Motorized and Nonmotorized Transport in Katmandu, Nepal: Where Do the Pedestrians Fit?

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Conceptual aspects of mode choice determinants regarding nonmotorized transport in developing countries are described. The influence of city size, trip length, and income is discussed with particular reference to the poor. Nonmotorized modes will be important for a long time, and planners need to devise methods that recognize the majority of trips made using these modes. Mode choice and various factors influencing it in Katmandu are presented to illustrate the importance of nonmotorized modes, particularly walking. Traffic studies in three different areas indicate that exclusive pedestrian and bicycle precincts in old areas of central business districts with narrow streets can be quite successful. This success could be replicated in other Asian cities. Examples of inefficient use of street space are given to indicate a lack of application of normal traffic engineering techniques and enforcement of traffic discipline. Experience in Katmandu indicates that exclusive nonmotorized mode precincts provide large volumes of person-trips, particularly by walking. These precincts must be related to street geometrics and adequate bypass routes must be provided.

Basic conflicts between motorized and nonmotorized urban transport in developing countries are described and analyzed. Policy analysis and mitigation measures are based on studies in Katmandu, Nepal (*1,2*). People in poor developing countries resort to nonmotorized transport primarily because they have no money and often because there is lack of adequate and cheap motorized transport.

Analytical methods and intellectual technology formulated in developed countries are based on the value of time and the assumption that capital and maintenance resources are available to provide adequate urban transport supply. Nonmotorized modes (walking, bicycling) are considered negligible and quite often are not included in data collection and policy analysis except in special circumstances such as recreational walkways and bicycle paths. Mixed traffic (motorized and nonmotorized) is not seen as a planning or engineering problem. Recent research emphasizes that under these circumstances, the transfer of intellectual technology from the west to the east (or from the north to the south) without drastic modification is dangerous and distorts the planning process, policy analysis, and investment priorities in developing countries (*3–7*).

In recent years, some progress has been made in including and emphasizing the nonmotorized modes used by the urban poor. Examples and studies have been conducted with the assistance of the International Development Research Center (IDRC) of Canada (*1,8,9*) in India, Nepal, the Philippines, and Indonesia. However, the use of data collection and analysis without the inclusion of nonmotorized modes persists. For example, in a recent study of 12 major cities in India conducted by the government of India there is no mention of pedestrians, although the pedestrian trips could vary from 40 to 70 percent of average daily traffic (*5,10*).

International technical assistance and lending agencies have a major influence on the thrust and focus of urban transport investment priorities in developing countries. Bilateral assistance agencies such as the Canadian International Development Agency (CIDA), Agency for International Development (AID), and Japan International Cooperation Agency (JICA) have, in the past, emphasized high-technology motorized and rapid transit solutions without any reference to the nonmotorized modes (*11–13*). Slowly, though, a more enlightened approach is being taken by agencies such as the IDRC, Transport and Road Research Laboratory (TRRL) of the United Kingdom, and the Swedish International Development Research Agency. These agencies are slowly awakening to the importance of nonmotorized modes in mixed traffic (*14*). However, the nonmotorized transport modes have been neglected in investment priorities. Only 1 percent of World Bank lending supports urban transport by pedestrians, as shown in Figure 1.

Until recently, there was little recognition of the importance of, and consequently little attention paid to, nonmotorized transport by planners in developing countries. In general, the origin-destination surveys and planning models were based on experience in developed countries. Many major transpor-

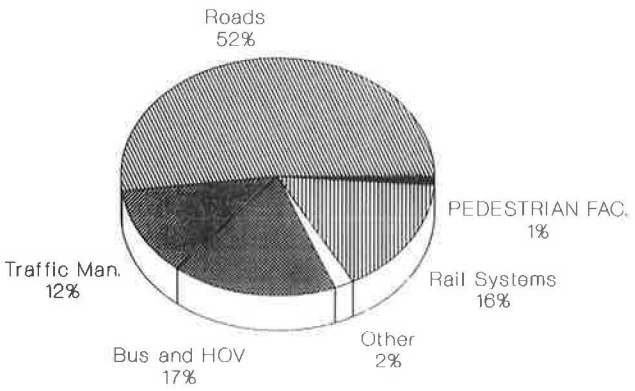

FIGURE 1 Urban transport lending of the World Bank (1972–1985).

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tation studies involving local and international funding were concerned only with cars, trucks, and buses and indirectly relegated nonmotorized transport to nuisance status (*10–12,7*). However, in recent years planners have begun to pay attention to nonmotorized transport because of a variety of reasons, which include their inevitable presence, the difficulties of handling mixed traffic, and their significance in urban transport (*15–17*).

MOTORIZATION

The desire for increased personal mobility is universal. Motorization, which occurs in all the major cities of developing countries to varying degrees, is influenced by a large number of factors, including the following:

1. National policies regarding motor vehicles and taxation,
2. City sizes and trip lengths,
3. Incomes, and
4. Availability of alternative modes with differing costs.

