IDPR, 26 (1) 2004

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Transport, urban structure and 'lock-in' in the Kuala Lumpur Metropolitan Area

The concept of 'automobile dependence', interpreted as a path-dependence phenomenon, informs this assessment of urban transport and structure trends in the Kuala Lumpur Metropolitan Area (KLMA). 'Automobile-dependent' cities, where high private vehicle use is strongly entrenched, are contrasted with 'traffic-saturated' cities, in which modest numbers of vehicles cause great problems for urban structures that are unsuited to them. Data from a recent international compilation are used to place the KLMA's patterns into perspective. The KLMA is found to be not yet very automobile dependent but a number of strong trends are encouraging and entrenching ever higher private motor vehicle use. Agencies in the KLMA are investing heavily in car-oriented mobility, while building urban designs that are hostile to non-car alternatives, yet with densities that may be incompatible with high car ownership and usage. These trends seem to run the risk of entrenching an intractable traffic crisis.

A surprising transport and urban structure trajectory in Malaysia?

This paper considers the extent to which the term 'automobile-dependent' may be applicable to Malaysia's largest urban region, the Kuala Lumpur Metropolitan Area (KLMA) which had a population in 2000 of 4.3 million (City Hall Kuala Lumpur, 2003). This allows some insight into the utility of the idea of automobile dependence in contexts beyond the most obvious ones. The term has been used most often to describe cities in the USA in contrast with wealthy urban areas in Europe and eastern Asia where automobiles play a less dominant role and which can be characterised as more transit-oriented (Newman and Kenworthy, 1989). The term has rarely been applied to urban areas in the poorer global South given their generally low levels of car ownership. This investigation involves an evolutionary perspective on urban transport which, although perhaps unfashionable, increases awareness of urban developmental trajectories (cf. Dimitriou, 1995) and may have important policy implications in the context of ongoing debates over the role of urban transport in sustainable development.

What is automobile dependence?

Two major streams in the usage of 'automobile dependence' can be distinguished: one stream refers to the extent to which an individual or household depends on the

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Paper submitted July 2003; revised paper received and accepted December 2003.

use of private cars (for example, Cullinane and Cullinane, 2003); a second stream refers to the extent to which higher order structures, especially the built environment, encourage and 'depend' on car use. This second stream is the focus of this paper. Drawing on definitions by Newman and Kenworthy (1999, 60), who popularised the term, and by the Victoria Transport Policy Institute (2002), I suggest that we define the degree of automobile dependence of an urban area as the extent to which it possesses a set of characteristics, systems and institutions that encourage, reinforce *and* entrench very high levels of private motor vehicle use and low usage of alternative modes of transport. The degree of automobile dependence can be thought of as the extent to which self-reinforcing processes have led to domination by private vehicles becoming locked into much of the urban and social fabric.

This definition is also influenced by the idea of 'path dependence', which has been widely discussed as a cause of policy inertia in technology choice and in the field of 'evolutionary economics' (Arthur, 1989; 1994). Unruh (2000) applies a path-dependence framework to energy policy, identifying what he calls 'carbon lock-in', and discusses as an example the dominance of the automobile in many land transport systems. Atkinson and Oleson (1996) discuss urban sprawl as a path-dependent process and argue that this perspective offers policy implications, encouraging a focus on altering incentives and dynamic evolutionary paths.

Clearly the legacy of past development in the urban structure is not lightly swept away. However, a rigorous sense of path dependence requires 'increasing returns' processes in which the probability of further steps along the same path increases with each move down that path (Pierson, 2000). These contrast with self-correcting processes where decreasing returns lead to an equilibrium (Arthur, 1994). With increasing returns it is often not possible to reverse the process (even if the 'stimulus' is reversed) since the system may have changed in structure. This prompts the use of the term 'lock-in' to describe the situation of systems that have been strongly influenced by a path-dependent process. This is not to say that escaping a locked-in state is impossible, merely that it is more difficult than equilibrium economics would suggest.

Mechanisms of automobile dependence

The transport system and the land-use system interact in intimate ways, with each influencing the range of possibilities that is open to the other, although neither fully determines the other (Hansen, 1959; Thomson, 1977). These interactions and their policy implications have been much investigated and debated (see Banister, 1995; Anderson et al., 1996; Cervero, 2002). Processes of physically entrenching high car use include attempts to make space for cars in existing areas; dispersed location of new urban developments, taking advantage of accessibility patterns offered by private transport; and design details and density of urban developments that are adapted to

the spatial requirements of cars. These reduce options and choices for movement by non-automobile modes such as pedestrians, cyclists and public transport and can help set in train positive feedback processes (Engwicht, 1992; Manning, 1984). There has recently been much investigation of the phenomenon of induced transport demand resulting from transport infrastructure investment (for example, Goodwin, 1996).

The intimacy of the connections between transport and urban structure has also prompted simple descriptive models that identify urban structure types with the dominance of particular transport technologies, using labels such as foot cities, tracked cities and rubber cities (Shaeffer and Sclar, 1975) or walking cities, transit cities and auto cities (Newman, 1995) or Thomson's (1977) urban transport and urban structural 'archetypes'. Thomson's 'full motorisation' archetype, the rubber city and the auto city are all clearly related to the idea of automobile dependence, or at least its urban structure dimension.

In addition to the widely discussed physical mechanisms, there are also a number of less widely considered mechanisms for automobile dependence. For example, the cumulative impact on many households of individual-level automobile dependence can also be argued to give rise to metropolitan-scale automobile dependence. The purchase of a private motor vehicle has a profound impact on household travel behaviour. Motorisation itself thus leads to choices, for example in housing location, shopping and such like, that together contribute to metropolitan-scale automobile dependence. Dupuy (1999) elaborates especially on how network economies, or so-called club and network effects, can give rise to automobile dependence. Using the dominance of automobiles as a key example, Unruh (2000) argues that network economies, lock-in arising from interdependent technological systems, co-evolution of technological systems with private institutions and lock-in of public institutions together give rise to a 'techno-institutional complex', with changes in each inter-connected system reinforcing change in the others.

Public transport networks exhibit positive network and scale economies that run counter to automobile dependence and lead along a different path towards 'transit metropolises'. For example, there are potential positive feedbacks between public transport and land use, in the form of transit-oriented development. Positive network externalities are also powerful if transfers between lines can be made sufficiently convenient (Mees, 2000). However, these features of public transport can lead to vulnerability. If usage declines then the decrease in revenue per passenger lost tends to be proportionately greater than the cost decrease. Furthermore, if services are cut then the loss of network effects can disproportionately erode the attractiveness of the network in a vicious cycle.

