pavement parking in Zhongshan Road is placed between every two street trees. The parking lots are not only provided for cars but also for bicycles (Figure 8.37). Although the pavement parking occupies a large area of footways, the regulated arrangement of parking lots can leave uninterrupted space for walking. In order to enable cars to climb onto the pavements, kerb heights at street corners are widely reduced. The practice also invites illegal parking on the pavement, particularly in rainy weather when the parking lots on the pavement may not be sufficient for the temporarily increased use of automobiles. Illegal parking can significantly block the movement of pedestrians and cyclists (Figure 8.38). Kerb height might be one of the essential elements in regulating pavement parking. The low kerb height can encourage vehicles to ride on the footway regardless of whether the pavement parking is legally provided. Enlarged kerb ramps can also be perceived as the permission for pavement parking once they are large enough to allow a car to go through, even if there is no legal parking lot, while the regular kerb ramp which is narrower than a vehicle width can effectively prevent illegal pavement parking (Figure 8.39).



Figure 8.37. (Left) *Pavement parking on Zhongshan Road*

Figure 8.38. (Right) *Illegal parking on the footway of Zhongshan Road*



Figure 8.39. *The enlarged kerb ramp in Zhongshan Road (left) and the regular kerb ramp in Guogeli Street (right)*

In comparison, on-street parking can have much less impact on the movement of pavement users, though it can only be used on streets with one or two lanes. On-street parking on secondary roads is usually arranged on one side of the street, in order to ensure adequate width for the carriageway. When the width of the carriageway has to be widened to meet the enlarged road space for additional lanes to provide space for vehicular movement, pavement parking would be provided as a supplementary solution. The occasional arrangement can cause unexpected detours for the pavement users. The pedestrians, therefore, would rather walk on the carriageway to avoid the diversion when the traffic is not heavy (Figure 8.40 & Figure 8.41).



Figure 8.40. (Left) *Pavement parking alongside one of the flares in Renmin Road*

Figure 8.41. (Middle and right) *Occasional pavement parking in Renmin Road can cause diversions for pedestrians*

As suggested above, pedestrians are no longer the only users of the footways. Their priority of using footways has been eroded by the increased arrangements for pavement parking. It seems to be a fight for road space between pedestrians and automobiles on these secondary roads. Generally, even though some pavement parking is officially permitted and placed, it is not charged since the motorists are considered as the customers of the stores along the street. According to the pavement maintenance policies in most Chinese cities (including the sampled cities), in a street with open frontages, the pavement is often maintained by the corresponding shop owners who are responsible for its cleanliness, tidiness, greenness etc., so that pavement parking is not officially controlled or charged. The solution of pavement parking itself is regarded as a factor for promoting local retail and business. When a motorist leaves the car, his or her traffic role has been changed from a driver to a pedestrian, but the car is still occupying at least 5 m² of road space. This implies that while the motorists could benefit from the free urban spatial resource, the pedestrians have to suffer from the inconvenience, which unconsciously encourages the use of automobiles and worsens the quality of the walking environment.

Footways

Following a reduction in walking journeys, the footways tend to be treated as peripheral in urban street design and maintenance. Although the integrity and continuity of pavements are emphasised in the design standards, in practice, they are usually subordinated to the quality of

carriageways, since the ‘fast travelling mode’ is assumed to be the symbol of the transport development in a modern city. One of the most significant issues is reduced pavement width. The problem may occur where the irregular shape of a building frontage meets the normative plans of carriageways. For example, Figure 8.42 shows the part of a footway in Zhongshan Road that shrinks along the broadened building fronts. Since the walking journey seems to be more tolerant of bad road conditions than motoring, the footway between the unchangeable building fronts and the stipulated carriageway could represent the compromise resulting from the negotiation between pedestrians and motorists.

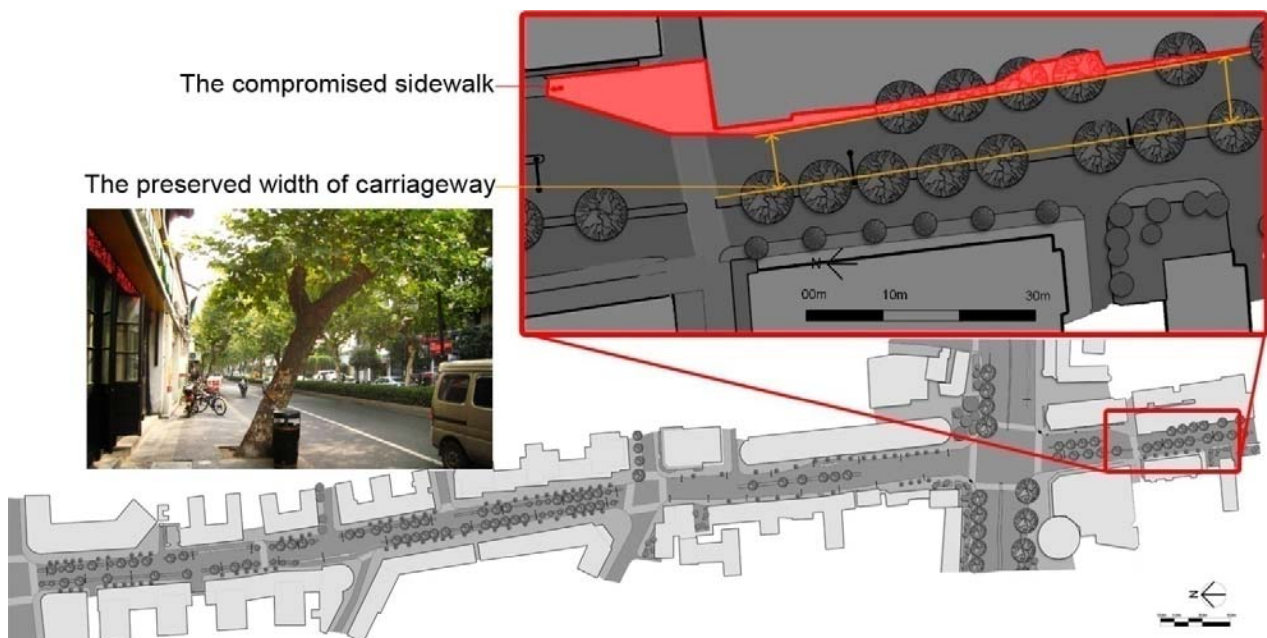


Figure 8.42. A section of footway in the south part of Zhongshan Road

Other street elements, such as street trees and entrances to underpasses, can also become obstacles to pedestrians who use footways (Figure 8.43). The conflict often occurs after street revision programmes that have failed to integrate different street elements. The condition of the footways in Renmin Road appears better than the other sample streets. The pavement is integrated and continuous without significant obstacles, because the carriageway has never been widened and all the street elements are holistically maintained.



Figure 8.43. *Examples of the shrunken footway in Zhongshan Road (left) and Guogeli Street (right) – it can place a significant obstacle to wheelchair users*

Separators and pedestrian crossings

Walking traffic could be significantly affected by the inappropriate placement of separators or pedestrian crossings. A simple cross (from A to B) in Zhongshan Road can become a diversion due to the safety strips (Figure 8.44). In terms of accessibility, automobiles can have more flexibility than pedestrians because pedestrian crossings can only be provided where the separator intervals simultaneously occur on both sides of the carriageway. The unacceptable length of diversion, which involves more than one pedestrian crossing, may lead to illegal crossing behaviour (Figure 8.45). It is a risky opportunistic behaviour that may result in accidents. The dangerous behaviour is intensively blamed as a lack of awareness of public ethics, whereas the physical reason for illegal crossing is seldom questioned. While improving vehicular efficiency is the primary target in urban road transport, pursuing ‘walking efficiency’ is considered as facilitating ‘uncivilised behaviour’.

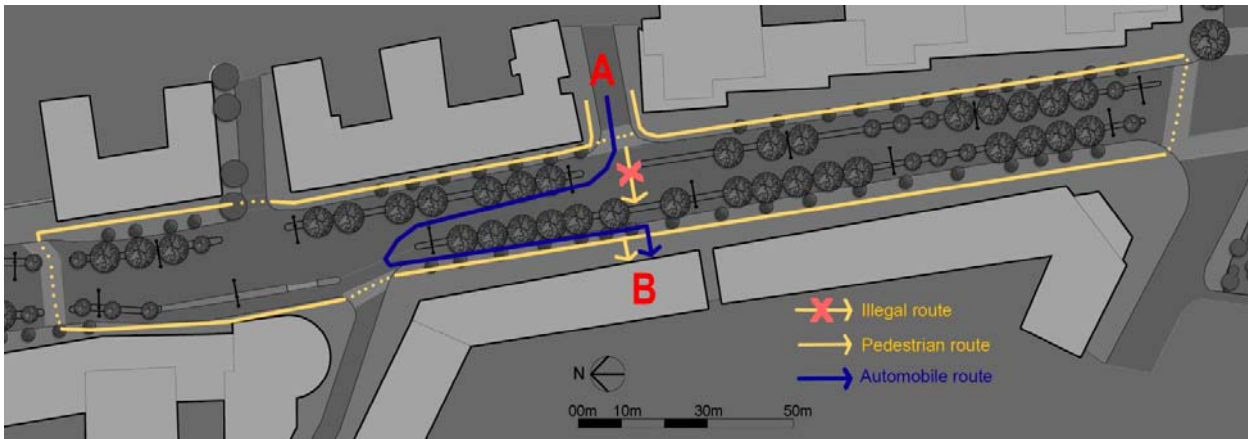


Figure 8.44. *Diversions in Zhongshan Road*



Figure 8.45. *Risky behaviour of the illegal crossing in Zhongshan Road- one of the negative results of the diversion*

Pedestrian underpasses can be regarded as another type of diversion. Enhanced by metal fences to prevent illegal crossing, the underpass provided in Guogeli Street is the exclusive legal way to cross the street, even if the carriageway is no more than 20 metres wide (Figure 8.46). Furthermore, since the cycle lanes are merged with the footways, the cyclists could never cross the street at this intersection in the ‘legal way’. The cyclists are the most impacted street users in Guogeli Street, but their demands are the least considered. Due to the inconvenience of pavement cycling, it is not surprising to see the cyclists using the carriageway (Figure 8.47).



Figure 8.46. (Left) *Pedestrians are obliged to use the underpasses at Intersection K in Guogeli Street*

Figure 8.47. (Right) *Despite the prohibition, a cyclist shares the carriageway with automobiles*

Nevertheless, due to the absence of traffic signals, the safety of legal crossing may not be fully guaranteed by the simple zebra stripes where pedestrians should have been given the right-of-way. It could be another factor for the opportunistic behaviour of illegal crossing. In other words, pedestrians have to bear an equivalent risk when crossing the carriageway in either legal or illegal ways. When the motor traffic in the carriageway is heavy or fast without leaving enough vehicular intervals for walking across, the zebra stripes become nothing more than pale prints and fail to provide pedestrians with any security. The design speed of Guogeli Street is as fast as 50

kilometres per hour, which adds significant safety concerns to pedestrian crossings without traffic light controls (Figure 8.48).



Figure 8.48. *An unsafe 'legal' crossing*
- the pedestrian crossing in Guogeli Street makes no difference to any random crossings

In contrast to Guogeli Street, the practice of Renmin Road allows permissive crossing except in the junctions (Figure 8.49). Although the design speed of 40 kilometres per hour in Renmin Road is fairly fast, the actual vehicle speed can be greatly reduced due to the surface of the carriageway being shared by different travel modes. However, the comparison between Renmin Road and Guogeli Street might not be justifiable since the latter serves a much heavier volume of motor traffic than the former. Although they are both secondary roads, there is a significant difference in actual vehicular volume and speed, as well as in the arrangement of pedestrian crossings.



Figure 8.49. A *permissive crossing* - pedestrians can cross the street without the provision of a pedestrian crossing in Renmin Road

Bus stops

In Zhongshan Road and Guogeli Street, the increased carriageway space is commonly seen to facilitate the provision of bus lay-bys. But such a provision is not significant in Renmin Road since it is not assumed as a necessity under the present conditions of vehicular traffic volume. As indicated before, the enlarged carriageway space is usually obtained from the reduced widths of footways. Figure 8.50 illustrates the significant decrease in the width of footways in Zhongshan Road where bus lay-bys are provided. Even in a secondary road, the design practice suggests a noticeable bias towards improving motor traffic flow by eliminating any preventable halts. Comparing with Zhongshan Road, the bus lay-by in Guogeli Street is relatively less significant due to the large width of the footway. It is noticeable that the sudden ending of the bus lay-by in Guogeli Street is not in accordance with the design code, which is not good at facilitating the acceleration of heavy buses (Figure 8.51).

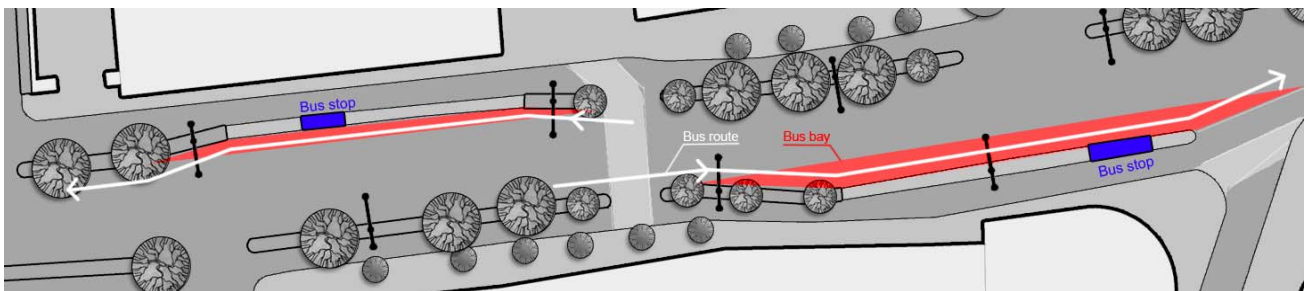


Figure 8.50. An example of bus lay-by design in Zhongshan Road

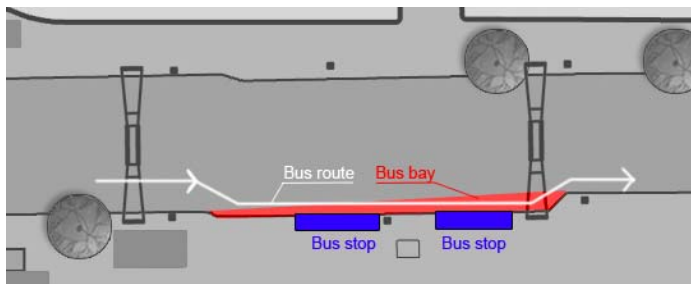


Figure 8.51. An example of bus lay-by design near Intersection K in Guogeli Street

As the convention in the sampled arterial roads, the bus stops mounted with advertising boards are commonly seen in the secondary roads (Figure 6.67). This means that commercial needs are also involved in the negotiation with the other needs of street users. As the boards provide street users with nothing more than visual clutter or a sight barrier, the commercial needs can hardly relate to the others. Regardless of the manifest conflict, the advertising boards are widely permitted in every formal bus stop of the sampled streets. It considers the bus stops and even the streets themselves as places for producing profitable interests rather than as a quality space for public use.



Figure 6.67. The designs of bus stops in Zhongshan Road (left), Guogeli Street (middle) and Renmin Road (right) – they are visually similar due to the striking commercial boards.

Public space

The traffic in the sampled secondary roads is comparatively slow and light, which provides the streets with opportunities for accommodating varied social activities. The potential of creating incidental public space is more significant in the streets with irregular building fronts than the

ones with monotonous frontages. Although the irregular building fronts in Zhongshan Road can cause a nuisance for the walking environment, they can create a number of positive places for public use (Figure 8.52, Images 1, 4 and 5). In addition, some incidental places generated from the varying frontages can potentially serve as public space (Images 2 and 4). In contrast, the even street frontage, i.e. the frontage in Renmin Road, may have less potential for creating incidental space for social activities (Figure 8.54). The linear road space may have difficulties in generating a sense of place for dynamic activities, despite the provision of facilities such as benches or green space (Image 4, Figure 8.53; Image 2, Figure 8.54). However, some places can serve occasional activities for which they were not deliberately designed (Image 5, Figure 8.52; Image 5, Figure 8.53; Image 1, Figure 8.54).