To a large degree, these factors also influence the role, survival, and success of nonmotorized modes.

Income is a major determinant of mode choice among the poor. Because of their affordability, walking and bicycling trips are common among the poor even when trip lengths are high. The data in Figure 2, derived from a number of studies in India and Nepal, show the decrease in nonmotorized mode use as incomes increase.

City size has a major influence on motorization. Larger cities involve a larger proportion of longer trips, especially for the poor. Figure 3 shows the changes in nonmotorized mode use in relation to city size.

As incomes increase, so does motor vehicle ownership (cars, motorcycles, mopeds). However, there is unlikely to be high vehicle ownership in poorer countries. Figure 4 shows car ownership rate versus income for several cities in Asia. Low car ownership rates correspond to low incomes. National policies regarding ownership and use of private cars have significant influence in spite of income. For example, Singapore (with higher incomes) has lower car ownership rates than Kuala Lumpur because of high taxes and import duties. Empiric forecasts based on average and high growth rates for Katmandu and typical low-income countries are shown in Figure 4.

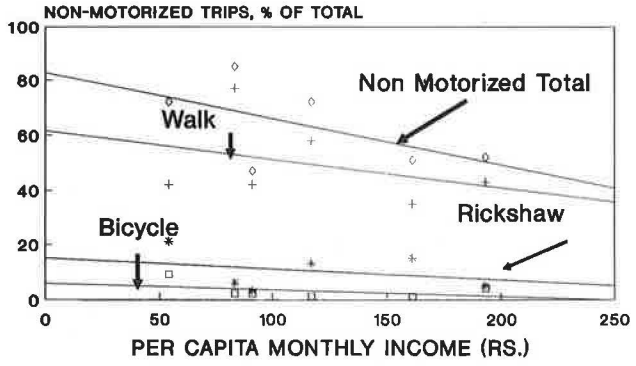

FIGURE 2 Urban travel patterns, mode choice versus income.

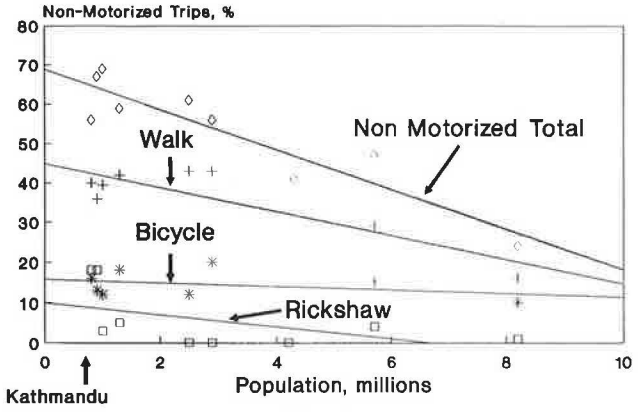

FIGURE 3 Nonmotorized trips in South Asian cities.

The availability of public transport in relation to income for several Asian cities is shown in Figure 5. Again, forecasts for Katmandu and for typical low-income cities are included. The forecasts shown in Figures 4 and 5 are based on assumptions presented in Table 1.

Given the slow growth rates of the lower-income economies, rapid increases in per capita income cannot realistically be expected and as a consequence neither can rapid increases in either private vehicle ownership or public transport availability. Table 1 indicates future income scenarios both for Katmandu and a typical South Asian city with a less-developed economy. These forecasts have been applied to Figures 4 and 5 with the aim of estimating car ownership and public availability. It can be seen that even in the best case (the high-growth scenario for the typical lower-income economy), car ownership and public transport availability estimates remain low. Car ownership could be expected to double from 20 to 40 cars per 1,000 persons but to remain far below the typical 400 to 500 cars per 1,000 persons typical of the industrialized economies. Public transport availability would also remain low at approximately 1.2 buses per 1,000 persons, similar to availability in lower-middle-income economies.

Although it is recognized that motorization will continue to increase in developing countries, it is postulated that nonmotorized modes will remain important for the 20- to 30-year planning horizon. This condition is more pronounced for the very poor countries like Nepal. Under these circumstances,

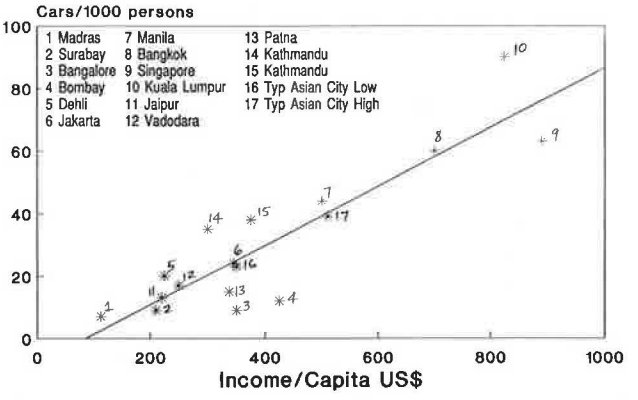

FIGURE 4 Automobile ownership versus income in South Asia.