Distinction between automobile dependence and traffic saturation

It is helpful to make a distinction between 'traffic-saturated' cities and those that are 'automobile-dependent'. Wright (1992, 166) uses different terms to make a similar distinction between 'automobile-threatened' cities in Asia and Latin America and 'automobile-dominated' cities in North America, pointing out that automobile-threatened cities have high enough population densities that they face gridlock and severe negative externalities from even modest numbers of cars. Bangkok is a key example of traffic saturation (Kenworthy, 2003). Modest vehicle usage per person but relatively high urban densities translate into very high traffic per urbanised hectare and, although the network of main roads is not unusually sparse compared with similar cities, the length of main road per person is unavoidably low (Barter, 2000). Car domination is not deeply entrenched and, with policy changes and other collective action, cities such as Bangkok might be able to change pathways in the dominant transport technology with relative ease. By contrast, extremely automobile-dependent cities, such as Houston or Phoenix where all but a tiny fraction of motorised travel is by private car, have dispersed destinations, extremely low urban densities and very high provision of car-related infrastructure capacity, especially expressways, arterial roads and parking space (Kenworthy and Laube, 2001). Both automobile dependence and traffic saturation can be considered problematic from an environmental perspective (relative to more transit-oriented cities, for example), with the former related to high global impacts, such as high carbon emissions per capita, while the latter involves more serious local impacts from transport, such as high levels of local air pollution per urban hectare (Barter, 2000). The social equity impacts of automobile dependence are also likely to be considerable (Shaeffer and Sclar, 1975; Manning, 1984; Wright, 1992).

The Kuala Lumpur Metropolitan Area in international perspective

The rest of this paper examines evidence on the specific case of the KLMA, using the evolutionary perspective discussed above and seeking to gain some insight into whether the idea of automobile dependence might be relevant here, and what policy implications this perspective might suggest. The discussions above suggest a number of arenas in which to look for evidence of lock-in, increasing returns, mechanisms for automobile-dependence processes and their results. The focus is primarily on the physical interactions between urban structure and transport.

Let us first briefly place the KLMA's situation into international context by comparing a set of key features with averages for other groups of cities around the world, as shown in Table 1. Most of the data reported in this paper were gathered as

part of two major urban data-compilation projects, the most recent of which sought to obtain comprehensive transport data for 1995 on 100 urban areas worldwide.[1] The study area used is in fact the 'Klang Valley' which is a slightly more constrained area than the KLMA (see Figs 1 and 2), comprising all except the newest extensions to the south and including about 95 per cent of the KLMA's population, so that the data presented here can be considered representative of the urbanised portion of the KLMA. The methodology of data collection for all the factors was strictly controlled by agreed-upon definitions. This is extremely important since data were obtained from a wide variety of official and unofficial sources. Data were carefully checked, triangulated and verified before being accepted into the databases. In addition, this paper draws on material compiled during five years of living in Kuala Lumpur in the late 1990s as well as recent investigations into current developments. The particular groupings of cities shown in Table 1 (a combination of income-based and regional groupings) were chosen with the help of hierarchical cluster analysis applied to various sets of key variables in the data-set.

The five high-income groups of cities in Table 1 are arranged in order of decreasing role for private cars (and increasing role for public transport). The data on the US cities reflect a high degree of automobile use, and indeed automobile dependence, followed by the Australasian (ANZ) cities. At the other extreme, the high-income Asian (HIA) cities have remarkably low private motor vehicle roles and a strong orientation towards public transport. The European (WEU) and Canadian (CAN) cities fall between these extremes. The US cities contrast strongly with the HIA and WEU cities, suggesting the existence of two alternative evolutionary paths in wealthy contexts. Clearly, changes in income levels influence many of the processes in urban transport and land-use development, especially the potential for motorisation, as has been widely reported. However, the diversity of transport outcomes among high-income cities suggests the importance of other factors in addition to income, at least within urban areas.

In the Klang Valley the indicators of private motor vehicle usage and infrastructure are higher than both the HIA cities and the average for its own group (the middle-income Asian [MIA] cities), and its public transport-related indicators are much lower. Actually, the level of private motor vehicle use in the Klang Valley (if motorcycles are included) is most comparable to that in the WEU cities, despite much lower income levels in Malaysia. Other indicators of private vehicle infrastructure and use as well as urban density are also similar to the European averages and to the 'other middle income' (MIO) cities but the performance and usage of public transport in the Klang Valley are much lower.

1 The data-sets arising from these projects are published as Kenworthy et al. (1999) (also reported in Kenworthy and Laube, 1999) and Kenworthy and Laube (2001).

Table 1 Key transport system and land use characteristics in the Klang Valley compared with middle-income and high-income groupings of cities, circa 1995

		USA	ANZ	CAN	WEU	HIA	MIA	MIO	Klang Valley
Metropolitan gross domestic product per capita	USD	31,386	19,775	20,825	32,077	34,797	9,776	6,625	6,991
Passenger cars per 1000 persons		587.1	575.4	529.6	413.7	217.3	198.3	265.1	208.7
Motorcycles per 1000 persons		13.1	13.4	9.5	32.0	65.8	154.0	14.7	174.5
Passenger car passenger km per capita	Pass. km/cap.	18,155	11,387	8,645	6,202	3,724	3,517	4,133	4,345
Motorcycle passenger km per capita	Pass. km/cap.	45	81	21	119	100	1,165	78	1,365
Length of expressway per 1000 persons	m/1000 cap.	156	129	122	82	22	27	43	68
Parking spaces per 1000 CBD jobs		555	505	390	261	121	164	374	298
Motorised passenger km on public transport	%	2.9	7.5	9.8	19.0	50.3	26.9	36.6	10.8
Public transport seat km of service per capita	seat km/cap.	1,557	3,628	2,290	4,213	5,535	2,734	3,283	1,331
Overall average speed of public transport	km/h	27.4	32.7	25.1	25.7	33.2	16.4	24.8	18.5
Average road network speed	km/h	49.3	44.2	44.5	32.9	31.3	20.9	35.9	28.1
Ratio of public versus private transport speeds		0.58	0.75	0.57	0.79	1.08	0.78	0.70	0.66
Total emissions per urban hectare (CO, SO_2, VHC, NOx)	kg/ha	3,563	2,749	4,588	5,304	3,894	12,952	7,236	7,889
Urban density	persons/ha	15	15	26	55	134	164	54	58

Source: Kenworthy and Laube (2001).

