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A Review of Strategies to Implement Sustainable Urban Transportation Options in Malaysia

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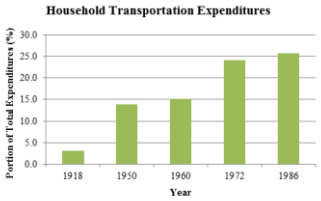
Graphical abstract



Abstract

Since the 1987 Brundtland Commission report brought global attention to sustainable development, many scholars and professionals have worked to apply its principles, notions and strategies in the urban context to transportation. Consequently, this paper examines strategies to implement sustainable transport. It traces efforts to operationalize the notion of sustainable road transportation in transport options. The authors address the problem faced by the Malaysian transportation sector today in major economic, social and environmental elements. Then, the authors identify various strategies that focused on improvement such as Non-Motorized Transport (NMT), Public Transport and Private Vehicles. The authors also discuss extending all strategies comprising these three parts. This paper calls for further studies to verify the best strategies to implement, given that some strategies may be suitable or convenient at certain places and under certain circumstances.

Keywords: Non-motorized transport; public transport; private vehicle; sustainable transport

1.0 INTRODUCTION

Since the beginning of human history, transportation has been an engine of growth. Without transportation, there would have been no trade or cities [1]. In addition, the transportation sector also is one of the major components of globalization and makes a vital contribution to the economy [2]. The economic development of any nation also requires a good transportation system, but in reality, cities are now faced with transportation problems such as air pollution [3-6], congestion [7-10] and road accidents [11-15]. However, the need for transport has increased from year to year. The absence of a comprehensive management policy and strategy and specific transport systems organization has created problems among the key elements that led to the creation of urban transport issues.

2.0 TRANSPORTATION ISSUES IN MALAYSIA

2.1 Economic Transportation Issues

Transportation costs increased as a portion of household expenditures during the last century, as shown in Figure 1 [16]. According to Lipman, transportation expenses are often higher than housing costs for middle-income households. The transport costs range from approximately 10% in multi-modal communities to approximately 25% in automobile-dependent communities [17].

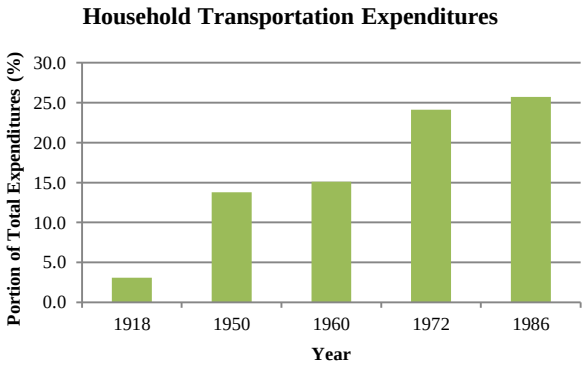


Figure 1 Household transportation expenditures [16]

Malaysia's population is approximately 27.73 million, and its gross domestic product (GDP) grew at an average of 6% over the

last 20 years. In such a quickly industrializing country, transportation makes a vital contribution to the Malaysian economy and plays a crucial role in daily activities. This is one of the factors that increased motor vehicle ownership. The motor vehicle ownership has increased significantly every year and doubled every 10 years [2]. Road users now have to pay a high price just for additional time and space to reach their destination. Transportation costs in Malaysia have become the third priority among household expenditures at 13.1%, compared to 21.8% of food and 21.8% for housing and utilities. In 1957, transportation expenses amounted to only 3.7% of household expenses and became the seventh of nine priority indicators. Transportation expenses include the purchase of a new vehicle tools, petrol, the purchase of spare parts and vehicle maintenance, road tax, insurance and freight transport services [18].

The rising cost of transportation, if not offset by disposable income, would likely increase poverty. Hence, Litman stated that lack of transportation affordability can cause significant problems, including imposing financial burdens and constraining people's economic and social opportunities [19]. Because these problems are greatest for physically and economically disadvantaged people, lack of transport affordability creates inequities. In fact, increasing transport affordability can provide large economic and social benefits by reducing burdens and expanding opportunities to disadvantaged people. Increased transport affordability is also equivalent to increased income.