TABLE 1 EXPECTED INCOME GROWTH

Location	Scenario	Growth* (%)	Present Income ($US)	20 Yr. Forecast Income ($US)
Kathmandu	Expected	0.2	300	312
	Hi Growth	0.9	300	359
"Typical" Low Income	Expected	0.9	300	359
	Hi Growth	2.8	300	521

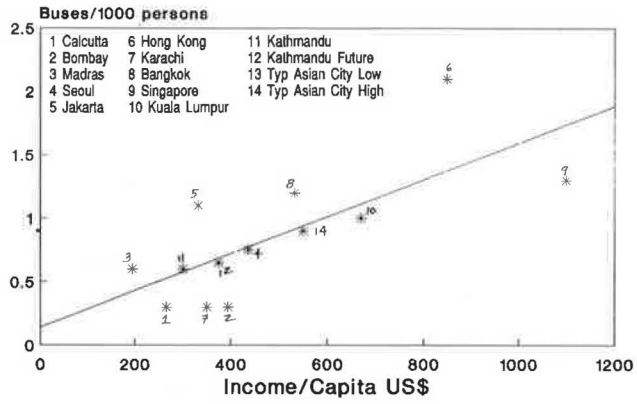

FIGURE 5 Public transport availability in South Asia.

there is an urgent need for further research into the efficient planning, design, and control of nonmotorized modes.

MODE CHOICE

Income is a major determinant of mode choice, especially among the poor. The poor walk and bicycle simply because they cannot afford to pay for other modes (*5*). In some instances, accessibility measures for these modes are either equal to or better than measures for motorized modes (*16*). Depending on the availability, quality, and cost of public transport, walking and bicycling can be as efficient or better depending on trip lengths, terrain, and climate.

Urban transport policies and priorities also have a major influence on mode choice. These policies cover pricing, regulation, enforcement, and safety aspects. Quite often, nonmotorized modes except walking are banned from the central business district (CBD). There is often inadequate provision of safe footpaths or sidewalks. In many developing countries, the supply side (technology and economics) and the regulation side (enforcement, economics, and availability) favor motorized transport. Planning, design, and road space allocation are heavily weighted in favor of motor vehicles. The intellectual technology relies heavily on equivalents of passenger-car units (PCUs). This one-sidedness would change enormously if the professional and research basis were person-trips and not vehicles.

Mode choice differences are probably the most important factor in the reduction of the effectiveness of the models transferred from industrialized to developing nations. Many local economic, cultural, and geographic factors combine to create a different set of mode choice conditions in the less-developed countries (LDCs), for which new mode choice models must be calibrated. An understanding of the set of parameters relevant to developing nations and, more important, of the values attached to the parameters by the particular population is essential.

Generally, the personal modes of travel such as bicycle, motorbike, and automobile provide greater convenience and flexibility but require an initial investment of capital. The passenger modes such as the low-cost transport modes (LCTMs) and the bus are less flexible but may offer more comfort in the guise of protection against the elements and possibly greater speed at a similar cost in continual smaller payments.

The treatment of time as a parameter in mode choice models is probably the major source of difference between the LDCs and the more industrialized nations. In general, the traveler in the developed world can be concerned with optimizing the travel time, whereas the traveler in the developing nation is more concerned with the immediacy of ensuring survival. As a result, income, passenger transport availability, trip distance, and terrain have greater significance.

The most critical parameter affecting mode choice in the developing nations is income. At the most basic level, income may inhibit choice by causing mode captivity. The very poor with minimal or no income may have to walk for the simple reason that all other modes have associated financial costs that the very poor may be unable to bear. Even the poor with a small income may be captive to a low-cost passenger transport mode such as the rickshaw or minibus if distance prohibits them from walking and capital outlay prohibits them from use of the cheapest of the personal transport modes, the bicycle. Aside from causing mode captivity, income versus cost is also one of the strongest factors in the balancing of values by the traveler comparing the relative merits of each mode.

Trip distance is also a strong factor in mode choice for the traveler in the LDCs. This factor, as well as mode type, affects energy expenditure, travel time, and protection from hot weather. The cost of these effects to the passenger is also often linked to trip distance, limiting the availability to the poor of these modes when they have to make long trips.

The availability and cost of passenger transport also have a strong bearing on the choice of mode. As in the developed nations, especially with fixed-route modes, transfer point proximity to both origin and destination and convenient scheduling are factors considered. These factors are less important in the case of the more flexible LCTMs, although for reasons of economics even these modes will still tend to congregate on the more highly frequented routes, and a premium may be paid for deviation from such routes.