The cities included in these groupings are as follows:

Western and Southern Europe (WEU): Munich, Frankfurt, Zurich, Geneva, Düsseldorf, Bern, Lyon, Paris, Stuttgart, Vienna, Oslo, Hamburg, Copenhagen, Stockholm, Ruhr, Nantes, Graz, Marseilles, Helsinki, Amsterdam, Brussels, Bologna, Rome, Milan, Berlin, London, Barcelona, Madrid, Glasgow, Manchester, Newcastle, Athens;

United States of America (USA): San Francisco, Washington, New York, Denver, Chicago, Atlanta, Houston, Los Angeles, Phoenix, San Diego;

Canada (CAN): Vancouver, Calgary, Toronto, Ottawa, Montreal;

Australia and New Zealand (ANZ): Sydney, Perth, Melbourne, Wellington, Brisbane;

High-Income Asia (HIA): Tokyo, Osaka, Sapporo, Hong Kong, Singapore;

Middle-Income Asia (MIA): Taipei, Seoul, Klang Valley (Kuala Lumpur), Bangkok;

Middle-Income Other (MIO): Tel Aviv, Prague, Curitiba, Riyadh, Budapest, S o Paulo, Johannesburg, Cape Town, Kraków.

Note: In the case of the Klang Valley, most of these data refer to 1997. CBD = central business district

Based on these data we can easily reject the notion that the KLMA is as highly automobile dependent as North American or Australian cities. Neither in its private vehicle use, nor in its infrastructure and urban structure, has the KLMA reached their extremes of locking-in high car use. If the KLMA is not automobile dependent, then to what extent could it be called traffic saturated? There are a number of variables in the data-set that can be used to help assess this, including two shown in Table 1: average road network speed and traffic-related air pollution emissions per urban hectare. Based on these, the preliminary answer would seem to be that the KLMA could be described as moderately traffic saturated although less so than many other Asian cities. Traffic density in terms of annual vehicle kilometres per urban hectare in the Klang Valley is moderate at just over 200,000 km/ha, which is considerably higher than in most US or ANZ cities, similar to that of many European and Asian cities but much lower than the levels in dense and traffic-clogged cities such as Bangkok, Seoul and Taipei. The data from Kenworthy and Laube (2001) tell a similar story for traffic per kilometre of road.

Asian responses to traffic saturation

Investigations below will focus on how relevant agencies in the KLMA have been responding to the challenges of increasing motorisation and traffic saturation. Therefore it is useful first to mention some precedents among eastern Asian cities, where we find two main contrasting responses to these challenges (Barter et al., 2003). In a number of eastern Asian cities the motorisation process was deliberately slowed from an early stage, using varying mixes of policy tools such as discouraging credit for private consumption, high taxation on vehicle purchases and high annual vehicle taxes. The key examples include the Japanese cities, Singapore and Hong Kong, while Seoul was also an example, at least until the mid-1980s. In the cases of Hong Kong, Singapore and Seoul, high-quality, high-capacity mass transit was not yet in operation at that time (the early 1970s) but, I argue, their slowed motorisation allowed a window of opportunity during which they were able to build bus-based public transport usage to a high level until mass transit was eventually built. Significant real estate development in these cities took place with public transport as a strong influence. In Seoul and the Japanese cities constraints on motorisation were implemented initially for national macroeconomic strategic reasons, not for urban transport reasons as in Singapore and Hong Kong, and have since been relaxed. Nevertheless, the role of public transport remains strong, reflecting a legacy of a transit-oriented urban structure and well-developed public transport infrastructure (see Fig. 3). These experiences contrast with the responses to traffic saturation in Kuala Lumpur, Taipei and Bangkok. In these cities motorisation was never curtailed and reached rather high levels before quality public transport systems began to be established in the 1990s. By then public transport had come to be used only by those without other choices.

Responding to traffic saturation by moving towards automobile dependence?

Although the KLMA is clearly not yet strongly automobile dependent, this section investigates the extent to which trends and policy responses may be heading in that direction by entrenching higher private motor vehicle use. It also asks whether we can find evidence of the kinds of lock-in or increasing returns processes that were discussed earlier. This may provide a test of the utility of the idea of automobile dependence and an evolutionary perspective.

As discussed earlier, automobile-dependence processes go beyond the physical mechanisms associated with urban structure and transport infrastructure. Various institutional arrangements in the KLMA underlie or contribute to locking in higher private motor vehicle use. Although important, such perspectives as the political economy of various trends discussed below are largely beyond the scope here which focuses on the physical interactions. In Malaysia a range of politically well-linked commercial groups have an interest in the current trends, especially the private motor vehicle trends, infrastructure contracts and large-scale real estate development patterns. The tendency towards a predict-and-provide approach to infrastructure can be seen as arising from patronage politics, with privatised infrastructure projects given to favoured businesses (Townsend, 2000; Gomez and Jomo, 1997). The KLMA, as Malaysia's pre-eminent metropolis, has become the increasing focus for federal government-led mega-projects, including transport infrastructure (Bunnell et al., 2002). During the later years of Dr Mahathir Mohamad's prime ministership, control over large-scale projects such as transport infrastructure in the KLMA came increasingly under the direct control of the Office of the Prime Minister and the Economic Planning Unit, both of which have keen interests in promoting motor vehicle ownership and use (Townsend, 2003). Private motor vehicle assumptions have also become built into the practices of numerous organisations, especially the Malaysian Highways Authority and Public Works departments at each of the three tiers of government. These play a key role in policy momentum for further expansion of road capacity, which they have institutionalised as their primary response to congestion.

Policy responses to motorisation and increasing motorised traffic

Motorisation and increasing private motor vehicle travel have been rapid in the KLMA, especially during the decade-long economic boom until the late 1990s. Klang Valley car ownership rose from 113 per 1000 people in 1985 to 209 in 1997 and motorcycle ownership rose in the same period from 105 to 175 motorcycles per 1000 people.[2]

2 These numbers, from consultants' household surveys such as JICA (1987, 1998), are the most reliable recent data. Official vehicle registration figures overestimate motorisation (partly because of a failure to properly remove defunct vehicles from records).

Vehicle sales suggest that this trend is continuing, despite a brief small dip in sales in the wake of the 1997 regional economic crisis. So if we include motorcycles, ownership of private motor vehicles in the KLMA is apparently now comparable with levels in many Western European cities. As mentioned previously, motorisation in itself plays a key role in processes leading towards lock-in of automobile dependence.

The KLMA has yet to see policy efforts to reduce the rate of growth of vehicle ownership or usage. Since the 1980s, national policy has actively promoted high vehicle sales, and the national vehicle industry, centred on 'national car' players Proton and Perodua and recently a 'national motorcycle', has been strongly nurtured by the government. Malaysian fuel prices are also subsidised, especially at times of high global oil prices, although fuel prices have been modestly revised upwards twice recently (*Straits Times*, 2001; 2000).