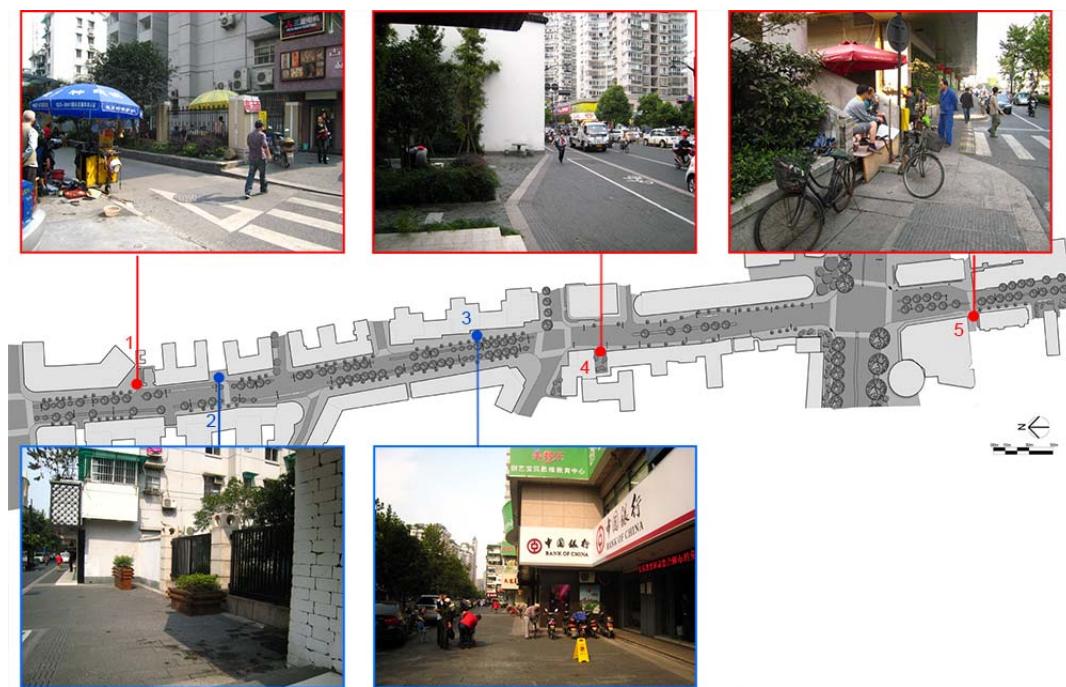


Figure 8.52. Casual public space in Zhongshan Road

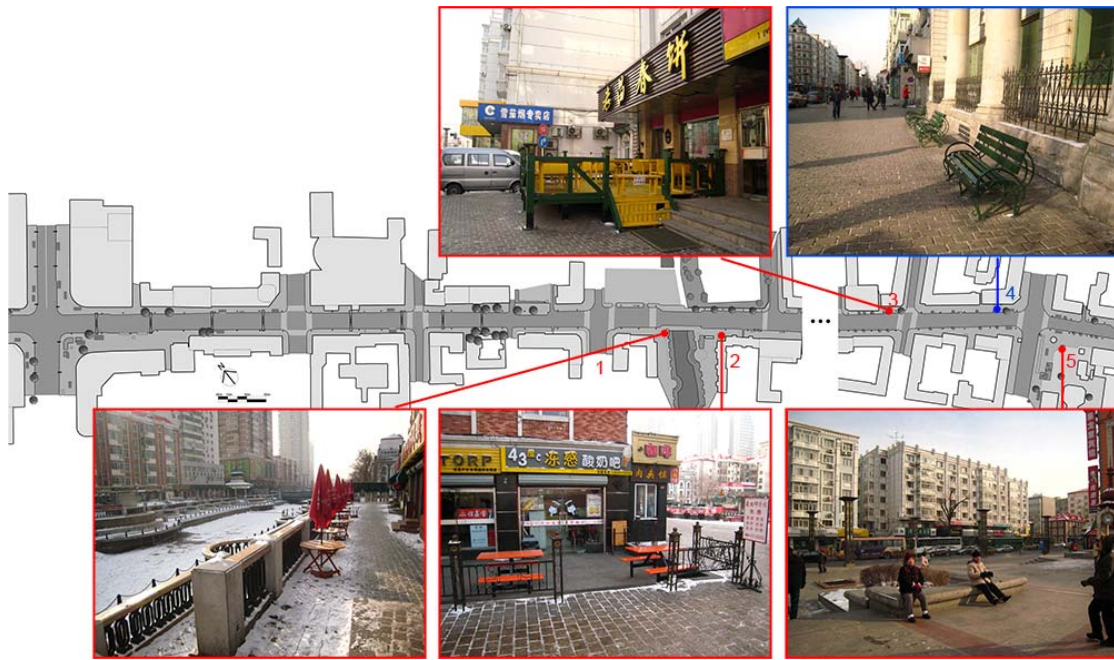


Figure 8.53. *Consciously provided public space in Guogeli Street*



Figure 8.54. *Linear street space in Renmin Road*

Such spaces show how needs other than traffic have been expressed in the secondary roads. Although some activities may not be deliberately allocated, rather than being rejected, they are well accommodated by the provision of accessible public space in the street. In this case, the different needs of street users are negotiated by the spatial organisation of the streets. In particular when the traffic need become less important, the opportunity to express other needs arises.

8.3 BRANCH ROADS

In Chinese cities, a branch road in the street hierarchical system usually refers to a minor street that serves light traffic and caters for access. Different from their counterparts of cul-de-sacs in American suburbs, branch roads are expected to be developed in a more conjoint way under Chinese standards (MoHURD, 1995b). The sampled branch roads are all well connected with other roads. The difference may be entrenched in the traditional Chinese mindset of a gridded urban street network and the land-use policy of superblock development. It may be one of the most difficult points in this research because empirical studies or theoretical bases for the difference are very limited.

8.3.1 Conformity with the national standards

As defined in the national standards, a branch road is the minor street which is not only providing access to buildings, but also connected with other branch roads to constitute the reticular networks. Implicitly, the expression ‘branch’ in the national standards can hardly reflect its actual position in practical circumstances. More importantly, superblock developments with restricted public access result in a confusing definition of branch roads in many Chinese cities. Other than ‘connecting secondary roads and inner lanes’, the relation between branch roads and street network and those blocks of privatised developments has never been further stated in GB 50220-95 or CJJ 37-90. The actual relationship is very different from the intension of the standards: the superblocks of privatised urban space are often bordered by secondary and even arterial roads, converting branch roads into a dispensable part of the street network. Regardless of the intrinsic defect in the official definition, the design codes for branch roads are clearly stated. Three sampled branch roads were selected to examine the discrepancies between the actual practice and the regulatory requirements.

Design principles

The practice of the sampled streets is compared with the standardised design principles for urban branch roads (Table 8.19). Like many other branch roads, these sampled streets are all developed in the form of Type A with no median or safety strips. Referring to the city size, the required total widths of branch roads in large and small cities are significantly different. The comparison shows that Haier *Xiang* appears narrower with fewer vehicle lanes than required, whereas Wenjin Road exceeds the maximum width of a branch road required in small cities. Along with the excessive width, the design speed in Wenjin Road is twice as high as the required 20 kilometres per hour.

Table 8.19. *Key indicators of sample branch roads: a comparison between actual practices and the national standards*

<i>Street</i>	<i>Key indicator</i>	<i>Current condition</i>	<i>Conformity</i>
Haier <i>Xiang</i>	Total width	12-19 m	Smaller than the required 15-30 m
	Design speed	30 km/hr	Yes
	Number of vehicle lanes	2	Fewer than the required 3-4
	Cross section form	1-roadway	Yes
	Intersection form	Mixed by crosses and T junctions	Yes
	Lane-width	N/A	Yes
Manzhouli Street	Total width	20-28 m	Yes
	Design speed	30 km/hr	Yes
	Number of vehicle lanes	2-4	Fewer than the required 3-4
	Cross section form	1-roadway	Yes
	Intersection form	Irregular	Irregular intersections are not recommended
	Lane-width	3.5-3.9 m	Larger than the required 3.5-3.75 m
Wenjin road	Total width	25 m (including a 5-metre wide green belt between the street and buildings)	Much larger than the required 12-15 m
	Design speed	40 km/hr	Much higher than the required 20 km/hr
	Number of vehicle lanes	2	Yes
	Cross section form	1-roadway	Yes
	Intersection form	Cross	Yes
	Lane-width	3.75 m	Yes

The tendency reflects that the design of the branch road in the urban periphery is more inclined to meet or exceed the maximum standard of total width and design speed. In contrast, the width of branch roads in downtown areas is restricted by the surrounding buildings and strictly retains the original scale. It also reflects the inclination of street designers to adopt a larger street width and

higher design speed as permitted by the surrounding physical conditions. The design trend of excessive road widths is actually significant in the suburban streets (Table 8.20).

Table 8.20. *Key indicators of suburban branch roads: a comparison between actual practices and the national standards*

<i>Street</i>	<i>Key indicator</i>	<i>Current condition</i>	<i>Conformity</i>
Chunxiao Road (in a newly developing district of Hangzhou)	Total width	30-40 m	Larger than the maximum width of 30 m
	Design speed	40 km/hr	Exceeds the required 30 km/hr
	Number of vehicle lanes	4	Yes
	Cross-section form	Type C	Type C is not encouraged for a branch road
	Intersection form	Cross	Yes
	Lane-width	3.5 m	Yes
Reyuan Road (in a newly developing district of Harbin)	Total width	35 m	Larger than the maximum width of 30 m
	Design speed	30 km/hr	Yes
	Number of vehicle lanes	4	Yes
	Cross-section form	Type A	Yes
	Intersection form	Cross	Yes
	Lane-width	3.5 m	Yes
Songfenggang Road (in suburban Pinghu)	Total width	25 m	Larger than the maximum width of 15 m
	Design speed	40 km/hr	Exceeds the required 30 km/hr
	Number of vehicle lanes	2, with additional lanes at intersections	Yes
	Cross-section form	Type B	Yes
	Intersection form	Cross	Yes
	Lane-width	3.75 m	Exceed the required width of 3.5 m, since it was not proposed for serving heavy vehicles

Design of street cross-sections and plans

Following the steps of the previous sections, analysis of the sample branch roads is carried out to determine how far the national design codes can direct actual practice. Figures 8.55-57 and Tables 8.21-23 compare the street design variables between practice and the related design codes. In comparison, Wenjin Road shows a closer correspondence to the design codes than the other two. The surrounding physical circumstances often place restrictions on the revision of a traditional street to meet the required width and layout, but such restrictions do not exist when creating a street in a new development. While the traditional minor streets struggle to maintain sufficient width for footways due to irregular spatial organisations, the new ones can often keep

the monotonous width of footways and carriageways.

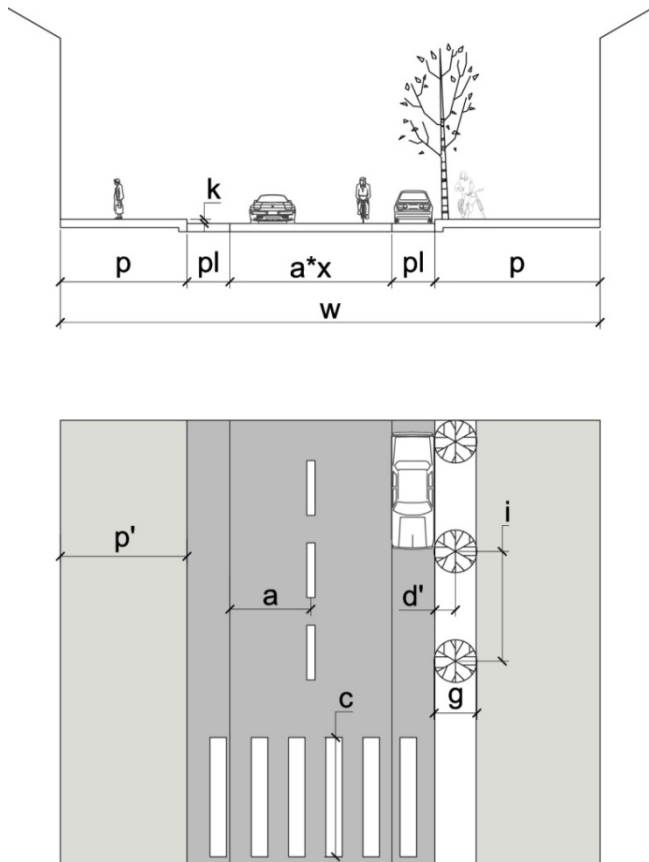


Figure 8.55. Cross-section and street plan of Haier Xiang

Table 8.21. Analysis of design variables in Haier Xiang

Variable	Definition	Design code	Actual practice	Conformity
w	Total width	15-30 m	12-19 m	-
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	N/A	X
x	Number of one-way vehicle lanes	1-2	1	-
p	Total width of a footway	4.5 m (min)	3-5 m	√
p'	Minimum valid pavement width	3 m (min)	0.9 m	-
c	Width of a pedestrian crossing	3-4 m	3-4 m	√
g	Width of a planting strip	1.5 m (min)	0.9-1.1 m	-
k	Kerb height	10-20 cm	15 cm	√
pl	Space for on-street parking	No	1.8 m	X
i	Interval of street trees	4-10 m	8 m	√
d	Distance between planting points and kerb edge	0.75 m (min)	0.5-0.6 m	-

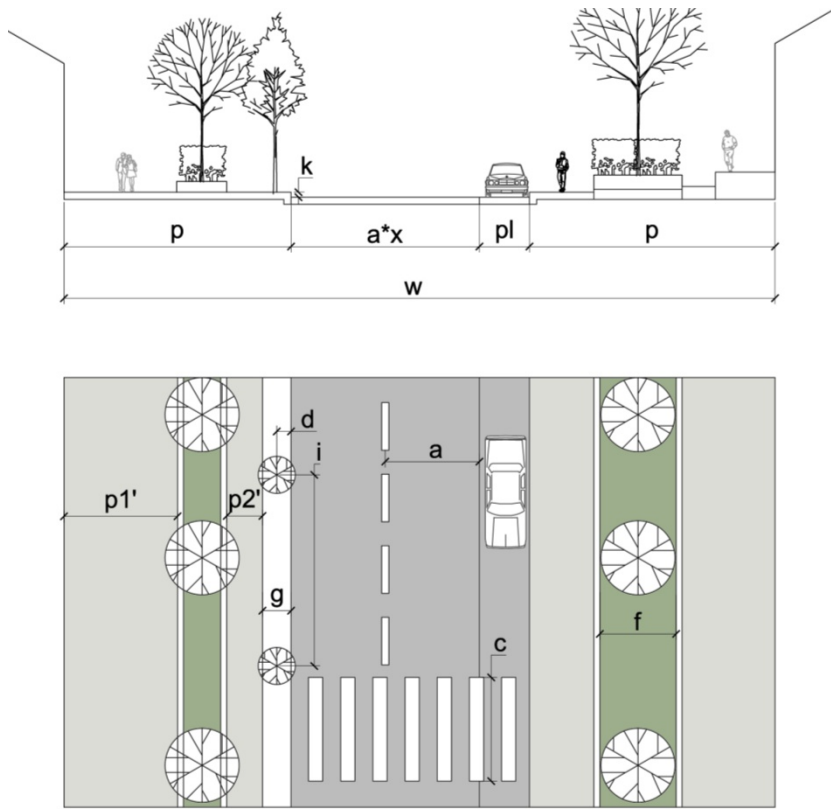


Figure 8.56. Cross-section and street plan of Manzhouli Street

Table 8.22. Analysis of design variables in Manzhouli Street

<i>Variable</i>	<i>Definition</i>	<i>Design code</i>	<i>Actual practice</i>	<i>Conformity</i>
w	Total width	15-30 m	25 m on average	√
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	3.5-3.9 m	+
x	Number of one-way vehicle lanes	1-2	1-2	√
p	Total width of a footway	4.5 m (min)	3-8 m	-
p1'	Minimum valid pavement width	3 m (min)	1.5 m	-
p2'	Minimum valid pavement width	3 m (min)	2 m	-
c	Width of a pedestrian crossing	3-4 m	4-5 m	+
g	Width of a planting strip	1.5 m (min)	0.8-1.2 m	-
k	Kerb height	10-20 cm	21 cm	+
pl	Space for on-street parking	No	2 m	X
i	Interval of street trees	4-10 m	6-10 m	√
d	Distance between planting points and kerb edge	0.75 m (min)	0.4-0.9 m	-
f	Space for facility use (planting)	1.0-1.5 m	2-4 m	+

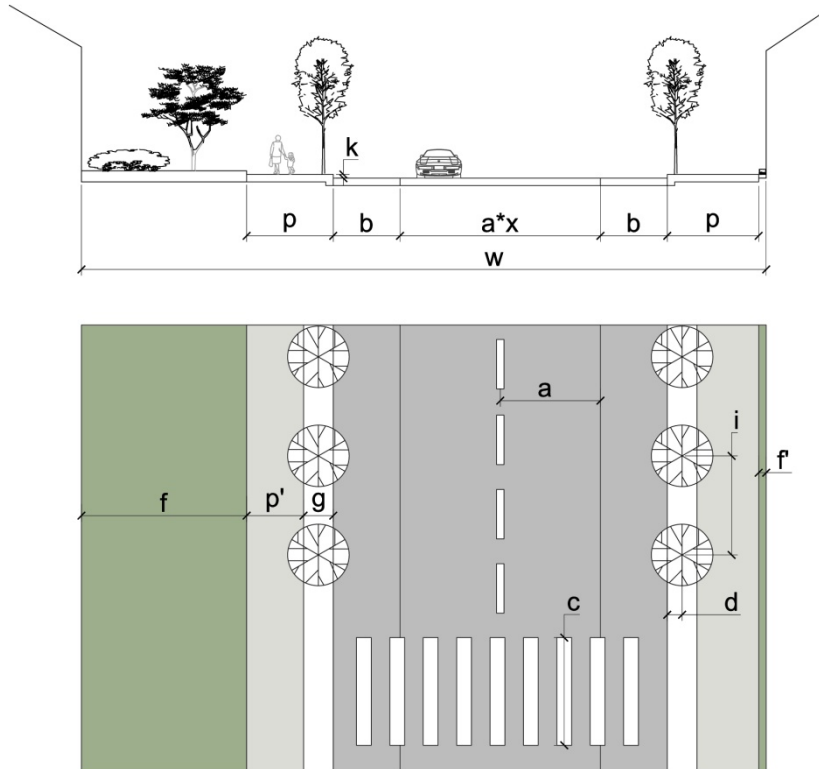


Figure 8.57. Cross-section and street plan of Wenjin Road

Table 8.23. Analysis of design variables in Wenjin Road

Variable	Definition	Design code	Actual practice	Conformity
w	Total width	12-15 m	25 m	+
a	Width of a vehicle lane (lane-width)	3.5-3.75 m	3.75 m	√
x	Number of one-way vehicle lanes	1	1	√
p	Total width of a footway	3 m (min)	3.5-3.7 m	√
p'	Minimum valid pavement width	1.5 m (min)	3 m	√
c	Width of a pedestrian crossing	3-4 m	4.5 m	+
g	Width of a planting strip	1.5 m (min)	0.8-1 m	-
k	Kerb height	10-20 cm	12 cm	√
i	Interval of street trees	4-10 m	8 m	√
d	Distance between planting points and kerb edge	0.75 m (min)	0.4-0.5 m	-
f	Space for facility use	1.0-1.5	5 m	+
f'	Space for facility use	1.0-1.5	0.4-1.0 m	-

In this case, the design codes for street planting seem to be ineffective in directing the practice, which may be due to the weak relationship between street planting and the concern for traffic fluidity or safety. The common situation is that the sampled branch roads are not able to provide sufficient width for the planting beds of street trees. Even in Wenjin Road, where the street width is relatively large, the planting beds are smaller than the standard. All the street trees in the sampled streets are newly planted and appear to be small and fragile as the imposed additions to

the streets (Figure 8.58).



Figure 8.58. *The street trees in Haier Xiang (left), Manzhouli Street (middle) and Wenjin Road (right)*

Design of intersections

The intersections of the sampled branch roads can be classified as the intersection of: 1) a branch road and an arterial road or a secondary road, 2) two branch roads and 3) a branch road and an access. The first type of intersection is analysed in Parts 1 and 2, while the second type cannot be determined in the sampled streets. The design codes for the third type, such as turning radius, SSD and lane control, may not be applicable because the right turning speed in access roads would be less than 10 kilometres per hour. Thus, the practice of intersections in the sampled branch roads cannot be analysed with the related design codes. Despite the difficulties, analytical diagrams and tables of the branch roads are listed below for further reference (Figures 8.59-61, Tables 8.24-26).