The climate, terrain, and available infrastructure also affect the choice of mode. Poor weather conditions such as heavy rain or extreme heat or cold may inhibit the use of nonmotorized modes such as walking and cycling, putting a premium on covered passenger transport modes. Rough terrain and steep hills may also inhibit cycling, whereas poor roads may inhibit the use of motorized modes.

Finally, there are many cultural and historic factors that may enhance or inhibit certain mode choices. For example, religious beliefs may preclude any contact between women and unknown men in public, such as in bus use by women. Frequent past bicycle use by a family will enhance this mode

for other family members because of familiarity, availability, and past route choice experience. These effects may prove the most difficult to discern, especially for expatriate specialists with little knowledge of the customs and culture of the developing country.

KATMANDU EXPERIENCE

Background

Nepal is a small landlocked country completely surrounded by India and China. It is a very poor country with a per capita gross national product (GNP) of U.S. $160 in 1984, the seventh lowest in the world. Its economic base is mainly agricultural, which provides employment for 93 percent of the labor force (*18*). Motor vehicles and parts are not manufactured in Nepal and are imported at significant cost. In contrast, nonmotorized transport in the form of bicycles and bicycle rickshaws is often manufactured and repaired locally.

Nepal's 16.5 million inhabitants are mostly rural with only 7 percent living in urban areas. However, between 1973 and 1984 the urban growth rate was very high, 8.4 percent annually. Katmandu, with a population of 235,000, has approximately one-fourth of the urban population of the country and is the largest and principal city (*1*).

As with most LDCs, unemployment and poverty are prevalent in Nepal. There is a significant amount of both unemployment and underemployment, especially among the educated. Shah (*1*) reports that various surveys have found unemployment among the educated to be between 25 and 65 percent. Income statistics for Katmandu are not readily available; however, given a poor income distribution in combination with the extremely low per capita GNP cited, a fairly high level of poverty is apparent. In fact, between 40 and 60 percent of all households are considered poor (*2*). Unlike in most Asian cities, though, the poor in Katmandu have been relatively well dispersed spatially; therefore the city has, to date, avoided the usual problems with slums and squatter settlements (*1*).

Transportation: Description and Observations

The following description of the transportation system of Katmandu stems from two separate studies as well as the personal experience in Katmandu of the principal author. The first study was carried out by Tribhuvan University during 1984 to 1987 under the guidance of the principal author and was funded by the IDRC (*1*). The second study was a miniature traffic study conducted in 1988 (*2*).

The transport system of Katmandu is typical of low-income Asian cities, with a heavy emphasis on nonmotorized transport. Walking is the dominant mode; Figure 6 shows that 56 percent of daily trips were walking trips. Fortunately, as indicated earlier, the poor in Katmandu are relatively well dispersed and thus seem able to keep their travel distances short, a necessary condition for the pedestrian travel mode. Figure 7 shows the large number of trips shorter than 5 km; two-thirds of these trips are by walking.

As it is in most lower-income nations, bicycle use is minimal in Katmandu. This low use is due in part to the hilly terrain

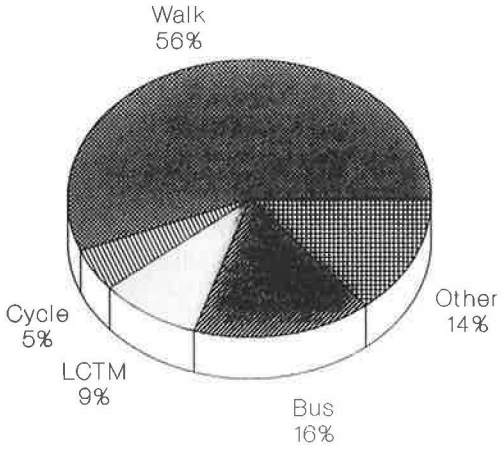

FIGURE 6 Mode split in Katmandu (percentage of total trips).

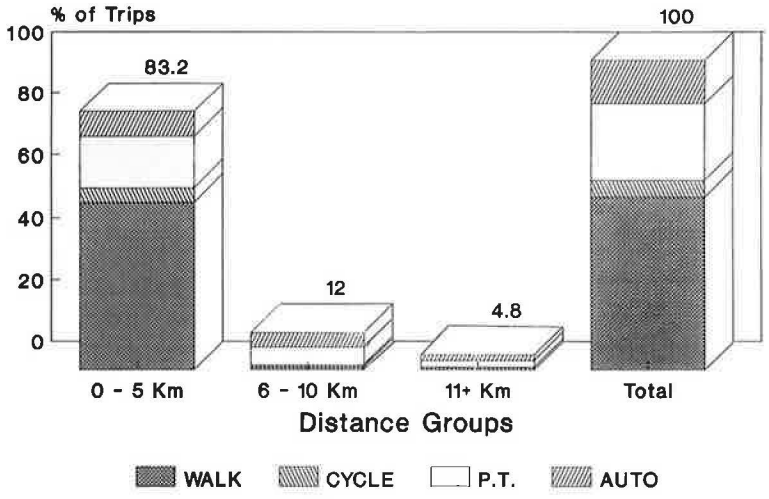

FIGURE 7 Trip mode split characteristics in Katmandu.

and in part to the low availability of bicycles. The hiring of bicycles is restricted somewhat by the lack of an identification system for clients. In addition, only 18 percent of all households own a bicycle, significantly less than in many other lower-income nations. Local production and access to financing may induce travel mode upgrading from walking to the more comfortable and efficient bicycling mode. There are two areas in which nontransport solutions may have significant impacts on travel patterns.