Restraint of traffic in Kuala Lumpur city centre (but not restraint of vehicle ownership) has often been considered but never implemented. Such policies would tend to help deflect a city away from an automobile-oriented development path, especially if imposed early in the motorisation process. A World Bank sponsored report in 1975 recommended an area licensing scheme for the city centre (Jamilah, 1992) but this was aborted days before implementation (Spencer, 1989). Authorities in Malaysia and in Kuala Lumpur have repeatedly announced that 'car-pooling' incentives or central-area traffic restraint would follow completion of mass transit systems (Abdullah, 1995). However, each time the conditions were met the restrictions have been postponed. The latest draft structure plan for Kuala Lumpur (City Hall Kuala Lumpur, 2003) again flags future city-centre demand management, partly through parking policy, but there are few signs of political will to go ahead (Bernama, 2002).

Parking in the city centre is a useful indicator of the extent to which cars are welcomed or restricted, and an important potential aspect of locking in high car use. After the 1970s traffic restraint plan was aborted, parking fees in the city centre were raised slightly but this policy was not maintained. By the early 1990s it was reported that central city parking in Kuala Lumpur was under-priced (Sir William Halcrow and Partners et al., 1994). Parking supply in Kuala Lumpur's central business districts, at 298 car-equivalent places per 1,000 jobs (Table 1), is higher than the average for Western European cities and is much higher than most other Asian cities, including the high-income Asian cities.

Can we find increasing returns or lock-in implications of these policy settings on demand management? Government agencies in the Kuala Lumpur region may eventually implement transport demand management (TDM) policies, albeit much later than originally proposed. However, the timing of such restraint is important for several reasons. For example, the political prospects for implementing demand management policies may worsen as an ever larger proportion of the population obtains a vehicle. It is also likely that the impact on the city's long-term structural

trends will be proportionately weaker than if TDM policies had been pursued at an earlier stage (cf. the experiences in Tokyo, Seoul, Singapore and Hong Kong).

Expressway network expansion

Efforts to expand transport capacity and disperse traffic (or supply-side strategies) have been the major collective action shaping urban transport in the KLMA during a period of rapid economic and population growth and urban expansion since the 1970s. Comparisons of road capacity between cities are difficult, partly due to a lack of comparable data and because comparisons of total road length per person are not easily interpreted.[3] However, expressways can provide an indicator of a commitment to high-speed, high-capacity vehicle flows. The role of expressways in entrenching high private motor vehicle use and car-oriented urban structures has been much discussed recently, especially in the growing literature on induced demand (for example, Hansen and Huang, 1997).

The Klang Valley data stand out among Asian urban areas for having a high level of expressway length per person (68 metres per 1,000 people), much higher than any other Asian city in the sample. Richer Singapore is next with 44 metres per 1000 people (Kenworthy and Laube, 2001). The rapid building of expressways in the KLMA since the late 1980s has been facilitated by private sector involvement under build-operate-transfer concessions (Gomez and Jomo, 1997). Although the length of expressway per person is well below levels in most US cities (where figures of 100 to 200 metres per 1,000 persons are common), the spatial density of the Klang Valley's expressway network, at 3.9 metres per urban hectare or an average grid spacing of about 5 kilometres, is higher than those found in the US cities, where San Francisco has the highest at just over 3.0 metres per urban hectare. Expressway network density in the Klang Valley is similar to those in many Canadian and western European cities and several of the wealthier Asian cities.

Evidence for automobile-oriented urban structures

Interactions between urban structure and transport patterns are complex and the extent of causality often contested, but these interactions have been seen as key mechanisms for automobile dependence. Many aspects of urban structure are considered to be influences on demand for transport modes (and at the same time can arise as responses to certain transport patterns) but the most widely cited are urban density;

3 Cities vary relatively little in their road network densities (Ingram and Liu, 1997; Barter, 2000), meaning that road length per person would automatically be inversely proportional to urban density and is therefore not a clear independent measure of policy commitment to road investment.

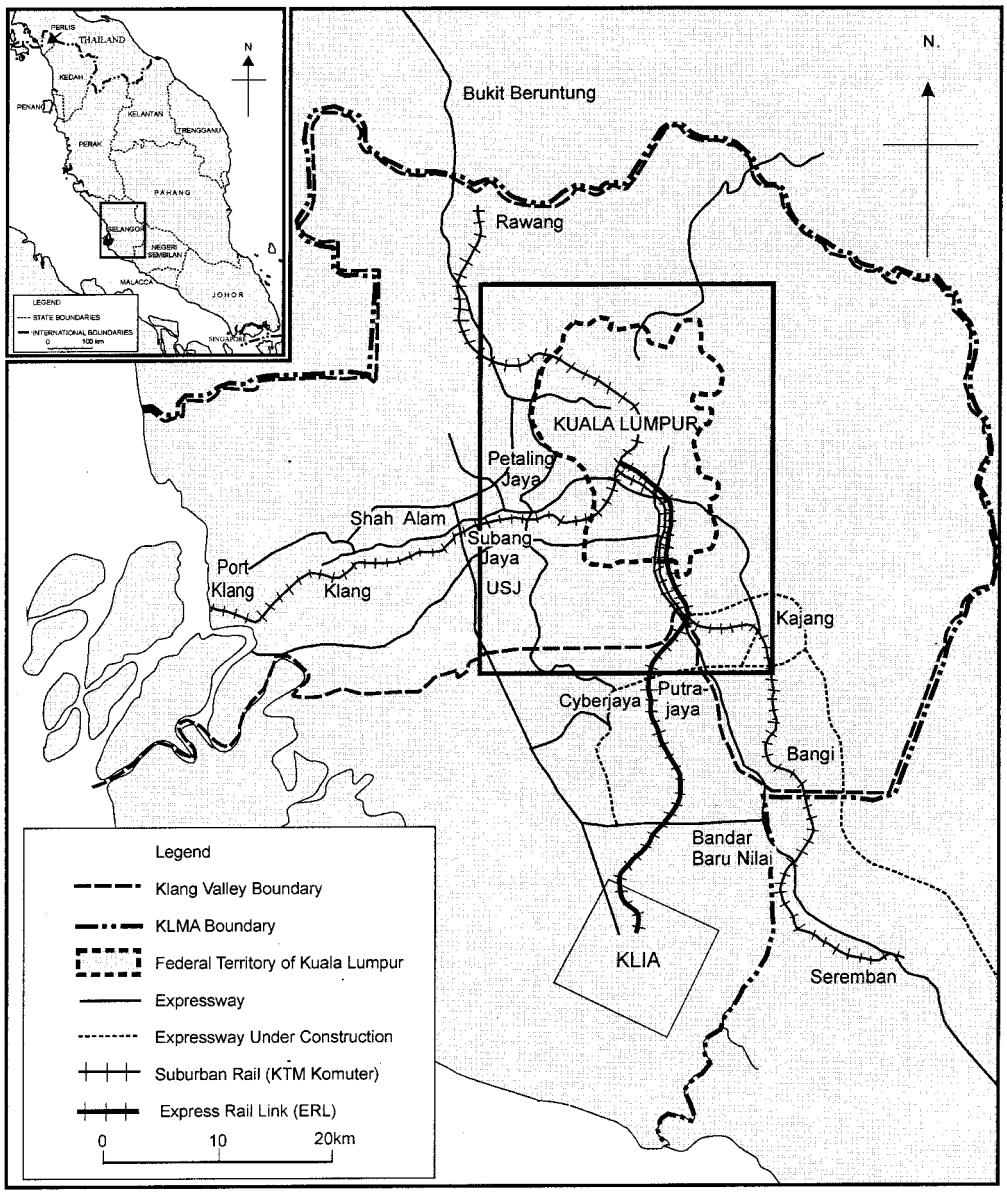

Figure 1 Map of the Kuala Lumpur Metropolitan Area, showing major transport infrastructure