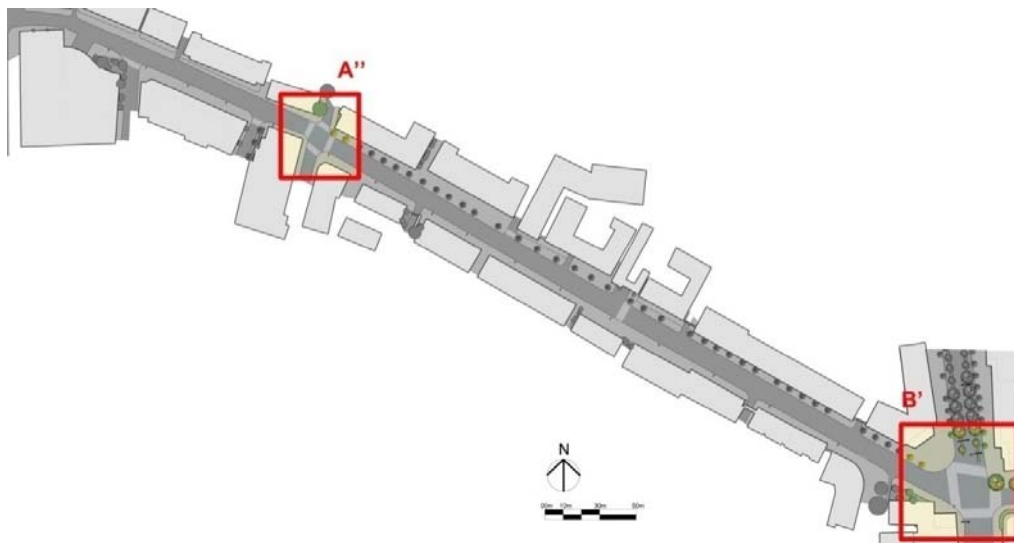


Figure 8.59. The map of Haier Xiang

Table 8.24. Analysis of intersections in Haier Xiang

Intersection	Type	Conformity with design codes			
		Cross angle	Kerb Radius	Visual clearance within SSD	Additional lanes
A''	X	Yes	N/A	N/A	No
B''	X	Yes	Yes	N/A	Partly

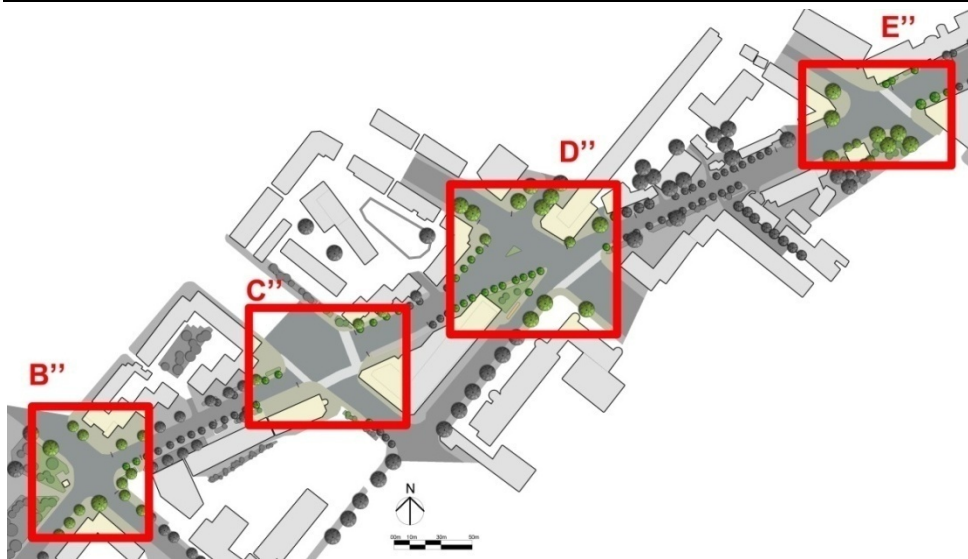


Figure 8.60. The map of Manzhouli Street

Table 8.25. Analysis of intersections in Manzhouli Street

Intersection	Type	Conformity with design codes				Remark
		Cross angle	Kerb Radius	Visual clearance within SSD	Additional lanes	
B''	X	Yes	Small radii	Yes	No	
C''	Irregular	Yes	Small radii	Yes	Yes	
D''	Irregular	N/A	N/A	N/A	No	
E''	Irregular	Yes	N/A	N/A	N/A	Underpass

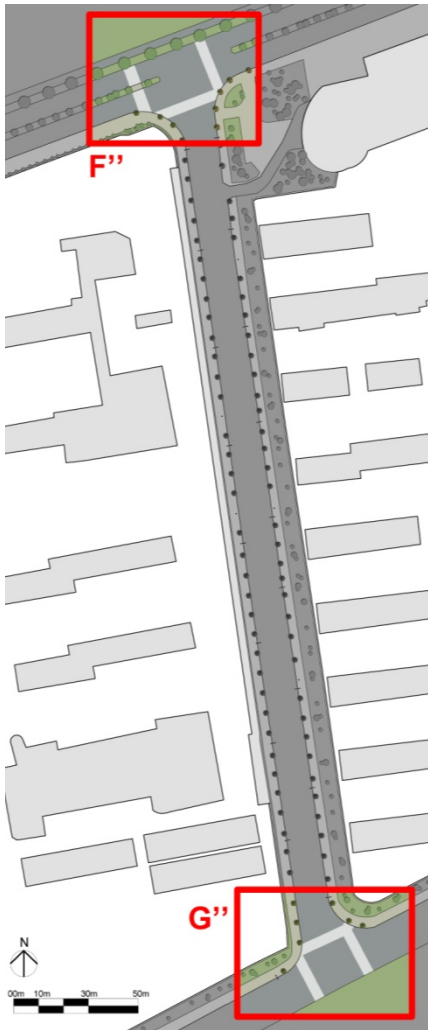


Figure 8.61. The map of Wenjin Road

Table 8.26. Analysis of intersections in Wenjin Road

Inter-section	Type	Conformity with design codes			
		Cross angle	Kerb Radius	Visual clearance within SSD	Additional lanes
F''	T	Yes	Excessive	Yes	No
G''	T	Yes	Excessive	Yes	No

The design practice of such intersections can be more or less considered as the negotiation between the public and private space. Usually, the design of a private development, such as a residential community, has to adapt its internal circulation system to the physical conditions of the external public streets. Strictly speaking, design variables of the junctions of the branch roads and the crossed accesses are stated or required by the design codes. As mentioned before, the design variables for the intersections are mainly proposed to improve traffic fluidity and safety with concerns for the vehicle speeds in the relevant streets. Because of the low vehicle speed in the access, the codes of SSD and turning radius cannot be applied.

Despite the similar orientations of Haier Xiang and Manzhouli Street, the intersections of the latter are more irregularly arranged. The buildings in Manzhouli Street are in fact more inclined to be oriented by the obliquely crossed streets which may have a higher hierarchy. Since the design codes for irregular intersections do not exist, the intersections of Manzhouli Street with the surrounding building frontages could hardly be regulated by any principles. In this case, since the practice is located beyond the scope of the national standards, the current design codes have proved ineffective in directing the design practice of the intersections in the sampled branch roads.

8.3.2 Inclusive design and street users' needs

As defined by CJJ37-90 (1991: 2.1.1), the branch roads, which are linkages between secondary roads and community access, mainly respond to traffic in a particular area and local services. In addition, the interpretation of GB50220-95 stresses on the accessibility function of branch roads. According to the statement of design standards, it is obvious that different levels of traffic are the main criteria for determining the street classification. Other functions of branch roads, such as accommodating social activities, are not actually defined by any regulations. The absence of an inclusive design code has not merely provided great flexibility for the diverse design proposals, but also the possibility for bad practice in the branch roads.

The development of the sampled streets shows very different preferences when dealing with the diversity of needs on streets. As shown in the street maps, Wenjin Road, Haier *Xiang* and Manzhouli Street are arranged differently according to the frequency of access to the buildings and communities. Although Wenjin Road facilitates few social activities, it is an eligible branch road according to the standards, because an active frontage is not a requirement. One can argue that the non-traffic needs of the streets in the urban periphery may not be as important as in downtown areas, but the design practice which initially posed a barrier to the expression of the diverse needs can be the main factor for the bias.

Parking provision

Unlike the sampled secondary roads, on-street parking is constantly arranged on both sides of the carriageway of Haier *Xiang*, which reflects the priority given to access on this branch road. The road also provides bicycles with pavement parking situated between the street trees (Figure 8.62). The parked cars can be regarded as the physical buffering strips between the two different travel modes, even though the vehicular speed is very low in this street. The provision of on-street parking retains sufficient road space for both automobile and bicycle movements. It is the

solution to the lack of public car parks in the surrounding area. The regularly arranged on-street parking can be deemed as a good practice and an acceptable result of the negotiation between motorists and pedestrians. On-street parking is also provided in Manzhouli Street in a distinct form (Figure 8.63): the parking lots are arranged perpendicularly towards the kerb line in order to accommodate more cars within a certain street length. Compared with parallel parking



arrangements, perpendicular parking requires a relatively longer width of the carriageway and less traffic volume, because the swept-path of parked cars can be wider and more likely to interrupt the vehicular flows.

Figure 8.62. *Parking provision in Haier Xiang*

Pavement parking occasionally applies to some parts of Manzhouli Street where the footway width is sufficient (Figure 8.63). Comparing with the pavement parking in the sampled secondary roads, the parking arrangements in these two branch roads have posed less negative impacts on pavement users, which might be the result of the strict control on the pavement kerb height. Kerbs in Haier *Xiang* and Manzhouli Street are consistently kept at no less than 150 mm high with a sharp edge which limits the entry points for automobiles climbing onto the pavement (Figure 8.64) whilst providing a sufficient area of slope for the access of cycles and wheelchairs. The practice found in the branch roads is clearly different from the samples of arterials which reduce kerb heights and extend kerb ramps to ‘invite’ cars onto the pavements (see Figure 8.4 and Figure 8.14).



Figure 8.63. *On-street parking (left) and pavement parking (right) in Manzhouli Street*



Figure 8.64. *The raised and sharp edge of pavement in Manzhouli Street (left) and in Haier Xiang (right)*

Footways

The width of the footways in Haier *Xiang* is not constant because of the irregular building lines (Figure 8.65). The narrowest part of the footway only allows one person to go through. Again, the case shows that the footway has become the first element being compromised where the total width of the street suddenly declines. The width of the carriageway has to be strictly maintained on the assumption that the space for vehicular movement cannot be compromised. Alternatively, it is possible to widen certain parts of the footway by removing some street trees, or cancelling some on-street parking lots. However, the local authority is reluctant to improve the footway conditions by compromising the provision of car parks or street trees, since the narrowness of the footway is just assumed to be a discomfort rather than a barrier to the pedestrians.



Figure 8.65. *The significantly varied widths of footways in Haier Xiang*

According to its appearance, Haier Xiang can be divided into two sections, east and west, by Intersection A''. The western part of Haier Xiang has retained the appearance as in 2003, while the eastern part was entirely updated in 2009. It is noticeable that the pavement materials of the footways in the east are different from the west. The newly paved grey bricks which are permeable to water can always keep the footways in a good condition in rainy weather, while the impermeable and slippery coloured tiles in the western part can cause difficulties to walking traffic (Figure 8.66). Besides, the footways in the western part have a problem in distinguishing the street boundary from the building fronts. Compared with the eastern part, the relationship between the footways and the shops in the western part is not clearly defined. The inconsistent pavements in poor condition extended from the shops have become a part of the footway (Figure 8.67). The failure indicates the unsolved negotiation between the interests of pedestrians and shop keepers.



Figure 8.66. *The inappropriate pavement material in Haier Xiang*



Figure 8.67. *Different conditions of the footways in the western (left) and eastern part (right) of Haier Xiang*

Generally, for pedestrians, the footways in Manzhouli Street are in an acceptable condition of integrity and continuity, despite some exceptional parts being invaded by some abnormally designed constructions, i.e. basement entrances (Figure 8.68). The irregularly planted street trees, randomly raised planting beds and occasionally elevated pavement, may add some interest to the



walking experience; but the aged pavements which are trembled and slippery in snowy or rainy weather can cause discomfort and difficulties to pedestrians, especially the disabled users.

Figure 8.68. *An occasional sudden shrinkage of the pavement in Manzhouli Street*

Restricted by limited funding for road repairs, the fast travelling modes could have the priority to be served because the fast speed of heavy vehicles are more likely to cause accidents in poor road conditions, whereas the updating of the pavement for slow traffic modes can be delayed. The uneven surface can be covered persistently by the snow throughout the winter, which may cause serious risks to vulnerable users. Because the carriageway can be damaged by the large variations in temperature, annual repairs and updates are employed to prevent accidental risks. The footways, becoming worn out over the years, however, have rarely been updated as there are few reports of injuries or fatalities on the pavement. Normally, blind and disabled people can be significantly affected by these conditions, but they tend not use the street since their potential traffic needs have been completely neglected. Therefore, zero injury or fatality records on the pavement are unlikely to reflect the actual conditions of the footway.

In terms of cycling traffic, the cyclists in Harbin have been required to use the footways after

cycle lanes were eliminated. However, no one can expect any cyclists to use the footways as cycling tracks because it is not an easy task to ride on the uneven pavement. Based on personal interviews, cycling traffic has steadily declined since the cycling policy was proposed in Harbin. According to the author's observation, most cyclists prefer to ride on the carriageway in spite of the prohibition. The cycling policy can be interpreted as giving absolute priority to motor traffic at the expense of bicycle travel.

The newly built branch road in Pinghu, Wenjin Road, may have the best pavement conditions among the sampled streets. The footways are paved by tidy and permeable materials and consistent in width and height without any unexpected physical obstructions. However, it is a facility with no users. Such a traffic-oriented design cannot provide street users with any opportunities for social activities (e.g. a public meeting place) in this residential area. Due to the great potential for the development of an appropriate road spatial organisation framework, it is shameful that local residents are provided with a mere traffic link.

Public space

Active public space can rarely be generated from the monotonous streetscape of a traffic channel like Wenjin Road in Pinghu. On the contrary, the streets with various building frontages and light traffic volumes can have greater potential to accommodate diverse social activities and visual interests. Figure 8.69 indicates that some activities other than travels can happen incidentally in Haier *Xiang*, even if the places are not consciously designed for social use. Images 2 and 3 show that the application of proper designs can potentially develop some places as public spaces. In contrast to Wenjin Road, although the building fronts and some street facilities can pose a significant inconvenience to pedestrians in Haier *Xiang*, they have the potential for improvement to generate an active public space for social activities. In the case of Haier *Xiang*, the spatial function of the branch road can be positively reflected by the negotiated result with the traffic function.

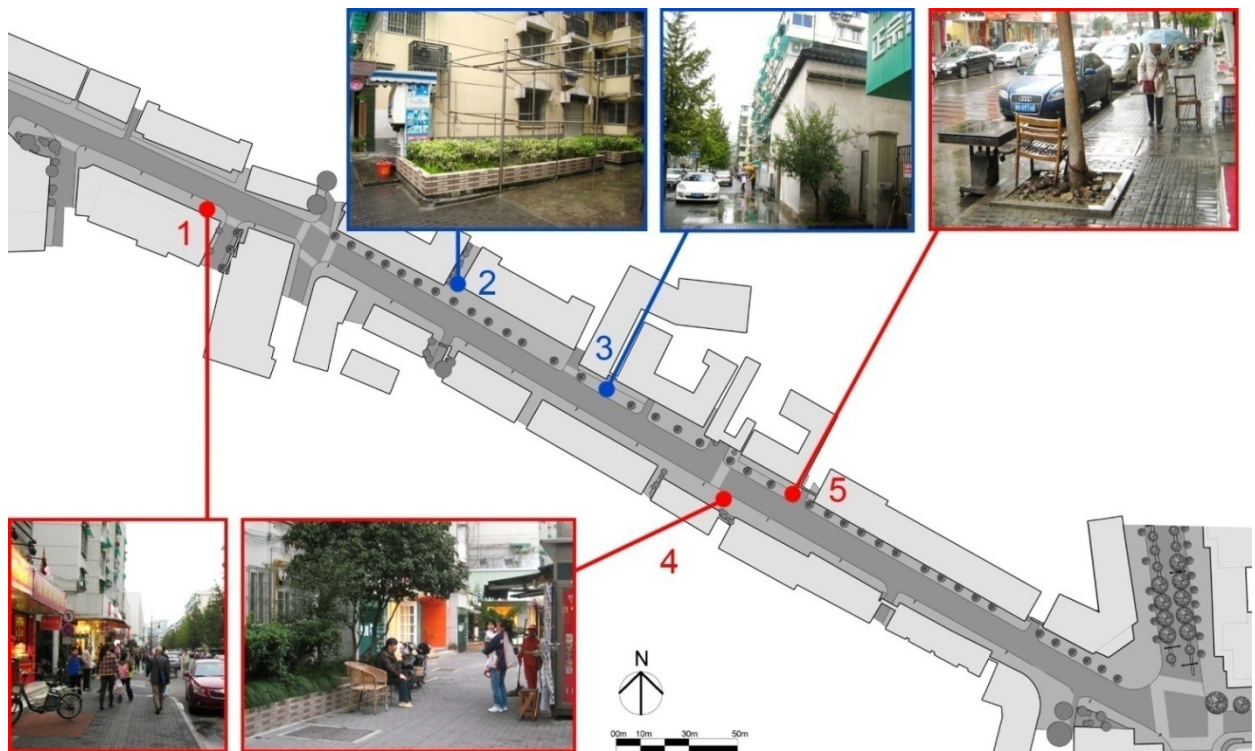


Figure 8.69. *The incidental public space in Haier Xiang*

Unlike Haier Xiang, the map of Manzhouli Street shows that the branch road is not defined by the surrounding buildings. The oblique pattern of the street may be in conflict with the demand for regular housing forms. Many buildings are reluctant to be developed along with the street since they are preferred to be in perpendicular corners, which results in the frequently interspersed open places on the footways. Such open spaces adjacent to the street lines are maintained and managed by the City Administration and adjacent private owners e.g. shopkeepers. Nevertheless, the authorities are only required to maintain the orderliness and cleanliness of the open spaces, with no responsibility for their quality or liveability for public use. Even with the greater potential to apply the spatial organisation framework, the situation of public space in Manzhouli Street is very disappointing. Even though there is a larger number of pedestrians and larger area of open squares and green space in Manzhouli Street than in Haier Xiang, social activities can hardly be generated in the cold places which are not arranged on the proper spatial scales or equipped with sheltered facilities (Figure 8.70). It is difficult to determine if those open spaces were originally designated for public use, nevertheless, the extensive open space might not be a

positive application to the site characterised by a cold climate. The case of Manzhouli Street shows that the needs of social activities are often neglected throughout the development process, despite the great potential of the numerous open spaces.

