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The Influence of Macroenvironment Forces on Road Transport Sustainability: The Case of Malaysia

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Introduction

Amid growing interest in finding sustainable solutions to global issues, sustainable road transport has become a growing area of interest in practice and research. This is evidenced by an increasing number of initiatives around the world to define and measure sustainable road transport systems, especially in terms of planning and infrastructure (Jeon 2005). The growing significance of road transport sustainability goes alongside major issues that need to be addressed: large increases in traffic demand, poor control of vehicle emissions, lack of adequate and appropriate infrastructure, and poor coordination of transport and land use policies (Hayashi et al. 2004).

Macroenvironment refers to the larger societal forces that affect the whole microenvironment of an industry (Kotler et al. 2006). These forces are political, economic, social, technological, and environmental in nature. World Bank proposed economic, environmental, and social forces as the elements of the concept of sustainability. Policy actions and technological opportunities are the other key drivers of transport sustainability (Tegart and Jolley 2001).

Malaysia's significant economic growth in the past decades has led to urbanization and rise of per capita income. Rising income leads to increase in vehicle ownership (Button and Nijkamp 1997). Individuals with higher disposable incomes are more likely to shift to personal transport than continue to rely on public transport. This is true of Malaysia, where the number of vehicles increased from 5 million in 1991 to 19 million in 2009, with an average annual growth of 8 percent. The volume of vehicles even outpaced population growth. Car ownership posted the highest increase of about three times from 98 to 300 units per thousand population during this period, followed by two-wheelers, the volume of which rose 2.3 times (140 to 316 units per thousand population). Ownership of public transport in Malaysia is extremely small compared to personal vehicles, with only six public motor vehicles per thousand population as of 2009 (Mustapa et al. 2011).

Although Malaysia ranks higher than other Southeast Asian countries in overall transport infrastructure quality (World Economic Forum 2011), extensive efforts are still required to improve its public transportation system. The lack of efficiency and reliability of public transportation system in urban areas has failed to attract road transport users and worsened traffic situations in the cities. Besides, there are too many agencies and companies involved in providing public transport, thus posing constraints to having integrated public transportation systems (Sadullah n.d.). The 10th Malaysia Plan (2011-2015), by the Economic Planning Unit (EPU), highlights four key thrusts aimed at developing a people-centric public transport system:

- Driving regulatory and industry reforms;
- Increasing investments in transport capacity to keep pace with urban growth;
- Promoting a seamless system across modes and operators; and
- Establishing a robust monitoring and enforcement regime.

The Malaysian government formed a new Land Public Transport Authority in June 2010 to reform the country's transport system (National Economic Advisory Council Report 2010). This agency was tasked to develop and monitor the implementation of a 20-year National Land Public Transport Master Plan, which aimed to provide a more integrated and efficient transportation system. The government also drafted the Kuala Lumpur City Plan 2020 to transform the capital into a world-class city, one of the features of which is an environmentally friendly transport infrastructure that takes into account people's road safety and comfort and use of road space. The plan includes the adoption of a model share of 50:50 between private and public transport for all trips in major urban centers with better integrated public transportation systems and pedestrian-friendly cities. However, the results of these sustainability plans have yet to be seen.

Although there is a growing literature on transportation sustainability, there is yet no standard framework for evaluating transportation sustainability. However, there seems to be consensus that progress must be made in at least three areas: economic development, environmental preservation, and social development (Environment Canada 1991, 2003; Litman 2003; Jeon and Amekudzi 2005). Still, the concept of sustainability of transport systems must go beyond these three areas (Janic 2006).

This research seeks to develop a measurement model for transport sustainability by examining the effects of macroenvironmental forces—political, economic, demographic, cultural, technological, and natural— and utilizing data from major cities in Malaysia. The study specifically aims to:

- Evaluate the key macroenvironmental factors that lead to transport sustainability;
- Examine the relationships between the macroenvironmental forces and transport sustainability; and
- Test the fitness of the model developed.

This study acknowledges that one of the requirements of sustainable transportation is greater reliance on public transport in urban areas and a reduction of personal automobile use (Geerlings 1999; Wadhwa 2000: Patrick and Roseland 2005). Against this backdrop, it focuses on the public transportation system in Malaysia.

Recent studies on transport sustainability focused only on three forces—economic, social, and environmental. This study looks at a broader scope by examining other forces like technological, demographic, and political factors. Although limited to Malaysia, this research should be useful as well to other countries in East Asia, which are generally highly populated and congested, and therefore need a suitable model for transport sustainability. East Asian countries' populations, geographical features, density, culture, environment, and technology are not vastly different from one another. In this regard the results of this study should be applicable to the region in contrast to those of existing research on transport sustainability, which focuses on Western countries, particularly, Europe, North America, Australia, and New Zealand.

The study is especially important to policymakers, particularly Malaysia's Ministry of Transport, specifically its and Road Transport Department, in developing plans and strategies for a more sustainable and people-centric transport system. A better understanding of the sustainability dimensions, namely, social, economic, nature, and demographic, political and technological forces, will be useful for future planning and development of sustainability measures.

The following sections consist of a literature review and discuss identify the relevant factors that affect transport sustainability. Next, we discuss the procedures used to generate and select scale items in the pilot and main studies. Then we assess internal consistency, validity, and statistical results of the study. Finally, we discuss the implications of the final scale to both practitioners and researchers.

Literature Review

Definition of transport sustainability. There is no universally accepted definition of sustainability, sustainable development, or sustainable transport (Beatley 1995). However, the overall concept of sustainable development is one that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission 1987) and necessarily includes "the capacity for continuance into the long term future." More specifically, anything that can go on being done on an indefinite basis is sustainable, and anything that cannot go on being done indefinitely is unsustainable (Center for Sustainability 2004).

The Transportation Association of Canada (Patrick and Roseland 2005) defines a sustainable transportation system as one that:

- meets the access needs of the present generation
- allows future generations to meet their own access needs
- is powered by renewable (inexhaustible) energy resources
- does not pollute air, land or water beyond the planet's ability to absorb/cleanse, especially carbon dioxide (CO2)
- is technologically possible
- is economically and financially affordable
- supports a desired quality of life
- supports local, national and global sustainable development goals

***Macroenvironmental forces*.** Macroenvironment refers to the larger societal forces that affect the whole microenvironment of an industry (Kotler et al. 2006). These forces were evaluated in specific literature and are discussed below.