2.2 Social Transportation Issues

2.2.1 Social Transportation Issues

Efficient public transport can be one of the potential solutions to urban road traffic congestion [20-23]. Additionally, the shift from private vehicles to public transport is also an effective strategy to reduce hydrocarbon (HC) and carbon monoxide (CO) emissions [2]. The current reality of public transport in Malaysian cities is, however, disappointing. For example, Nor in his survey of regular bus users in Putrajaya, illustrates that the quality of intra-city bus services is far from the desired standard as illustrated in Table 1 [24].

Table 1 User perception of bus services in Putrajaya [24]

Bus Service Features	Percentage
Uncovered and uncomfortable bus waiting facilities	76.0%
Incomplete bus travel information	65.1%
Long wait for the bus	60.3%
Crowded	59.3%
Unreliable bus itinerary	58.8%
No entertainment or information on the bus (e.g., radio or music)	52.3%

In fact, the number of buses is limited, and the bus reliability is low. In addition, it took passengers a long time to catch a bus, especially during off-peak hours as shown in Table 1. As such, public transport was also the last choice for consumers. Although it is of low cost at the rate of RM0.50 per trip regardless of the distance with a discount rate for students, public transport was not preferred by residents. Most regular users are 'captive passengers' who had to use public transport because they have low income, do not own a personal vehicle or do not have a valid driving license.

The problems regarding public transport were not just limited to Putrajaya; they also occurred in other major cities in Malaysia, as indicated by the percentage user rate of public transport displayed in Table 2. These statistics clearly indicate that public transport is not the popular choice of Malaysian citizens. In 2008, public transportation only recorded 1.9% of all road use, but private transport reported 98.1% of all road use [25].

Table 2 Proportion trend of private and public transport vehicles for road transport in Malaysia [25]

	Private cars		Public transport vehicles		
Year	Passenger cars	Share (%)	Bus	Taxi/Hire cars	Share (%)
1990	1,678,980	96.58	24,057	35,405	3.42
1995	2,553,574	96.56	36,000	55,002	3.44
2000	4,145,982	97.30	48,662	66,585	2.70
2005	6,473,261	97.93	57,370	79,130	2.07
2008	7,966,525	98.10	64,050	90,474	1.90

2.1.3 Road Accidents

Road accidents are a major problem, triggering hundreds of thousands of deaths, millions of injuries and hundreds of billions of dollars in economic costs annually [26-29]. For the younger generation, traffic accidents are the single greatest cause of fatalities and disabilities [30, 31]. In Malaysia, road injuries and fatalities are a growing anxiety, with more than 6000 people killed and over 25,000-recorded injuries yearly for the past 5 years [13].

According to Riduan in 2009, Malaysian roads ranked among the 33 countries with highest death rate due to accidents. Malaysian roads produced 23.8 deaths per 100,000 people compared to Britain's roads, which were among the safest, with a death rate of only 3.8 per 100,000. This rate is 6.3 times higher compared to developed countries such as the United Kingdom, Sweden and the Netherlands [18].

In fact, Malaysia is ahead of Thailand at 19.6, Indonesia at 7.1, the Philippines at 4.8 and Singapore at 1.3 deaths per 100,000, respectively. Malaysia ranks alongside Argentina and Cambodia on the list of deaths caused by traffic fatalities, and its rate increased 12% from 2000 to 2009, although the trend showed a decrease among the 30 other listed countries. As evidence, Abdul Manan and Várhelyi compared accident statistics in Malaysia with Sweden, as shown in Table 3, and confirmed that Malaysian roads carry ten times more of a risk compared with Swedish roads [13].

Table 3 Road accident severity in Sweden and Malaysia in 2008 [13]

Nation	Fatal	Severely Injured	Slightly Injured	Ratio of Severe to Fatal	Ratio of Slight to Fatal
Sweden	397	3,657	22,591	9:1	57:1
Malaysia	6,527	8,868	25,747	1.4:1	4:1

On average, Malaysian roads contributed to approximately 6,323 deaths per year from 2000 to 2009, with an estimated RM9 billion loss every year. In 2009 alone, there were 6,640 road accidents recorded or 18.2 deaths per day. This amounts to the death of a Malaysian road user every 1 hour and 20 minutes [18].