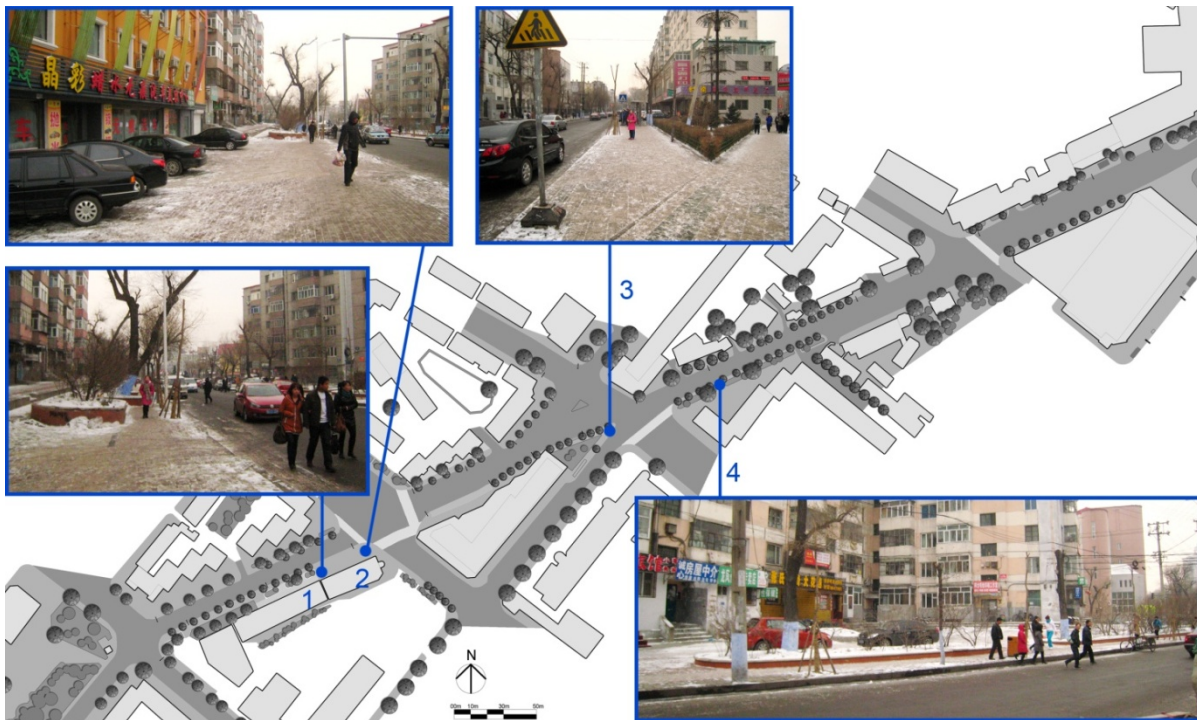


Figure 8.70. *The negative open space in Manzhouli Street*

8.4 CONCLUSION

The case studies indicate that there are significant discrepancies between the practice and the standards. The redevelopment of urban streets is often restrained by surrounding land-use and buildings. Nevertheless, the design of a new street can often meet and even exceed the required width and speed once permitted by conditions. It is worth noting that when the number of motor vehicles increases in a street with spatial restrictions, giving the space of footways or cycle lanes to carriageways is the approach usually considered first. Reduction in the width and area of the pavement and cycle lanes is often found in the sampled streets. The examination of conformity does not suggest any significant differences between large and small cities, though the cities have very different levels of traffic demand and car ownership. Except for street trees, very little

evidence shows any other differences in street design practice responding to the distinct local climate and customs.

The design of the sampled streets is not inclusive, which is particularly true in the arterial roads. The inequities of spatial distribution and arrangement, such as enlarged carriageways, eliminated cycle lanes, the reduced width of footways and pavement parking, reflect the dominance of automobiles in urban street development and the excessive attention paid to motor traffic flow in design practice. It is also reflected by the deprived mobility, accessibility, convenience, comfort and enjoyment of non-motorists. The channelization which aims to optimise the efficiency of motor traffic flows at intersections significantly increases the waiting and crossing time of pedestrians and cyclists. Median and safety strips which aim to reduce the interruption to vehicular flows are pervasively applied at the expense of pedestrian accessibility and permeability. The car-dominated spatial organisation of streets represents some common interests of the dominant social groups.

The traffic-centred design still dominates actual practice in urban streets in Chinese cities, though it has proved a failure in solving traffic problems and has had a complete disregard for non-traffic needs over the years. The design trends may be driven by a mixture of economic, cultural, political and technical factors. It needs to specify what these factors are and how they have become the obstacle to the inclusive design and sustainable development of urban streets in China. It is equally important to identify the extent of the opportunities for new alternative approaches to street design given by the distinct conditions of China.

CHAPTER 9 DISCUSSION

Although improving public transport services and controlling private motorisation are the declared objective of China's urban transport policies, they have rarely been realised in actual street design practices. The empirical findings show that motor traffic flow is still the primary focus in street design, while the needs of pedestrians and cyclists are largely neglected. The manifest inequities in street design practice in Chinese cities are the main barrier to achieving sustainable urban road transport and inclusive design of urban streets.

Factors affecting street design are identified for further discussion: spatial reorganisation; neglected needs; political issues and technical issues. The discussion of these factors is based on in-depth interviews with academics, urban planners, highway engineers, architects, landscape architects, government officials and local bus operators in five Chinese cities.

9.1 SPATIAL REORGANISATION AND STREET DESIGN

Reorganised street network and reallocated road space are the outcomes of superblock-oriented development and an automobile-dominated urban circulation environment. Along with the rapid urbanisation process in China, spatial organisation in a majority of Chinese cities has changed to adapt to the growing superblock redevelopments. On the large scale, permeability and accessibility are overlooked under the advocacy of arteriability. Expressways and arterial roads are the dominant road types in development trends, while the development of minor streets is less valued and receives little policy support. At the micro-level, extra numbers and width of vehicle lanes have been implemented while the road space for other street users has been compromised. The traditional urban streets and their networks have been significantly changed and become increasingly unpleasant to non-motorised street users.

9.1.1 The decline of permeability

The loss of permeability in urban streets can be well illustrated by the case studies of the sampled cities. As one of the factors for reshaping urban space, car-oriented road transportation development calls for changes in the organisational framework of the traditional street network (Vasconcellos, 2001; Marshall, 2005). Although vehicular travel speed can be raised by increasing road capacity, the total point-to-point journey time significantly depends on street permeability. The loss of traffic efficiency by the limitation of route choices and accessibilities cannot be merely compensated by the increased capacity in some related streets.

Today's street networks in Chinese cities may not be driven exclusively by the increasing use of automobiles or forecasting the growth of car ownership. The result is complicated by China's *market-oriented economic policy* and *party-state political machinery*, as well as by *imperial and Socialist traditions and constraints* (Abramson, 2005: 234-235). Under this distinctive circumstance, urban streets and networks in China appear differently to their counterparts in western or many other developing countries.

The street hierarchy system is interpreted differently in the western convention and the Chinese national standards. The standards prefer a joined-up hierarchy of the streets forming a network to the dendritic model. Strictly speaking, a branch road is non-reticular in the western convention. The definition of a branch road in the standards, i.e. GB 50220-95 and CJJ 37-90, is a minor street which is not only providing frequent access points to an upper street and to building frontages, but also connecting itself with other branch roads to form a dense network. The reticular network of urban streets with a clear stratification is an idea historically entrenched in China's planning tradition since the Zhou Dynasty (1100-256 B.C.) (Dong, 2004). Under this tradition, the modern ordinance of a street hierarchy is readily accepted by Chinese planners and often interpreted with conjoint forms in effect.

At present, the street patterns in urban areas can be perceived as spaced traditional reticular

networks with clear stratifications, which are driven by increased superblock redevelopment. Concentrated power of land control and capital make superblock or large-scale redevelopment possible in major Chinese cities (Abramson, 2008). During the last two decades, this trend has been clearly reflected by the mushrooming walled residential quarters (i.e. gated communities) which tend to restrain their entryways to through traffic (Xu & Yang, 2008). Such assembling large sites for development are infrequently seen in European countries (e.g. the UK) because of fragmented private land ownership. Compared with its American counterpart, this development pattern in China tends to have a much higher population density and more standardised layouts. Moreover, unlike the US suburban gated community surrounded by green fields, the residential development in China tends to be bordered by arterial roads with other communities across the roads (Miao, 2003). This trend significantly reduces the overall permeability of the street network. When the residents' privacy and exclusive access is highly valued by the market-oriented decisions, the general public interests in efficient, convenient travel, liveability and amenity, are often disregarded.

Permeability-related requirements have never been articulated by the design standards. Although street density can be seen as a relevant indicator, it only reflects the average value in an entire administrative region and it is hard to see how it can direct planning practice effectively. Although the standard advocates the advantages of high street density and small developments, it fails to specify clearly the requirements which support its advocacy. More importantly, despite the relatively high street density and well jointed-up networks in some urban areas, an apparently permeable street pattern is often blocked by access restrictions and barriers (see Section 7.1.1). By access control, a large number of minor streets are transferred from public to private use. It significantly reduces the actual permeability, which is difficult to identify by a map-based analysis of street networks.

9.1.2 Reallocation of road space

The increased demands of motorisation can be reflected in the practice of road space reallocation. Enlarging the road area of carriageways is often perceived as the solution to the increasing congestion generated by the growing use of automobiles. In particular, urban streets are usually constrained by fixed boundary lines and building lines. Enlarged carriageways are always arranged at the expense of road space for cycle lanes and footways.

The analysis in the case studies in Chapter 8 shows that five out of the nine sampled streets have widths that are smaller than the requirement due to the restrictions imposed by surrounding buildings or facilities. In turn, without those constraints, the newly developed roads in these cities are much wider than the design speed and number of vehicle lanes in the regulations. The manifest trends show that the demand of motor vehicle movement is likely to be met by widening the carriageway as soon as there is sufficient space.

There has been a persistent shortage in road supply in major Chinese cities since the advent of automobiles. Currently, the urban streets and networks are built and revised because they are thought as not large enough either in quantity or width for the increased traffic demands. In Pinghu, for example, despite many proposed widening and extending projects, most of them are carried out slowly because of the restriction of the existing frontages.

(Personal interview with an urban planner PH2, 2010)

The roads in downtown Hangzhou are generally narrower than the standards since the street widths are usually confined by the existing building frontages and aged street trees. It implies that tremendous costs need to be paid for removing them if any widening projects are carried out. However, it is very common to find a carriageway in Binjiang District which is excessively wide and equipped by up to 10 vehicle lanes. It is not difficult to foresee the inconvenience of pedestrians before they have moved to this new administrative

business centre, because the new district is totally designed for automobiles.

(Personal interview with an urban planner HZ1, 2011)

In order to make way for carriageways, the removal of cycle lanes is one of the most remarkable changes in the spatial arrangements of streets in Harbin. The elimination and transfer of cycle lanes in Harbin clearly represents the absolute priority of motorists over cyclists and pedestrians. The deteriorating cycling environment leads to a declining number of cyclists, which causes an underestimated demand for cycling in Harbin and cyclists' rights of way can hardly be reclaimed.

Generally speaking, the urban streets in Harbin, especially the arterial roads, are narrower than the requirement of the national standards and design codes. Because the road space is usually restricted by the existing buildings, it could be a solution to widen a carriageway by eliminating pre-existing cycle lanes. Cycle lanes in Harbin have all been moved to pavements and their space reassigned to carriageways since the end of the 1990s. The combination of cycle lanes and footways is a hazard to both pedestrians and cyclists. This might result in the significant decline of cyclists at present. Once there were a large number of students cycling to school, but now, cycling is not allowed by their parents for safety concerns.

(Personal interview with an urban planner HB2, 2010)

Regarding the traffic induction loop, increased road supply or capacity can draw in extra traffic, which leads to new waves of congestion. The development history of Qingchun Road, as a sort of 'advanced artery', is a good demonstration of the induction loop (see Section 7.1.2). The enlarged road space, particularly the carriageway, attracts increased motor traffic. The vision of a freely flowing movement has never been achieved in this road by the widening and retrofitting projects, while peak time congestion is commonly seen at present.

It is hard to prove that the loop theory is totally ignored in the reallocation practice. Sometimes it

is believed as the only choice for a decision maker who is dealing with urgent congestion problems in an urban street.

As present, reallocation of road space is the most common way to increase road capacity within the restricted road boundaries. To a decision maker, a temporary relief of congestion, as a provisional compromise, is still a safe result in effect.

(Personal interview with an academic NJ2, 2011)

Some authors argue that the prevalent use of cars implies a whole lifestyle and mobility strategy and requires physically reorganised urban space (Bernard and Julien, 1974; Reichman, 1983; Vasconcellos, 2001). In China, there might be a common opinion that the automobiles, as well as the automobile-oriented road development, represent social wealth and advanced productivity, while walking, cycling and the relevant facilities, are the symbols of poverty and underdevelopment. The mindset is seen as a temporary change of values in the rapid urbanisation process:

The favour in automobile-oriented design of urban streets and networks could be derived from the changing mindset in the rapid urbanisation process. The majority of citizens, including decision makers, who newly-migrated to cities, had never experienced such a rapid change in economy and lifestyle. The use of private cars had never been questioned until the last five years when road congestion and accidents had become the widespread problems. The bias may diminish along with increasing urban living experience.

(Personal interview with an academic HZ2, 2011)

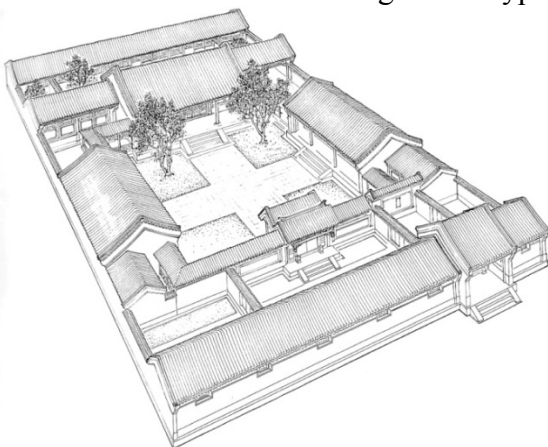
With limited financial support, improvement in non-motorists' travelling environment received little attention and investment. It can be well demonstrated by the case of Manzhouli Street, even though it is a branch road serving light motor traffic volumes. The strong bias towards vehicular movement can also be explained by revealing a set of political factors, which will be discussed

later.

9.1.3 The weakening relationship between streets and architectures

Under the increasingly applied superblock approach to urban development in modern China, the relation between streets and adjacent buildings has gradually become weaker than before. The increasing use of automobiles demands larger road space for ensuring fluidity of vehicular movement. Streets are becoming wider in their retrofitting process and after, accompanied by a reduction of enclosures and illegible boundaries. This trend is particularly significant in peripheral and suburban areas where large-scale redevelopments are taking place.

However, the inward-oriented development model is entrenched in the Chinese urban planning tradition. Historically, street boundaries were defined by walls of enclosed courtyards as the basic typology in a majority of Chinese cities (Figure 9.1). Chinese traditional housing values orientation, natural lighting, ventilation and privacy. It tends to be adapted to the climate and cultural environment in a majority of Chinese cities. Thus, the enclosed compound with a north-south exposure and a quad can be the typical layout of traditional housing which tends to isolate it from the surroundings. This type of development produced entirely opposed functions



and clear boundaries between streets and buildings.

An urban street has never been seen as an extension of architecture in the Chinese tradition.

Figure 9.1. *The typical model of an enclosed courtyard (Sihe-yuan)* - it rejects interference from streets or public spaces by impermeable walls.

Source: Pan, 2009, Figure 3.1.

At a larger scale, the morphology of urban design, as reviewed from historical maps, shows little interest in describing street-architecture relationship (Figure 9.2). Although active frontages have been widely adopted in many Chinese cities - particularly after the colonial period, the

inward-oriented development model and mindset have never diminished.

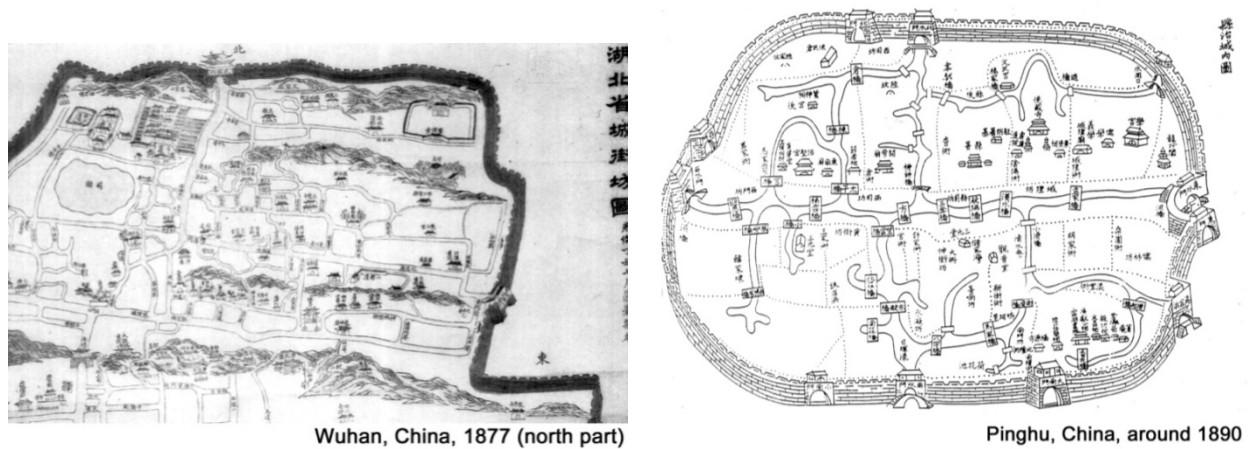


Figure 9.2. *Historical maps of Wuhan (left) and Pinghu (right), China - this mapping approach suggests little figure-ground relation between streets and architecture.*

Source: Liu, 1995, Figure 41; traditional map collection in Pinghu Library

The loss of enclosure or boundary legibility of a street can also be related to improper height-to-width ratios, discontinued frontages and excessive building set-backs (Blumenfeld, & Spreiregan, 1967; Jacobs, 1993). Illegible street boundaries can hardly imply a positive relationship between streets and their surroundings. These indicators strongly relate to the extent of land controls in street design itself and the surrounding development. It is well-demonstrated by the analysis of the sampled streets in the case studies that the sense of enclosure, as well as the legibility of boundaries, tends to decline along with the process of retrofitting and the large-scale development in the adjacent area.

Planning a residential quarter has to be controlled primarily by a set of regulations on orientation, lighting, ventilation, greenery, etc. It is rarely requested to consider the relationship between buildings and the adjacent streets to generate active frontages. Those regulations requiring multi-storey apartment buildings to be north-south oriented with a decent distance to each other are for maintaining the minimum daylight-hour standard for every household. Continuous frontages can rarely be created by this approach. Excessive building-to-street set-back is another factor for the loss of enclosure. In order to minimise interference between architecture and streets, it is required to maintain a 3-5 metre wide vacant space between the boundary lines of buildings

and streets.