Infrastructure investment enhances road accessibility, which in turn provides the engine for potential increases in economic activity, realized mainly through employment and productivity increases. However, levels of accessibility in developing countries are not high enough compared to those of developed countries. The 2010 World Economic Forum report highlights the strong correlation between infrastructure connectivity and global competitiveness index. This implies the importance of building a reliable and efficient transport infrastructure network, especially in developing and emerging Asian economies. Moreover, various studies have shown that the quality, effectiveness, and extensiveness of infrastructure networks greatly impact economic growth and reduce income inequalities and poverty (ADB/ADBI 2009).

Transport connectivity is a basic necessity for developing economies to sustain growth. Although transport infrastructure connectivity has improved across large parts of Asian economies, much more investments are needed to enhance cross-border and intraregional flows of trade and investment (Bhattacharyay 2011). One of the major challenges to transport sustainability is to mobilize available resources to finance infrastructure projects. South Asian countries are expected to see major infrastructure investment needs being diverted to the transportation sector. Transport investments in Malaysia account for 30 percent of total infrastructure investments in the country (Bhattacharyay 2011). Net gains from transport connectivity are intrinsically linked to investment. Zhai (2009, ADB/ADBI 2009) mentions the benefits of creating national and regional infrastructure for transport connectivity, in developing countries in Asia like Thailand, Vietnam and Malaysia.

There is a strong consensus that transport infrastructure development is linked to economic growth, and this relationship has been widely used to justify the allocation of funds to the transport sector. Banister and Berechman (2000) affirm such a link, saying that in developing countries and cities, the relationship does exist and is quite clear.

Based on the foregoing, we propose the following hypothesis:

H1. *Economic forces have a significant positive impact on transport sustainability.*

Environmental forces. Rapid urbanization, coupled with an unprecedented growth in personal motorized transport, is strangling the economic vitality of many Asian cities. Private ownership of cars is on the rise in Malaysia. National transportation policies have consistently been geared toward meeting the ever-increasing demand for road space by private vehicles. The Malaysian government has targeted the motor vehicle industry as a key economic growth sector and has actively promoted private car ownership. It is therefore hardly surprising that traffic congestion has worsened in major urban centers in Malaysia such as Klang Valley Region. This trend is moving away from sustainability. As a result, health and the environment now bear the brunt of the deleterious impact of vehicle emissions. In 2009 the International Energy Agency reported that the contribution of the transportation sector to carbon dioxide per-capita emissions was significant in Asian countries. Respiratory and other diseases related to local air pollution in developing countries contributed to the premature deaths of at least half a million people each year, imposing an economic cost of up to 2 percent of gross domestic product (Gwilliam et al. 2004).

Efforts toward economic development should always take into account constraints imposed by nonrenewable resources and the absorptive capacity of the environment for different types of burdens. Spangenberg (2002) considers this dimension as the sum of all biogeological processes and their associated elements. According to Litman (2003), the potential adverse impacts of a given transport system on its sustainability are air pollution, climate change, water pollution, noise, habitat damage and loss, and depletion of nonrenewable resources. Severe traffic congestion has been identified as one of the major causes of transport-related environmental problems in many Asian countries. Air quality has deteriorated due to urbanization, motorization, and inadequate control of vehicle emissions. Cities lacking rail infrastructure are forced to settle for scattered and sprawling development, resulting in higher dependence on private cars and intermediate public transport systems. Hayashi et al. (2004) attribute inadequate understanding of environmental deterioration mechanisms to the current transport-related environmental challenges. Apart from the domestic problems imposed by transport, global environmental impacts of transport are increasingly becoming a major concern (Button and Nijkamp 1997). The transport sector alone is the single most important contributor to greenhouse gas emissions. According to the World Resources Institute (2005), the sector alone accounts for 24.1 percent of carbon dioxide emissions worldwide. Evidently, prior studies have demonstrated the consequential impact of transport development on the environment. This brings us to the next hypothesis:

H2. Environmental forces have a significant positive impact on transport sustainability.

Social-cultural forces. Urbanization represented by an increment of the population living in urban areas leads to different demand for transport. Among motorists in urban areas, generally with higher incomes and living modern lifestyles, vehicle ownership is seen as a symbol of success (EIA 2000). Commuters in urban areas rely on public or commercial transport vehicles like taxicabs, passenger vans, and buses (Harwit 1995; EIA 2000). However, the increasing density of urban areas may lead to the development of public transportation systems. Malaysia has witnessed urban settlement patterns of outward growth with lower population densities, and increased demands for personal transportation. As locations of residential, work, and leisure activities have become increasingly separated spatially, mobility has increased.

Social-cultural forces affect society's basic values, perceptions, preferences, and behaviors (Kotler et al. 2006). They also influence the preference of road users, which in turn impact transport sustainability. The now-defunct Commission for Integrated Transport (2001) of the United Kingdome examined the attitudes of public transport users, pedestrians and cyclists, as well as car users. Findings show that half of the population would reduce traveling by car if the local bus services were better, a third if local rail services were better, and a quarter if local conditions for walking were better. Bonsall et al. (2005) noted that dissatisfaction with the price, safety, and reliability of public transport would affect the preferences for types of transport used. Usage of public transport is determined by the availability and quality of the services provided, that is, in terms of frequency, security, speed, comfort, convenience, and affordability (Geurs et al. 2009). The sustainable development of transport system is expected to influence the perceptions and preferences of road users. The following hypothesis is thus proposed.

H3. Socio-cultural forces have a significant positive impact on transport sustainability.