2.3 Environmental Transport Issue

The Malaysian energy sector still depends heavily on non-renewable fuels such as natural gas [32]. From 2000 to 2008, energy consumption in Malaysia has increased at an annual growth rate of 6% and reached 45 million tons in 2008. The

transport sector solely contributed to 36% of the total energy consumption in 2008, as illustrated in Figure 2 [2]. The transportation sector, which fully utilizes fossil fuel products, is the main contributor to carbon dioxide (CO_2) emissions [33].

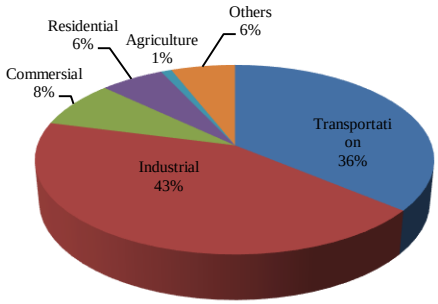


Figure 2 Energy consumption by sector in Malaysia [2]

3.0 CONVENTIONAL VS. SUSTAINABILITY TRANSPORT

According to Litman and Burwell, conventional transport planning assumes that transport improvements are linear. This linear form refers to modes of transport that replace the older and slower forms with more advanced and faster forms as displayed in Figure 3, in contrast to the sustainable forms displayed in Figure 4 [34]. Sustainable transportation reflects a parallel model by assuming that each mode plays an important role. Sustainable transport also creates a balanced transportation system that uses all modes of transportation services optimally. Thus, the sustainability of transport attempts to improve the overall quality of the available transport modes in a balanced and optimized way, not focusing solely on modern and advanced transport.

Walk → Bicycle → Train → Bus → Automobile → Improved automobiles

Figure 3 Conventional transport planning. Source: Litman and Burwell [34]

Walk → Improved walking conditions
Bicycle → Improved cycling conditions
Train/Bus → Improved public transit service
Automobile → Improved automobile travel conditions.

Figure 4 Sustainable transport [34]

4.0 STRATEGIC IMPROVEMENTS TOWARD SUSTAINABLE TRANSPORT

Today, hundreds of cities are pursuing sustainable transport strategies [34]. However, sustainable transportation is a complex and integrated issue. Full integration strategies will likely never be accomplished. Putting too many requirements on sustainable transport may even lead to failure of achieving anything approaching a sustainable system [35]. This article therefore presents strategies toward sustainable transport divided into three main parts: the strategic improvement of non-motorized transport, public transport and private vehicles, as described in Figure 5, with details in Figure 6.

Walk & Bicycle → Improvement of Non-Motorized Transport
Train/ Bus/ Taxi → Improvement of Public Transport
Automobile → Improvement of Private Vehicle