the nature and distribution of centres of activity; city size; and the degree of land-use mixing versus segregation (Cervero, 2002; Newman and Kenworthy, 1999).

The KLMA, as represented by the Klang Valley data, has a relatively dispersed

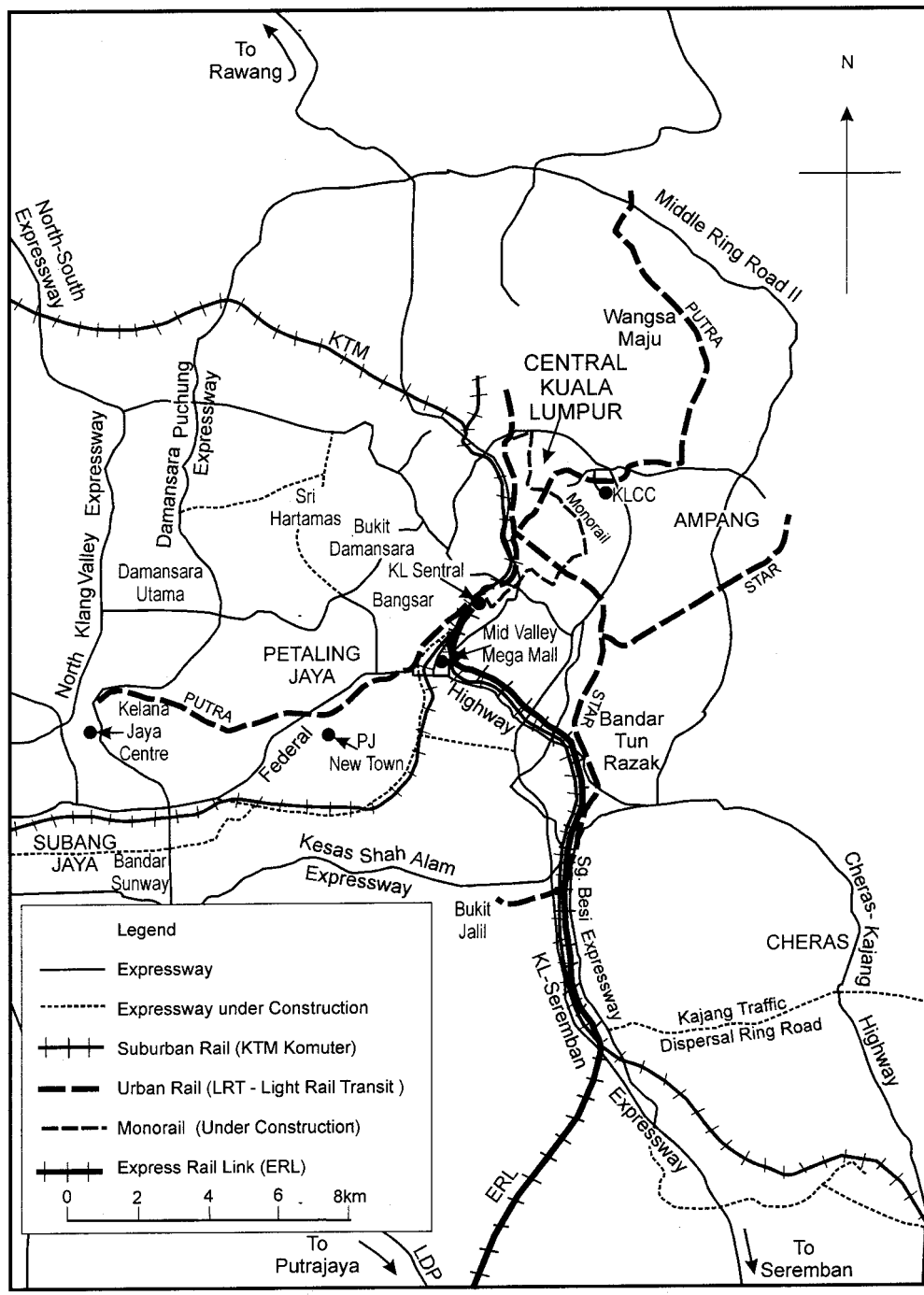

Figure 2 Map of the central part of the Kuala Lumpur Metropolitan Area, showing details of transport infrastructure

and far-flung urban structure with a low–medium population density overall, the lowest of the Asian cities in the database used in Table 1. With 58 persons per urbanised hectare, it is close to the average for the western European cities. Nevertheless, it is far from the extremes of low density found in the USA and Australia, where densities of less than 20 per hectare are typical. The recentness of much of the KLMA's urban growth is significant for the transport-influenced aspects of its urban development patterns. As recently as 1970 the population of the conurbation was less than a million people. The next three decades saw rapid urban development in a context of poor public transport, rapidly increasing private transport and major road investments.

Sub-centre characteristics that are said to reinforce car use include low employment densities, a dispersed internal layout, plentiful parking and convenience to major highways, whereas intense sub-centres focused on public transport interchanges and with limited parking tend to reinforce the role of public transport (Bernick and Cervero, 1997). Kuala Lumpur's central area reflects the fact that, until recently, access was dominated by cars, motorcycles and buses in mixed traffic. Its employment density is low by international standards (Kenworthy et al., 1999) with employment spread along several roads and into several sub-centres near major road intersections. Other major urban developments are increasingly being located in close proximity to major expressway interchanges or exits. With very few exceptions recent 'big box' shopping centres and hypermarkets have such locations. Prominent recent examples include Mid Valley Mega Mall; Sunway Pyramid in Bandar Sunway; One Utama and nearby Tesco in Damansara Utama; Makro at Shah Alam; Summit in the USJ area; and Carrefour at Bukit Jalil. A recently announced policy no longer to approve hypermarkets near established town centres (in order to moderate retail competition) will actually promote the trend for such developments to locate in automobile-oriented sites.