Political forces. Jeon and Amekudzi (2005) reviewed major initiatives in North America, Europe, and Oceania to address the issue of sustainability in transportation planning. This study found that most of these countries or states have indicated sustainability issues in their policies and missions. Janic (2006) said the institutional dimension is relevant to transport sustainability. Institutions such as governments and related agencies are supposed to bring various social entities and actors together to provide a holistic approach to transport sustainability. Richardson (2005) summarized five indicators of transportation sustainability: fuel, access, congestion, emissions, and safety. These indicators are greatly influenced by government policies on taxes, road design, fuel prices, availability of public transportation, and vehicle factors. According to Owens (1999), a sustainable transport policy means maximizing accessibility amid environmental constraints and that sustainable road transport must be achieved through a coordinated policy package. Government policies, therefore, have a great influence on transportation sustainability issues. This is evident in Malaysia.

Since the launch of the national car, Proton, in the 1980s, Malaysia has become one of the countries having the highest number of private car owners in the region. As an oil-producing country, Malaysia has substantial supplies of petroleum, thus enabling the government to subsidize fuel prices for many years. Thus, owning a car or another type of motor vehicle is relatively easy and cheap in Malaysia. Such a situation, however, has resulted in several transport issues, especially in cities like Kuala Lumpur, Johor Bharu, and Penang. These include increased levels of traffic noise and air pollution. It is estimated that 75 to 80 percent of the total air pollutant emission loads come from motor vehicles (Department of Environment 1994). This shows that while government policies may be good for the economy, they could also have adverse impacts on the environment.

Studies in other countries, however, show that government policies could have positive impacts on the environment. Santos et al. (2010) highlighted the importance of government policies for sustainable road transport. They said increased use of public transport combined with a decreased use of private cars could reduce congestions and carbon dioxide emissions. Several policies implemented by some governments have successfully encouraged transport sustainability. These policies revolve around two major objectives: 1) reduce road users and 2) increase usage of public transportation. London has implemented the Congestion Charging scheme, which charges private vehicles traveling at daytime in central London, thus providing revenue to improve public transport (Small 2004). As a result, there are less private vehicles in central London during peak hours while the use of public transportation has increased. Singapore, on the other hand, has implemented the Area Licensing scheme, which only allows private vehicle to pass through central business districts during nonpeak hours. In addition, the island city-state charges high ad valorem car duties and ownership taxes to halve private vehicle ownership growth. The Singapore government has also adopted a Vehicle Scrappage scheme to rid roads of inefficient high-emission vehicles. Its motorization policy has had no major adverse impacts on economic growth but has even generated substantial funds for the improvement of social welfare (Willoughby 2001). In Copenhagen, there are efforts to reduce parking spaces by 3 percent every year to discourage private vehicle usage in the city. Currently, Copenhagen is the only European capital that does not have a chronic problem of road traffic congestion (Vuk

2005). These government or city council initiatives have successfully reduced road congestion in big cities as well as private vehicle ownership.

It is estimated that 50 percent of greenhouse gas emissions in Asian cities can be traced to transport and industries (Battacharyay 2011). While the region's fast-growing economies have resulted in better trade performance, they have also spawned some environmental challenges. Thus, many Asian countries have taken proactive measures to reduce the impact of their rapid economic growth and infrastructure development on the environment. The following table presents the transport priorities in several Asia countries that promote transport sustainability.

Country	**Priorities**
China	Construction of high-speed rail networks to the tune of approx. $120 billion for 42 lines by 2012 Transport roads, especially in the interiors, to build service sector and integrate the domestic economy Increased use of natural gas as transport fuel
India	Improvement of public transport through provision of mass transit, bus rapid-transit, nonmotorized transport, and car-free transport development Improvement of transport connectivity; transit-oriented development; and comprehensive mobility plans
Korea	Adoption of a low-carbon green growth national development paradigm through adoption of green technology
Indonesia	Promotion of sustainable transport infrastructure and public transport development
Philippines	Pursuit of intermodal initiatives and shifting of road investments to regions with less density and lower road quality

Japan	Adoption of an intelligent transportation system and integrated modes of transport system Reduction of carbon dioxide emissions by improving technical efficiency; increasing modal shift from truck to rail; increasing use of water-transport; and increasing truck-load factor by 3 percent

Source: Battacharyay 2011

Some governments and transport ministries have also effectively employed policies seeking to encourage the use of public transport, to which the integration of different transport modes is also critical. Rapid urbanization and prohibitive housing costs have moved residential areas further away from the cities. As a result, many workers and road transport users require several transportation modes such as train, metro, tram, or bus to travel to their destinations on a daily or weekly basis. This situation underscores the need for an integrated public transport system. Hong Kong and Singapore have successfully integrated their transit systems around high-density urban development areas by offering integrated ticket systems. Another form of integration is park-and-ride facilities that combine private and public transport. City councils in big cities such as Bristol, Houston, and Amsterdam provide ample parking spaces for cars and bicycles to allow private vehicle owners to switch their travel modes at suburban train or bus stations.

An effective and suitable fiscal policy to improve public transportation is deemed vital to reducing car ownership, which in turn will contribute to a sustainable living environment in fast-growing urban cities. In this light, the following hypothesis is proposed:

H4. Political forces have a significant positive impact on transport sustainability

Technological forces. Transportation systems are integrated with information technologies for system operations and management (Cetin and List 2006). Information and communications technology (ICT) as a set of heterogeneous technologies (hardware and software) enables electronic communications, and data collection and processing in distributed networks to be applied at every scale of transportation system (Delponte and Ugolini 2011). Transport authorities and planners would do well to develop methods built around advancements in the ICT field and urban dynamics, and formulate appropriate transport rules.

The use of ICT and other appropriate technologies in public transportation network management systems ensures an efficient and effective movement of people and goods, and helps reduce energy consumption (Cetin and List 2006; Janic 2009). After all, transportation, energy consumption, and environmental protection are closely intertwined (Wang 2007). Per capita energy consumption declines with increased transit use (Siu 2007). The use of rail transits results in substantial energy conservation and emission-reduction benefits. This mode of public transport, known for its high efficiency and load factors, consumes about one-fifth that of automobiles in terms of energy per passenger kilometer (Litman 2004; Siu 2007). Data (Sun et al. 2009) shows that the total energy consumption for every 100 kilometers per capita of cars, buses, trains, and subways are 8.4 percent, 3.4 percent, 4 percent, and 5 percent, respectively.