Buildings are often isolated from streets by large-scale private development where the sense of enclosure can hardly be generated in the street. There is no policy or regulation that requires a street to be enclosed by its surrounding architecture. Thus, developers are difficult to be persuaded to give up the most profitable development model to adopt an alternative which has never been encouraged by any policies. Active frontages, particularly those along a north-south oriented street, can hardly be created by developers' intrinsic motivation... For both urban planners and developers, it is safe to maintain a maximal building set-back to circumvent potential interference. The enlarged space between buildings and streets results in illegible boundaries and loss of enclosure.

(Personal interview with an architect SH1, 2011)

Nevertheless, there are an increasing number of new housing developments providing podium extensions, instead of walls or fences, along adjacent streets for creating retail and business opportunities. However, these up-to-2-storey building podiums with large street widths can hardly generate an appropriate height/width ratio for creating a sense of enclosure, or an inviting environment for social activities (e.g. Chengnan Road, Pinghu). As a speculative approach without governmental guidance, it is often profit-motivated and neglects the actual needs for quality street space. It can hardly be considered as a positive approach to creating active frontages.

The development policies in China are more or less 'inward-oriented' with few concerns about their relationship to streets (Abramson, 2008). The policies reflect that the demand for good housing conditions often outweighs the demand for quality public space. Except for the retrofitting projects with historic or commercial significance, there is no financial or policy support to encourage active street frontages in new- or re-developments. There is also no mandatory control on height/width ratios or the continuity of the building frontages. Without

such mandatory regulation, neither residents nor developers are willing to sacrifice the optimal inward order to facilitate the outdoor activities in streets.

9.2 NEGLECTED NEEDS IN DESIGN CONSIDERATIONS

The development of urban streets reflects the weighting given to the conflicting interests of street users within the decision-making process. The findings reveal that improving vehicular mobility is always considered as the primary intention in street design practice in modern China and this intention is assumed to be well-facilitated by the engineering approach. When conflicts occur between vehicular movement and other needs in an urban street, the latter is more likely to be compromised as an outcome of an automobile-oriented circulation environment. It reflects the existence of significant inequity in urban transport development and the allocation of public resources.

9.2.1 Non-vehicular movement

In practice, it is common to reallocate road space by adding separators to redefine the movement space for different travel modes. Road separators in the form of median and safety strips are commonly used as a feasible solution to prevent accidents from unexpected interruptions between travel modes moving at different speeds. In most Chinese cities, dedicated cycle lanes are generally arranged along the carriageways with the edges clearly defined by safety strips. Separators are often considered as a necessity for roads designed to accommodate heavy traffic volumes.

Usually, both cyclists and motorists feel at risk when they are using the streets without safety strips. The cyclists have to be aware of the rude driving behaviour of motorists, while the drivers feel very stressful because of the frequently unexpected crossing of pedestrians and cyclists.

(Personal interview with a highway engineer PH1, 2010)

The standards and codes provide pedestrians with a variety of crossing types to improve pedestrian safety and vehicular flow. However, pedestrians' right of way at crossings is difficult to maintain since it is not instrumentally included in the design codes.

Traffic rules in China admit the priority of pedestrians in urban streets, particularly at the crosswalk. However, the situation is that pedestrians have to suffer if the cars are not willing to give priority to them. Especially at the right turning corners, with the absence of control by traffic lights, the car fleets become invincible barriers to pedestrians who want to walk across the street.

It is difficult to force motorists to give way for pedestrians crossing by mandatory rules. Especially right turning cars which are free from the control of traffic signals often make impossible for pedestrians to walk across the street. It greatly frustrates the pedestrians waiting for the change of the traffic lights and they are often forced to venture across the street illegally when and where they are not allowed.

(Personal interview with a highway engineer HB1, 2010)

Concerning the conflicts between pedestrians and motor vehicles, GB 50220-95 (1995: 5.2.6) suggests that pedestrian bridges and underpasses should be applied at the intersection where the volume of pedestrians and automobiles is significantly larger than 5,000 and 1,200 per hour. The standard nominally requires the local environmental character to be fully respected in the design of pedestrian bridges and underpasses. However, bridges and underpasses have been widely implemented in large cities with little regard for the surrounding circumstances, because there is no criterion for how a construction could conform to the character of the local environmental. More importantly, they have compounded the time and effort required for pedestrian movement. The application of pedestrian bridges or underpasses is discouraged by Gehl (2010) who believes that the solution should always be applied as the last resort, since they cause significant

inconvenience to pedestrians, especially the children, elderly and disabled.

Local government and developers are reluctant to invest in improving the quality of pedestrian pavements, except in the case of ‘pedestrian-only’ environments such as car-free streets, pedestrian precincts, waterfront walkways, ‘ecological pathways’ and some inner pedestrian routes in gated communities. In fact, segregated circulation networks have been tried all over the world, but have never proved to be a successful approach. However, it remains a hot topic in the name of ‘green’ transport development today (Han, 2003; Lu, *et al.*, 2004; Zhang, *et al.*, 2008).

The consideration for different travel modes mainly depends on the function of the street. It might be the mainstream to distribute the ‘slow’ travel modes to another transport system, by separating them from the ‘fast’ ones, providing a safer and better travelling environment for people walking and cycling. These ‘ecological streets’ are usually developed along waterfronts, integrated with green land and public parks, providing pedestrians and cyclists with natural landscape amenities and absolute safe spaces for ‘slow’ travel modes.

(Personal interview with a government official PH3, 2010)

To create a separate road system for non-vehicular traffic is possibly the most effective mechanism to reduce the rate of road fatalities. However, to separate non-motorists from vehicular traffic cannot be absolutely achieved. Despite the geographic limitation on building separated circulation systems, the shift between slow and fast travel modes inevitably happens at the same time and space. Besides, safety is not the only need of pedestrians and cyclists. The road safety ensured by the separate circulation system is always at the expense of convenience, accessibility and enjoyment. The additional circulation system may also cause detours and the fear of crime, which can generate even more risks to vulnerable pedestrians. This approach implies an elimination of traditional urban streets, with all their qualities of convenience, flexibility and permeability, which coincidentally match Le Corbusier’s vision of the ‘city of tomorrow’.

The interviews with government officials (i.e. PH3, PH4 and HB4) show that these decision makers have a significant gap in their knowledge about urban street design. The safety-related applications, either the idea of separate circulation systems or the provision of road separators, are built on the presumption in favour of the fluid flow of vehicular traffic. Alternatives for improving road safety, such as traffic calming schemes and the design of shared streets, have rarely been applied in practice since they do not satisfy the traffic flow demand. The current road safety practices in Chinese cities are nothing more than a physical enforcement to reduce the rate of road accidents, neglecting the overall picture of the circulation environment for the non-vehicular travel modes.

9.2.2 Public transport

Public transport is highly valued in the national transport planning strategy, especially in large cities where travelling by public transport constitutes more than 60% of daily trips (Sun, 2009). For most Chinese cities, bus transit is the most frequently used public transport service. According to the national standards, the requirements for bus transport planning are summarised as below:

The network for urban public transportation requires comprehensive planning which concerns the connectivity of the routes in either urban areas, periphery areas or suburban areas. Transport capacity should harmonise with the actual traffic volume. The density of bus routes should be no less than 3 km/km² in the central area and 2 km/km² in the urban periphery. The total service area of a bus station should cover no less than 50% of the urban area when the service circle radius is fixed at 300 metres; the proportion should be no less than 90% when the radius reaches 500 metres (GB 50220-95, 1995a: 7-8).

The standard employs a number of quantitative requirements to guarantee the accessibility to bus services in both urban and peripheral areas. Except for some particular exercises, in most Chinese

cities, buses usually share the same carriageway with other motor vehicles, thus they do not require any specific design considerations at present.

The recent design practice known as Bus Rapid Transit (BRT) systems have been tested in a number of municipalities. The BRT system in Hangzhou, for example, has operated for five years and developed up to four routes which mainly serve inter-district trips. After the first BRT route had been in service for three months, it had attracted widespread criticism from the public. The report from the Transport Department indicated that the special separators for BRT had caused twenty accidents with 1 person killed in those three months (Fang & Huang, 2006). A lot of comments indicated that the BRT had not only increased the traffic accident rate, but also occupied a large proportion of the already limited road resource: “it was not reflecting the principle of bus priority, but wasting the road resource and taxes”. Some believed that the intention of implementing BRT routes was to raise the land value and real estate prices around the destinations in the Xiasha District (Jiang & Hu, 2006).

Bus passengers are pedestrians when they are on the way to or from bus stops. Without providing pedestrians with a good-quality walking environment and easy access to bus services, the BRT is merely a point-to-point mechanism rather than an integrated ‘system’. For example, although the recently completed BRT system in Guangzhou claims significant advantages in travelling speed and volume, the 300-metre long segregated platforms are a horrible barrier to street users and a big obstruction to pedestrian permeability. Bus passengers have to use the highly raised pedestrian bridges as the only access to the platforms. Besides, the provision of one-direction elevators means that passengers have to use stairs to walk down, which is remarkably inconvenient to old people and those in wheelchairs (Figure 9.3).



Figure 9.3. *The design of the road with the BRT stops in Guangzhou*

Source: <http://www.chinabrt.org/en/cities/guangzhou.aspx>, accessed in July 2012

Since little sound evidence has suggested that they are appreciated by the passengers and other street users, the motivation for the development of the BRT system should be questioned. Like the massive implementation of expressways and arterial roads, the application of the BRT system might be strongly related to the decision makers' personal interests.

The development of BRT systems can be regarded as the projects for political performance and the abuse of urban spatial resources. Although the BRT programmes are claimed to be non-profit, the citizens can rarely benefit from the accelerated movement of bus transit by paying doubled price and having a longer waiting time.

(Personal interview with a highway engineer HZ4, 2011)

In fact, the BRT system is another practice designed with movement segregation in mind. As the practice of pedestrian circulation systems, the BRT approach tends to isolate bus services from urban road transport. The BRT practice neglects the interests of pedestrians as well as the other street users' rights of way. While large cities are showing their intense interest in such megaprojects, small cities, such as Pinghu, are struggling to collect revenue for their bus transit systems.

In Pinghu, bus transit has more or less satisfied the basic demand of daily travel so far. However, the bus transit company in Pinghu could hardly get enough financial support

from the government. There is an essential conflict between private profit and public service. It might be better to have special lanes for busses in big cities, while it is not quite necessary to set special lanes for BRT in small cities such as Pinghu, because of its relatively lower traffic demand. Nonetheless, the policies emphasising the priority of bus traffic at peak times would be a very effective solution to the problem of congestion.

(Personal interview with a local bus operator PH6, 2011)

In terms of the geometric design of bus stops, the design of the bus lay-by is an important consideration in the streets where space allows. GB 50220-95 requires the provision of bus lay-bys in expressways, arterial roads and highways to facilitate the free movement of other motor vehicles. CJJ 37-90 specifies the designated shape of a lay-by with precise dimensions determined by the different running speeds of buses. Unlike the statement in MfS that the principles for the design of a bus stop are to ensure their accessibility on foot with extensive consideration of noise nuisance, visibility requirements and the convenience of pedestrians and cyclists, the GB and CJJ codes exclusively focus on the flow of vehicular traffic regardless of the passengers' needs and local residents' concerns.

In some special cases, an insufficient bus service can also be caused by extreme weather conditions. According to a personal interview with a local bus operator (i.e. HB6, 2010), buses in Harbin are not able to run at a normal speed in winter due to the icy road surface. The reduced frequency cannot be offset by raising the number of buses, which makes difficulties for passengers' daily travel in winter. It implies that bus services are not fully respected at the street design level.

At present, the provision of public transport services is still isolated from the planning and design process of urban streets in most Chinese cities. The current design practice of urban streets cannot physically reflect the actual needs of public transport passengers. Since the consumption of private cars is much higher than walking or cycling, access to different travel modes is

significantly constrained by personal, economic and social differences. The people who cannot financially afford to use private automobiles, i.e. the majority of the urban population, are usually the deprived social groups who are rarely involved in the decision-making process and their actual needs are not the central concern of the decision makers.

9.2.3 Street aesthetics

The visual environment of the road space might be nominally valued in the current practice. Many streets are designed with a full consideration of ‘greenery’ and ‘orderliness’. However, such universal criteria entirely neglect the importance of surrounding architecture in composing a distinctive street visual environment. The traffic-engineering-oriented street design practice which aims to facilitate motor traffic fluidity and safety can hardly reflect the needs of street aesthetics. Its outcomes, such as inflated carriageways, diminished sidewalks, expanded intersections, median and safety strips, traffic signs, pedestrian bridges and underpasses are all the physical changes which have dramatically merged urban streets into a similar appearance.

The reconstruction of Qingchun Road in 1992 and 2005 was a typical case showing how the visual environment has been transformed. The early street could provide users with the feeling of enclosure, belonging, security and comfort due to the proper scale and height/width ratio. Today, the integration of the visual environment is broken by the widened carriageway with heavy vehicular flows in the middle. The enlarged road space and the raised building frontages significantly exceed the requirement for a ‘human scale’ indicated by Blumenfeld and Spreiregan (1967).

The sense of an integrated street can be broken by the reorganised street space. The street elements could be isolated by the sparse carriageways and heavy motor vehicular flows, which visually block most interactions among street users, building frontages and street facilities. Along with the increasing motor traffic and declining walking journeys, street frontages for public use

have confronted a recession or transformation. Many shops and restaurants along streets are permitted to provide pavement parking at the front to attract the motorised customers, which generates a monotonous and passive street façade instead of active frontages.

The integration of the visual environment can be easily interrupted by visual clutter generated from a variety of street appliances for some traffic or commercial purposes. The appliances may include traffic signs, separator strips, pedestrian bridges and advertising plates. Visual clutter on urban streets might be the indirect result of the demand for traffic flow and safety, or for some personal interests, which can be regarded as the erosion of the local environmental character and public rights.

The display of traffic signs and street furniture without a comprehensive arrangement plan can usually be seen as a common source of visual clutter. The disordered traffic signs and street furniture can be seen as the result of a failure of cooperation among different managerial departments. Street advertising can be another source of visual clutter. Many bill boards, either being attached to the bus stops or placed individually, are commonly seen in the sampled roads (Figure 9.4). They are usually placed with no regard to the surroundings or to the visual composition of the street, which results in significant impacts on street aesthetics.



Figure 9.4. *Visual clutter of advertising boards and frames in the sampled streets*

Median and safety strips are widely used without respect for the surrounding environments. For example, median strips in the form of metal rails are applied through Dazhi Street and appear as an abrupt white barrier in this historic street. Besides, some provision of traffic facilities, such as the pedestrian bridges and the entrance to underpasses, can also cause remarkable visual clutter to

the street environment whilst inconveniencing vulnerable street users.

The engineering-dominated street design approach, plus the weak control of public advertising, has diminished the local character which used to be valued in urban streets. When comparing with traffic engineering's concern for traffic flow and safety, street aesthetics may not be so conveniently evaluated by fixed standards. While the demand for efficient traffic flow and commercial advertising has become the primarily pursued goals, aesthetic-related needs have been compromised with the increased visual clutter and auto-oriented road spatial organisation.

9.3 POLITICAL ISSUES IN STREET DESIGN

Political power is significant in the decision-making processes of urban street design in China. Most urban street development projects are conducted by local government and more or less reflect the interests of the administrative class. The representative level of the decision makers in urban street design practice needs to be questioned due to the lack of an electoral mandate in China. Their personal interests could closely relate to their personal political goals which highly relate to short-term local economic achievement and social stability. Thus, efficient road transport can be exclusively interpreted as a temporary improvement in traffic flow and safety. This objective coincides with the traffic engineering's target, which reinforces the current trends of urban street design.

9.3.1 Discretionary power of decision makers

Although the national policies and standards show little interest in facilitating private motorisation, private motorisation has been widely supported by the current urban circulation system. This can be understood by examining the dominating group in the decision-making process. Public participation is required by the 2008 *Urban and Rural Planning Act* in the form

of a public hearing and publicity. Nevertheless, the intention of the public participation process is to make the planning procedure legal and prevent the risk of litigation, rather than for considering public needs. Under the dominant political system of democratic dictatorship in China, public participation and influence in urban planning and design procedures can be difficult to achieve (Chen, 2009). Without an appropriate means of public participation, the final decision by local authorities with their planners may exclusively reflect their personal preference and the market interest rather than the actual public needs. The declining permeability of urban streets can be a reflection of the disregard for the convenience of the commuting public under the overriding interest of superblock developments.

Usually, street design objectives are exclusively determined by governments and actual developers while the only role that public should play is 'receiving and accepting'. Public participation is nothing more than a process to legitimise the already confirmed decision.

(Personal interview with a government official PH4, 2010)

Public participation, by the means of a public hearing, has a limited effect in the decision-making process. Public hearings tend to be dominated by the professionals and provide few non-terminological platforms for the representatives of local residents to express their concerns.

(Personal interview with an academic HB3, 2010)

Since the mechanism of public participation in the Chinese planning system has not been fully established, it leaves the negotiation between politicians and planners to be the only collaborative relationship in most decision-making processes. At present, the role of local politicians in urban planning is becoming increasingly important as they are the main decision makers, which leaves the planners as the executors.

Before 2000, urban planners usually had strong cogency supported by their profession in

planning procedures, whereas local administrators lacked relevant knowledge and experience. In recent years, the latter are becoming more sophisticated in urban planning. The significant power of local administrators can hardly be disregarded throughout the planning procedures and they are increasingly becoming the dominant force. The major consideration of local administrators is the feasibility of implementation, funding sources, local economic development and social influence.

(Personal interview with an urban planner NJ1, 2011)

Local politicians can often deploy their discretionary power in many specific aspects that support auto-oriented street development. Firstly, these decision makers instinctively appreciate the road system that allows easier car usage, because they themselves are the users of private automobiles. Secondly, land transactions can be seen as the main source of local government revenue in many Chinese cities. A planning scheme which implies significant potential for land transaction is always supported by local government. These kinds of schemes often involve an auto-oriented road framework and superblock development as they can potentially create a large area of land for transactions. Thirdly, for local politicians, particularly in small cities, prompt economic development is highly valued in every planning scheme. Auto-oriented road transportation is always believed to be a key attraction to industrial investment.

Especially for the decision makers in small developing cities, economic development may be the primary consideration. The planning scheme which has significance in attracting investment is always preferred. On the contrary, a scheme which is not attractive to developers, particularly if the scheme focuses on long-term rather than short-term benefit, can rarely be adopted.