Urban expansion has been based substantially on planned townships or new towns that have been privately and/or publicly developed in a style adapted from the British post-war new towns model (Lee, 1987). They are somewhat car-oriented in their layout and their centres of activity rarely coincide with public transport nodes. Prominent examples include Petaling Jaya (the first, begun in the 1950s), Shah Alam, Subang Jaya, its extension USJ, Putrajaya, Cyberjaya (see Fig. 1) and almost 40 others (Dasimah, 2001). The influence of expressways on the locations of many new townships can also be seen clearly, such as a series both north (including Bukit Beruntung) and south (such as Bandar Baru Nilai) of the previously built-up area and close to the North–South expressway that was built in the early 1990s (Fig. 1). Successive townships or housing estates often tend to be built with little attention to local connections to their immediate neighbours. This results in a rather impermeable landscape which forces even short trips onto the main road. It also hinders efficient bus routing. However, it should be noted that some key features go against the trend of entrenching

high private vehicle use. Malaysian new towns are generally developed at much higher residential densities and with lower parking and road provision than in suburban USA or Australia, which may restrict the amount of traffic that they will be able to cope with.

Decline in the role of public transport

The percentage of trips by public transport modes in the Klang Valley has dropped from 37 per cent in about 1970, to 33 per cent in 1980, and 32 per cent in 1990, followed by a precipitous drop to only about 10 per cent in 1997 (Kenworthy and Laube, 2001). Public transport use in the KLMA is thus now comparable to the levels found in the relatively automobile-dependent cities of Australia and Canada and even some US cities.

The elimination of the minibuses from the main Kuala Lumpur/Petaling Jaya conurbation (the heart of the Klang Valley and KLMA) in several quick stages of revoking licences during 1995/96 had a particularly disastrous effect. The 'unincorporated' minibuses, run by small entrepreneurs, had been introduced in the 1970s to complement the stage buses, and by 1990 had come to play a significant role, carrying about 25 per cent of public transport passenger kilometres (Rimmer, 1986; Kenworthy et al., 1999). Their hasty elimination led to a sudden drop in capacity and frequency of service (based on data compiled by the author for Kenworthy and Laube, 2001). Intrakota, the company supposed to replace the minibuses, failed to come close to matching their level of service, and rail traffic remained insignificant at that time. Lock-in arises here, even in the short term: such a drop in public transport can become entrenched since, for individuals, abandoning public transport is often linked to the purchase and habitual use of a private car along with other lifestyle changes (G rling and Axhausen, 2003).

Buses are also vulnerable to traffic congestion but although bus priority has been tried several times in Kuala Lumpur it has not been strongly pursued. A busway (the Pudu Busway) was recommended by a 1970s World Bank project but was not implemented. This might have helped entrench a higher role for public transport in Kuala Lumpur before motorisation took a strong hold. Kuala Lumpur briefly had a trial of bus lanes on one major route (Jalan Ipoh) in the early 1980s but this lapsed due to lack of enforcement (Jamilah, 1992). In 1997 bus lanes were introduced on key roads in Kuala Lumpur; however, all but a small number of successful sections have since been dropped. The latest Draft Structure Plan for Kuala Lumpur does not mention on-road bus priority (City Hall Kuala Lumpur, 2003).

A further well-entrenched cause of poor public transport for the KLMA, particularly with regard to buses, is the institutional framework (Sabariah, 2001). No single agency is responsible for public transport for the whole metropolitan area. Since the

early 1970s, permits for bus routes and taxis have been regulated by the Commercial Vehicle Licensing Board (CVLB) under the Ministry for Entrepreneur Development. The criteria used relate primarily to business viability and the impact on rivals rather than integrated transport planning principles (Sabariah, 2001). Public transport generally also fails to serve new urban extensions quickly since there is no regulatory mechanism to ensure this. This is a major problem in this rapidly expanding urban area, since it helps to entrench the use of private vehicles among new residents.

Expansion of the rail network

The very rapid expansion of the rail network in the KLMA since the mid-1990s is an important trend that, at first glance, goes against the private vehicle tide and should help to lock in the use of alternatives. In 1994 there was no passenger rail service within the metropolitan area. By 2003 there was a system of about 272 kilometres of electrified double-tracked service in five major systems (KTM suburban rail, STAR LRT and PUTRA LRT, ERL to the airport, and KL Monorail[4]) as shown in Figures 1 and 2.

Mass transit systems are often seen as playing a key role in helping a city to move away from automobile-oriented trends (Allport, 1995; Newman and Kenworthy, 1999). There is debate over the importance of mass transit relative to other complementary initiatives, such as TDM and transit-oriented development patterns. Rail investment is an important step but may not be sufficient alone to transform the overall trend (particularly if it comes late in the motorisation process) in the absence of complementary transport and planning policies, and when mass transit is expected to serve an already dispersed urban structure. A number of important mass transit investments, such as in Washington, DC, the San Francisco Bay area and Perth, Western Australia, though relatively successful in themselves, have apparently failed to make a significant difference to an otherwise automobile-oriented development trajectory (Cervero and Landis, 1997 and based on evidence in Kenworthy and Laube, 2001).

In the KLMA we find that rail does now apparently account for about half of all public transport use (Mohamed Azman, 2003). The rail investments may well have arrested the decline in public transport usage but, in the absence of any significant complementary or supportive measures and with the bus system continuing to languish, public transport's modal share remains very low. Furthermore, it has been argued that the rail systems completed so far lack sufficient capacity to stave off central congestion for long (Tai, 1994). There are also recent signs of a more cautious approach to major infrastructure projects, associated in part with the change in leadership from

4 However, as of 1997, which is the year for most of the data in Table 1, only the KTM system and the first 12 km phase of the STAR system were in operation.

Dr Mahathir to Abdullah Ahmad Badawi, making further expansions of the rail system unlikely in the near future.

It has been argued that 'suburban'-style mass transit systems may actually complement suburbanisation and automobile dependence (or at least not go strongly against it) but merely help maintain the viability of the city centre (Cervero, 1997). The distinction is not always clear-cut but in Kuala Lumpur the KTM suburban system and the airport rail system could be described as more 'suburban', while the PUTRA LRT and monorail systems are more 'urban' and the STAR system falls somewhere between.

Path dependence can be seen in the unfortunate timing of the opening of most of the mass transit projects in the late 1990s. This coincided with economic crisis and came at a nadir in bus use, after motorisation had reached high levels and after two decades of rapid urban development had created a substantially car-oriented urban fabric. This inauspicious timing is also a result of the lack of complementary policies, most importantly the failure to restrain motorisation or vehicle use.