The perception of urban transport as an integrated issue is (?) strictly related to land use, landscape, and energy planning (Delponte and Ugolini, 2011). The distribution of land uses, such as residential, industrial or commercial, in urban areas determines the location of human activities such as working, shopping, studying, or finding leisure. Rapidly modernizing cities in the developing world, such as Bangkok, Manila, Jakarta, and those of China, have significant car ownerships and, consequently, huge traffic problems (Newman and Kenworthy 1996). Siu (2007) said building more roads to relieve traffic congestion achieves nothing except to add more vehicles, resulting in more congestion and pollution, not to mention inefficient use of energy. The obvious solution is to implement public transport systems that enhance mobility and network connectivity. This is what transit-oriented Singapore and Hong Kong have already done. A well-coordinated city planning system with an efficient and integrated transit infrastructure cannot be emphasized enough.

Stradling and Anable (2008), and Hall (2010) pointed to the relationship between mobility, sustainability, and ICT, which is marked by the following:

- The extent and nature of new types of trips generated by ICTs through telecommuting
- Patterns of online shopping replacing, supplementing, or stimulating face-to-face purchasing
- Energy and environmental impacts of home-delivery transport use
- Modal consequences of ICT-influenced transport substitution
- Decentralization impacts on home and work-location decisions
- Degree and impact of the take-up of latent demand by other transport users

- Modifications to travel time budgets as a result of ICT-facilitated en route work, networking and recreational activities

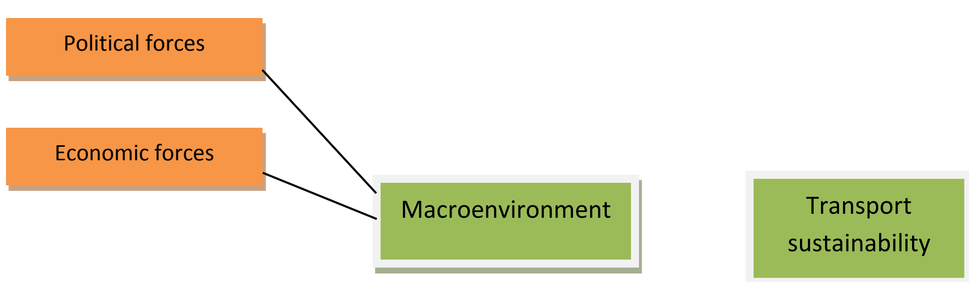
Since technologies enhance human mobility, here is another hypothesis:

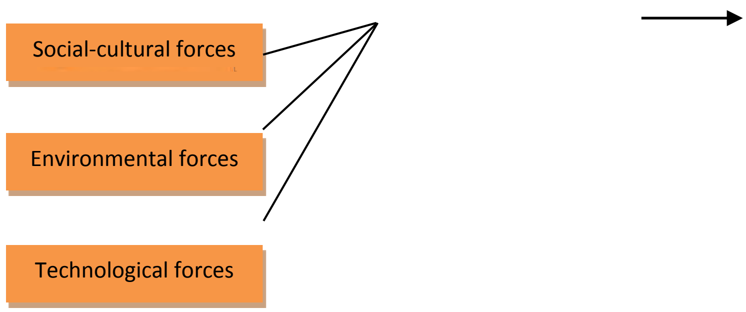
H5. Technological forces have a significant positive impact on transport sustainability

Conceptual model

The conceptual model (see Figure 1) for this study is developed based on the theoretical contributions of various dimensions of transport sustainability. Given the many definitions and forms of sustainability, this study applies the definition of the Transportation Association of Canada (TAC) for sustainable transport system (Patrick and Roseland 2005). TAC states that future road transportation development should move toward a system that allows the basic access needs of the individual, does not endanger human health and the environment, does not compromise the ability of the future generations to enjoy equal or better quality of life, is affordable, operates efficiently, offers choice of transport mode, limits pollution emission and waste, minimizes consumption of nonrenewable resources, reuses and recycles its components, and minimizes the use of land for construction of transportation infrastructure.

Figure 1: Conceptual Model





A linear multiple regression model is constructed and performed to investigate the explanatory power of the predictor variables. The model seeks to test the associations between the five macroenvironment forces and transport sustainability. The following model is estimated as below:

$$TS = \beta_0 + \beta_1 ECON + \beta_2 ENVIRON + \beta_3 SC + \beta_4 POL + \beta_5 TECH + \varepsilon \,,$$

where TS_{jt} is transport sustainability; *ECON* is economic forces; *ENVIRON* is environment forces; *SC* is socio-cultural forces; *POL* is political forces; and *TECH is technological forces.*

Methodology

The survey instrument (i.e., self-administered questionnaire) used for this study consisted of three sections: a) respondents' demographic data (9 questions), b) macroenvironment forces (measured by 30 items), c) and concepts of transport sustainability (measured by 10 items). The items were assessed on a five-point Likert scale, consisting of the following: 'strongly disagree?' (1); 'disagree?' (2); neither agree nor disagree?' (3); 'agree' (4); 'strongly agree?'(5).

To increase conceptual equivalence, as well as to test the clarity of the questions and determine the length of time it would take the respondents to answer all them, the questionnaire was pilot-tested on a convenience sample of 30 road users (Chen 2001). The results showed that the respondents found the questions simple enough, and that the questionnaire could be complete in an average of five minutes. A Cronbach's alpha for the total instrument was conducted to test the internal reliability of the 45 items on the questionnaire taken as a whole. A Cronbach's coefficient alpha for raw score variables for the total instrument was 0.9.

Sample and data collection

The population of the study consisted of road users, particularly passengers of public road transport from Subang Jaya, Kuala Lumpur, and Klang. These cities were selected due to their high population density (each with a population exceeding 1 million in 2010) and well-developed public road transport systems. A total of 350 questionnaires were distributed randomly in shopping malls, colleges, and night markets. Of this figure, 324 questionnaires (93 percent) were usable as 26 questionnaires were incomplete.