Other modes used in Katmandu are buses and LCTMs. These LCTMs include cycle rickshaws, tempos, meter tempos, and minibuses. Figure 6 shows the popularity of LCTMs and buses, with a total patronage of 25 percent of all trips. Figure 8 compares these two modes, indicating that the actual use of buses is higher than for other for-hire modes in relation to seat capacity. However, from a social perspective LCTMs provide employment to a greater number of people, resulting in additional social benefits.

Nepal is one of the poorest countries and nearly half of Katmandu's residents are poor. The effect of income on mode choice is shown in Figure 9. In addition, the dependency ratio is very high and incomes are very low. Under these circumstances, the majority chooses to walk or to use other, cheaper nonmotorized modes of transport.

Because of the hilly terrain and very cold climate during 6 months of the year, trip distances have a significant influence on mode choice, even by the poor. Figure 10 shows that walking is the predominant mode when trip length is less than 5 km. When trip length exceeds 5 km, there are major shifts to buses and other modes. In the range of 6 to 15 km, terrain, climate, and fatigue are major factors influencing mode choice. Beyond 16 km, walking is not a practical choice.

Conflict Mitigation and Capacity Enhancement

Traffic patterns in three specific areas of Katmandu were studied by the authors in 1988 (2). These areas were Bhotahity, Lainchaur, and Ratna Park. The map in Figure 11 shows these three areas in detail within the overall traffic network. The purpose of this study was to observe and analyze traffic volumes and modes during peak hours.

Bhotahity is an ancient inner city core with narrow streets that contain thriving retail businesses and much informal vending on the streets themselves. This area is quite typical of the many older cities in developing countries. The street widths from building line to building line are very narrow at 8.12 m. The retail market area is thriving, dynamic, and economically successful.

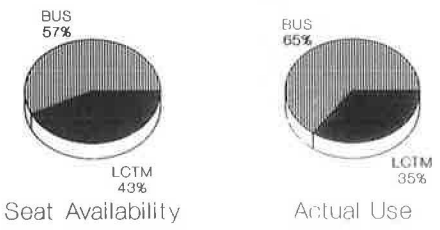

FIGURE 8 Passenger travel in Katmandu.

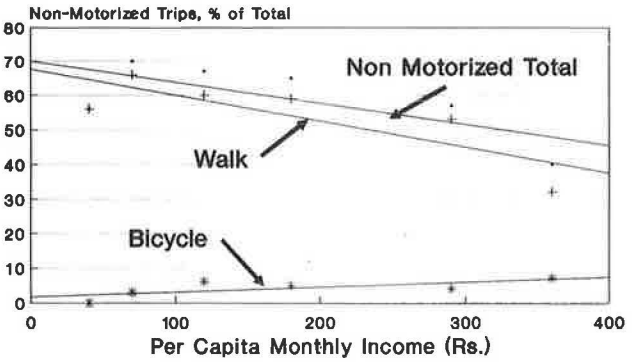

FIGURE 9 Mode choice versus income in Katmandu.

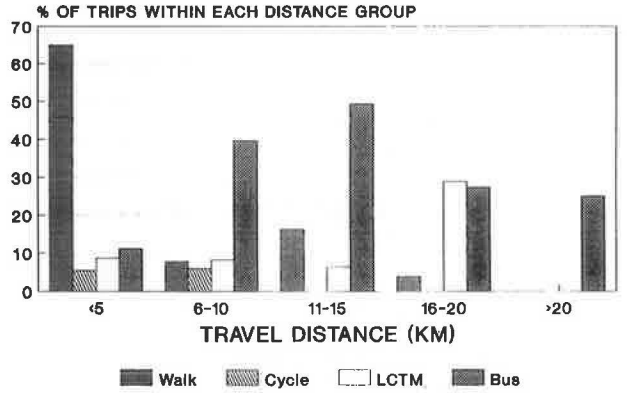

FIGURE 10 Distance versus mode choice in Katmandu.