(Personal interview with an academic SH3, 2010)

Last but not least, auto-dependency is reinforced by the expanding built-up areas. In order to prevent urban sprawl, the designation as an urban built-up area is required to adapt to local

population forecasts, but it has given an unexpected impetus to urban sprawl in a majority of Chinese cities. If a certain degree of population growth in a city can be proven by forecasting methods, more land under administration can be expropriated for new development. With the rapid urbanisation process, local government always expects significant growth of new development by increasing the amount of development land to generate revenue. This trend leads to the widespread urban sprawl characterised by inefficient use of land and great leaps in suburban development (Qian & Wong, 2012). Without sufficient public transit services, inflated urban space can always result in a high dependence on automobiles. For both decision makers and the public, auto-oriented street design seems to be the justifiable approach to the increasing demands of motor traffic.

9.3.2 Personnel administrative system

In practice, vehicle-related traffic fluidity and safety are the dominant considerations in local transport planning and individual street design programmes. The manifest inconsistency between the policies and local interpretations has been observed. Some scholars believe that this phenomenon is the result of China's personnel administration system. The local leaders are appointed by higher-level governments, plus the rotating tenure system (*Lunhuan Zhi*), their primary responsibility is thus to their superiors rather than to public needs (Leaf & Hou, 2006).

The tenure of a government official is usually 5 or 10 years. Thus, a planning scheme which requires 20 or 30 years to become effective would not be positively advocated by an official. The schemes which focus on short-term economic benefits or explicit improvements of urban infrastructure are always embraced by local government.

(Personal interview with a government official PH4, 2010)

The influence of local officials' personal political goals in the decision-making process is

significant. The political goals in urban transport development are commonly assessed by the significance of the improvements in urban traffic conditions, such as reduction in road congestion and accidents. Nevertheless, the short-term reduction in traffic problems can be achieved by the road widening projects which merely increase the number of vehicle lanes or by providing new expressways and arterial roads which favour fluid motor traffic. Under the rotating tenure system, a local official can accomplish his or her political goals and get promotion soon enough before the long-term problems emerge.

(Personal interview with a government official HB4, 2011)

Since the focus on economic development continues to dominate social or environmental development, urban street planning and design are constantly oriented towards the land market rather than the balance of public needs (Leaf & Hou, 2006). The decentralised cost-benefit planning and design practices with insufficient consideration for social and environmental factors have led to the decline of city liveability and sustainability. Meanwhile, the legitimated standards and codes, the only mechanism for controlling and monitoring physical development, seem to be ambiguous between the rigidity in description and flexibility in practice. Therefore, the excessive scale of development activities in the name of ‘providing room for future economic development’ is more likely to be supported and legitimised by local government than the modest alternatives.

Following the rapid urbanisation process, the construction of urban arterial roads is becoming a profitable industry which attracts public investment. The bureaucratic personnel administration system in China also makes it difficult to support investment in the ‘discreet’ development of minor streets or the improvement of traffic conditions for non-motorised street users. The narrow and irregular traditional minor streets tend to have very light traffic because the lower design speeds could hardly attract investors’ or local governments’ interests under the proposed vision of ‘transport modernisation’ and the political goal of promoting ‘city branding’. Due to the defects of the personnel system in China, appointed local officials could only achieve their political goal by large-scale projects which generate instant benefits.

It has become a convention since the 1980s that infrastructure construction, especially road transport development, can represent the growth and development potentials of the local economy. The development of arterial roads can motivate the consumption of private cars and increase the surrounding land value. Both the local government and investors can benefit from urban road construction. The road development itself has become a competitive industry between cities.

(Personal interview with a highway engineer PH1, 2010)

Planning and design rules are understood as the legal method for regulating and controlling spatial development by the central state. However, these regulations are expected to be flexibly interpreted by local planning practice, which tends to be the way that local authority officials can achieve greater performance and secure their personal promotion during their limited tenure (Lu, 2001; He, 2003; Leaf & Hou, 2006). Particularly in smaller or less-developed cities where there is a lack of sufficient investment on large scale activities, local officials tend to engage in closer ‘cooperation’ with planners and elite investors to meet their political goals (He, 2003: 16).

In the development procedure of urban streets, interviews and negotiations with local residents and relevant users between the planning and design stages are not mandatory. In other words, no statutory rights have been given to residents to participate in or question the design of the street which would strongly influence their present living conditions, since the design principles and details are assumed to be exclusively based on technical criteria.

9.4 TECHNICAL ISSUES IN STREET DESIGN

Technical issues refer to the deficiencies in traffic-engineering-dominated standards and their ideology. Although the conventional approaches and ideological models have been widely questioned and criticised, it is still the exclusive, legal reference for urban street design in China. The national standards, i.e. GB 50220-95 and CJJ 37-90, are intensively equipped with

engineering measurements and geometric regulations for organising the most ‘efficient’ road transport. The standards and codes assume that all the travel modes are moving like motor vehicles which can be fully measured by size, speed, direction and volume. However, there is little evidence that the conventional traffic problems of congestion and accidents have been resolved by these regulations. Meanwhile, the traffic-centred approach activates the traffic induction loop which *stimulates* even more demand for private motor traffic in Chinese cities and leaves the deteriorating street environment to non-motorists.

9.4.1 Inherent defects of traffic engineering ideology

The current national standards and codes for urban street design in China are mainly based on the ideological conventions of traffic engineering. Urban streets are classified into four types and given four levels of geometric criteria. This implies that there are limited models of sizes and forms for each street type. The stratified criteria are not consecutive, which implies that a street with a certain width may not be allowed. For example, with a full consideration of the design codes, a street width of 30 to 40 metres should not be found in a large city. In fact, as indicated by Marshall (2005), the artificial classification regarding the functions of mobility and access in urban streets has an inverse relationship that cannot represent the actual street types. The analysis of the sampled streets in the case studies corroborates Marshall’s argument.

Although the hierarchical system for urban streets is emphasised by the national standards, the purpose of the classification is not given by these regulations. According to the literature reviewed and personal interviews with highway engineers (i.e. HZ4, HB1, PH1), the hierarchical system is valued as a means to improve traffic efficiency in urban streets through fluid movement with a lower risk of casualties (Tripp, 1950; Buchanan, 1963; Plowden, 1972; Hass-Klau, 1990; Southworth and Ben-Joseph, 2003; Brown, 2006). Traffic efficiency pursued by the standards and design codes is to allow the utmost possible number of automobiles to pass through an area

in a time unit with the least risks of traffic accident. However, an efficient door-to-door journey is not merely the fluid movement in a road, but also involves easy accesses to buildings and places. More importantly, if traffic efficiency is so valued, the focus should shift to improving the bus services and the walking environment to encourage the use of public transport as the most efficient mode of people travelling.

Faith in the rapidly improving technology can always provide decision makers with the possible vision of the most efficient road transport in time, space and budget. The time saved in vehicular movement, the construction budget and economic benefit of road transport can be evaluated by employing the conventional cost-benefit approach. Then the 'right' number and form of vehicle lanes and the optimal setting of signal intervals can be obtained as the most efficient way to deal with the traffic flows. However, the current traffic conditions can hardly compliment the effectiveness of this approach, since the conditions are often affected by unpredictable mobility. The failure may be attributed to the shortcomings in forecasting and evaluating technology (Vasconcellos, 2001). But more importantly, this ideology neglects the complexity of actual traffic conditions and the diverse needs of street users.

Another important defect of the ideological convention is the absence of an inclusive appraisal system. Instead of concerning the overall picture, the advocacy of auto-oriented traffic efficiency always neglects 'efficiencies' on the social, health and environmental fronts. Road congestion and accidents are the two dominant indicators in the current appraisal system for urban street development in China. Health risks, environmental damage and costs, time and spatial requests of non-motorised users are not properly considered in effect, as they are in many other developing countries (Vasconcellos, 2001). Even the costs and benefits of traffic flow and safety-related issues are found difficult to price.

This defect can clearly be determined by examining the standards and actual practice. For example, CJJ 37-90 defines the different traffic capacities of pedestrians in a certain width of pavement within different surrounding circumstances and different road types. Most dimensions

are intensively related to pedestrians' average walking speed, assuming that constant movement is the exclusive activity on pavements (MoHURD, 1991a). Comparing with the carriageways, a pavement seems to be less regulated since walking is thought of as the most flexible travel mode that has the greatest endurance in poor travelling conditions and the lowest risks of accidents. Neither the standards nor the cost-benefit appraisal have directed the design decisions towards pedestrian amenity in urban streets, since the standards for 'amenity' do not exist under any traffic-engineering-based appraisal models.

9.4.2 Applicability of the national standards

Technically speaking, the national standards and codes have deficiencies in specifying accuracy and strictness when taking the great differences between Chinese cities into account. The standards at the national level have difficulty in dealing with local diversities in topography, climate, economy or customs. Thus, the standards have to provide as much design flexibility as possible for local practice. Many regulation clauses allow 'exceptions for local distinctiveness'. Under this permission, personal interests in local decision-making processes can lead to a departure from the actual expectation of the national standards.

The standards for urban transport planning and codes for urban street design are not as strict as the ones for architecture or civil engineering and are relatively flexible in controlling current planning and design practices.

(Personal interview with an urban planner HB2, 2010)

Although great flexibility has been provided for coping with the diverse conditions of different cities, it is often interpreted by duplicating models of design practice. Duplication becomes the 'efficient' means to design a street (Yin, 2010). For example, Figure 8.16 (see Section 8.1.2) shows that the three intersections in Hangzhou, Harbin and Pinghu are similarly implemented,

regardless of the differences in climate, population, traffic volume and travelling behaviour of the three cities. It can hardly be seen as a good intersection design because the right-turn vehicles free from the control of traffic lights can be significant threats to people crossing the road. Despite this, the fully channelized model is favoured by local authorities and enthusiastically applied to many intersections in the sampled cities. It remarkably exemplifies the combination of political and technical issues in the street design process.

The case studies illustrate that the execution of national standards and design codes is often constrained physically by the existing spatial frameworks and the limitation of financial support. Due to the constraint of surrounding circumstances, many urban streets were not strictly implemented in accordance with the design codes. Due to land-use restrictions, motor vehicle movement is always the primary issue to be accommodated at the expense of non-motorists' rights of way. In contrast, once permitted by the physical spatial conditions, a newly developed arterial road is very likely to be equipped with oversized vehicle lanes, both in number and width, which exceed the maximum criteria.

The excessiveness in the size of a road or an intersection has rarely been questioned, while the bad quality of pavement and narrowness of a carriageway are more likely to be complained about, because the latter can be easily perceived and measured by the common use of the street. The design of an implemented street is rarely complained about by the users, because it was assumed to be approved officially by the relevant agencies. For another reason, in China, the costs and potential risks of bringing an accusation against official decisions are too high to be afforded by any individuals.

(Personal interview with an academic HB3, 2010)

The excessively designed urban streets are commonly recognised and even appreciated as 'providing room for further development'. Based on conservative estimates, such oversized projects exist in one fifth of all the cities and towns in China (Guangming Daily, 2006). Yin

(2010) argues that such practices stemmed from rapid urbanisation and stagnant institutional development. This implies that the liability concern and cost-benefit appraisal have been subordinated to government officials' own personal political agendas.

The applicability of the current standards is sometimes questioned for their obsolescence. Due to the rapid urbanisation process in China, the standards established in 1991 and 1995 can never catch up with the new development trends. Regarding the remarkable growth in superblock developments and use of automobiles, the pedestrian- or cyclist-friendly streets and networks are gradually being replaced by auto-oriented spatial layouts and frameworks in different areas ranging from new suburban districts to central areas.

Regarding the rapid growth of automobile ownership and the gated communities, the urban street design standards and codes established in the 1990s are becoming unreasonable and outdated without paying sufficient considerations to the current conditions. The standards need to be revised frequently according to the changing social needs and environmental conditions.

(Personal interview with an academic HZ2, 2011)

Many planners criticised the standards for the time lag of adjustment. A standard requires a long time period for drafting, publishing, accepting and practising and is difficult to change once becoming a convention. It is a practical issue that the current standards cannot adapt to the swift transformations in the economic, social and technical fields. It is worth quoting the words of a senior planner who is also a ministerial official: 'based on my working experience for decades, there are numerous deficiencies in the current standards. Some standards are ridiculous but have to be strictly followed in practice'. It reflects the negative attitude of a senior executive to the current planning and design regulations.

(Personal interview with an academic NJ2, 2011)

Although there is an increasing recognition that the various needs of street users should be inclusively considered in urban street design, there is little action for any changes in the national standards. Although the current standards are widely questioned, traffic flow and safety are still the primary issues pursued in urban street design. Within the domain of traffic engineering conventions, alternative design practices can hardly be adopted as they are risky challenges to the professionals.

Even supported by local policies, alternative street designs and layouts which consider the overall picture and long-term benefits are reluctant to be adopted. The instant gains from individual projects are often overestimated, while future effects both in positive and negative terms are often underestimated. It is also the reason why a design concerning sustainability is hesitantly practised.

(Personal interview with an urban planner SH2, 2010)

9.5 CONCLUSION

Sustainable development is no longer a new topic in Chinese urban transport. The strategy has been practised in many large cities since the 1980s, focusing on the development of public transport (MoHURD, 1995a; Zhou, J., 2006; Qiu, B., 2006). However, urban road transport has become increasingly dominated by private motorised traffic during the last 30 years. The dramatic discrepancy might be the consequence of household income growth in recent years. More importantly, even with widespread congestion problems and increasing economic loss from road casualties and delays, the advantages of private motorisation can hardly be replaced by other travel modes on the current urban streets in most Chinese cities.

One of the most fundamental factors is the rapid urbanisation process which brings a large population from rural areas into cities. The remarkable migration level is always accompanied by

increased demand for residential land and traffic demands. Along with the urbanisation process, superblock developments are increasingly driven by the concentrated power of land control and capital investment. This trend leads to spaced street patterns and a decline in permeability which are more auto-friendly than pedestrian-friendly (Miao, 2003; Abramson, 2008).

Although private car users are the main beneficiaries of the reorganised urban spatial frameworks and reallocated road space, none of them appreciates these changes since the conventional traffic problems have never been resolved. More importantly, the changed urban circulation environment becomes hostile to non-motorised street users and contributes to the deterioration of social liveability and environmental quality. Traffic-centred design approaches do not only neglect the needs of non-motorists, but also the traffic induction loop. Nevertheless, the failure of the conventional approach does not evoke alternative design practice. Instead, it places a great technical barrier against the challenge of new ideologies.

In terms of the decision-making process, politicians' personal political agendas often outweigh other considerations such as planners' professional norms and public needs and values. Particularly in China, politicians' personal interests are strongly associated with auto-oriented circulation developments, e.g. suburbanisation, gated communities and the local car and road industries. Due to the limited time period of administrative responsibility and the economic-based evaluation system, rapid economic progress is always the primary consideration in local planning. Thus road supply and auto-oriented retrofit programmes are widely adopted as temporary solutions to current congestion problems, since decision makers do not have to be responsible for the negative consequences generated by the traffic induction loop. This significantly reinforces the trend towards car-centred street planning and design and the resulting surge in highway building.

There is both documentary and empirical evidence showing that national policy is contradicted by the actual trends of urban street design in Chinese cities. Changes in the current design standards, development modes and administrative systems which call for feasible support from

appropriate methodologies and indicators are urgently required. It is more important to establish policies to support more inclusive solutions to address inequities in street development than to wait for future technological innovations to resolve the problems of urban transport.

CHAPTER 10 CONCLUSIONS

By examining the design standards, practices and outcomes of urban street design in modern China, this research revealed the unsustainable trajectory of current street development and dominant impulses of design trends. It began with the power of traffic engineering convention in reshaping and restructuring cities and their circulation environments around the world, followed by the emergence of alternative approaches which challenged the conventional morphological model in western countries. Then the research focus was transferred onto the current urban street design practices in China. It involved reviews of empirical studies and debates, as well as an examination of the street design standards and policy framework. Meanwhile, a multi-case study research investigation was carried out on the actual design practice and outcomes of urban streets in Chinese cities. By analysing the problems and shortcomings of the sampled streets, a set of key findings were revealed and discussed. Based on this, the research highlights a number of recommendations for achieving sustainable design practices for urban streets in China and provides suggestions and opportunities for further studies.

10.1 RESEARCH FINDINGS

The current trend of street development in China is unsustainable with an apparent departure from the requirements of inclusive design. With the significant growth of the private vehicle population, China is experiencing the most intensive development of street and road construction in history, while suffering from serious road congestion and casualties in its cities. The current design practice of urban streets can be reflected in two ways: spaced street networks and auto-dominated road spatial reallocation. Most urban street developments and design practices have discretion in facilitating vehicular movement in urban streets. However, non-motorists' rights of way are eroded and paid little attention. Very few studies in China have fully recognised

that traffic problems are a social crisis of inequity rather than just a technological issue (Li, 2000; Qiu, S., 2006; Chen & Guan, 2006). For political and technical reasons, their suggested principles have gained little ground in current practice and rarely been agreed by either local policies or decision makers. There is also little evidence showing any support from the public. As an alternative to the engineering conventions and standards, the ideology of inclusive design of urban streets has to confront mixed barriers of economic, political, technical and cultural bias to automobiles' dominance of the urban circulation.

The paradigm shift in western countries

In order to bridge the knowledge gap of street design practice between the Western and Chinese systems, this research develops a critical understanding of the paradigm shift of urban street design in developed countries. Since the 1920s, traffic engineers have taken the responsibility to accommodate the increasing use of automobiles which may be one of the immutable facts of modern life (Sloman, 2006). The basic concept is to stratify streets into different types by arteriability and accessibility to facilitate motor traffic flows while reducing their nuisance to local residents. It also segregates different travel modes on the road surface to maintain vehicular movement and reduce interruptions. The method is based on motor traffic forecasting tools used as the primary indicator to inform urban street design, traffic management and parking supply. Street design standards and codes, which strongly relate to vehicle size, movement speed and traffic volume, are formalised regulations and universally adopted in conventional practice. The standards composed by 'non-negotiable yet mathematically arbitrary requirements' are the major engineering mechanism for regulating street planning and design (Hebbert, 2005: 56). The conventional approach gives exclusive attention to motor traffic and reshapes traditional streetscapes and urban spatial frameworks, which in turn reinforces the dependence on automobiles (Mogridge, 1990; Downs, 2002).

There are considerable criticisms of the traffic-centred design approach. Over the decades, urban streets were increasingly reclaimed as both traffic links and multi-functional places that serve diverse needs (Jacobs, 1961; Alexander, 1965; Plowden, 1972; Appleyard, 1981; Francis, 1987; Gehl, 1987; Hass-Klau, 1992; Southworth & Ben-Joseph, 2003). In recent years, sustainable development and inclusive design is aggressively advocated and practised in many developed countries (European Commission, 2004; DfT & CLG, 2007; New York City Department of Transportation, 2009). In the beginning, most achievements of new paradigms of street design were limited to some particular regions, i.e. residential streets with low levels of traffic volume. Today they have the impact on many redevelopments of central areas with intensive traffic demand and flow. However, the new western paradigms are reluctantly adopted in some developing countries (e.g. China) and the frustration with the traffic-centred approach of urban street design did not stop these countries repeating the conventional paradigm.