Data Analysis

The 324 questionnaires were used for the final analysis. Structural equation modeling (SEM) was employed for confirmatory factor and path analyses. The two-step approach recommended by Anderson and Gerbing (1988) was followed. Initially, reliability and validity of the measurement model were analyzed. Cronbach's alpha coefficients were used to examine the internal consistency of the items. Then a confirmation factor analysis (CFA) with Amos Graphic software for the measurement model was performed. In the second step, a structural equation modeling was developed to assess the statistical significance of the proposed relationship between constructs. Hooper et al.'s (2008) recommended SEM reporting was adopted, specifically reporting deviance (model chi-square), its degrees of freedom, and its p value, along with RMSEA (Root Mean Square Error of Approximation) and its associated confidence interval, SRMR (Standardized Root Mean Square Residual), CFI **(**Comparative fit index) and a parsimony measure such as PNFI (Parsimony Normed Fit Index). These model fit criteria were selected, being the least sensitive to sample size, model misspecification, and parameter estimates.

Findings

Respondents' Profile

The sample consists of an almost equal proportion of male (52.8 percent) and female (47.2 percent) respondents. The majority of the respondents are 18 to 35 years old (70 percent) and have a monthly income of less than RM3,000 (70 percent). Nearly 63 percent of the respondents spend less than RM50 per month on public transport whereas 69 percent of them spend less than RM250 monthly on gasoline. A total of 89 percent of the respondents travel less than 100 kilometers daily. This shows that most of the respondents stay close to their places of activities, namely, commercial centers, workplaces, and public facilities. The profile of the respondents is provided in Table 1.

Descriptive statistics

The descriptive results of transport sustainability and five macroenvironmental forces are presented in Table 1. The average level of transport sustainability among the respondents is 4.39. The highest contributory factor affecting sustainability is *pollution emission*, which recorded a mean of 4.59. The factor that least influences sustainability is *use of land for construction of transport infrastructure*, which has a mean of 4.20. Among the five macroenvironmental forces, social forces elicited the least reaction among the respondents, with a mean of 2.89. The respondents' reaction to environmental forces is relatively stronger, with a mean of 3.75, followed by economic forces, with a mean of 3.53. The respondents react quite indifferently to technology and political forces, with means of 3.38 and 3.25, respectively. Details of each item comprising transport sustainability and the five macroenvironmental forces are shown in Table 2.

Psychometric properties of the measures

Exploratory factor analyses were conducted for each of the proposed model's factors, using principal axis factoring and the Varimax rotation method. The final list of variables for the proposed factors was based on a consideration of the variables communality index and factor loadings. Variables with a factor loading of at least 0.4 were retained for further investigation (Hair et al. 1998). Based on the results of the exploratory factor analysis, 24 constructs of the original pool of 30 macroenvironmental measures served as indicator variables in the confirmatory factor analysis. The appropriateness of exploratory factor analysis was determined by examining the correlation matrix of the macroenvironmental variables. The Kaiser–Meyer–Olkin measure of sampling adequacy topped 0.80 in all constructs. This indicates very good overall sampling adequacy (Hair et al. 1998).

Confirmation factor analyses were employed to address issues of dimensionality, and convergent and discriminant validity (Anderson and Gerbing 1988). Items having standardized loadings below 0.4 (Hair et al.) were eliminated. From the results of the confirmatory factor analysis, two items (pol4 and pol5) from the political dimension were discarded as well.

As indicated in Table 3, the magnitudes of the standardized loadings ranged from 0.30 to

0.91, and the majority of the standardized loadings were above 0.7. These results collectively provided empirical support for convergent validity (Anderson and Gerbing 1988). Cronbach's alpha coefficients were used to examine the internal consistency of the latent constructs. Hair et al. (2006) and Burns and Burns (2008) highlighted 0.7 is an acceptable level of reliability. As shown in Table 1, all the reliability coefficients were deemed acceptable as they exceeded the benchmark of 0.70.

Table 1: Respondents' Profile

Variables		Frequency	Percentage
Gender	Male	171	52.8
	Female	153	47.2
Age	18-25	131	40.3
	26-35	95	29.2
	36-45	53	16.3
	46-55	29	8.9
	>55	16	4.9
Income	≤RM1000	119	36.6
	RM1001-3000	110	33.8
	RM3001-5000	57	17.5
	RM5001-7000	16	4.9
	RM7001-9000	11	3.4
	>RM9001	3	0.9
Education	Primary/Secondary School	57	17.5
	Pre-University/Diploma	121	37.2
	Bachelor Degree	133	40.9
	Postgraduate	14	4.3
Ethnic	Malay	55	16.9
	Chinese	191	58.8
	Indian	58	17.8
	Others	20	6.2
Marital Status	Single	215	66.2
	Married	105	32.3
	Widowed	4	1.2
Monthly expenditure on public transport	≤50	204	62.8
	51-100	37	11.4
	101-150	42	12.9
	151-200	5	1.5
	> 200	37	11.4
Monthly expenditure on gasoline	≤50	112	34.5
	51-150	38	11.7
	151-250	75	23.1
	251-350	39	12
	351-450	23	7.1
	> 450	38	11.7
Distance travel	<50km	183	56.3
	50-99km	105	32.3
	100-149km	22	6.8
	150-199km	5	1.5
	≥200km	10	3.1