Figure 5 Three main categories of strategic improvement of transport

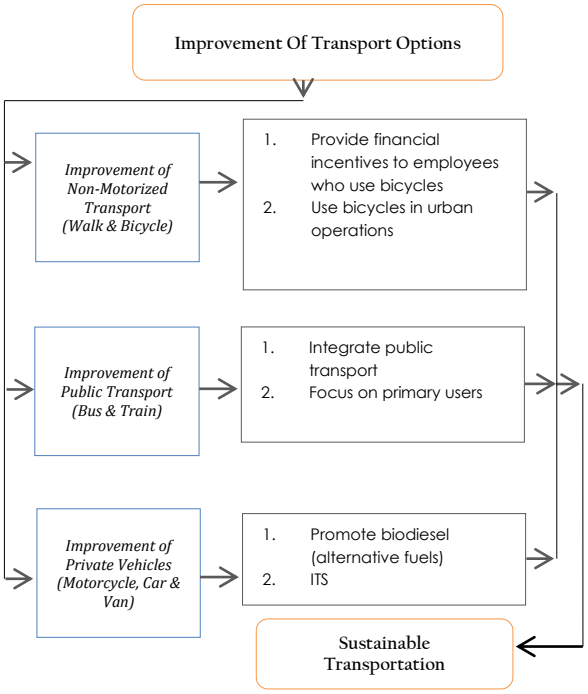


Figure 6 Strategic improvements of transport options

4.1 Improvement of Non-Motorized Transport (NMT)

Non-motorized transport (NMT), also described as active transport or human-powered transport, refers to walking, cycling and variants including wheelchairs, scooters and handcarts [36]. Strategies for NMT travel benefit communities by removing barriers to mobility, increasing the safety and comfort of pedestrians and cyclists, broadening travel options for non-drivers, reducing conflicts between motorists and other road users, reducing automobile traffic and related problems [37], increasing recreational activity and healthy lifestyles [38-43], encouraging NMT tourism, better accommodating people with disabilities and creating more liveable communities [44, 45]. This article will present two strategies under NMT.

4.1.1 Providing Financial Incentives for Bicycle Use

Financial incentives for bicycle use are uncommon for bicycle users. To alleviate this situation, local governments can provide subsidies or reimbursements to employees who commute by bike. Governments may also provide low-interest or interest-free loans for the purchase of bicycles and bicycle equipment for bicycle commuters. They can also reimburse employees who use bicycles on the job and encourage businesses and institutions in the community to do the same. Bellevue, Washington, offers employees who bike to work at least 80% of the time a $15 per month bonus [4]. Honest Tea, an organic beverage maker in Bethesda, Maryland, gives its employees who commute by biking or walking an additional $27.50 to their monthly pay checks to offset equipment costs [46].

4.1.2 Using Bicycles in Urban Operations

Police patrolling today is primarily achieved via automobile, but in many places, police officers are also assigned to foot, horse, bicycle, watercraft and aircraft patrols [47]. Governments, businesses and institutions can provide bicycles instead of motor vehicles to perform certain job duties. If employers cannot supply bicycles, they can reimburse employees who use their own. Examples of jobs that could incorporate bicycle patrolling include building inspectors, meter readers and employees travelling from one site to another for a meeting. Bicycles can also be used to generate more effective government programs. "Cops on Bikes" programs have succeeded in many U.S. cities in reducing vehicle expenses and impacts and in improving police-citizen relations and patrolling speed and flexibility. For example, the police department in Dayton, Ohio, is saving 2,700 gallons of gasoline and 7.5 tons of CO_2 a year by using bicycle patrols instead of police cars for selected patrol beats [4].

4.2 Improvement of Public Transport

Public transport, also referred to as public transit, urban transit and mass transit, includes various services using shared vehicles to provide mobility to the public [48]. Public transport is important for overall societal mobility and can play a role in reducing the problems related to several transport externalities including accidents and traffic congestion [49]. In addition, it also transports commuting passengers to their workplaces [50]. An increase in the use of public transport combined with a decrease in the use of private cars may also significantly reduce CO_2 emissions because public transport generally creates lower CO_2 emissions per passenger kilometre than private cars [51]. This article proposes two strategies to improve public transport.

4.2.1 Integration of Public Transport Systems

Public transit integration allows passengers to travel from one place to another via rider-friendly inter-modal facilities and interconnections. Improved integration between the public transport modes helps people move around more easily and reduces the costs and inconveniences of travel [52]. Integrated, high-quality and accessible transit systems are essential to attract travellers and to persuade them to adopt public transport [53].

4.2.2 Focus Primary User

Among the main strategies for increasing the number of public transport passengers more efficiently is targeting the transit user preferences areas, including schools, colleges and universities. The transit agency may cooperate with the institutional administration to provide students with special pass cards as well as discounts [4].

4.3 Improvement of Private Vehicle Use

Road transport dominates Malaysia's transportation sector, and the road network accommodates 96% of the economic activities for transporting goods and passengers. Additionally, the share of the passenger sector is further divided into private cars at 65% usage and public transport at 30% [54]. According to Kamba *et al*., local road users in Malaysia highly prefer to use their personal vehicles rather than public transportation due to the convenience factor. Two strategies have been proposed in this article to improve private vehicles use and achieve sustainable road transport [55].