However, there is always a problem in adjusting the physically built environment to the new fashions of urban life. The traditional urban layouts designed for periods of 'old' technologies (e.g. carriages and tramcars) have been challenged and changed by the demand for the 'new' motorised lifestyle and assumed forecasts. But the developments which exhibit 'new contemporary' forms (e.g. car-cities and BRT cities) may well become obsolete in the 21st century. Generally, when a city or an area is developed in time, like a contemporary coastal city in China, it always tends to adjust its layout to reflect the current fashion, like car-dominated streets and their networks. Following the experience of developed countries, this trend will change when the benefits of an alternative design become more apparent.

The current design standards, practices and outcomes in China

The conventional approach is enshrined in China's national standards and codes (e.g. GB 50220-95 and CJJ 37-90). The standards mainly focus on facilitating vehicular movement in

urban streets based on the idea of a street hierarchy which highlights traffic segregation with great emphasis on the spatial separation of different travel modes. This research shows a number of inherent defects in the national standards which have rarely been questioned in previous studies. Firstly, although the standards show positive attitudes toward the sustainable development of urban transport, they provide very little substantial support for the inclusive design of urban streets. Secondly, acknowledging regional variations, the national standards often allow exceptions for local distinctiveness, which gives local authorities the flexibility to achieve their personal interests. Thirdly, the design standards are often criticised for being ‘out-dated’ in dealing with the current traffic conditions. Substantial revisions need to be applied to the standards to ensure better adaptation to new circumstances. Thus, the standardised design practice should not be considered as the only right form of an urban street. For example, little evidence shows that the design practice of the roundabout in Dazhi Street, which significantly deviates from the standards, has any negative impacts on vehicular movement.

There are more discrepancies between the standards and design practice than generally recognised. In the cases of streets in central areas, the inconsistency often results from restrictions caused by surrounding buildings and land-use. In the cases of streets without such restrictions, design practice can always meet the required parameters (e.g. total road width and design speed) and sometimes exceed the maximum standards. The decision makers’ preference for larger road space and higher design speed can be reflected in this trend – sufficient or excessive road space for motor traffic is primarily considered once permitted by surrounding physical conditions. The bias prevails in many Chinese cities regardless of their different sizes or traffic volumes and intensities which are used as the important considerations in urban transport developments. This research shows that the conventional engineering methods, such as traffic surveys and forecasting, can be overridden by some other issues, like local economic development targets and the political goals of some local officials.

In most retrofitting projects for congested urban streets, when street width and design speed are

restricted by surrounding land-use, road space is often reallocated with strong bias to motor vehicles' movement and parking. The bias is apparent but evokes little attention from academic studies, media or the public. The reallocation enlarges carriageways at the expense of road space for cycle paths and footways. In some cases, pavement parking, as an alternative solution to the lack of public parking lots in urban areas, is encouraged by reducing kerb heights and 'inviting' cars to ride on the pavement. Some cases of retrofitting history (e.g. Qingchun Road) can be the typical example of the traffic induction loop with short-term effects. This trend is more apparent in arterial and secondary roads than in branch roads, since it strongly relates to the traffic intensity of motor vehicles.

Non-motorists' needs, particularly their convenience and non-traffic needs, are often neglected as the outcome of auto-oriented design practice. Pavement parking and fast turning speeds are often facilitated by reducing kerb heights and enlarging the kerb radius, which challenge pedestrians' right of way at footways and crossings. Shrunken pavements and a decline in the relationship between a street and its buildings implicitly reject social activities in urban streets. Pedestrian bridges and underpasses are frequently applied at busy intersections to ensure motor traffic flow at the expense of pedestrians' convenience. Cycle lanes in some cities (e.g. Harbin) have been eliminated to create more road space for automobiles. Cyclists have to use pavements or take the risk of riding on carriageways. Vulnerable people may be the most impacted street users in such a circulation environment since they are rarely seen in any sampled urban streets according to the author's observation. The deteriorating walking and cycling environments show the strong policy bias towards motor traffic.

These outcomes reflect significant inequity between different travel modes and, to some extent, between different social groups in using urban streets. Motorists, standing for the social group with higher incomes, have been given more public resources and facilities to ensure their mobility, while the remaining people, usually the economically deprived social group, receive little support from policies and decision makers. The most vulnerable users are the least

considered social group who are almost excluded from the urban circulation system. The current design trends can hardly be justified on social equity, stability or moral grounds.

Struggle for a paradigm shift in China

The street design paradigm should be shifted from being oriented by automobiles to an inclusive design for all people regardless of their travel modes and mobility. The large projected urban population in China, combined with growing family incomes, means a rapid increase in car ownership and use in the coming decades. Achieving greater efficiency of energy use in the urban transport sector is challenged by the rising level of private motorisation (Zhao *et al.*, 2011). Rising carbon emissions and deteriorating atmospheric quality make future developments in China unclear. Carbon and energy efficiency can be considered as a factor that will drive change in the conventional design practice in China. Due to the persistent limitation of land resources, sustainable land development patterns with mixed land-use, small residential quarters and active street frontages should be encouraged to replace the superblock development models. Public health can be another factor that may contribute to a paradigm shift. China faces for the first time an obesity epidemic (Wang *et al.*, 2006). Thus, designs that encourage walking and cycling will be justified by both health economics and equity.

Since the negative impacts of automobiles are increasingly recognised, ‘green transport’ is advocated recently as a sustainability strategy in urban transport. Major debates and studies have contributed to this strategy, but very few of them have influenced practical conditions. The frequently-cited and repeated arguments such as “technological revolution for traffic forecasting; environment-friendly circulation framework; energy-efficient transport modes; optimal traffic organisations and flexible land-use for road construction” found in the recent literature are nothing more than advertising publicity with little practical value for policy-making and delivery whilst still ignoring non-traffic needs (Jing, 2000; Hu, 2002; Wu & Shen, 2003; Guo *et al.*, 2011;

Zhou & Yi, 2011). The extent of methods used to reduce car use in some large cities is limited to car registration control. The managerial approaches, such as the ‘lottery’ system in Beijing and the ‘registration auction’ system in Shanghai, may have an effect in restraining the speed of growth in car ownership but achieve little substantial reduction in auto-dependence levels.

Under a ‘green transport’ policy, car-free zones, pedestrian streets and ecological walks are widely practised (Han, 2003; Lu *et al.*, 2004; Zhang *et al.*, 2008). Although those ideas and exercises give strong support to walking and cycling, they are based on the ideology of traffic segregation. Urban streets and networks are persistently assumed to be an independent system that exclusively serves traffic and are individually designed regardless of their relationship with the surrounding environment. Despite some short-term successes, the restraint of direct car access has medium-term impacts on land value and a class-based physical expression in the built environment. More importantly, these practices have ignored the basic organisation of urban life and broken the integrity and diversity of the urban circulation environment. The current development of pedestrianised areas, as well as the development of expressways, flyovers, pedestrian bridges and underpasses, implies that the ideology of traffic separation by different travel modes is still the dominant design trend in China. There is strong resistance to a paradigm shift.

10.2 KEY FACTORS AFFECTING THE CURRENT DESIGN TRENDS

The design trends are driven by growing private motorisation and reinforced by centralised land control power and capital investment preferences. Increases in the motor vehicle population have been significant in recent years and are likely to accelerate with income growth in the future. Many studies believe that this trend is an inevitable outcome of rapid economic development and assume that it should be well accommodated by improving the infrastructure of urban road transport (Yang, 1997; Jing, 2000; Wu & Shen, 2003). However, the increased households’

income is not the only driver for the growth in private motorisation. On the contrary, the European experience shows that the demand for private motor traffic can be compromised by the improved public transport service and reduce within the pedestrian- and transit-oriented urban spatial organisations. Moreover, this belief ignores the restriction of urban land-use and non-traffic needs in urban streets and shows little awareness of the traffic induction loop. Although the knowledge gap has been gradually recognised, alternative solutions to traffic problems (e.g. road congestion) have not yet been justified or applied. The lesson of Qingchun Road may arouse some criticisms about such projects and new thinking for alternative approaches, but similar retrofitting and widening projects are still prevailing in most Chinese cities and being considered as the ‘only’ and ‘safe’ way to provide temporary relief from road congestion.

Given the massive urbanisation, the dominant development pattern of superblocks and uneven distribution of urban population as the basic background, the advocated sustainability in the street design standards can be distorted by their problematic indicators. First, the population-based mechanism can hardly be justified as a proper indicator for the actual traffic demand or as a determinant for street density, design speed and width. The uncertainty in population projection results in excessive design and provision of new roads in urban peripheries and leads to spaced street networks with disengaged frontages, which intensifies the reliance on private motorisation in new development areas. Second, the average density of streets makes it difficult to distinguish the different traffic volumes and features between central and peripheral areas. The average street density has particular disadvantages as a standard for the development of branch roads, since the street density is significantly underestimated in central areas. It fails to satisfy the actual traffic demand and reflect the diverse needs of different travel modes. Last but not least, the indicator of street density cannot accurately describe the actual street permeability. It is common to see apparently permeable street patterns blocked by the access restrictions of gated communities. The density presented by a two-dimensional map of street networks also overestimates the actual permeability because of vertical intersections. On a small scale, median and safety strips can also

result in diversions for pedestrians and cyclists, which cannot be indicated by street density. Without frequent provision of crossings, pedestrians have to walk a much longer distance than presented on maps, which makes their use of the 'legal' crossings problematic. Oriented by the problematic indicators, these changes in urban layouts intensify the dependence on automobiles and result in the deteriorating circulation environment for non-motorists.

Discretionary power of decision makers, particularly the power of local officials, dominates design processes with an apparent personal bias towards superblock development and auto-oriented road reconstruction which are robustly supported by the great achievements in local economic development in the last three decades. This development mode is closely intertwined with personal political goals. Firstly, with the increased influence of local politicians in the decision-making process, the current urban street design practice more or less reflects their personal interests rather than planners' professional values or public benefits. Secondly, short-term benefits from road construction and large-scale developments are highly valued and more easily achieved, while long-term benefits are rarely considered since they provide the decision makers with few instant political or economic benefits in their current 5 to 10 year tenures. Thirdly, the flexibility given by the national standards to reflect local conditions can be distorted by personal interests. Excessive design practice can often be tagged as 'advanced provision' of road space for future increases in motor traffic.

The tradition of Chinese inward-oriented urban form is an important cultural factor for the current design trends. The traditional housing shows great emphasis on interior living conditions and a disengagement from its surroundings. This cultural intention has more or less motivated the development of walled residential quarters but rarely considered the relationship between the developments and adjacent streets. Particularly given the development patterns of superblocks and increasing use of automobiles as a common circumstance, housing development is kept increasingly separate from road communications in spatial organisation.

The key findings show the different design trends of urban streets in modern China to those in western countries. It identifies the main factors driving the trends from technical, political and cultural perspectives and reveals the challenges for a paradigm shift within the Chinese context. Due to these factors, the notion of sustainable development and inclusive design is not well supported by the public or decision makers. The resulting bias attributes the urban traffic problems to a persistent shortage in road resources, which makes the problems unsolvable. New good practice of urban street design therefore demands for a justifiable definition and alternative approaches to challenge the conventional paradigm in modern China. Policies that support alternative good practice in urban street design to orientate decision makers and the public towards a comprehensive understanding of the values and functions of urban streets are urgently required. These original findings can therefore propose key elements and new principles to decision makers for achieving sustainable and inclusive design practice.

10.3 POLICY RECOMMENDATIONS

Based on the research findings, policy recommendations can be approached to shift the conventional policy bias in urban street design. Since the paradigm shift in China has obtained little support from the economic, political, technical or cultural sectors, it has to seek for consistent support from policies oriented by sustainable land development patterns, environmental value and public and economic health. The western experience shows that the distortion can be gradually changed by re-valuing the multiple functions of urban streets. It involves a major academic contribution on historical reviews and empirical studies to challenge the convention's authority (Jacobs, 1961; Alexander, 1965; Plowden, 1972; Gehl, 1987; Moudon *et al.*, 1987; Hass-Klau, 1990; Downs, 1992; Whitelegg, 1993). Subsequently, new ideologies are generally acknowledged and interpreted by the public and government departments (English Heritage, 2000; CABE, 2002; European Commission, 2004; DfT & CLG, 2007; New York Department of Transport, 2009). These efforts are then progressively supported by local

government and become an influential power in today's urban street planning and design in developed countries.

More importantly, the unsustainable street design in China is strongly linked to the superblock land development model, which is very different from the western experience. Thus, the policy bias should be shifted towards small and mixed land-use with more permeable street patterns and active frontages. The change requires a long-term strategy for policy and delivery that can orientate sustainable land-use.

Despite the mixture of challenges, accumulated knowledge and experience can increasingly provide modern China with potential opportunities for the paradigm shift. First, urban streets need to be re-evaluated for their multiple functions. Diverse needs can be inclusively considered by providing decision makers with a new evaluation system. Then, a new framework for design standards based on the inclusive evaluation system can be established to narrow the gap between national policy principles and practice on the ground. Last but not least, to achieve the balance between short- and long-term benefits, a top-down motivation mechanism for a new pattern of land development through cooperation across different sectors is needed. These recommendations advocate the importance of consistency in policy, ranging from the national strategy to local delivery and from the overall design principles to individual practices.

Short-term: reclaiming urban streets for multiple functions

To achieve the inclusive design of urban streets for multiple functions requires new specific surveys and alternative indicators that can evaluate the actual impact of every individual solution. Accommodating multiple functions in urban streets is more than an engineering issue. The dominance of traffic-centred requirements needs to be challenged by taking other non-traffic interests into account. Only when an inclusive evaluation system has been applied to the street environment, can a variety of functions be well-integrated and accommodated through the

design-practice process.

The environment for non-motorised traffic should be valued as equally important to that for vehicular movement. Based on the current conditions in the urban circulation environment in China, there is an urgent need for an alternative traffic assessment system to be implemented. First of all, some conventional considerations in urban street development, such as car ownership, per-capita road length and area, accident rates and vehicle speed on a road, need to be replaced by more accurate and precise indicators capable to specify the distribution of spatial resources for each type of travel mode, the levels of road safety and traffic demand of all people and door-to-door journey time. It is important to acknowledge that the efficient circulation system is not exclusively decided by the total road capacity. Instead of the general statistics, multiple assessment methods should be involved in traffic surveys to have a more inclusive description for the real conditions of urban circulation environment. For example, network structures, bus service radius and accessibility, pedestrians' walking and waiting time at crossings, are even more important than the road capacity in indicating the actual traffic efficiency.

Secondly, regarding the current development patterns in most Chinese cities, the permeability and connectivity of street network patterns need to be evaluated as key indicators in the planning process. The current standard uses average density for each type of street as the only indicator for network planning, which cannot distinguish the apparently different levels of traffic demand from central to peripheral areas. Using street density as the only indicator can result in an overestimated street permeability in an area where there are access restrictions or vertical intersections. Thus, permeability, which is a more accurate indicator of the actual traffic mobility in a certain area, can be the alternative indicator to street density.

Thirdly, there is a need for an alternative 'hierarchy' system based on both the movement and place functions of urban streets. The case studies show that there is a constant aspiration for multi-functional street designs with some economic purposes in local street developments, but it can hardly be supported by the current standards. The inverse relationship between movement /

mobility and place / access needs to be changed. All urban streets should be two-dimensionally addressed in a new classification system within a movement and place matrix (Figure 10.1). The proportion of each type of street should be carefully considered and specified in every planning scheme to organise the permeable network pattern. With the new classification system, urban streets serving both movement and place functions can be well defined and encouraged for facilitating ‘green transport’ and social activities.

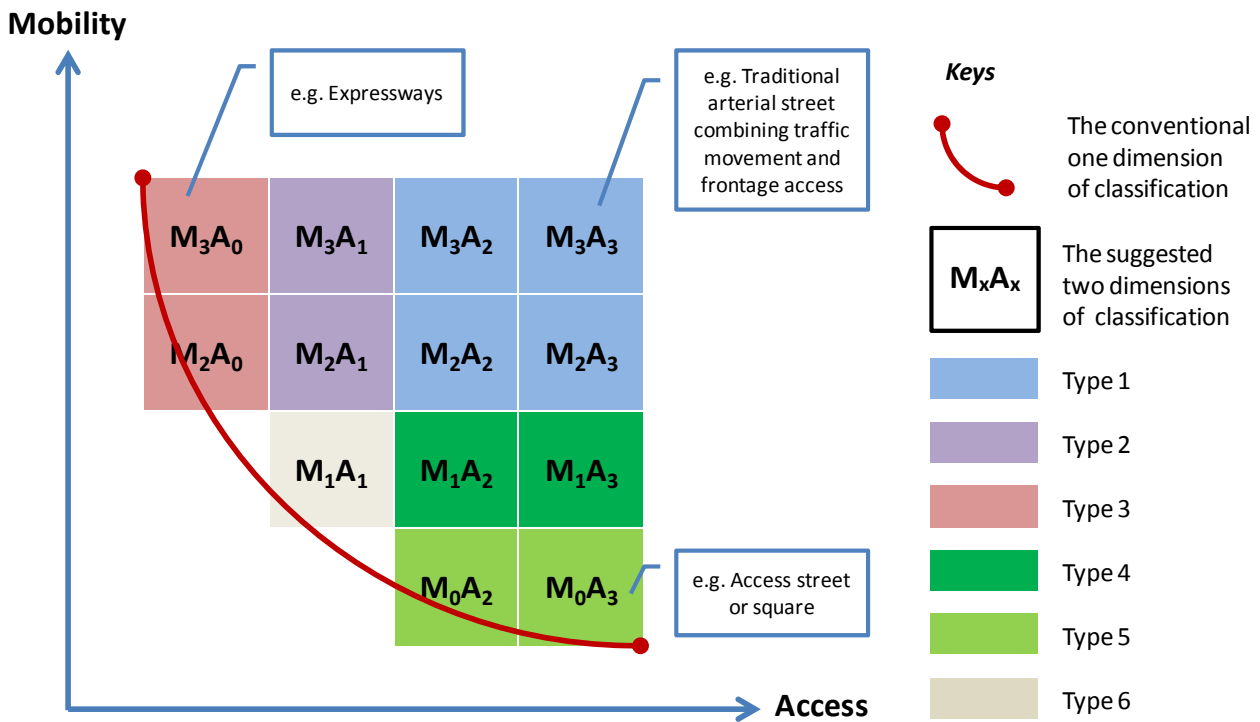


Figure 10.1. *Mobility and access hierarchy with 6 suggested types of urban streets*
 Source: adapted from Marshall, 2005; DfT & CLG, 2007; Jones *et al.*, 2008, Figure 3.