Table 2: Descriptive Statistics		
	Mean	SD
Technology	**3.38**	**1.11**
tec 1 Planning public road transport network	3.26	1.09
tec 2 Development of public road transport network with land use	3.21	1.02
tec 3 Managing public road transport network	3.32	1.10
tec 4 Enhancing mobility of people.	3.50	1.12
tec 5 Reducing the energy consumption	3.63	1.23
Soical	**2.89**	**1.17**
soc 1 Transit services	2.94	1.23
soc 2 Crime rates onboard	2.37	1.25
soc 3 Route coverage	2.83	1.21
soc 4 Public transport schedules	2.82	1.16
soc 5 Ability to reach commercial services	3.44	1.02
soc 6 Ability to reach public facilities	2.92	1.14
Economics	**3.53**	**1.17**
eco 1 Operating and maintenance cost of private vehicles	3.49	1.12
eco 2 Fuel price	3.53	1.21
eco 3 Facility costs	3.57	1.19
Nature	**3.75**	**1.05**
nat 1 Gases emission	4.04	1.02
nat 2 Traffic noise	3.86	1.03
nat 3 Land use for transportation development	3.60	1.02
nat 4 Wild life habitat preservation	3.64	1.05
nat 5 Road accidents	3.56	1.20
nat 6 Waste from vehicles	3.77	0.98
Political	**3.25**	**1.17**
pol 1 Government policies - subsidy on national car	3.08	1.12
pol 2 Facility costs - toll charges	3.34	1.19
pol 3 Facility Costs - parking fees	3.34	1.21
Sustainability	**4.39**	**1.21**
sus 1 Basic access needs of individuals	4.35	0.84
sus 2 Human health and the environment	4.50	2.37
sus 3 Quality of life for future generations	4.30	0.86
sus 4 Affordability	4.46	0.78
sus 5 Efficient operations	4.47	0.82
sus 6 Choice of transportation mode	4.44	0.81
sus 7 Pollution emission	4.59	2.94
sus 8 Consumption of non-renewable resources	4.34	0.83
sus 9 Reuse & recyclable	4.24	0.89
sus 10 Use of land for construction of transportation infrastructures.	4.20	0.98

Table 3: Scale items, reliabilities and Confirmatory factor analysis results		
	Standardized loadings	Cronbach alpha (α)
Technology		0.87
tec 1 Planning public road transport network	0.81	
tec 2 Development of public road transport network with land use	0.84	
tec 3 Managing public road transport network	0.87	
tec 4 Enhancing mobility of people.	0.70	
tec 5 Reducing the energy consumption	0.62	
Soical		0.81
soc 1 Transit services	0.60	
soc 2 Crime rates onboard	0.56	
soc 3 Route coverage	0.82	
soc 4 Public transport schedules	0.74	
soc 5 Ability to reach commercial services	0.47	
soc 6 Ability to reach public facilities	0.57	
Economics		0.75
eco 1 Operating and maintenance cost of private vehicles	0.47	
eco 2 Fuel price	0.90	
eco 3 Facility costs	0.78	
Environment		0.81
env 1 Gases emission	0.82	
env 2 Traffic noise	0.81	
env 3 Land use for transportation development	0.54	
env 4 Wild life habitat preservation	0.60	
env 5 Road accidents	0.38	
env 6 Waste from vehicles	0.52	
Political		0.73
pol 1 Government policies - subsidy on national car	0.32	
pol 2 Facility costs - toll charges	0.91	
pol 3 Facility Costs - parking fees	0.90	
Sustainability		0.93
sus 1 Basic access needs of individuals	0.72	
sus 2 Human health and the environment	0.78	
sus 3 Quality of life for future generations	0.84	
sus 4 Affordability	0.81	
sus 5 Efficient operations	0.76	
sus 6 Choice of transportation mode	0.80	
sus 7 Pollution emission	0.30	
sus 8 Consumption of non-renewable resources	0.75	
sus 9 Reuse & recyclable	0.75	
sus 10 Use of land for construction of transportation infrastructures.	0.68	

Table 4 demonstrates the correlation coefficients among the constructs. The correlation coefficients ranged from 0.04 to 0.3. This indicates that all the constructs were free from multicollinearity as the correlation coefficient for all the constructs are below the cutoff points of 0.8, providing empirical support for discriminant validity.

Table 4: Correaltion Matrix of independent variables (n=324)							
	Mean	SD	Technology	Social	Economics	Nature	Political
Technology	3.38	1.11	1.00	0.15	0.04	0.28	0.16
Soical	2.89	1.17		1.00	0.12	0.04	-0.02
Economics	3.53	1.17			1.00	0.30	0.20
Nature	3.75	1.05				1.00	0.29
Political	3.25	1.17					1.00

Evaluating the goodness-of-fit criteria

Technology, political, social, economic and environmental factors were taken as the exogenous variables while sustainability was the endogenous variable. The 33 constructs were tested on normality and kurtosis. No variable was found to have significant departure from normality. Thus, all the constructs were retained. The final results of the confirmatory factors demonstrated a reasonable fit of the five-factor model on the basis of a number of fit criteria suggested by Hooper et al. (2008). Since SEM has no single statistical test that best describes the strength of the model predictions, multiple fit indices should be used to assess goodness of fit. The chi-square value of 2165.62 with 899 degrees of freedom, and sample size of 325 were found to be statistically significant at ($p<0.00$) level. This indicates that the model is lack of a satisfactory model fit. However, the chi-square test is less reliable and has a tendency to indicate significant differences when sample sizes within the range of 100 to 200 (Hair et al. 2006).

RMSEA and SRMR are computed to provide a more robust evaluation of the fitness of the model (Kline 2005). In a well-fitting model, RMSEA should be less than or equal to 0.06; the lower limit should be close to 0 while the upper limit should be less than 0.08 (Hu and Bentler 1999). MacCallum et al. (1996) (cited in Kline 2005) used 0.08 to indicate a mediocre fit. RMSEA for the proposed model is 0.058, with 90 percent confidence interval of 0.05 and 0.06. SRMR value below 0.08 is considered a good fit (Hu and Bentler 1999). The proposed model's SRMR is 0.06, which is below the cutoff point of 0.08

The values of CFI (0.902) are slightly below the cutoff value of 0.95. To test for model parsimony, the PNFI is assessed. A model with PNFI greater than 0.60 can be considered as good parsimonious fit (Garson 2006). The proposed model's PNFI (0.744) is higher than the cutoff value, indicating a good parsimonious fit. To conclude, goodness-of-fit tests indicated that the proposed model is an acceptable model.