4.1.2 Alternative fuels (Biodiesel)

One of these practical alternative fuels is biodiesel, the renewable energy derived from the reaction of vegetable oils or lipids and alcohol. Biodiesel has great potential to serve as an alternative to petro-diesel fuel in compression ignition (CI) engines. Commercially, these blends are named B10, B20 or B100 to represent the volume percentage of the biodiesel component combined with diesel fuel as 10%, 20% and 100% volume, respectively [2]. According to Shahid and Jamal, using a mixture of petroleum diesel and biodiesel at an 80:20 ratio, or B20, was the most effective strategy [56]. Meanwhile according to Ong *et al*., biodiesel and diesel blends can reduce smoke opacity, particulate matters, unburned HC, CO_2 and CO emissions and the typical greenhouse gas emission savings for the main feedstock of biodiesel (Table 4) [2].

Table 4 Typical greenhouse gas (GHG) emission savings for biodiesel [2]

Type of biodiesel	Typical GHG emission savings (%)
Palm Oil	36
Palm Oil (process with methane capture)	62
Soybean	40
Rapeseed	45
Sunflower seed	58

4.2.2 Enhancement Using Intelligent Transport System (ITS)

The future of transportation no longer depends solely on traditional approaches; it increasingly relies on using information technology (IT). IT enables the communication of elements within the transportation system through wireless technologies through microchips and sensors. Additionally, the transportation system becomes a means of transferring services and information [57]. ITS significantly improves transportation system performance by reducing congestion, enabling the evaluation of social and economic data and increasing safety [58, 59] and traveller convenience [57, 60]. ITS also maximizes the capacity of infrastructure and reduces the need to build additional highway capacity. According to Atkinson *et al*., applying real-time traffic data to U.S. traffic signal lights can improve traffic flow significantly, reducing stops by as much as 40%, reducing travel time by 25%, cutting gas consumption by 10% (1.1 million gallons of gas annually) and cutting emissions by 22% (cutting daily carbon dioxide emissions by 9,600 tons) [60]. Meanwhile according to Marell and Westin, drivers indicated high acceptance rates for using an electronic device for speed checking, and drivers perceived that they had become more aware of traffic regulations and behaved in accordance with safety regulations [58].

5.0 CONCLUSION

In the context of sustainable development and transportation, economic, environmental and social elements are indispensable for the short- and long-term success of sustainability. These elements are traditionally considered separately, but the transportation problems faced by major cities in Malaysia incorporate all three elements.

For example, from the economic standpoint, the cost of transportation from household expenses faced by Malaysians is increasing significantly. The rising costs occur at a rate almost four

times the rate 50 years prior. If not offset by rising incomes, this increasing cost will likely exacerbate poverty rates.

Simultaneously, this article considered social problems related to transportation in two sub-categories: lacking public transport services and accident rates. The public realized that public transportation is an important aspect in promoting sustainability, but the data indicate that the number of users who use public transport in Malaysia are disappointed due to the lack of services. Accidents in Malaysia have also increased, with a fatality rate of nearly 19 people per day. Unless addressed immediately, road accidents in Malaysia may become the main contributor to *death*.

The evaluation of environmental problems caused by road transportation was based on studies conducted by Ong *et al.* and revealed that CO_2, SO_2, NOx and CO emissions have risen steadily over the past 13 years [25]. The data regarding these emissions not only threaten public health but also indicate that our non-renewable energy resources are being depleted .

Due to transportation problems, the approach for implementing strategies toward sustainable transport should account for environmental, economic and social elements. Some researchers currently focus strategies only on certain environmental problems, but this method is inaccurate because some strategies may affect economic and social elements while resolving environmental problems.

This study examined various strategies to implement transportation options and attain sustainable transportation. Further studies should be conducted to verify the optimal strategies for urban transport by surveying experts, given that certain strategies may be suitable or convenient for certain places and under certain circumstances. Moreover, each of the three categories discussed in this paper represents only a portion of the many on-going advanced efforts around the world.

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