Expansion of these streets to allow for all modes is economically prohibitive. As a result, instead of allowing motorized transport during peak periods at the expense of pedestrian capacity, motorized traffic has been restricted. From 8 a.m. to 8 p.m., only bicycles and pedestrians are allowed. Motorized personal vehicles are not permitted except when the owners live in the area. Goods vehicles are allowed access for delivery purposes. The result is a nonmotorized precinct allowing for relatively free and safe pedestrian and cyclist flow. Obstructions to capacity had been apparent, especially in the form of sidewalk vendors. The informal sector may have been a significant source of income to the poor, and enforcement of street vending restrictions could have proved to be difficult. In this instance, once the motorized traffic was removed, capacity was adequate for use of the street both as a nonmotorized traffic route and as a vending area constituting an integral part of the economic system. Creative interaction of transport and land use planning can optimize the use of the minimal infrastructure available in developing nations.

In Bhotahity, the number of cycle rickshaws, delivery vehicles, and personal motorized vehicles was small. The traffic consisted primarily of pedestrians and cyclists. The peak-period mode split is shown in Figure 12 and the pedestrian flows in Figure 13. Traffic flows were 5,015 pedestrians per hour and 286 bicycles per hour.

In the Lainchaur area, traffic counts were made on Kanti Path, an arterial street just outside the CBD. In Ratna Park, the counts were made on Ratna Park East and Ratna Park

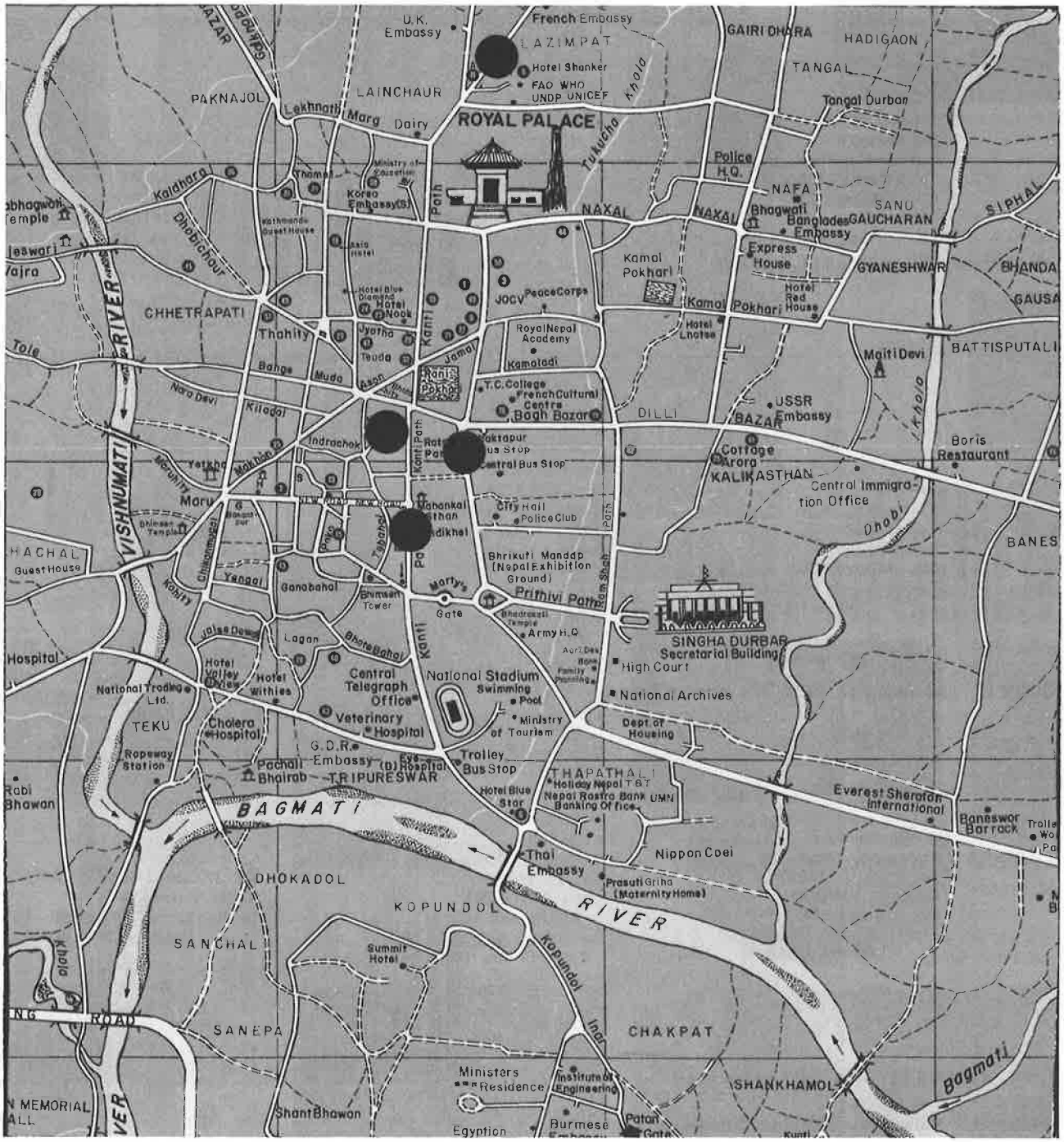

FIGURE 11 Map of Katmandu (areas studied indicated by ●).