Table 5: Goodness-of-fit Measures		
Goodness-of-fit Measures	**Default Model** (n=324)	**Macro**
Absolute fit measures		
Chi-square	986.08	CMIN
Degree of freedom	474	DF
Significance level	0.001	P
Standardised root mean square residual	0.00622	SRMR
Root mean square error of approximation	0.058	RMSEA
Incremental fit measures		
Comparative fit index	0.902	CFI
Parsimonious fit measures		
The parsimony normed fit index	0.744	PNFI

Regression Analysis

Apart from the model's general fit for the data, it is also important to test its parameters. The significance tests for the model parameters are the basis for accepting or rejecting the proposed relationships between exogenous and endogenous constructs (Hair et al. 1998). Table 6 summarizes the multiple regression results of the relationship between transport sustainability and the five macroenvironment forces. The result reveals a positive and statistically significant ($P < 0.01$) relationship between transport sustainability and environment, thus supporting H4 hypothesis. The result implies that the sustainability planning on public transportation system complements the increasing environmental concerns. Contrary to what is hypothesized, the result shows that transport sustainability is statistically significant ($P < 0.01$) and negatively related to social-cultural forces. H3 is therefore not supported. The findings suggest that society in general experiences negative effects from the public transportation system in meeting the sustainability objective. This finding is consistent with Leong and Mohd Sadullah (2010).

The study highlights that other major environmental forces such as technological, political, and economic are not statistically significant in influencing transport sustainability in Malaysia.

Table 6: Regression analysis of the relationship between transport sustainability and five forces (n = 324)

	Estimate	S.E.	C.R.	P-Value
Technology	0.088	0.045	1.952	0.051
Social	-0.196	0.055	-3.576	***
Economic	0.062	0.038	1.620	0.105
Political	0.081	0.032	2.583	0.010
Environment	0.525	0.090	5.828	***

Implications of Findings

Based on the empirical results, a more comprehensive understanding of macroenvironmental factors on transport sustainability can be derived. Political factors which were hypothesised to have positive impacts on transport sustainability are not supported by this study. Compared to government interventions and relevant policies (political) in European countries (Schade 2004), transport polices enforced by the Malaysian government are not seen by road users as having significant influence on the sustainability of the transport system. Although some successful examples were found in London, Singapore, and Copenhagen (Small 2004; Willoughby 2001; Vuk 2005), where governments' transport policies have effectively reduced the number of road users and increased usage of public transport, this study revealed a contrasting result. This may suggest that the Malaysian government needs stronger determination in implementing a public transport policy that is heavily influenced by the need for sustainability.

The second hypothesis (H2) is also not supported by the results of the study, as no significant relationship was found between economic forces and transport sustainability. This implies that Malaysians do not see increasingly high private transportation costs as having any influence on transport sustainability. This finding supports Leong and Sadullah's (2010) proposition that the public reacts strongly to the removal of gasoline and vehicle price subsidy or to de-meriting private vehicle ownership. Public resistance to negative economic implications does not encourage them to embrace transport sustainability behaviours by shifting to public transportation. This is clearly justified by a relationship where socio-cultural forces have a significant negative impact on transport sustainability, thus nullifying the H3 hypothesis.

The general public in Malaysia appears to have a poor impression of the quality of their public transport system, especially amid serious urban congestions problems and rising private vehicle costs. Geurs et al. (2009) said the availability and quality of services offered by public transport determine the extent of usage. Findings show that a serious revamp is needed in Malaysia's public transportation system. Yet transport sustainability appears to be a low priority despite the economic and social cultural forces hounding the country's transport system.

The only forces found to have a positive impact on transport sustainability are environmental ones, thus supporting the H4 hypothesis in the statistical test. This result indicates that Malaysian road transport users are positively driven by environmental factors, thus encouraging transport sustainability. This finding also complements those of several studies (Hayashi et al. 2004; Button and Nijkamp 1997), which have identified strong links between environmental forces and transport sustainability. Such positive relationship suggests that Malaysian road transport users link environmental concerns to transport sustainability issues. Environmental issues such as gas emissions, traffic noise, accidents, and environmental wastes are deemed relevant to transport sustainability. On the other hand, technological advancements do not seem to influence transport sustainability, consistent with hypothesis five. Malaysian do not think that ICT applications could help improve public transport efficiency and road transport sustainability. This runs counter to the assertion put forth by Cetin and List (2006) and Janic (2009).

The foregoing findings support only one hypothesis and reject the four others. Nevertheless, the research model used in this study complied with the goodness-of-fit tests. Therefore, the empirical results justified the appropriateness of this model in examining transport sustainability.

This study brings to the fore several important issues that policymakers and public transport operators alike should consider. The research results may also be useful to academic studies and related researches on transport sustainability. Based on the findings, there is a need for the Malaysian government to formulate a more effective transport policy that will ensure a sustainable public transport system in the country. Serious commitments and good policy implementation are needed to generate political forces that will help build a sustainable transport system. Existing public transport policies must be evaluated, among others by soliciting feedback from road users and encouraging public participation in drawing up a transport sustainability blueprint.

As earlier pointed out, road transport users in general have a low view of public transport services. However, environmental forces have brought significant impacts to transport sustainability. Hence, public transport operators are encouraged to assess their current services. They should examine them from the perspectives of accessibility, reliability, and adequacy of facilities. Further actions are also required to increase the confidence of road transport users in public transport such as by highlighting its role in curbing environmental externalities in the country. Public transport operators should show their commitments to reducing congestions, pollutions, and gasses emissions by providing state-of-the-art public transport services.

Finally, the theoretical contributions of this study include offering diverse opinions on macroenvironmental forces. Unlike in other countries, where similar studies have been made on transport sustainability, Malaysian road users are hardly encouraged by current public policies on the transport system. This shows that political forces across countries have varying influences on transport sustainability. Nevertheless, transport sustainability is consistently linked to environmental forces, as shown by this study. Most importantly, this study confirms the practicality of using macroenvironmental forces in evaluating transport sustainability in this country. Lastly, it is highly recommended that this model be replicated in other countries to bring out responses to transport sustainability issues.

Limitations and Future research

This study has several limitations that must be addressed in future research efforts. For one, the population size (324) is small. A larger sample might yield better results. For another, there are biases in samples in terms of demographics: 131 (40.3 percent) out of 324 of respondents are between 18 and 25 years old; 191 respondents (59 percent) are Chinese, 215 respondents (66 percent) are single, and the income levels of 229 respondents (71 percent) are pegged at RM3,000 and below. Indirectly, the research results were influenced by these demographics.