Unfortunate rail design features

The potential of mass transit in the KLMA is hindered by a number of poor design features of the rail systems themselves, possibly resulting from inadequacies in the relevant governance arrangements. These include failures in physical integration between lines and poor accessibility of stations. Currently single-ticket travel on more than one system is not possible, although this should soon change (Barrock, 2001). In its physical layout the new central rail hub, KL Sentral, allows relatively easy transfers between KTM's suburban rail (and KTM's intercity services) and PUTRA LRT (see Fig. 2). However, the monorail station (to open in 2003) terminates about 400 metres short of the KL Sentral complex, and users will have to negotiate stairs and cross a road and a large open-air car park to make a transfer to other systems at KL Sentral. Other interchange stations tend to have significant barriers to easy transfers. Many stations, especially those of KTM and STAR, also suffer from poor accessibility. Stairs have to be negotiated in order to reach or move within almost all of these stations. Most KTM suburban rail stations were designed to be approached from only one side, resulting in repeated illegal fence cutting to create short cuts.

Lack of transit-oriented development

With few exceptions, all of the rail systems suffer from poor integration with land-use patterns and have poor alignments and station locations in many places. The KLMA has numerous examples of missed opportunities for transit-oriented developments. The rail systems generally follow low-cost or historical rail alignments and as a result

miss many important activity centres that lie within their respective corridors. For example, the PUTRA system, which overall has one of the better alignments, misses important centres such as Petaling Jaya New Town, Kelana Jaya Centre and the Mid Valley Mega Mall. This final case is striking. Having opened in late 1999, it exploits a strategic location in terms of expressway access and centrality but fails completely to exploit mass transit lines passing close by. A few examples of transit-oriented development are beginning to emerge, such as the KL Sentral development around the central rail hub, but these represent only a very small trend that runs counter to a tide of private vehicle-oriented development. The recent Draft Structure Plan for Kuala Lumpur in 2003 flags a new policy of promoting high-density land uses around rail stations (City Hall Kuala Lumpur, 2003) but future transit-oriented nodes may find it difficult to become established in competition with established sub-centres. Again, timing appears to have been important.

Is the KLMA 'building in' future traffic saturation?

I have argued so far that in seeking to cope with traffic saturation, the urban structure and transport systems of the KLMA are showing signs of locking in various trends that contribute to increasing private motor vehicle use. Thus, although it is not yet thoroughly automobile dependent, there is strong evidence of automobile-dependence processes at work. However, a closer look at the urban fabric that is emerging may prompt a slight rethink. We have seen that the KLMA has many features that depend on, and even foster, significant private vehicle access and that the urban fabric is not friendly to public transport and non-motorised transport. Nevertheless, it may not be well adapted to high rates of private car ownership and usage either. This subsection suggests that choices in the KLMA may be entrenching the 'worst of both worlds', which will leave it vulnerable to more severe traffic saturation and yet facing enormous problems encouraging the major alternatives (Fig. 3). It is speculated that motorcycles play a role in allowing these patterns to emerge.

The KLMA has large swathes of urban development dominated by two-storey terraced houses together with a scattering of apartment blocks and flats, resulting in urban densities remaining at around 60 persons per hectare overall, despite the continued spread of the urban area. Based on international comparisons, the KLMA's density would be incompatible with a 'full motorisation' scenario without heroic investments in an expanded, probably multi-level, road and parking infrastructure. Road network density (or capacity per urban hectare) can only be increased so much (Zahavi, 1976) and therefore the KLMA's middle density would tend to limit its road length and main road length per person to moderate levels (Barter, 2000). Nevertheless, much could probably be done to expand road network capacity, but at a potentially high price in terms of the local impacts of higher levels of traffic per urban

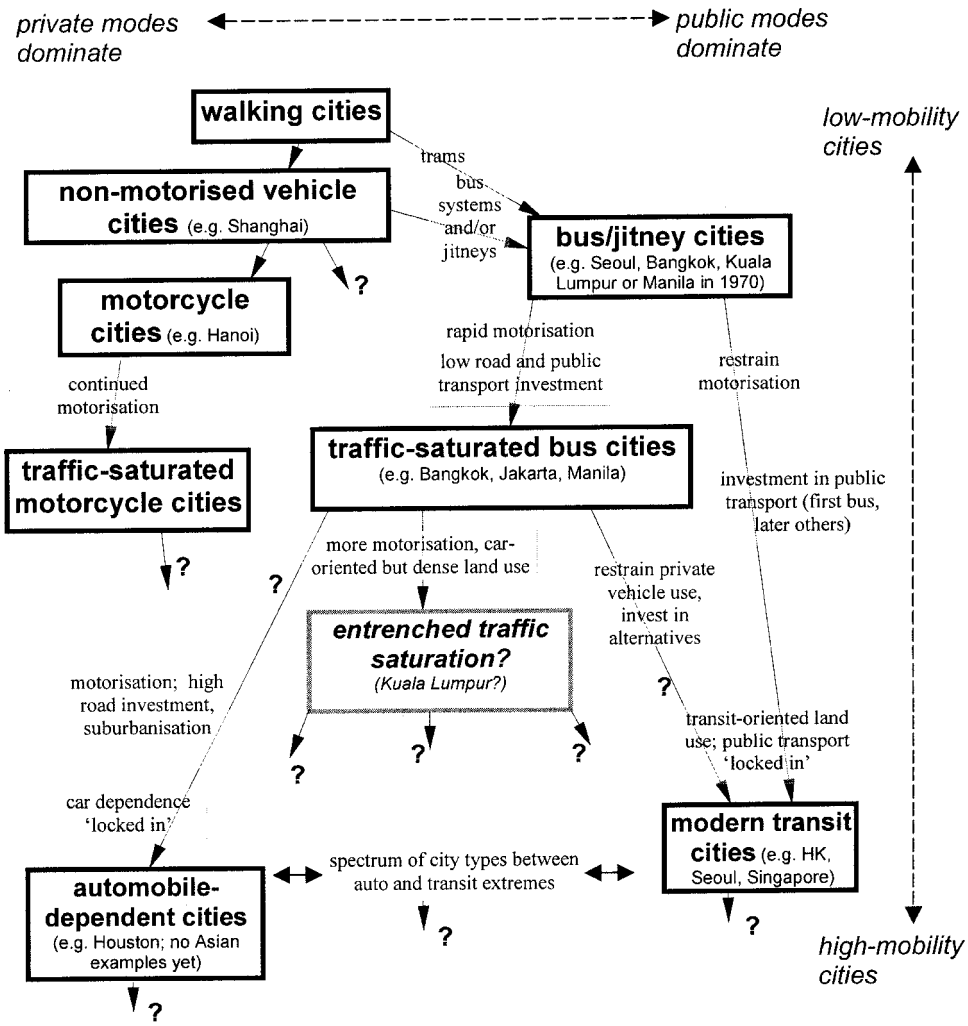

Figure 3 A simple generic model of urban transport and urban structure development scenarios in developing Asian cities

hectare (for example, increased air pollution). Further major infrastructure expansion will inevitably involve significant displacement, especially of those with insecure tenure, who have already suffered disproportionately from evictions for transport infrastructure in the KLMA (Barter, 2002).