West, two one-way streets designed originally as ceremonial streets. The locations of the counts are shown in Figure 11.

Mode split and traffic volumes for Lainchaur are shown in Figures 14 and 15. Similar data for Ratna Park are shown in Figures 16 and 17. On these two arterials, there are no capacity problems. However, visual observations suggest inefficient traffic controls; insufficient enforcement of pedestrian use of the vehicular roadway; and unregulated use of space at bus stops, tempo stops, and intersections. These problems can easily be rectified by normal traffic engineering practices, at the same time paying attention to all modes and person-trips.

Despite the fact that more than 60 percent of all trips in Katmandu were by nonmotorized modes, the arterials showed less than 15 percent of nonmotorized trips. This low number may indicate that nonmotorized traffic on other arterial routes is reduced by the use of nonmotorized precincts such as Bhotahity. The reduction of nonmotorized traffic on the arterial routes increases the capacity of these routes by reducing the effects of the slower cyclists on the speeds of the faster mo-

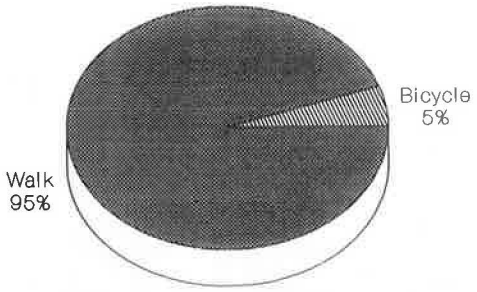

FIGURE 12 Mode split in Bhotahity.

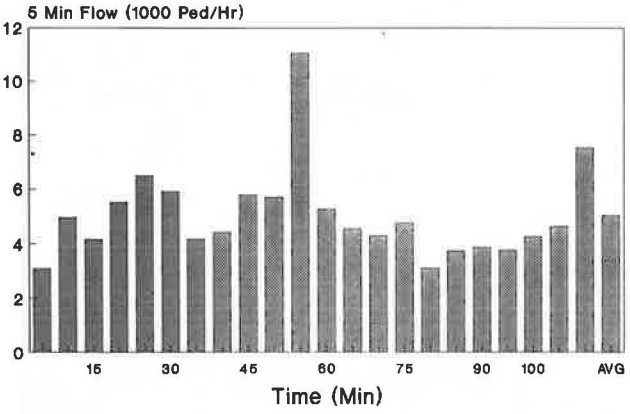

FIGURE 13 Five-minute pedestrian flow rates in Bhotahity.

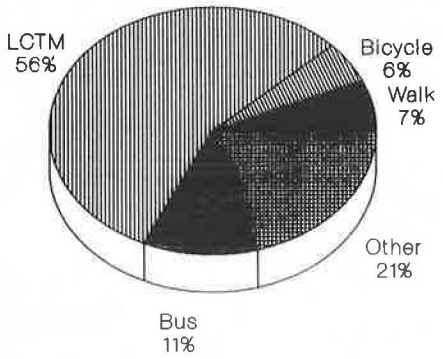

FIGURE 14 Mode split in Lainchaur.

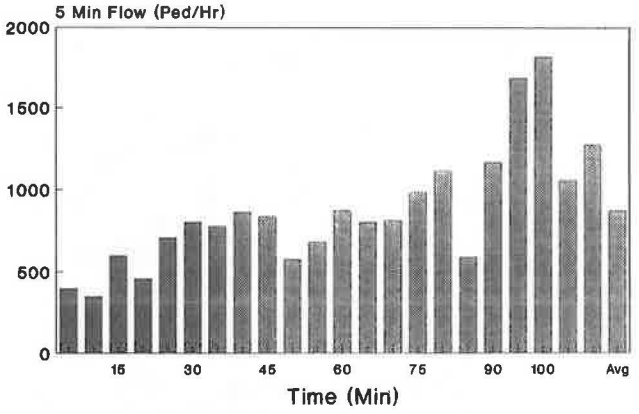

FIGURE 15 Five-minute pedestrian flow rates in Lainchaur.

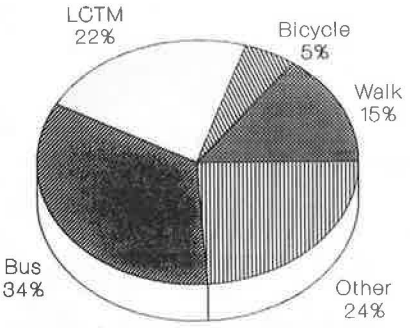

FIGURE 16 Mode split in Ratna Park.