This study shows a negative correlation between social forces and transport sustainability. Since sustainability and livability are closely related (Litman 2010; Miller et al. 2013), further study needs to be conducted along these lines. Moreover, to ensure sustainability, the development of public transportation should focus on a new trend of public transportation. It should meet local and global requirements. Sustainable transportation institutions must promote efficient transport utilization and system production and maintenance (Hayness et al. 2005). There are still obstacles to the creation of an efficient and environmentally friendly transport system (Golinska and Hajdul 2012). These include low safety, increasing congestions, charges and distortions, incompatibility of infrastructure, growing carbon dioxide emissions from transportation, dependence on fossil fuels, and changing mobility patterns.

Conclusion

The sustainability of transportation systems is an important activity for planning and infrastructure in developing countries like Malaysia. Major issues linked to transportation sustainability in Malaysia includes large increases in traffic demand due to dependency on personal vehicles; poor control of vehicle emissions; lack of adequate and appropriate public transport system; and poor coordination of transport and land-use policies. This paper conceptualized the definition of transport sustainability and developed a model to evaluate the impacts of different macroenvironmental forces, namely, political, economic, social, technological, and environmental forces, on road transport sustainability in Malaysia. Transport sustainability is always linked to environmental forces, as shown by this study. Deteriorations in environment such as gas emissions, traffic noise, and environmental wastes were deemed positively related to transport sustainability. The empirical results of the study point to the appropriateness of these macroenvironmental forces in evaluating transport sustainability in this country. Decision makers may look into different policies and plans in a broader context by engaging public transport users in drawing a transport sustainability blueprint. Furthermore, it is highly recommended to replicate this model in other countries to identify different responses over transport sustainability.

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	Please rate the extent to which you agree or disagree with the following statements on road transport system in **Klang, Kuala Lumpur, and Subang Jaya.** (Please circle one number for each statement)	***Strongly disagree***				***Strongly agree***
1.	Advanced technology is used in:					
	Planning public road transport network (eg: connectivity of the transport network).	1	2	3	4	5
	Integrating development of public road transport network with land use planning.	1	2	3	4	5
	Managing public road transport network.	1	2	3	4	5
	Enhancing mobility of people.	1	2	3	4	5
	Reducing the energy consumption (eg: fuel, electricity)	1	2	3	4	5
2.	These cities provide quality pedestrian and bicycle infrastructures	1	2	3	4	5
3.	The following factors encourages me to use public road transport:					
	(a) Faster as less time lost to congestion	1	2	3	4	5
	(b) Faster as less time lost looking for parking lots	1	2	3	4	5
	(c) Frequent of transit services (eg: short transit time)	1	2	3	4	5
	(d) Low crime rates onboard (eg: pickpocket)	1	2	3	4	5
	(e) Wide route coverage	1	2	3	4	5
	(f) Availability of public transport schedules/information	1	2	3	4	5
	(g) Affordable fares charged	1	2	3	4	5
	(h) High operating and maintenance cost of private vehicles	1	2	3	4	5
	(i) Ability to reach employment centres (e.g., offices)	1	2	3	4	5
	(j) Ability to reach commercial services (e.g., shops, shopping malls)	1	2	3	4	5
	(k) Ability to reach public facilities (e.g., hospital, library)	1	2	3	4	5
	(l) Increase in fuel price	1	2	3	4	5
	(m) High facility costs (e.g., road toll, parking fees)	1	2	3	4	5
4.	Public road transport dependency reduces					
	(a) gas emission	1	2	3	4	5

	(b) traffic noise exposure	1	2	3	4	5
	(c) land use for transportation development	1	2	3	4	5
	(d) wildlife habitat preservation	1	2	3	4	5
	(e) road accidents	1	2	3	4	5
	(f) waste from vehicles (eg: tyres)	1	2	3	4	5
5.	Future road transportation development should move towards a system that:					
	(a) allows the basic access needs of individuals (eg: transport to work, leisure)	1	2	3	4	5
	(b) does not endanger human health and the environment	1	2	3	4	5
	(c) does not compromise the ability of future generations to enjoy equal or better quality of life	1	2	3	4	5
	(d) is affordable,	1	2	3	4	5
	(e) operates efficiently	1	2	3	4	5
	(f) offers choice of transportation mode	1	2	3	4	5
	(g) limits pollution emission (noise, air, water) and waste,	1	2	3	4	5
	(h) minimizes consumption of non-renewable resources	1	2	3	4	5
	(i) reuses and recycles its components	1	2	3	4	5
	(j) minimizes the use of land for construction of transportation infrastructures.	1	2	3	4	5
6.	National car policy (government support to national cars) encourages private car ownership.	1	2	3	4	5
7.	Government should remove subsidy of gasoline and diesel fuel price to increase usage of public transportation.	1	2	3	4	5
8.	Government should increase price and taxes on private vehicle to increase usage of public transportation.	1	2	3	4	5
9.	The increasing toll charges in the cities fail to shift the public dependence from private vehicles to public transportation.	1	2	3	4	5
10.	The increasing parking fees in the cities fail to shift the public dependence from private vehicles to public transportation	1	2	3	4	5

General Information (Please circle your answers)

A. Age (year)

1. 18-25 2. 26-35 3. 36-45 4. 46-55 5. >55

B. Gender

1. Male 2. Female

C. Nationality: __________________________

D. Ethnic

1. Malays 2. Chinese 3. Indians 4. Others: _________________________

E. Marital Status

1. Single 2. Married 3. Widowed

F. Education

1. Primary/Secondary School 2. Pre-university /Diploma 3. Bachelor Degree
4. Post Graduate 5. Others: ___________________________

G. Personal Monthly Income

1. <RM1,000 2. RM1,000-RM3,000 3. RM3,000-RM5,001
4. RM5,001-RM7,000 5. RM7,001-RM9,000 6. >RM9,000

H. Monthly Expenditure on Public Transport: RM __________________________

I. Monthly expenditure on gasoline/diesel purchase: RM______________________

J. Daily Travel Distance

1. < 50km
2. 50-100km
3. 101-150km
4. 151-200km
5. >200km