Fourthly, non-motorists’ right of way, especially for vulnerable users, needs to be fully considered in the design process and ensured in practice. It involves the equity of road space allocation and the extent of their priority in using street facilities. New indicators, such as motility, accessibility, health risk and costs of non-motorised travels should be involved in the decision-making process. Some research findings show that the current design standards are weak in facilitating non-motor traffic when it conflicts with motor traffic. Thus, physical improvement

in the walking and cycling environments, rather than a managerial approach, is required in design practice. For example, by raising kerb heights, the integrity and continuity of footways can be maintained without the invasion of cars. By reducing kerb radius at intersections, the turning speed of cars can be reduced to allow pedestrians a safe crossing. Some traffic-calming solutions, such as kerb extension and raised crossings, can also be used to ensure pedestrians' priority at crossings.

In terms of non-traffic considerations, the relationship between a street and its buildings should be evaluated as the potential for creating socialising space. Since the main reason for building set-back is the fear of architectural interruptions to adjacent streets, positive relationships between streets and building frontages should be approached by integrating the design of streets and the surrounding architecture. However, as indicated before (see Section 6.1.1), urban streets are designed at a much earlier stage than buildings. In the current planning system, their relationship can hardly be considered in integrative ways. Thus, in the short-term, new measures need to be adopted to indicate the street/building relationship. For example, the building height to street width ratio which is effective in indicating the actual scene of a street can be considered as a robust indicator of the street/building relationship. In some retrofitting practice for historic streets, for example, the street/building relationship is indicated by the proportion of overlapping boundaries of the street and building frontage. Generally, a larger proportion can indicate a closer street/building relationship. There are a variety of indicators that can be applied to develop active frontages and the sense of enclosure in urban streets.

Last but not least, the quality of the visual environment should also be assessed in the decision-making process. For example, the application of traffic signs, street furniture and advertising should be reconsidered and controlled through cooperation between different social sectors. As a source of revenue, commercial advertising in public streets often reflects the fiscal interests of local government rather than the visual interests of the public. In the private sector, advertising boards on storefronts are the main source of clutter in the urban street environment.

Quantity, quality, size, position, type and colour of advertising should be controlled, particularly in some historic streets.

It is worth noting that, rather than providing absolute regulations for every individual street design practice, the proposed indicators should be used as the key reference for an inclusive consideration in any design-practice process (Table 10.1). It provides decision makers with an inclusive method of evaluating multi-functionality instead of rigidly adhering to standardised parameters. With this method, every urban street can be inclusively evaluated and designed to encourage more sustainable transport developments, rather than to keep on facilitating the increasing motorised traffic.

Table 10.1. *Inclusive design check list for each type of street in China*

Street type	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Objectives	High streets with balanced movement and place function	Arterials with low place function	Expressways or ring roads	Public streets encouraging social activities	Commercial streets or public squares	Residential streets serving low traffic and place function
Urban context						
Local history & character	√	○		√	√	○
Surrounding land-use	√	√	•	√	√	
Walking						
Safe and easy crossings	√	√	•	√	√	√
Legible design for disables	√	√	•	√	√	√
Quality pavement	√	√		√	√	•
Kerb condition	√	√		√	√	•
Cycling						
Cycle parking	√	○		○	√	√
Cycle lanes	○	○	•	•		
Public transport						
Bus priority measures	√	○		○		
Bus lay-by	•	•	√			
Easy access to bus service	√	√	•	√	•	•
General motor vehicle transport						
Speed-oriented street geometry	•	√	√	•		
Efficiency of car	√	√		√	√	√

parking provision						
Non-traffic needs						
Visual environment	√	•		√	√	√
Public space	√			•	√	√
Street greening	√	○		○	√	√
Active frontage	√	•		√	√	
Street/building relationship	√	•		√	√	
Street furniture	•			√	√	√
Street facilities						
Sustainable drainage system	•	•	•	•	•	•
Street lighting	•	•	•	•	•	•
Traffic signs	•	•	•	•	•	•

√ means the issue with its form and quality must be highly valued throughout the design process

○ means the issue with its form and quality should be highly valued depending on the local conditions

• means the issue with its form and quality should be considered in the design process

Source: adapted from DfT & CLG, 2007; New York Department of Transport, 2009

However, the modern standards embedded in the engineering profession are rigidly and indisputably regulated by precise physical and geometric features. With liability concerns, the new standards have to face resistance from the dominance of the old technical criteria. On the other hand, many Chinese cities, in particular large ones, have adopted various managerial approaches to reduce the use of automobiles. Nevertheless, they are proving helpless in improving non-motorists' circulation environment or the attractiveness of public transport services. Despite these disadvantages, the cost of the managerial approaches is significantly smaller than physical improvements on streets. Without policy support or changes in the existing planning system, local authorities are reluctant to adopt and implement new design practices.

Long-term: building a consistent policy framework

The manifest gap between the national sustainability policy and the actual design trends reflect the inconsistent concerns in the decision-making process and need to be narrowed. The identified problems demand changes in the present policy framework and planning system. Based on the factors for the policy-practice gap revealed in this research, the new policy package includes two

major revolutions to establish a more consistent association between the national policy and local practice: a multi-level framework of design standards and the highlighting of the importance of urban design in the planning system. The multi-level standards can specify local features while adhering to key principles at national level. Rather than an option, urban design needs to be employed as a requisite phase in the planning system for integrating street design to the surrounding context.

The multi-level standards can be developed based on the new classification system and inclusive design requirements. Instead of proposing rigid design codes, establishing inclusive design principles and methods can be the main purposes of the national standard. Under the key principles, local governments and different institutions should work cooperatively to develop local standards that interpret the national principles in detailed ways with regard to local history and character. The local standards allow less elasticity so restricting improper interpretations distorted by local politicians' personal interests in the decision-making process. Street design standards and manuals at the local level are widely practised in many western cities. Recently, local standards have also been applied in some Chinese cities, though they are fully traffic-centred. The current exercises provide experience and feasibility for developing the multi-level framework of street design standards in China.

Urban design should be valued in the future planning system as a key stage linking regulatory plans to individual developments. The existing planning system isolates street planning and design from surrounding developments as an exclusive pattern for road transport development. Applied in the urban design stage, street forms with surrounding land-use can be inclusively evaluated and designed, taking non-traffic needs into consideration. However, administrative reorganisation is required to support urban design as the key linkage. Cooperation of urban designers, traffic engineers, architects and landscape architects is required and should be organised and facilitated by local government. Today, such a cooperation of urban design has been practised for street developments with historic or cultural significance, showing the

advantages in the response to inclusive design requirements e.g. the Zhongshan Road Retrofitting Project in Hangzhou. This suggests a real possibility and potential for integrated urban design under the reorganised administration system in China.

Another suggestion that contributes to the paradigm shift is building a motivation mechanism that encourages small and mixed land development. As mentioned before, the superblock development patterns lead the urban circulation environment to be more auto-dependent in most Chinese cities. Without changing this unsustainable development model, permeable street patterns and inclusive design are difficult to achieve. However, due to the existing personnel administration system, the conflicting interests between long-term social and environmental benefits and personal political goals, such as short-term economic achievement, may be one of the most difficult problems to be solved. Furthermore, there is a technical difficulty in evaluating the long-term influence of a new practice from environmental, social and economic perspectives. Thus, new sustainable development and practice need to be encouraged by a top-down motivation system.

The system employs the power of the upper-level government to stimulate local planning authorities to place a stronger focus on the long-term benefits from social, ecological and economic perspectives. Above all, national policies should pursue the priority of public resources being used in the type of infrastructure that serves the most deserving social sector. Local decision makers must evaluate the actual developments with both short- and long-term considerations. In the private sector, small developments should be encouraged by compensation paid by local government. Alternatively, improvement in pedestrian permeability can be achieved by opening some of the routes within superblock developments (e.g. large-scale gated communities) for public use. Such a solution needs to be financially supported by local government for its contribution to public traffic.

In summary, the paradigm shift faces considerable difficulties derived from the conflicting interests of different social groups and political sectors. The local government which should have

the most responsible role in the delivery of sustainability policies is currently the obstacle to achieving the advocated long-term benefits. The recommended proposals of the new planning system and policy framework must be further enriched and developed to overcome the current inconsistencies in the design process.

10.4 LIMITATIONS AND FURTHER RESEARCH

This research identified the knowledge gaps, trends and challenges of urban street design in China. It examined the development histories and current conditions of nine urban streets in Hangzhou, Harbin and Pinghu to illustrate the unsustainable trajectory of urban transport and land development and the strong policy bias towards motor vehicle traffic. The current street design trends were complicated by various interests leading to a compromise result. Due to the limitations of time and resources, the quantity of streets and cities sampled was constrained by practical and logistical considerations. Although some key findings and policy recommendations can be generalised to other modern Chinese cities regardless of size and geographical differences, several limitations to this generalisation should be pointed out.

Firstly, the sampled streets and cities are all located in the east of China, representing relatively higher family incomes and more advanced infrastructure developments than the cities in central and western China. Different levels and models of the local economy can result in different interests in the decision-making process. Exceptions to the design trends can be found in some underdeveloped cities and those heavily relying on tourism or heavy industry. Secondly, with the focus on central urban streets, the design practice of new streets in new urban districts was not fully investigated. Brief reviews and map analyses have shown a much stronger bias towards motor traffic in these new developments. To have more precise descriptions and explanations, these ‘advanced’ design practices need to be investigated in further research studies. Thirdly, although the superblock development pattern prevails in a majority of Chinese cities, a number

still retain the traditional development models with mixed land-use and street-oriented urban lives. Their transport development and street design trends were not specified in this research. It would be inspired to have a wider range of study areas and an extended scope for the analytic methods in further research studies.

The elite interviews were helpful in acquiring in-depth insights and understanding of the current design trends but, due to their relatively small number, may not be effective at representing the inclusiveness of perspectives. Besides, as mentioned in the methodology chapter, interviews with street users were not included in this research, since they had provided very limited information for either describing street conditions or explaining the design trends. Rather than the small quantity of semi-structured interviews, massive structured questionnaires for street users could be a better choice for further surveys to obtain a more comprehensive understanding of the cultural bias.

At the time of the research, the traffic-centred approach still dominated urban street design and transport development in Chinese cities, thereby providing this research with very few good examples of practice which can be regarded as alternative models for the paradigm shift. At present, new exercises such as landscape boulevards, urban green corridors, ecological walks and the developments of ‘historic-cultural-commercial’ streets are a ‘hot topic’ for discussion. However, none of them can actually reflect the contemporary global consensus of ‘good design practice’. On the other hand, the study focus on road transport management has not moved further than the conventional model of traffic forecasting or the appraising technology for free-flow designs. The lack of empirical support may be one of the greatest difficulties in achieving the paradigm shift in China. Hence, instead of pursuing the imaginary ‘technical revolution’ for ‘transport modernisation’, further research studies should be more aware of the public and economic health and environmental issues for urban street design and transport development. Rather than facilitating the ever-increasing motor traffic, further design practice should be more alert to the need for spatial, social and environmental equity for all people.

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APPENDIX 1

Samples of large cities

	Shanghai (2008)	Tianjin (2008)	Hangzhou (2008)	Guangzhou (2007)	Nanjing (2008)	Shenyang (2007)	Harbin (2008)	Chengdu (2008)	Wuhan (2008)
Population of the districts under city administration	Very high	High	Medium	High	High	Medium	Medium	Medium	Medium
Built-up area	High	Medium	Low	High	Medium	Low	Low	Medium low	Very low
Mean population density	Very high	Very high	Medium high	Medium high	High	High	Low	Medium	Medium high
Per capita annual income	High	Medium high	High	High	Medium high	Medium	Medium	Medium high	Medium
Number of private automobile	High	Very high	Medium	High	Medium low	Low	Medium low	Very high	Low
Private automobile ownership	Medium low	High	Very high	Medium high	Medium	Medium	Medium high	Very high	Medium
Number of private motorcycle	Very high	Medium	Medium high	High	Medium	Very low	Very low	Very high	Medium
Number of taxis	Very high	High	Low	Medium	Low	Medium	Medium low	-	Medium low
Number of buses	Very high	Medium	Medium	High	Low	Low	Medium	-	Medium
Number of daily public transport passengers	Very high	Medium low	Low	Very high	Low	Low	Low	-	Medium
Number of bus per 1000 person	Medium	Medium	High	Medium	Low	Medium	Medium	-	High
Paved road length	Very high	Medium	Low	High	Medium	Low	Low	-	Low
Paved road area	Very high	High	Medium	High	High	Low	Low	-	Low
Proportion of paved sidewalks	-	Medium	-	Low	-	Medium	-	-	High
Per capita paved road area	Low	Medium	Medium low	Medium low	Medium high	Medium	Very low	-	Medium low
Investments in road transportation	High	Medium	Medium low	Medium low	Medium high	Low	Medium	-	Medium

Samples of small cities in Northern Zhejiang Province

	Jiashan (2009)	Pinghu (2008)	Haiyan (2008)	Haining (2007)	TongXiang (2007)
Population in urban district	Medium low	Medium	Medium low	High	High
Built-up area	Medium	Medium	Low	High	High
Mean population density in built-up area	Medium	Medium	High	Medium	Medium
Per capita citizen annual income	Medium)	Medium	Medium	Medium	Medium
Number of private automobile (including the rural area)	-	Medium	-	-	Medium
Reported private automobile ownership	-	Medium	-	-	High
Number of private motorcycle	Low	Medium low	Medium	High	Medium
Paved road length	Medium low	Medium low	Medium	High	High
Paved road area	-	Medium high	-	-	High
Per capita paved road area (Reported)	-	Medium high	High	-	Medium high
Investments in road transportation	Medium low	Medium high	Medium	High	-

APPENDIX 2

Data sheet for each street:

1, archival data, maps and plans:

- current maps for the certain street
- historic maps for the certain street and its surrounding land-use
- the latest master plan for the certain district
- design detail of the certain street (if the street is new or revised)
- records of traffic accident
- data for street related investment
- data for public transport
- specific local policies on road transport
- local historic records about street and transport development

2, observation details:

- photographs of streetscape by different time periods and by different weather conditions
- personal feelings about the sense of the place
- historical photos, paintings or drafts

- video records
- traffic activities
- social activities: place, time and frequency
- casual activities
- traffic volume and speed
- pedestrian crossing time
- number, positions and conditions of street pavement, trees, lighting and furniture

APPENDIX 3

Table of elite interviews

Date	Interviewee	Occupation	Organisation
26/10/2011	HZ1	Urban planner	Institute of Urban Planning and Design of Hangzhou
26/10/2011	HZ2	Academic	Zhejiang University
26/10/2011	HZ3	Landscape architect	Hangzhou Landscape Architecture Design Institute Co., Ltd.
27/10/2011	HZ4	Highway engineer	The Transport Planning and Research Institute of Hangzhou
27/10/2011	HZ5	Landscape architect	Hangzhou Landscape Architecture Design Institute Co. Ltd.
05/12/2010	HB1	Highway engineer	The Institute of Highway & Bridge Construction in Heilongjiang Province
06/12/2010	HB2	Urban planner	Harbin Urban Planning & Design Institute
06/12/2010	HB3	Academic	Harbin Institute of Technology (HIT)
14/02/2011	HB4	Government official	Harbin Urban and Rural Planning Office
07/12/2010	HB5	Architect	The Architectural Design & Research Institute of HIT
08/12/2010	HB6	Local bus operator	The Bus Transit Company of Harbin
05/10/2010	PH1	Highway engineer	The Transport Planning and Research Institute of Pinghu
05/10/2010	PH2	Urban planner	Pinghu Urban and Rural Planning Office
27/12/2010	PH3	Government official	Pinghu Urban and Rural Planning Office
04/10/2010	PH4	Government official	Pinghu Urban and Rural Planning Office
26/10/2011	PH5	Architect	Pinghu Architectural Design Institute Co., Ltd.
11/01/2011	PH6	Local bus operator	Pinghu Tianlong Bus & Coach Transport Co., Ltd.
04/10/2011	SH1	Architect	East China Architectural Design & Research Institute Co., Ltd.
04/10/2011	SH2	Urban planner	Shanghai Tongji Planning & Design Institute
20/12/2010	SH3	Academic	Tongji University
07/12/2011	NJ1	Urban planner	Nanjing Urban Planning & Design Institute
19/09/2011	NJ2	Academic	Nanjing University

Interview questions

Academics: questions for academics are wide but in-depth, such as 1) professional opinions on urban transport planning and street design with the consideration of sustainability, 2) evaluations about the selected streets, 3) opinions on current street design standards, and 4) suggestions and

methods for “good design” of urban streets.

Urban planners: questions depend on the district in which the street selected: 1) the leading concept of transport planning in this district or in this city, 2) the effectiveness of the national standards in real planning project, 3) the reason for exceptions, 4) planning barriers and liability concerns, 5) the assessment process, 6) public participation, 7) reasons for the planned hierarchy system, 6) justification for the designed speed, 7) social equity, environment quality, and historic conservation considerations, etc.

Highway engineers: questions depend on the street selected: such as 1) the leading concept of design, 2) the effectiveness of the national standards in real design project, 3) the reason for exceptions, 4) design barriers, liability concerns, and assessment, 5) street and intersection geometry, 6) crossing forms, 7) the justification for designed speed, 8) traffic safety and efficiency considerations, 9) social equity, environment quality, and historic conservation considerations, etc.

Architects: the questions about street-building relationship include: professional evaluations on street frontages and characteristics, reason for existing problems, suggestions, and useful examples of good design.

Landscape architects: the questions about street landscaping include: professional evaluations on street landscaping, reason for problems, suggestions, useful examples of good design.

Government officials: the questions prepared for officers are varied and sharp, in order to explore the political factors for the problems of urban street design, such as 1) the annual investment in road construction in this city, is it enough or not, 2) personal opinions about the local transport policy, 3) reasons for existing traffic problems, 4) opinions about the road transport planning, 5) opinions about the design quality of the sampled street, 6) political barriers against alternative design.

Local bus operators: the questions about local bus service include: conditions and costs of local bus transit service, existing problems and solutions, and opinions about BRT system and bus special lanes.

APPENDIX 4

Maps of sampled streets are illustrated in the following pages: Qingchun Road (eastern part), Zhongshan Road (middle part), Haier *Xiang*, Dazhi Street (middle part), Guogeli Street (eastern and western part), Manzhouli Street, Chengnan Road (eastern and middle part), Renmin Road (eastern and western part) and Wenjin Road.