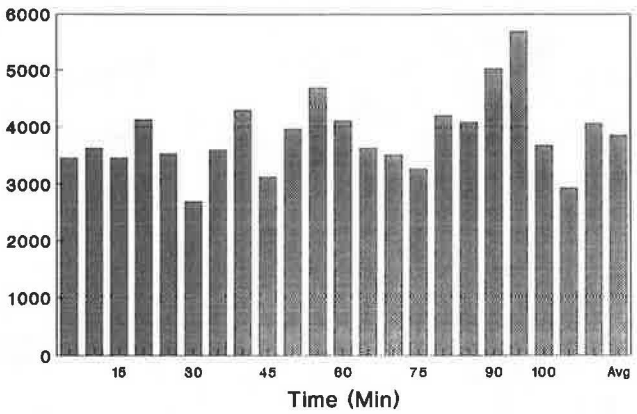

FIGURE 17 Five-minute pedestrian flow rates in Ratna Park.

torized modes, allowing for possible additional roadway width through smaller pedestrian flows, and reducing conflicts (Figure 18).

Such efficient use is possible only when planners focus on total person-trips (not on vehicles only) and allocate appropriate exclusive and mixed precincts for various modes. This allocation must be done by recognizing the important role of nonmotorized modes in developing countries.

CONCLUSIONS

The data and analysis presented here lead to several conclusions. The more important conclusions are as follows:

1. Developing countries and major international lending agencies have previously ignored the nonmotorized modes, particularly pedestrians, in planning and investment strategies. These attitudes appear to be changing as planners begin to recognize that a majority of the people in poor countries are dependent on nonmotorized transport, particularly walking.

2. Income is a major determinant of mode choice. Because rapid increases in personal incomes are not predicted for Katmandu, the majority will continue to walk.

3. It is unlikely that there will be a significant increase in bicycle trips in Katmandu because of the constraints of terrain and climate. Currently, the available bicycles are all single speed.

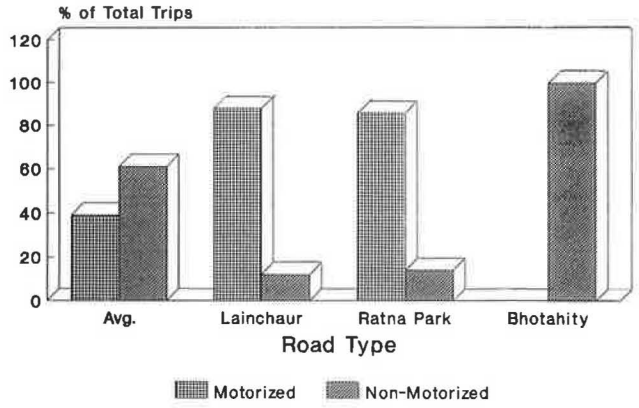

FIGURE 18 Mode separation effects in Katmandu.

4. The number of bicycle and cycle rickshaw trips in Katmandu is significantly lower than that in cities of similar size. This is attributed to terrain, climate, and cost versus income factors.

5. Although it is recognized that motorization will continue to increase, considering the predicted GNP and income increases for Nepal, it is estimated that motorized vehicles and motorized trips will remain proportionately insignificant during the next 20-year period.

6. Bus availability is a function of both regulation policies and urban transport investment (which is dependent on the strength of the national economy), especially when it involves foreign currency expenditures. Katmandu is likely to increase its bus fleet but unlikely to do so in substantially large measure.

7. Car ownership in Katmandu is now higher than it is in other Asian cities with similar economic status.

8. Fifty-six percent of all daily trips in Katmandu are by walking and another 5 percent are by bicycle. Other low-cost transport modes account for 9 percent of the total.

9. For trips of up to 5 km, walking is the mode choice for a variety of reasons including cost and unavailability of other cheap transport. Beyond 5 km, walking appears to be impractical even for the poor.

10. There is a pronounced shift from walking to public transport for trips longer than 5 km.

11. The public transport system is overloaded and there is an adequate supply of other for-hire transport.

12. Katmandu planners have successfully used exclusive pedestrian precincts within the CBD to relieve congestion, create additional capacity on other arterial streets by diverting pedestrians to these precincts, and achieve higher safety levels.

13. On certain arterials, apparent crowding may be the result of capacity obstructions such as trees and an unregulated mix of traffic including pedestrians; inadequate traffic controls; and unplanned bus, tempo, and taxi stands and stops.

ACKNOWLEDGMENTS

The authors are grateful to Sant Bahadur Guring, Director, and Arjun Shaw, researcher, both of the Center for Economic Development and Administration (CEDA), Tribhuvan University, Katmandu, Nepal, for their assistance and valuable comments. The detailed transport study by CEDA, coordinated by the principal author, was funded by the IDRC, whose interest and funding are also acknowledged. Particular thanks are due Lynn Thurston and François Belisle of the IDRC.

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Publication of this paper sponsored by Committee on Pedestrians.