Typical new-town street designs and housing plot layouts also quickly render parking problematic, for example in affluent areas such as Petaling Jaya and Subang Jaya municipalities where car ownership has risen well past one per household on

average. Even the latest new towns are apparently being planned for urban densities that are considerably higher than a fully car-oriented pattern would demand. The new administrative centre of Putrajaya, whose low density is often highlighted in promotional material, has a planned eventual overall gross density of up to 70 persons per hectare (with 330,000 or so projected for the 4,580 hectare site) (Putrajaya Corporation, 1997).

In numerous developments and districts throughout the KLMA we can find a mismatch between density and access arrangements. Many high-intensity developments have design details that are oriented towards access by private motor vehicles. For example, there are highly car-oriented access arrangements and poor public transport links to many high-density apartment block districts such as in Sri Hartamas or Bangsar, to the massive Mid Valley development and to the office concentration at Bukit Damansara. Even low-cost flats are frequently located far from the main routes served by public transport. Many areas are thus too dense to be comfortable with very high car use, yet in their design details and in their loosely connected locations they are too car-oriented to make the provision of alternatives straightforward. The combination of many medium- or high-density, but car-oriented and loosely connected, neighbourhoods would suggest a looming traffic disaster. Ironically, trends in the KLMA may be entrenching high car use through many aspects of its structure while other aspects resist adapting fully to cars. The KLMA is spreading out but not sufficiently to accommodate fully very high car use. Further dispersal and infrastructure expansion may be possible but only with continued rapidly rising wealth and huge investments.

The role of motorcycles in this phenomenon is worth noting and investigating further (both here and in many other Asian cities where motorcycles are prominent). Their significant role in the KLMA may help to explain how relatively dense urban patterns can remain viable. Motorcycles complement cars in providing access within an urban fabric that is simultaneously lacking a strong role for public transport, is private-vehicle oriented in its scattered layouts and urban design features, and is more intensely developed than could comfortably be served by cars alone. Malaysia's small motorcycles are highly space-saving, in their parking requirements but also in congested on-road conditions when they are able to pass between lanes of stalled or slow-moving four-wheeled vehicles. However, what this means for the future may be problematic, especially if affluence leads to a rapid replacement of many motorcycles with cars without the possibility of equally rapid renovation of the urban fabric to either adapt to cars or better promote the alternatives.

Conclusion

This paper set out to apply an evolutionary perspective to the study of the land use and transport system of the KLMA. It used a concept of automobile dependence that emphasises the path-dependent nature of the phenomenon and attempted to investigate evidence for any automobile-dependence trend in this particular urban area. A path-dependence perspective emphasises a tendency for policy choices and major investments to send cities down irreversible development paths. It also prompts greater attention to the timing of policy interventions, it being easier to try to avoid entrenching automobile dependence than to attempt to 'reverse' such a process.

It was found that the KLMA could not yet be considered significantly automobile dependent and that 'moderately traffic-saturated' might be a better description. Traffic saturation arising from the rapid growth of motorisation is not surprising and can be seen in more extreme form in several other large Asian cities with urban structures that are even more ill-suited to cars. Nevertheless, strong signs of automobile-dependence processes were evident and seem set to gradually entrench higher private motor vehicle use in the KLMA. The beginning of a trend towards automobile dependence is more surprising than traffic saturation in an Asian context and in a newly prosperous middle-income urban region.

Most interesting (and worrying) perhaps is the incompatibility observed in the final section. In the KLMA there are heavy investments in car-oriented mobility and trends in line with an automobile-dependence scenario. Many new urban design features are hostile to non-car alternatives, and yet the region is *also* developing at densities and with concentrations of activities that seem incompatible with much higher rates of car ownership and usage. This seems to be a recipe for an intractable traffic crisis. Nevertheless, the city is currently coping relatively well (frequent traffic jams notwithstanding) perhaps as a result of the safety valve offered by the significant role of small, space-saving motorcycles in providing access to congested locations and at congested times.

One way to look at this is to view traffic saturation itself (rather than automobile dependence) as becoming entrenched or locked into the urban structure of the KLMA. This interpretation sees traffic saturation here as arguably more profoundly locked-in than in cities such as Bangkok or Manila. It suggests that it may actually become a more intractable problem in the KLMA than elsewhere. In this view, the KLMA is well on the way towards entrenching a high role for both cars and motorcycles, with an urban fabric that is relatively dense and yet remarkably hostile to public transport and non-motorised transport.

The transport predicament and desirable policy responses for KLMA decision makers are distinct from those in the more highly automobile-dependent cities of North America or Australia and certainly from transit-oriented cities in Asia or

Europe. Its experiences are perhaps most relevant to traffic-saturated cities in Asia and elsewhere, although the KLMA appears to have gone further down a path towards entrenching private vehicles than many other cities with similar levels of income. Kuala Lumpur's experiences may be relevant for the policy choices that face other cities in middle-income countries, particularly smaller and intermediate-sized cities that have moderate urban densities, already lack significant public transport and depend heavily on motorcycles.

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Acknowledgements

Most quantitative data on the Klang Valley presented in this paper were gathered by the author through participation in two major collaborative projects based in the Institute for Sustainability and Technology Policy (ISTP), Murdoch University. Data-sets from these have been published as Kenworthy et al. (1999) and Kenworthy and Laube (2001). Data from many of the other cities were gathered by other members of these teams, notably Jeff Kenworthy, the team leader, Felix Laube, Michelle Zeibots, Gang Hu, Momoko Kumagai, Tamim Raad, Chamlong Poboon, Benedicto Guia (Jr) and Antonio Balaguer. Financial support and collaboration came from the International Union (Association) of Public Transport (UITP) in Brussels for the 'Millennium Cities Database for Sustainable Transport' project. Additional investigation while at the National University of Singapore (NUS) has been funded through NUS research grant R-109-000-035-112. Special thanks should go to Jeff Kenworthy, who helped spark the thinking that led to this paper with his observation that Subang Jaya seemed to be a 'traffic time bomb'. I am grateful to Lee Li Kheng for his cartographic work. Thanks also to Craig Townsend and two anonymous referees for very valuable suggestions and comments. Finally, thanks must go to the many people in Malaysia and worldwide who cooperated by providing data and assisting with innumerable requests for clarification and follow up, to ensure that all data were of the best available quality.